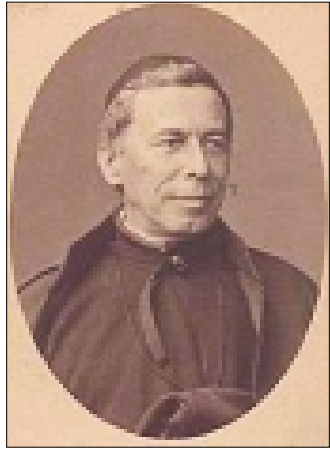


Measuring plant forms in the sea

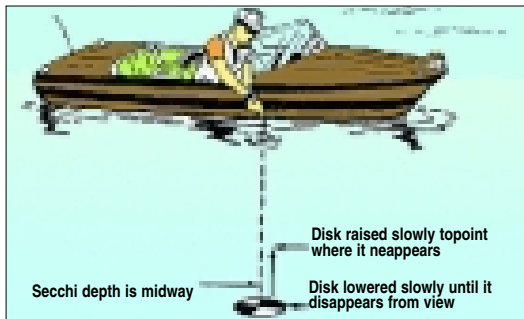
An Italian astronomer's device to help look into the depths is helping map global warming, says **S Ananthanarayanan**

SOME 50 per cent of the earth's vegetation consists of microscopic plant organisms that drift in the few hundred uppermost metres of our planet's oceans. As these organisms also account for about 50 per cent of all the photosynthesis, or the trapping of atmospheric carbon into carbohydrates with the release of oxygen, keeping a close watch on their abundance and health is as vital as monitoring the forest and green cover on the land masses.

Plankton are the animals, plants, bacteria and other single-celled creatures that inhabit the upper part of the open sea. The part of this community which uses light, with the help of chlorophyll, to convert carbon dioxide into plant matter are *phytoplankton*. Mostly, they are too small to be seen except through a microscope, but in large numbers they appear as a green shade in the water. Being living things that seek food and energy, they show a drifting behaviour, sinking to deep water in search of minerals and nutrients and rising to



Father Pietro Angelo Secchi, SJ.



the surface to make the best of sunlight. Hence the name — from *phyton*, or plant, and *planktos*, or wanderer.

Various measurements indicate that the phytoplankton abundance has been declining over the last century. This has implications for marine ecosystems, carbon cycling and fishery yields the world over. This apart, the phytoplankton level can serve as a sensitive indicator of ocean warming and other conditions that bring about the changes. Hence the interest and effort and urgency for careful observation and monitoring.

Methods of assessment include analysis of samples of seawater by spectrometric

methods or by irradiating the sample and then watching for fluorescence of the suspended plant material. But a faster method to cover large areas is either by measuring the transparency of seawater or the amount of light reflected by the sea.

This last method, of measuring the light reflected by the sea using satellite imaging, is now the most productive. But the data through this route has been collected only after 1979, which is not enough for long-term analyses. Fortunately, there is a supplementary resource of reasonably accurate transparency data available right from 1899, through surveys of the transparency of the sea that used a simple device called the *Secchi disk*.

Pietro Angelo Secchi

Father Pietro Angelo Secchi, SJ, was a versatile priest-astronomer-scientist of Italy who lived from 1818 to 1878. He joined the



Working with the Secchi disk.

Jesuit order of Roman Catholic priests at the age of 16 and showed great scientific ability. He had a successful academic career and rose to be director of the observatory of the Pontifical Gregorian University in Rome, for 28 years.

His work in astronomy was extensive — he compiled data of more than 10,000 binary stars, he discovered three comets, including one that is named after him as *Comet Secchi*, he observed and drew maps of the moon, Mars and the surface of the sun, he did important work with the spectra of stars and developed a first system of classifying stars.

Apart from his work in astronomy, Fr Secchi also contributed to physics, meteorology and oceanography and made a mark in this third field with his simple device, the Secchi disk, for measuring transparency of seawater.

The Secchi disk

In 1865, Fr Secchi was asked to map the clarity of the Mediterranean Sea for the Papal navy. This is when he invented the simple contraption, just a black and white coloured circular disk which is lowered into the water by a rod or a line till it is no longer visible. The depth at which this happens was taken as a measure of clarity or opacity.

