A ROUND TABLE ON SCIENCE , LETTER AND ART

NIC'S CORNER

FROM THE STARS TO THE MIND

Globalisation – a biological and cultural challenge

Natura, enim simplex est (Newton)

SUMMARY

Globalisation is an anti-entropic process peculiar to living organisms, and right now it is promoting the expansion of living matter all over the planet. Increased organization and complexity, with a concomitant decrease in entropy, is the ruling mechanism of this process, which is increasingly taking on the characteristics of a universal biological law. In prehistoric times globalisation made itself felt in the domains of "culture", and was in fact instrumental in the evolution of *homo sapiens.* Violation of biological and cultural niches (ecosystems) by humans has led to various past and present epidemics – plague, AIDS, Ebola, BSE, etc. – and could well cause further harm in the future. In some circumstances globalisation can induce opposite reactions, varying in their violence and duration (antiglobal movements). Their very nature needs to be reconsidered in the light of the law of complexity. Globalisation and the law of complexity are universal in dimension, and are likely to regulate not only the planetary but even the cosmic expansion of life.

Globalisation and antiglobalisation are two of the buzz-words of our times, forever bandied around by the press, radio and TV. No day passes without the mass media bombarding us on this subject, generating ample confusion by taking sides indiscriminately. A scientist's viewpoint seemed timely, to cast some light, however dim, on the topic.

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Even before what we call prehistoric times all forms of life must surely, directly or indirectly. have travelled around, crossing natural frontiers. The modern edition has been graced with the pompous definition of *globalisation.* The migration of men and other animal species, to explore and conquer territory, is a typical expression of a planet-wide tendency of all living matter[1]. This process is accompanied by a growing level of organisational complexity[2], hence a decrease in entropy[3].

Globalisation is more than a purely human or earthly phenomenon: it is a universal biological law, as documented by the arrival on earth of primordial life forms borne on meteorites or comets from the depths of the cosmos [4]. Although typical of the biological sphere, globalisation has spread now to culture, even dictating its development. The impulse of globalisation spares no living thing, not even plants or microorganisms – viruses, bacteria, fungi or protozoa. It sometimes spreads by indirect routes, using appropriate biological or atmospheric carriers: pollens and seeds carried by insects or the wind; germs, bacteria and viruses in the form of mist-like aerosols, or whipped along in dust or sand clouds raised by the wind.

Homo sapiens has been the main instrument in this spread, with trade and migrations, sharing culture and knowledge, through science and technology. Peoples understand each other better, either in their own written and spoken languages, or using "dominant" languages such as ancient Greek, Latin, English, Mandarin Chinese, or Hindi, and cultural exchange leads to cross-fertilisation. The use of Latin as a *lingua franca* and people's freedom to travel between the cities and states were key factors in the development of the Renaissance, fostering the rapid and comprehensible dissemination of information[5]. Without this globalisation of language and logistic-cultural exchange we would never have seen the impressive advances we enjoy today in technology and science.

Yesterday's events are repeating themselves today, in modern key. The two factors giving impulse to developments are the spread of English as an "international" language, and freedom to roam, even without moving, telematically: not only are words bartered, or people shifted, but ideas are exchanged through the Internet.

Both biological and cultural evolution involves forces pushing in opposite directions, often creating niches that are sided off from the main trend and environmental context, and may wrongly be interpreted as defending biodiversity. In these biological niches life proceeds in small steps and there is little opportunity for exchange with the surrounding world. Some parameters seem even to be independent, for instance, some seem to move slower (consider the Galapagos

Islands). Likewise, there are cultural niches in which whole ethnic groups life a prehistoric life – or something close to it – far removed from modern lifestyles (consider Australian aborigines, Indios in Amazonia, and others).

If a biological niche unexpectedly collides with the modern world, the encounter may be dangerous. Health and hygiene problems can arise, their disastrous consequences spanning the planet (Ebola virus, AIDS, etc.). If the collision involves a cultural niche there may not only be health problems but political and social questions too, with no easy answer.

Globalisation itself can sometimes arouse opposing reactions, varying in their violence and duration. These antiglobal reactions[6] are becoming frequent in modern society, and need reexamining in the light of the law of complexity.

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For millions of years innumerable hordes of primordial life forms –viruses, bacteria, fungi, protozoa – have lived together symbiotically or in competition with other organisms. It is anything but simple to survive this horde, with its high levels of aggressivity, enormous variety and ability to adapt. From a range of chance possibilities, animals of the higher orders developed an original defense system: the immune response. On one side of the barrier, therefore, we have the inexhaustible capacity for mutation of the bacteria and viruses, while on the other we have admirably adaptable immune systems that spend their time relentlessly building up models of resistance, to pass on to coming generations. The match is uneven and the outcome far from guaranteed. There are synergisms and antagonisms, interactions with a hostile environment, and with animals carrying lethal germs.

