Corso di formazione alla sostenibilità per dottorandi fruitori di borse di studio finanziate dalla Regione Piemonte

2° ciclo – 4 ottobre 2006

Il linguaggio visivo nella comunicazione scientifica
dalla certezza alla complessità

Alice Benessia

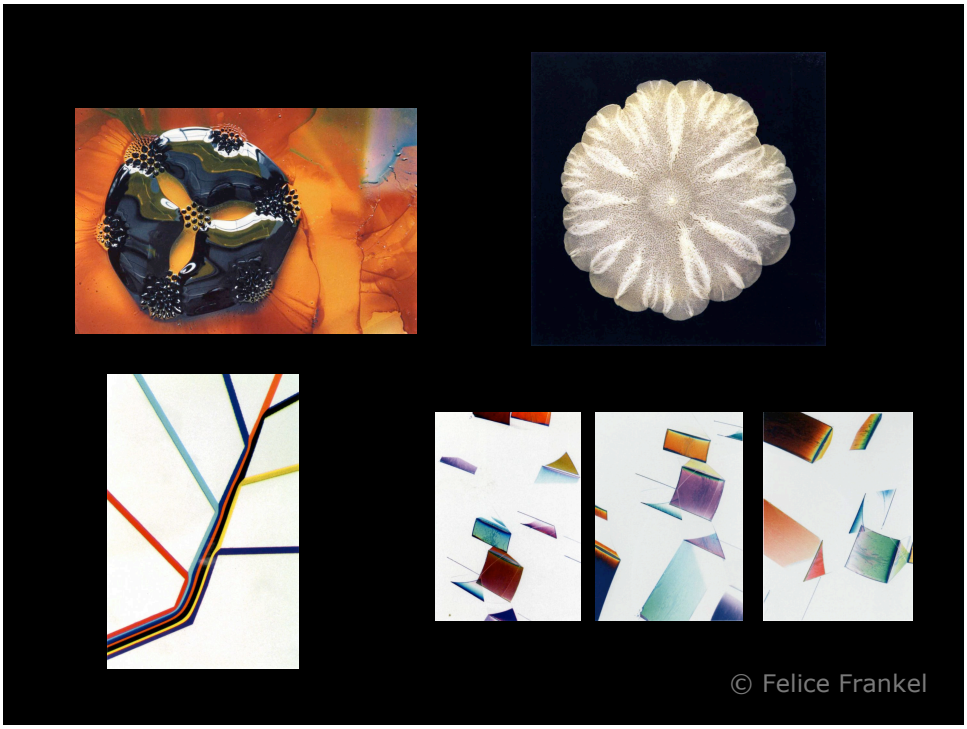
Centro Interdipartimentale IRIS
Istituto di Ricerche Interdisciplinari sulla Sostenibilità
Università di Torino, Università di Brescia
www.iris.unito.it

QUALITA' qualis - modo di essere, proprietà, natura	QUANTITA' quantum - ciò che può essere misurato o numerato
processo	prodotto
assunto estetico	assunto antiestetico
visione dinamica	visione sinottica
sfera dei valori (etica)	sfera della conoscenza (epistemologia)
paradigma olistico sistemico	paradigma riduzionistico
soggettività (agente)	oggettività
sfera emotiva	neutralità
intuizione	ragionamento analitico-deduttivo (relazione lineare causa-effetto)

"Le nostre immagini di mondo non sono mai già date. Scaturiscono dal processo conoscitivo. Da interazioni dinamiche, da *accoppiamenti generativi tra filtri creativi e vincoli esterni*, che mettono al mondo qualcosa che prima non c'era: le nostre immagini appunto." (Manghi 2004)

"Io credo, e lo dico sul serio, all'esistenza di un legame tra la mia 'esperienza' e ciò che accade all'esterno e che influisce sui miei organi di senso, ma non tratto questo legame come se fosse ovvio, bensì come cosa misteriosa, che richiede molto studio." (Bateson, 1989)

Prove e metafore della *certezza*



2005 VisualizationChallenge

Some of science's most powerful statements are not made in words. From the diagrams of DaVinci to Hooke's microscopic bestiary, the beaks of Darwin's finches, Rosalind Franklin's x-rays, or the latest photographic marvels retrieved from the remotest galactic outback, visualization of research has a long and literally illustrious history. To illustrate is, etymologically and actually, to enlighten.