This simple measure, which came to be known as the Secchi depth, became the unit

for innumerable oceanography investigations for nearly a century. But more interestingly, the Secchi depth is readily converted into a measure of the abundance of phytoplankton, the chief reason for the opacity of seawater. The oceanographic records of the past century thus become a valuable history of the rise and fall of phytoplankton, across the world and over a long, continuous period.

The modern method of satellite imaging uses the level of sunlight that is reflected from the earth. Here, there is first the reflection of light by the atmosphere and then the reflection from the surface of the sea, which need to be accounted for before the relatively feeble reflection, because of seawater opacity, can be assessed. But the satellite method has the benefit of fast and accurate spectroscopic analysis and also the capacity to assess levels of not just phytoplankton but other organisms as well.

Daniel G Boyce, Marlon R Lewis and Boris Worm of Halifax, Canada, have reported in the journal *Nature* a review of satellite data, in conjunction with the record of Secchi depth measurements, to plot the variations on plankton levels at local, regional and global scales over the last century.

The review reveals a strong correspondence between the phytoplankton, and hence chlorophyll record, and the changes in both the leading climate indices and conditions of ocean temperature. The study also shows a statistically significant long-term decrease in chlorophyll concentrations for eight of the 10 ocean basins, as well on an overall basis.

This finding is also consistent with the satellite observation of ocean colour, which indicates that the fall in indices of phytoplankton productivity corresponds to increases in ocean warming. This is a grave feature in a world that faces warming, as phytoplankton is basic to the food chain and productivity of the sea.

The current methods of satellite-based assessment are still affected by many factors, such as limited life spans of satellite observation posts and the need to standardise the kind of instrumentation required. There is then the matter of cost and complexity and competing demands on science funding by states. The work of Boyce and others may help ensure that this area of investigation does get the attention it merits.

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of its cervical cancer vaccine, Cervarix by 60 per cent in the Philippines and gained a 14-fold increase in volume sales. Further, it proposed the establishment of an LDC patent pool for neglected tropical diseases and donated 13,500 compounds for malaria vaccines into it.

Slowly, other companies are following suit. Sanofi-Aventis recently announced it was halving the price of its diabetes drug, Lantus, and cancer treatment, Taxotere, in Indonesia and the Philippines. The Japanese firm, Eisai dropped its price for Aricept, an Alzheimer's treatment in six Asian countries. Other companies are experimenting with base-of-pyramid models that seek to boost sales. Novartis' Arogya Parivar model sells medicines in smaller, more affordable pack sizes. The jury is still out on whether or not these new approaches deliver systemic change and whether companies are adopting a "serve" rather than "capture" market strategy; but at least the issue of access to medicines is no longer viewed at arm's length.

More needs to be done on the issue of IP rights — the sacred cow of the pharmaceutical industry. Governments in developing countries continue to go head-to-head with Big Pharma in battles over compulsory licensing and patent legislation that protect public health. There are serious misgivings on whether IP rights are actually an effective incentive for drug development, especially with regard to medicines relevant to diseases in developing countries, given the current dearth of R&D into these diseases.

New models are being tested. Unitaids' patent pool for Aids medicines, for example, allows generic companies to make cheaper versions of patented medicines by creating a common space for patent-holders to license their technology in exchange for royalties.

Ultimately, generics remain the current frontrunner at delivering affordable medicines. Formulating policies that enable generic competition whilst capturing most value from the branded pharmaceutical industry will require creative, dynamic approaches that emphasise the collective imperative.

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Up in smoke

Agonising migraines had Marie Summers in a 'prison of pain', until she overcame inhibitions about using illegal cannabis. The result seemed like a miracle

TELL someone you suffer from chronic migraine and you're unlikely to get sympathy in scale to the pain you suffer. Tell them you've got chronic migraine-causing neuro-deficit, plus a small cavernoma with venous angioma and you will understandably get a blank stare. This collection of words is woefully inadequate at conveying the pain that has systematically dismantled my brain and disabled my body, but they are all I have without resorting to illustrations.

