DETECTING A

A sudden onset of harmful algal blooms (HABs) can poison fish, shellfish and other marine life, and pose a major threat to peopleís health and fishermen's livelihoods.
(Photo: F. Boisson/IAEA)

They are the seas' silent killers, toxin-laden patches of algae that amass along coastal shores and wreck havoc on marine ecosystems. They appear with no warning and outbreaks have become more frequent. Virtually every coastal country in the world has suffered from their effects.

These are harmful algal blooms (HABs), more commonly known as 'red tides' because their ominous presence is sometimes characterized by a massive red patch of water encroaching the shorelines. Often outbreaks are invisible and thus pose an even greater threat. HABs occur when colonies of algae—simple ocean plants that live in the sea—grow out of control and produce toxins that can poison fish, shellfish and other marine life, and pose a major threat to people's health and fishermen's livelihoods.

Not all algal blooms are harmful. In fact, most of them sustain marine life, providing a vital source of nutrients for a host of sea creatures. Certain algal species produce poisons called saxitoxins. When conditions are ideal – i.e., higher nutrients in water through coastal upwelling or agricultural runoffs - these algae can "bloom" and overpopulate, inevitably resulting in the release of massive amounts of toxin that kill fish and can accumulate in clams, mussels and shellfish, making them dangerous to eat. Paralytic Shellfish Poisoning (PSP), characterized by death through paralysis of the respiratory system, is one of the most common health threats from eating contaminated shellfish.

Despite its 'red' moniker, many outbreaks of HABs often do not discolour the water, or may have other colours like green or yellow. In fact, most blooms are difficult to detect with the naked eye. Undetected, the risk of spoiled fish harvests and/or contaminated sea products entering the human food chain increases many times over.

The global impact that HABs can have on human health, economies and the ecosystem, makes it one of the most serious, naturally occurring coastal problems in the world. As outbreaks of these poisonous blooms of algae become widespread and more frequent, the IAEA is stepping up efforts to help countries understand the phenomenon and use more reliable methods for early detection and monitoring so as to limit HABs' adverse effects on coastal communities everywhere.

Detection as the Best Form of Prevention

Early detection is key in HABs control. For decades, the conventional method to test for impending red tide events was through mouse bioassay.

by Rodolfo Quevenco

KILLER TOXIN

Scientists would inject toxin extracts from suspect algae or shellfish samples into a laboratory mouse and measure how long it would take for the mouse to die. The mouse bioassay method is considered to have a low sensitivity, and is not able to precisely pinpoint levels of toxicity.

A nuclear-based technique using receptor binding assay (RBA) is benign, quicker and much more precise. RBA works by mixing a shellfish sample with a 'marker' — in most cases, tritium-labeled saxitoxin — then exposing the mixture to a tissue sample. If the shellfish is contaminated, the poisons compete with each other to "bind" to the nerve cells of the tissue, with the radioactive toxin being displaced or "bumped off' its receptors by poison already present in the shellfish. By measuring the amounts or radioactivity left, scientists can then pinpoint exactly what the levels of toxic concentrations are.

RBA is thus a far more sensitive and precise measuring method, and the IAEA has long been spearheading efforts to widen its use among as many countries as possible. To this end, it has entered into partnership agreements with international organizations involved with HABS; it actively facilitates international collaboration on the use and advancement of RBA, and supports several regional and national projects.

Currently 23 IAEA Member States have active technical cooperation projects dealing with the monitoring and early warning of seafood toxicity using the RBA method. Several successful applications of RBA for HABs have been reported and documented in Chile, El Salvador, Namibia, and the Philippines, to name a few.

RBA Research and Deployment

Leading the IAEA's efforts on HABs is its Environment Laboratories in Monaco (NAEL). For years, the laboratory has been at the forefront of promoting the use of RBA for early detection and monitoring of HABs occurrences in Member States.

Philippine Nuclear Research Institute Director, Alumanda de la Rosa, says completion of major modifications to the receptor binding assay technique would enable the technology to be brought to the field. (Photo: D. Calma/IAEA)

Florence Boisson, a scientific consultant of the Principality of Monaco working at NAEL, believes the IAEA has a clear leadership role in delivering the benefits of the RBA to its Member States.

To further understand the paths used by the HABs toxin to enter seafoods, NAEL Monaco works with its Collaborating Centre — the Philippine Nuclear Research Institute (PNRI) — to apply RBA in field studies at selected aquaculture areas in the country. PNRI's pioneering work in RBA since the late 1990s, and the country's rich aquatic resources, makes it an ideal partner for research and development work. Experts are giving special attention to measuring the transfer and elimination of the biotoxin which causes PSP, and tracing the transfer of the toxin from the shellfish all the way up the human food chain.

With technical support from NAEL Monaco, the Philippines is also extending R&D work to modify the procedure and instrumentation — for example using iodine-125 instead of tritium and a gamma counter instead of liquid scintillation — which would allow the procedure to be performed in the field or in small laboratories in the coast. Analytic results would be quicker, and alerts of impending red tide events can be announced at a shorter notice.

PNRI, whose status as IAEA Collaborating Centre on HABs was renewed in July 2011, hopes to fin-

A fisherman in Sorsogon Bay in the Philippines sets out at dawn for the early morning catch.

(Photo: F.Boisson/IAEA)

ish major RBA modifications this year. When completed the technology will then be shared with other IAEA Member States through an IAEA technical cooperation project.

"It is an honour for the Philippines that our peers recognize the work that we have done in this area", says PNRI Director Alumanda de la Rosa. "We are also glad that our R&D strategies have become the model that other regions can use in studying their HABs problem."

Horizons of International Cooperation

In early 2011, IAEA and the US National Oceanic and Atmospheric Administration (NOAA) signed a practical arrangement formalizing their collaboration to provide technical assistance in the management of the impacts of HABs.

This announcement followed in the heels of a major meeting of an international scientific advisory committee on harmful algal blooms organized by the IAEA in March 2010. Held in Charleston, South Carolina, the meeting brought together international experts known for their expertise in the use of receptor binding assay for HABs.

The meeting reviewed reports on existing applications of RBA for HABs; addressed issues of supply for radio-labeled toxins; defined strategies for further development; and plotted the course for strengthened international collaboration among organizations involved with HABs. It was held as part of an IAEA inter-regional project (INT/7/017) to provide coordinated support for using RBA to address impacts of harmful algal toxins in seafoods.

One overall project aim is to build a support structure to allow countries to develop and implement strategies and programmes on HABs. Another is to upgrade regional capabilities in receptor binding assay through training and technology transfer.

As a part of the tripartite agreement between the IAEA, UNEP and UNESCO's Intergovernmental Oceanographic Commission (IOC), signed on 25 February 2011, a long-term collaboration began with the IOC to build countries' capacity to monitor HABs. This collaboration has already resulted in regional initiatives in Africa and Latin America aimed at strengthening these regions' capacity to monitor outbreaks of harmful algal blooms.

A direct offshoot of this international coordination is a *Manual of Methods for Harmful Algal Toxin Detection Using RBA*, due for issue in late 2011. A joint endeavor by the IAEA and NOAA, the manual will serve as a useful guide for developing countries wanting to use RBA for HABs. It is another step forward in the growing acceptance — and use — of RBA to help detect and forecast the location of harmful algal blooms.

Controlling the toxic menace from the sea will continue to be an elusive goal for years to come. Continued research in technologies like RBA are helping to bridge the gap in understanding the phenomenon of the 'red tide; and forewarning of its coming.

With health and livelihood in the balance, these are potent tools for countries that need them the most.

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