You can do science without graphics. But it's very difficult to *communicate* it in the absence of pictures. Indeed, some insights can only be made widely comprehensible as images. How many people would have heard of fractal geometry or the double helix or solar flares or synaptic morphology or the cosmic microwave background if they had been described solely in words?

To the general public, whose support sustains the global research enterprise, these and scores of other indispensable concepts exist chiefly as images. They become part of the essential iconic lexicon. And they serve as a source of excitement and motivation for the next generation of researchers.

The National Science Foundation (NSF) and *Science* created the Science and Engineering Visualization Challenge to celebrate that grand tradition—and to encourage its continued growth. In a world where science literacy is dismayingly rare, illustrations provide the most immediate and influential connection between scientists and other citizens, and the best hope for nurturing popular interest. Indeed, they are now a necessity for public understanding of research developments: In an increasingly graphics-oriented culture, where people acquire the majority of their news from TV and the World Wide Web, a story without a vivid and intriguing image is often no story at all.

We urge you and your colleagues to contribute to the next competition, details of which will be available on NSF's Web site (www.nsf.gov), and to join us in congratulating the winners.

Susan Mason of NSF organized this year's challenge; Carolyn Gramling of *Science*'s news staff wrote the text that accompanies the winning images displayed in the following pages; and *Science*'s online editor Stewart Wills put together a special Web presentation at www.sciencemag.org/scienceVis2005. In addition, Graham Johnson, who won first place in the Illustration category, is profiled on *Science*'s Next Wave (www.nextwave.org).

Curt Suplee, Director, Office of Legislative and Public Affairs, NSF
Monica Bradford, Executive Editor, *Science*

PANEL OF JUDGES
(left to right)

Gary Lees
Chair and Director,
Department of Arts as Applied to Medicine
Johns Hopkins University
Baltimore, Maryland

Thomas Lucas
Thomas Lucas Productions
New York, New York

Felice Frankel
Research Scientist,
Massachusetts Institute of Technology
Cambridge, Massachusetts

Donna J. Cox
Professor, School of Art & Design
University of Illinois, Urbana-Champaign

Michael Keegan
Assistant Managing Editor, News Art
The Washington Post
Washington, D.C.

Published by AAAS

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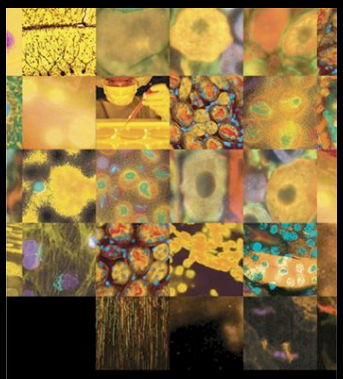


Emission Peak 585–595nm	EX	EM
ATTO-TAG™ FQ	486	591
BODIPY® 581/591	582	590
DsRed2 (Red Fluorescent Protein)	558	583
Lissamine rhodamine B	570	590
LysoTracker® Red	577	592
Resorufin	570	585
Rhodamine B	555	580
Rhodamine Red™	570	590
SpectrumOrange®	559	588
Tetramethylrhodamine (TRITC)	555	580

www.visions-of-science.co.uk

As Subhanu Saxena, President & CEO of Novartis Pharmaceuticals says,

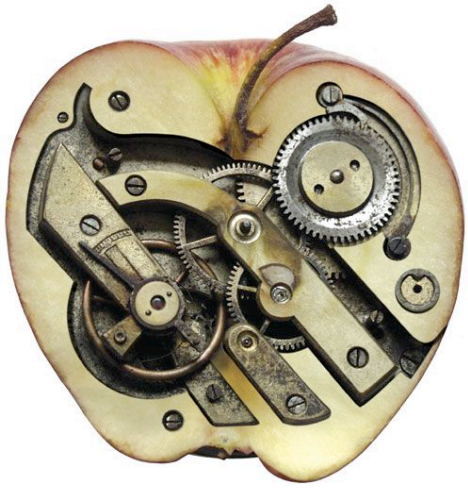
"Visions of Science is one of the only public competitions to encourage links between science and the arts with the specific aim of stimulating public interest in science.