I'd suffered from worse than average migraines my whole life but gradually throughout my 20s the pain and frequency intensified. A couple of years ago I began to realise there was no longer a gap between attacks. My brain slipped into a loop, migraine begetting migraine, pain creating more pain, and nothing could stop the juggernaut of my malfunction. Despite heavyweight preventative medications (each with its own difficult side-effects), mid-2009 my daily migraine became more sinister. I'd lived in constant pain for so long that I expected nothing better; what I did not anticipate was the rest of my body rebelling as well. Suddenly I couldn't walk, and it wasn't because I was in pain — it was because my legs were simply randomly unable. When I tried to force myself, I began to shake and jerk like a leaf caught in a storm, then I usually lost consciousness. I couldn't focus on reading and writing or long conversations and any movement made me unmanageably nauseous. I was nearly always unable to get out of bed, in and out of hospital, but we kept coming back to the fact that migraines were doing this to my brain. If migraines continue to run amok within me, they will progressively destroy my quality of life and, significantly, shorten it.

It's difficult to describe what living within a broken body feels like without sounding as if it's a call for pity. Pity is not what is wanted, understanding is. When pain is a constant, sickness and weakness creeps into every corner of your self and your mind begins to lose memories or words, you feel a wasted human husk. All the potential you once had seems a shadow, your beauty ephemeral and faded. You begin to feel a liability to those you love.

In what felt like a moment of madness, I Googled the medicinal effects of cannabis on migraines and related neurological conditions. What I found was a surprise, and almost an unwanted one at that. I didn't want to read how effective it could be, because I didn't want to feel compelled to try something I'd once done for an illicit pleasure.

I've been trained to expect my medicine to be extremely unpleasant and, like the Victorians were with sex, if I'm enjoying it I must be doing something wrong. After reading arguments for and against, I decided that trying cannabis had significantly less risk of side-effects than nearly every other prescription drug I had already legally tried, but with less of a "hit and miss" approach to the matter. I, like most chronic pain sufferers, am strongly advised not to take any pain relievers, from morphine to paracetamol, because they cause rebound pain and significantly compound the problem. When modern medicine sentences you to a lifetime of pain with little hope for a cure this simply adds insult to injury. Medical evidence shows that cannabis almost certainly does not cause rebound pain; in this it is almost unique among viable pain relief medicines. The opportunity to break the cycle chipping away at my brain seemed to be presenting itself; I still had to decide if I was brave enough to break the law at the advanced parental age of 31.

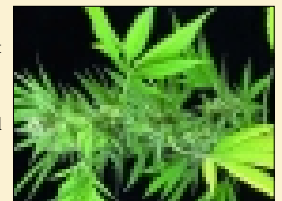
Taking my inspiration from Bertrand Russell, who said that "one should, as a rule, respect public opinion in so far as is necessary to avoid starvation and to keep out of prison, but anything that goes beyond this is voluntary submission to an unnecessary tyranny, and is likely to interfere with happiness in all kinds of ways", I reflected on the aspect of staying out of prison. This is of crucial importance to me, not for my own sake (I can be sick anywhere) but for my young son's. Once I resolved that I was prepared to fight any charge that might be brought upon me in the event I was caught with cannabis, the decision had made itself.

After managing to find some marijuana, it sat unused and hidden in a far corner of the house. I continued to suffer as before, but I'd lost my courage. I remembered being high as a teenager, and I didn't want to be like that again. I didn't want to lose control of myself amid a roomful of sober adults. My internal battle waged for four weeks. Finally one night when the pain became too extraordinary, it was either try the pot or go and be scanned in case I'd had an aneurysm. In my hospital-jaded and exhausted state, I finally opted for the pot, reasoning that if it was an aneurysm it would still be there afterwards, but if not I'd feel better and save myself an unnecessary trip.

Within minutes of taking a small amount of cannabis there was not an inch of my body in pain, and my tremors had stopped. My body felt at peace, and I don't think I can ever convey the enormity of that to anyone. Nothing hurt or felt wrong. I was still weak, but I could move with as much ease and grace as I used to. Yes, I was intoxicated, but it was I had two weeks of this beautiful cure, and every day of those two weeks I became stronger. I was able to take up activities long abandoned and sorely missed. The excitement my husband and I felt was palpable. If I took it slowly, I was nearly normal and every minute my brain was taken out of its loop it was being allowed to recover. Personally, this is a joy, but in the bigger picture it could be an economic blessing.

Marie Summers is a pseudonym.

The Independent, London



Cannabis "will induce loss of any concept of time for approximately two hours. Full beneficial effects will continue for 24 hours".