Until culture started to spread, man was slave to biological evolution and had no means of defense against infection other than his body's own resources. The price was in fact high: infantile mortality was heavy, puerperal infections frequent, and gangrene and septicemia were often the outcome of accidents while collecting food, hunting, or fighting off fierce predators; bacterial and viral gastrointestinal and respiratory infections were also certainly all too familiar to our ancestors. Those few who survived transmitted priceless immunity to various afflictions to their descendents. Thus new equilibria were established between mankind, germs and animals, in ecologically protected niches. Some of these states of balance lasted decades, some centuries or even millennia, and probably some are still around today.

Together with a lack of nourishing food and an adverse climate, these negative

factors would certainly have relegated human beings to some secondary niche, with scant opportunity for competition and even scantier chances of affirming themselves over more efficient predators. Fortunately, however, an unexpected turn led our brains to develop, with the resulting extensive cognitive activity. *Homo sapiens* made his appearance, and culture followed. This was very shortly to subjugate biological evolution.

Once fire was tamed, techniques and arts knew no limits. The relations between men, germs and animals changed, and the ground was ready for the progress in hygiene and healthy eating habits that has lengthened the average lifespan of modern man[7]. This led in a fairly short time to a widening of the gap between the animal/plant world and that of man, as he rapidly scaled the cultural ladder. The two systems moved at different paces: the biological world followed nature's leisurely rhythms, while the cultural world raced ahead. The former strolls in steps of thousands or even millions of years, while the latter bounds in months or years. The gap is still growing, and the two systems seem inevitably to be getting further and further apart.

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As he learned to domesticate animals man's contacts with them became closer. The price he paid was in terms of hitherto unknown diseases, that are endemic to animals. More than eighty infectious diseases - *zoonoses* - can be transmitted from animals to man, and many may be life-threatening; they may be caused by bacteria, viruses, fungi, protozoa, parasitic worms, arthropods and other organisms[8]. There is a clear phylogenic link between zoonoses and human diseases. The measles virus comes from cattle plague and the word was once used to refer to tapeworm infection in dogs and pigs; the smallpox virus is genetically related to a pox virus that afflicts domestic animals; the Mycobacterium tubercle bacillus came from a bovine disease in Africa; the Mycobacterium that causes leprosy is a mutation of a rodent parasite *(M. lepraemurium),* and the list is long. The "black death" – once known in Italian as the *peggior malattia* from the Latin *peius* – arrived in Europe after having crossed the high plains of Asia where it had been confined to rodents.

A long list of pestilences raced through the ancient world, finally reaching the Empire of Justinian (542 A.C.). There was a peak in the late Middle Ages, when trade and transport really got moving, and there were waves of mass migration, stretching the capacities of the cities. All these factors, combined with often disastrous conditions of personal and urban hygiene and with poor nourishment, laid the foundations for the rapid spread of the plague throughout the West. The black and brown rats predominant in the temperate zones and seaside areas were the main

carriers.

Although they could not understand the dynamics of the epidemic, it did not take people long to realise that an infected person and his belongings could be a source of disease, and they started taking serious – though belated – measures to improve hygiene. Old documents depict a terrifying scenario: people fleeing the cities in terror, taking the disease with them; others barricading themselves in their homes, but too late; yet others who march in long purification processions, winding through alleys and squares carrying flaming torches and playing pipes, drums and strident instruments, blind fear finding a sort of extreme exorcism in the mindless noise and the flare of the torches. Medieval man had no way of knowing that this crazed behaviour had at least the effect of chasing the rats back to the sewers, maybe even helping keep infection at bay.

Once the plague was over and the pathogen had been identified – *Pasteurella pestis*, or *Yersinia pestis*, from A. Yersin (1863-1943) – the danger seemed to have been conquered. Unexpectedly, however, at the end of the First World War, an epidemic of black death broke out in Manchuria, spreading to the gates of India. The World Health Organisation soon found the cause. The local population, starving and desperate, had taken to hunting marmots for their fur and flesh. These animals, however, were carriers of the microorganism and also had fleas, which soon carried the infection to humans. Once again man had upset a balance that had been stable for centuries, by violating a biological niche.

Not so many years ago another outbreak of plague was reported near Bombay in India; then another, in the Rocky Mountains in America. They all repeated the drama of the Middle Ages, though in modern key.

Zoonoses are an ever-present latent risk to public health. Every now and again they bare their teeth in the least likely ways. The latest is perhaps the originally unknown infection caused by human immune deficiency virus, HIV, that has had dramatic consequences in man, causing AIDS. Violation of nature's purity and globalisation have been blamed, to explain the origins and mode of transmission[9].