This image represents how farming is increasingly relying on advanced modern technology to improve yields and efficiency.

The sheep in the cyberfield made me laugh; a lovely original idea.

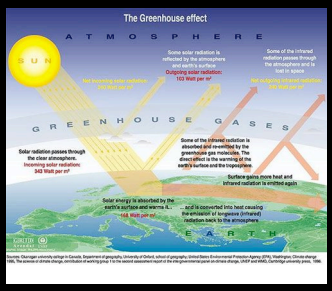
This image was created to show one of the possible applications of nanotechnology in medicine in the future - microscopic machines roaming through the body, injecting or taking samples for tests.

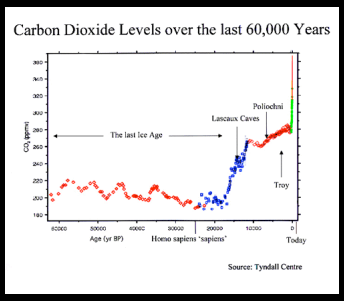
Brilliantly done. The red blood cells are convincing, and the 'nano-louse' with its pincers and in-built syringe cleverly conveys the idea of nano-medicine.

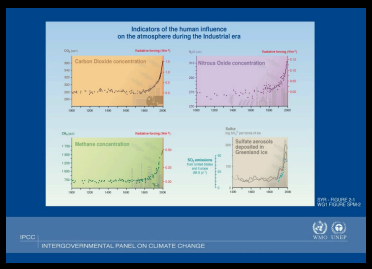


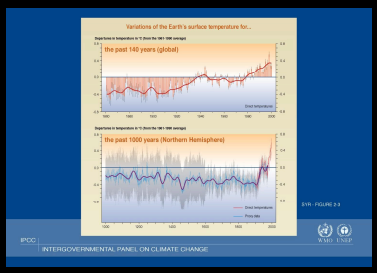
Viktor Koen's clockwork apple was intended as a visual metaphor for **the principle of emergence in complex systems, as an expression of the saying "The whole is greater than the sum of the parts."** The apple illustrated a review by Keay Davidson of the 2005 book A Different Universe: Reinventing Physics from the Bottom Down, by physicist Robert B. Laughlin, published in the New York Times Book Review June 19, 2005. The review notes that Laughlin's discussion of emergence employs a visual analogy—the dabs of paint in impressionist paintings, which organize into familiar shapes when viewed from a distance. The choice and crafting of a visual metaphor or analogy can be an analytical process as well as an aid to communicating ideas.

Prove e metafore della *complessità*



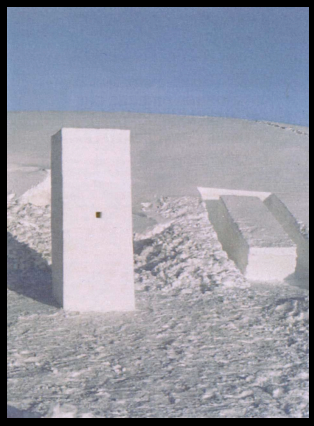






WORLD VIEW OF GLOBAL WARMING
The Photographic Documentation of Climate Change
1999-2005 GARY BRAASCH

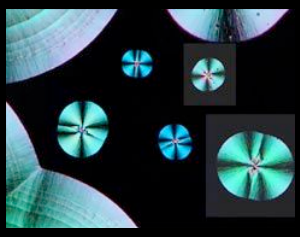
http://www.worldviewofglobalwarming.org/index.html