Best of both worlds

IT has been a challenging decade for the pharmaceutical industry. With a high number of patent expiries, pipelines drying up and intensifying competition from generics, branded pharmaceuticals have been hemorrhaging value. At the same time, traditional markets are becoming saturated. Stark realities in industrialised countries — such as the impact of ageing populations on tax-based social healthcare and employer-funded models — are leading governments towards regulatory regimes that demand more economical, value-based and transparent drug pricing.

Under these circumstances, emerging markets present a new frontier. Originally attractive for their offerings of low-cost production, consumers in developing countries now present a viable market to multinational corporations. The pharmaceutical industry has been eyeing this trend for a while. A recent study predicts that 17 "pharmarming" countries — including India, Indonesia, Pakistan, Thailand and Vietnam — will "in aggregate expand by \$90 billion during 2009-2013" (IMS, "Pharmarming Shake-UP: New Imperatives in a Redefined World" (2010), accessed at http://www.healthcarepackaging.com/archives/2010/03/emerging_economies_represent_p.php)

However, many emerging economies are still developing countries where a large portion of the population is poor and those who are not remain vulnerable to falling below the poverty line in times of crises. Healthcare is financed largely out of pocket — up to 60 per cent in Asia — and many countries shoulder a "triple disease burden" of "old" diseases like tuberculosis and malaria, new infectious diseases like Influenza A (H1N1) and a "silent pandemic" — The World Economic Forum's 2010 Global Risks Report uses this particular phrase to describe the rapid overtaking of infectious diseases by chronic diseases as the world's biggest killers — in the form of non-communicable diseases such as diabetes and cancer. The challenges around access to medicines remain critical and, indeed, relevant

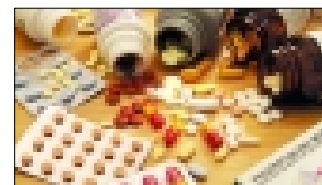
The pharmaceutical industry needs creative, dynamic approaches that prioritise both social responsibility and free-market competition, writes **Sumi Dhanarajan**

to the industry's business model.

Philanthropic approaches to the problem have achieved little systemic change. Drug donations by companies have been criticised as being mostly unsustainable. Often, the medicines are unsuitable for patients, unfamiliar to local prescribers, do not match national clinical guidelines, or are near expiry. As supplies can be unpredictable, they have the potential to create chaos in the market as they prevent accurate quantification of needs and affect forward planning. They also have an overarching negative effect of undermining market competition — even generics cannot compete with free medicines. Price discounts have, to an extent, been more effective, though limited by their focus on specific high-profile diseases and least developed countries.

The access to medicines movement has posed three key demands of the pharmaceutical industry: a) pricing schemes that systematically address challenges around affordability that are transparent; b) investment in research and development relevant to the diseases affecting developing countries as well as into medicines suitable for resource-poor contexts (for example, heat-stable formulations or fixed combination drugs); and c) a flexible approach towards intellectual property rights and support for developing country governments' use of related public health safeguards, in recognition of the role generics play in vastly reducing medicine prices.

Leading companies are starting to understand how integrating these concerns into core business practices may well hold the answer to sustainable long-term profitability in emerging markets. Reliance on the traditional blockbuster model that targets the



At a time when branded pharmaceuticals are hemorrhaging value, transparent drug-pricing is the need of the hour.

elite is proving unfeasible and short-sighted. For starters, it limits the size of the consumer base. More importantly, the model's dependence on aggressive defence of patents and high profit margins, in order to generate the all important \$1 billion per annum, detracts companies from serving target markets effectively by providing products that are relevant, affordable and accessible. Many argue that perverse incentives created by the model have discouraged innovation. Finally, governments in developing countries are beginning to prioritise healthcare and are seeking cost-efficient outcomes as well as the means to effectively manage disease burdens. In these countries, building access to medicine concerns into the core business models becomes vital to securing the social license to operate.

At the end of 2008, one company attempted to tread a new path. The chief executive officer of GlaxoSmithKline unveiled a four-point plan that included a commitment to cap prices for patented medicines in LDCs at 25 per cent of the price in the developed world. In middle-income countries, prices closely reflected a country's ability to pay, for example, GSK cut the price