Various biological niches shelter ancient viruses that have survived thousands – maybe millions – of years in an immune host species, whose habitat is virtually untouched by man. If these isolated areas are violated for some reason – for example, the forests are cleared to make way for plantations and roads - many species that live in trees and at ground level have to move closer to humans. Woodcutters and agricultural workers are easy prey to hitherto unknown viruses, against which they have no defenses. Infection is then transmitted by oro-fecal or

sexual contact to relatives and other people living with them, to friends, or even to casual acquaintances. Like a stream in flood the infection will spread beyond its borders, along the main routes of communication: rivers, roads and highways, and airports all become conduits for the disease. Sailors, drivers and tourists, willy-nilly, will help trigger far-reaching epidemics, as has happened with AIDS.

The impact of zoonoses on public health varies from one case to the next, and there is no general rule. Some infections have a long symptom-free phase – HIV can have a latency of 5-10 years – which facilitates their transmission through unprotected sex or contact with blood (transfusions, infected needles). These have a dramatic impact, as we have seen with the steep rise in cases of AIDS in many countries, especially Africa and Asia. The Ebola, Marburg and Lassa viruses are more infectious through contact with blood, but less dangerous for the community [10]. The infection progresses so fast that patients generally die in a short time, before the disease can spread beyond their immediate contacts.

The influenza virus is endemic in many animal species, from birds to pigs, and is a true zoonosis. It is believed to be transmitted to man when it arrives periodically from Asia, either with migrants, or carried on the wind, or even on the wings of little birds. The various strains of virus mutate easily, continually changing their structure; they shift from one host to another, acquiring fresh genetic material. This process of continuous transformation makes the virus more virulent, and enables it to dodge most immune defenses. These interactions between germs and animals are what give rise to epidemics of fatal disease: the so-called “Spanish flu” took more than twenty million lives, in three waves – more than the whole world war.

Crossing frontiers and global expansion – globalisation as it might be called nowadays - is altogether routine for biology, though not without its risks. The consequences may be serious every time we upset long-standing balances by violating ecosystems. Many pestilences have afflicted mankind in ancient and more recent times[11]; others – such as AIDS - are devastating the modern world, and yet more may well do so shortly: examples are BSE, and the molecular diseases[12], [13]. These plagues are just unfortunate accidents along the path of globalisation, which has been going on for a long time on our planet – from its very beginnings.

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[2] Paul Davies, *The Cosmic Blueprint*, Simon and Schuster, New York (1989); *The last three*

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[3] Ilya Prigogine, *La nuova alleanza,* Longanesi, Milano, 1979; *La fine delle certezze*, Bollati Boringhieri, Milano, 1997

[4] Bruno J.R.Nicolaus and Rodolfo A. Nicolaus, *Lo scrigno oscuro della vita – Riflessioni sul ruolo chimico-biologico della materia nera interstellare e sulla comparsa della vita nell'universo*, Atti Accademia Pontaniana, Naples (1999), XLVIII, 355-380

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[6] B. Mandelbrot, *The fractal geometry of nature*, Wiley, San Francisco, 1982.

[7] Bruno J.R.Nicolaus, *L'arca di Noè; le invenzioni della natura e della cultura*, Collana Prometheus 21 (1995), Franco Angeli ed. Milano (1996).

[8] Michael J. Pelczar Jr., Roger D. Reid, *Infectious diseases of animals*, in Microbiology 3rd Ed., McGraw-Hill (1972).

[9] HIV is a retrovirus originating in central Africa where it is carried by monkeys, which have a silent form. It became virulent when it was exported to the USA, and has spread from there, in two highly pathogenic forms, throughout the world.

[10] These retroviruses cause hemorrhagic fever, which is fatal in 80% of cases. It is apparently endemic in certain monkeys, and man can catch it by eating their flesh.

[11] Tuberculosis, leprosy, syphilis, rabies, anthrax, smallpox, chickenpox, cholera, plague, measles, German measles, parotitis, scarlet fever, poliomyelitis, meningitis, tetanus, diphtheria, trachoma, Herpes, malaria, schistosomiasis, filariosis, tripanosomiasis, leishmaniasis, and many others: A. Cockburn, *The evolution and eradication of infectious diseases,* Johns Hopkins Press, Baltimore (1963); R. Dubos, *The evolution of infectious diseases in the course of history,* Canad. Med. Ass.J. (1958) LXXIX, 445-451; W. McNeill, *Uomini e parassiti, una storia ecologica,* Ed. Il Saggiatore (1993).

[12] To the list of classical viral diseases we must add the diseases caused by prions (proteins with no genome) such as scrapie in sheep, bovine spongiform encephalopathy – BSE – in cattle and its human variant, and FSE in cats.

[13] Bruno J.R.Nicolaus, *Malattie molecolari*,, paper read at the Accademia Pontaniana, Naples, 28 June 2001, in press in Atti Accademia Pontaniana, Quaderno 34 (2002).

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