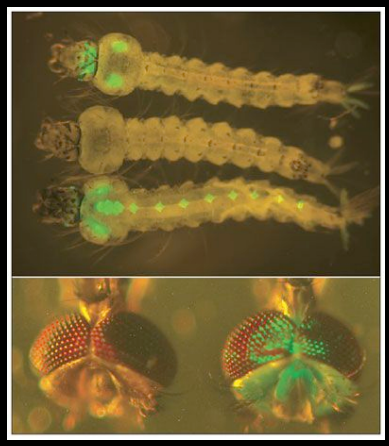


CAPE FAREWELL
Artic Expeditions
2003-2005 DAVID BUCKLAND

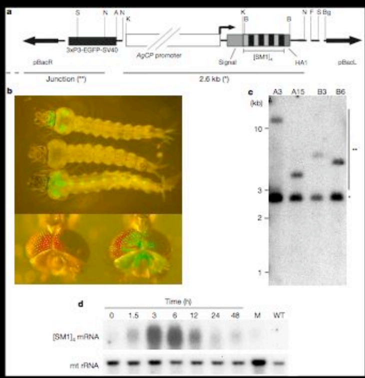
www.capefarewell.com

©Antony Gormley, Peter Clegg © Gautier Deblonde ©Heather Ackroyd and Dan Harvey





Oltre la *certezza*
DDT e zanzare GM



Acknowledgements

We thank the patients for contributing to this study; Y. Terado for discussions on immunohistochemistry, K. Tachampa and J. Y. Kim for help in characterization of URAT1; A. Toki, M. Takahashi and M. Ikeda for technical assistance; and Merck Research Laboratories for providing losartan and EXP-3174. The anti-URAT1 polyclonal antibody was supplied by Trans Genic Inc. (formerly Kumamoto Immunochemical Laboratory). This work was supported in part by grants from the Japanese Ministry of Education, Science, Sports, Culture and Technology, Grants-in-Aid for Scientific Research, and High-Tech Research Center, the Science Research Promotion Fund of the Japan Private School Promotion Foundation.

Competing interests statement

The authors declare that they have no competing financial interests.

Correspondence and requests for materials should be addressed to H.E. (e-mail: endouh@kyorin-u.ac.jp). The sequences of URAT1 cDNA and protein have been deposited under GenBank/EBML/DDBJ accession number AB071863.

Transgenic anopheline mosquitoes impaired in transmission of a malaria parasite

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† *These authors contributed equally to this work*

Malaria is estimated to cause 0.7 to 2.7 million deaths per year, but the actual figures could be substantially higher owing to under-reporting and difficulties in diagnosis[1]. If no new control measures are developed, the malaria death toll is projected to double in the next 20 years[1]. Efforts to control the disease are hampered by drug resistance in the *Plasmodium* parasites, insecticide resistance in mosquitoes, and the lack of an effective vaccine. Because mosquitoes are obligatory vectors for malaria transmission, the spread of malaria could be curtailed by rendering them incapable of transmitting parasites. Many of the tools required for the genetic manipulation of mosquito competence for malaria transmission have been developed. Foreign genes can now be introduced into the germ line of both culicine[2,3] and anopheline[4] mosquitoes, and these transgenes can be expressed in a tissue-specific manner[5,6]. Here we report on the use of such tools to generate transgenic mosquitoes that express antiparasitic genes in their midgut epithelium, thus rendering them inefficient vectors for the disease. These findings have significant implications for the development of new strategies for malaria control.

When a mosquito ingests a blood meal from an infected host, *Plasmodium* gametocytes transform into gametes that mate and differentiate into zygotes and then ookinetes (elongated motile zygotes). Ookinetes cross the midgut epithelium and differentiate into oocysts, which after 10–15 days liberate sporozoites into the haemocoel. The development of the parasite in the mosquito is completed when sporozoites cross the salivary gland epithelium[7]. The mechanism by which the parasite crosses the mosquito epithelia is unknown, but is suspected to be receptor mediated. *In vivo* selection from a library of bacteriophages displaying random 12-amino-acid peptides led to the identification of a peptide—PCQRAIFQSICN (termed SM1 for salivary gland- and midgut-binding peptide 1)—that binds specifically to the two epithelia that are traversed by the parasite: the distal lobes of the salivary glands and the lumenal surface of the midgut[8]. Significantly, SM1 strongly inhibited crossing of the two epithelia by the parasites[8]. These results suggest that if SM1 is produced and secreted into the mosquito gut lumen when an infectious blood meal is ingested, then *Plasmodium* development would be blocked.

We searched for a system to drive the expression of genes that inhibit *Plasmodium* development, and found that the carboxypeptidase (CP) promoter and signal sequence has many desirable attributes. The CP promoter is strongly activated by a blood meal, and the CP signal sequence drives secretion of the protein into the midgut lumen, where the initial stages of *Plasmodium* development take place[5,9]. We constructed a synthetic gene (termed *AgCP[SM1]₄*) consisting of four SM1 units joined by 4-amino-acid linkers attached to the CP signal sequence and driven by the gut-specific and blood-inducible CP promoter (Fig. 1a). This gene was inserted into a *piggyBac* vector and transformed into the germ line of the mosquito *Anopheles stephensi*[4]. Of 394 embryos injected, 63 (16.0%) larvae hatched, yielding 33 (8.4%) adults. The adults were distributed into 14 families, of which 2 (families A and B) yielded green fluorescent protein (GFP)-positive progeny (Fig. 1b). Progeny from two separate mosquito lines from each family were analysed by Southern blot hybridization (Fig. 1c). The results indicate that each of the four lines originated from a different integration event. Northern blot analysis indicated that the *AgCP[SM1]₄* transgene is rapidly and strongly induced by a blood meal in midguts of transgenic mosquitoes with a peak around 3–6 h (Fig. 1d). This pattern is consistent with that previously observed for genes driven by the *Anopheles gambiae* CP promoter[5,9]. We investigated the synthesis of the *AgCP[SM1]₄* protein by the midgut epithelium by immunofluorescence microscopy. The recombinant protein was detected in the midgut epithelium of mosquitoes dissected at 6 h (data not shown) and 24 h (Fig. 2) after a blood meal, but by 36 h the signal had declined to close to basal level (data not shown). Because ookinetes invade the midgut epithelium

Table 1 Inhibition of oocyst formation in transgenic mosquitoes

Experiment	Oocyst prevalence*	Oocyst intensity†	Inhibition (%)‡
1. Control	80 (16/20)	80.8 (0–273)	–
B6	53 (9/17)	25.3 (0–186)	68.7
2. Control	86 (18/21)	70.3 (0–225)	–
B3	37 (7/19)	7.3 (0–40)	89.6
3. Control	94 (17/18)	63.8 (0–365)	–
B3	35 (7/20)	7.2 (0–80)	88.7
4. Control	89 (17/19)	64.9 (0–292)	–
B3, B6	41 (9/22)	3.3 (0–19)	94.9
5. Control	89 (17/19)	132.6 (0–328)	–
B3, B6	54 (14/16)	26.8 (0–105)	79.8
6. Control	89 (17/19)	95.1 (0–290)	–
B3, A3	50 (11/22)	22.1 (0–85)	76.8
7. Control	90 (18/20)	83.4 (0–285)	–
A15	33 (7/21)	9.6 (0–98)	88.5
8. Control	90 (18/20)	129.0 (0–250)	–
A15	45 (10/22)	34.0 (0–134)	73.6
9. Control	86 (19/22)	115.2 (0–292)	–
A15	70 (16/23)	30.3 (0–101)	73.7
Average			
Control	88.1 (17.4/19.8)	93.1 (0–365)	–
Transgenic	46.4 (10.0/21.3)	18.5 (0–186)	81.6

For each experiment, transgenic mosquitoes and sibling control (non-transgenic) mosquitoes from the same rearing were fed simultaneously on the same mouse, which was infected with *P. berghei* ANKA 2.34. A3, A15, B3 and B6 indicate the transgenic lines used in each experiment (Fig. 1c). Where two lines are indicated, a mixture of mosquitoes from those lines was used. All transgenic lines were kept as heterozygotes and mosquitoes were fed on mice with 10–15% parasitaemia and 1–1.5% gametocytaemia. Mosquitoes were kept at 21 °C and the number of oocysts per midgut was counted on day 15 after feeding.

* The per cent mosquitoes that had oocysts in their midgut. This value was derived from the number of oocyst-positive mosquitoes over the total number of mosquitoes examined (shown in parentheses).

† The mean oocyst number per midgut. The range of observed values is indicated in parentheses. In all cases, transgenic mosquito values were significantly different ($P < 0.05$) from those of controls, as analysed by the Mann–Whitney *U*-test.

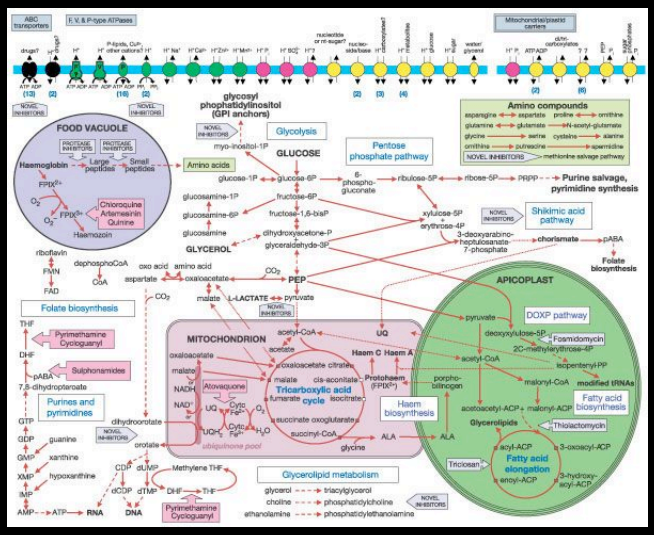
‡ Reflects the reduction in the mean oocyst number in transgenic mosquitoes relative to control mosquitoes.

- 10 % popolazione mondiale soffre di malaria
- 36-40% popolazione è esposta al rischio di contagio
- 3 milioni di vittime all'anno
- 90% vittime in Africa, *Plasmodium Falciparum*, i più colpiti sono i bambini sotto i 5 anni.
- ogni 30 secondi un bambino muore di malaria in Africa (Novartis).

- Anni '50 e '60 programma annientamento con uso massiccio del DDT: decrescita.
- Dagli anni '70 agli anni '90: recrudescenza, fasi alterne
- Dagli anni '90 ad oggi: grave recrudescenza, mortalità raddoppiata.

Fattori socio-ambientali

- urbanizzazione massiccia con carenza di servizi sanitari,
- aumento numero dei rifugiati
- aumento irrigazione per agricoltura industriale (export),
-costruzione dighe, canalizzazioni
- deforestazione
- aumento malnutrizione
- difficoltà di accesso ai servizi di cura
- aumento del business di contraffazione dei farmaci
- cambiamento climatico globale
- resistenza vettore agli insetticidi chimici
- resistenza del parassita a terapie antibiotiche


FOOD VACUOLE
Haemoglobin
Large peptides
Small peptides
Haemozoin
Chloroquine
Artemesinin
Quinine
GLUCOSE
Glycolysis
Pentose phosphate pathway
glycosyl phosphatidylinositol (GPI anchors)
Amino acids
Amino compounds
Purine salvage, pyrimidine synthesis
Shikimic acid pathway
chorismate
pABA
Folate biosynthesis
GLYCEROL
PEP
L-LACTATE
pyruvate
APICOPLAST
DOXP pathway
Fosmidomycin
isopentenyl-PP
modified tRNAs
Fatty acid biosynthesis
Thiolactomycin
Triclosan
Fatty acid elongation
MITOCHONDRION
Tricarboxylic acid cycle
Haem biosynthesis
Protohaem
Haem C
Haem A
UQ
Atovaquone
Glycerolipid metabolism
Folate biosynthesis
Pyrimethamine
Cycloguanyl
Sulphonamides
Purines and pyrimidines
RNA
DNA

"…questa soluzione potrebbe permettere, una volta regolate le implicazioni etiche ed economiche, di liberare rapidamente il mondo dalla malaria."

Matthew W. Hahn, Sergey V. Nuzhudin, *The fixation of malaria refractoriness in mosquitoes", Current Biology, Londra, 2004.*

"Il progresso, nella maggior parte delle nuove tecnologie, utilizza un modello che non è mai cambiato dal XIX secolo - prima si ottimizza la tecnologia, poi si verifica l'accettazione da parte degli utilizzatori e alla fine vengono esaminati tutti i regolamenti inerenti la sua utilizzazione. Visti gli investimenti fatti nelle prime fasi, diventa difficile modificare una tecnologia anche quando, in momenti successivi, si riscontrino effetti sociali potenzialmente nocivi. Di conseguenza, di fronte ad una nuova tecnologia, chi decide è obbligato a difenderla,una risposta gestionale tecnocratica di fronte alla quale potenziali conseguenze negative sulla società o sull'ambiente, individuate al di fuori del puro processo concettuale, sono considerate alla stregua di problemi di accettazione da parte degli utilizzatori."

Tom Wakeford,
"Democratising Technology: reclaiming science for sustainable development", 2004

September 16, 2006

W.H.O. Supports Wider Use of DDT vs. Malaria

By CELIA W. DUGGER

WASHINGTON, Sept. 15 — The World Health Organization on Friday forcefully endorsed wider use of the insecticide DDT across Africa to exterminate and repel the mosquitoes that cause malaria. The disease kills more than a million people a year, 800,000 of them young children in Africa.

The health organization's news release quoted Senator Tom Coburn, Republican of Oklahoma. "Finally, with the W.H.O.'s unambiguous leadership on the issue, we can put to rest the junk science and myths that have provided aid and comfort to the real enemy - mosquitoes", said the senator, a medical doctor.

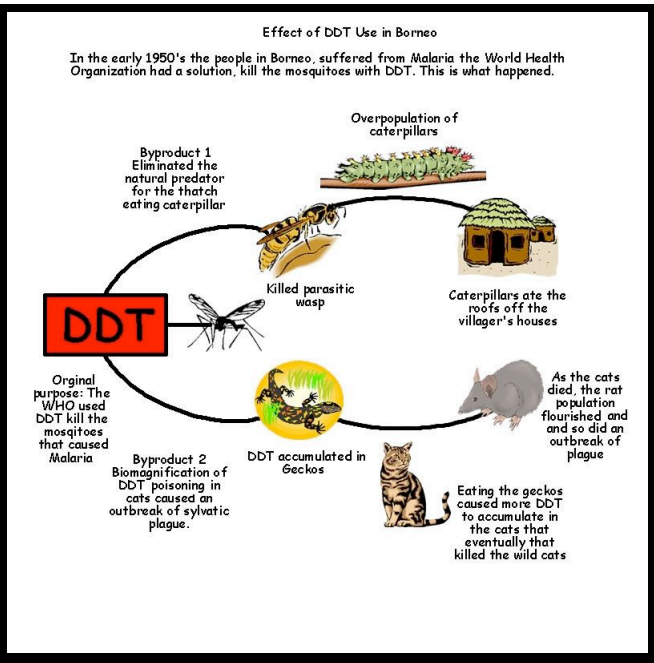
DDT has carried a special stigma since the publication in 1962 of Rachel Carson's "Silent Spring", which helped set off the environmental movement in America by documenting how mass spraying of DDT entered the food chain, causing cancer and genetic damage and threatening to wipe out some bird species, including bald eagles.

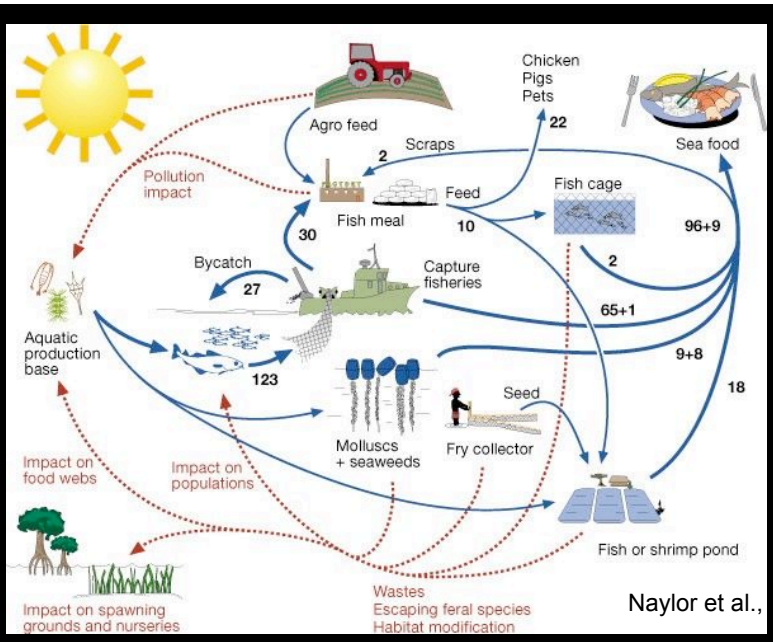
Dr. Kochi said he himself did not worry about whether he would lose his job if he took on too many influential players. Success will require many difficult changes, he said. "I don't want to fail."

Parachuting cats into Borneo! A Cautionary Tale.

In the early 1950's, the Dayak people of Borneo suffered a malarial outbreak. The World Health Organisation (WHO) had a solution: to spray large amounts of DDT to kill the mosquitoes that carried the malaria. The mosquitoes died; the malaria declined; so far so good. But there were unexpected side effects. Amongst the first was that the roofs of the people's houses began to fall down on their heads. It seemed that the DDT had also killed a parasitic wasp which had previously controlled thatch-eating caterpillars. Worse, the DDT-poisoned insects were eaten by geckoes, which were eaten by cats. The cats started to die, the rats flourished, and the people were threatened by outbreaks of typhus and plague. To cope with these problems, which it had itself created, the WHO was obliged to parachute 14 000 live cats into Borneo. Operation Cat Drop, now almost forgotten at the WHO, is a graphic illustration of the interconnectedness of life, and of the fact that the root of problems often stems from their purported solutions.

(Quoted in Rachel Wynberg and Christine Jardine, *Biotechnology and Biodiversity: Key Policy Issues for South Africa,* 2000)





Naylor et al.,

Excess of objectivity

Nature itself - the reality out there - is sufficiently rich and complex to support a science enterprise of enormous methodological, disciplinary and institutional diversity. …Science, in doing its job well, presents this richness…that can legitimately support a range of competing value based political positions."

….

Put simply, for a given value based position in an environmental controversy, it is often possible to compile a supporting set of scientifically legitimated facts.

D. SAREWITZ "How science makes environmental controversies worse"

NAIROBI, KENYA, BARACCOPOLI DI MUKURU KAYABA, APRILE 2002
I bambini che giocano con l'acqua di un canale di scarico sono il bersaglio preferito delle zanzare portatrici di malaria

CHERI SAMBA
Lotta contro le zanzare, 1989

The Calcutta Chromosome
by Amitav Ghosh
A previously unpublished interview by **Paul Kincaid**, conducted in July 1997.

… **Paul Kincaid:** What first attracted you to the story of the research into malaria?
Amitav Ghosh: I used to pass the Ronald Ross memorial in Calcutta several times a week and it kindled my interest both in malaria and in Ronald Ross. About ten years ago I had a bout of malaria myself and it had a profound effect on my thinking about the human body and its relationship with disease. Malaria was a strange and hallucinatory experience, but not at all frightening. In fact it was in an odd way very comforting. Then an anthropologist friend of mine, an Englishman, who was working with a tribe in a remote and mountainous part of Orissa (in Eastern India) told me that the people of this tribe thought of malaria as a friend and a protector - a barrier against the encroachments of plainspeople and other strangers. When I began to look into the history of malaria I found that the disease has historically been a fairly benign one: it took very few lives. This has changed over the last couple of decades. Malaria has mutated in response to new drugs and has become a really deadly killer: statistically it is now the single most deadly disease in the world. In other words science has succeeded in making the malaria situation much worse than it ever was.

… **Paul Kincaid:** Do you think local people with their empirical knowledge could, or would, have directed research the way you present?

Amitav Ghosh: Ross's work made such a huge splash because it 'proved' the connection between malaria and mosquitoes. Ross deserves a great deal of credit for this because his work was indeed a very elegant piece of research. but in effect much that he 'proved' was already well known amongst common folk in India and Africa. Ross's *Memoirs* clearly show that he used folk knowledge in advancing his work. His real achievement then, lay in translating folk knowledge into the language of science. Clearly local people were well ahead of Ross in their knowledge of malaria. But would they have directed research in the way I present? Look at it this way: Ross made a major breakthrough in science based upon a very partial acquaintance with folk knowledge. It follows, surely, that someone who was better acquainted with that knowledge would do even better, especially if they happened to pick up a fluency in the language of science.

Di fatto, paradossalmente, malgrado l'esplosione della comunicazione e delle fonti di informazione, il mondo in cui viviamo ci è largamente sconosciuto. Non già nel senso degli esploratori e viaggiatori del passato, ma sempre meno percepiamo i rapporti e le interazioni dei fenomeni in atto in sfere diverse.

Ignatio di Ramonet, Le Monde Diplomatique, L'Atlante