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FEATURE ARTICLE

PANDEMICS – FROM ANCIENT TIMES TO COVID19. SOME THOUGHTS

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Since the dawn of civilization, there have been epidemics and pandemics. They are, in reality, an unintended consequence of civilization. Prehistoric societies (our ancestors), surely have been affected by diseases, but they had few opportunities to exchange germs outside their own culture since the earliest humans lived in small isolated bands. The condition shifted drastically when, about 10,000 years ago, the agricultural revolution replaced a nomadic, hunting-gathering society, with a sedentary lifestyle. Here we present our views on the causes of pandemics, the human and natural causal factors, review some hallmarks of regional / global diseases from history, while in outbursts we recall the theory of complexity from the non-linear human cultural evolution.

1. NATURAL VS ACCIDENTAL / INTENTIONAL AGENTS. THE ANTHROPIC VALUES

When humans started living in confined spaces (castles, acropoleis, villages, and particularly cities), they had to struggle to surmount on a larger scale with infectious diseases. They've been doing so since then. COVID-19 is just the latest in a long historical pandemic sequence. Knowing and perceiving properly how people reacted in the past helps understanding future challenges and prepare them out. This is after all the ultimate role of archaeology and archaeometry together, delving in the past cultures to unveil the lifestyle from human remains and reconstruct human past; together with sister history, both aid considerably present and future trend of humanity.

A pandemic (from Greek πάν pan "all" and δήμος demos "people") is an outbreak of infectious disease that occurs over a wide geographical area and that is of high prevalence, generally affecting a significant proportion of the world's population, usually over the course of several months. Pandemics, especially those involving influenza, sometimes occur in waves, so that a post-pandemic phase, marked by decreased disease activity, may be followed by another period of high disease prevalence (Porta 2008; Encyclopedia Britannica).

The cause of a pandemic today is by, a) unintentional natural (human, animal, environmental, extra-terrestrial) agents, b) intentional manipulated and targeted spread of artificial viruses (e.g. biological warfare), c) accidental during laboratory experiments.

Throughout history there have been a number of pandemics of diseases, namely, smallpox, cholera, typhus, leprosy, tuberculosis (https://www.mphonline.org/worst-pandemics-in-history/). Current pandemics include HIV/AIDS and the 2019 coronavirus disease. Other notable pandemics include the 1918 influenza pandemic (Spanish flu) and the 2009 flu pandemic (H1N1) (Little 2006). The motto "we learn from the past", or "history repeats itself", in an analogous manner, rests and will remain an unquestionable reality. For the *Homo Sapiens Sapiens / Cro Magnon or Anatomically Modern Humans* (50-60,000 years ago), but especially the most recent ones, after the last Glacial stage (~25,000 years BP), humans think and act alike.

I wish to exclude conspiracy scenarios for spreading viruses on the basis of human principles, and our thesis is explained below.

Privileged, the humans, being equipped with logic and conscience, - by, call it, the Anaxagorean *Nous* or the *Great Architect of the Universe* or *Supreme being*, or *materialistic nucleosynthesis processes* - yet are characterized as the "wildest animals on earth", and none is willing to disagree with 4th c BC great Aristotle. Yet, at the same time humans are "political animals" because they are social creatures with the power of speech and moral reasoning (Aristotle *Politics*, A, 1253a 1-5 και A, 1252b - 1253a 33; Aristotle, *Politics*, A, 1253a 31-1253b 39). But the aim of logic is the elaboration of a coherent system that allows us to investigate, classify, and evaluate good and bad forms of reasoning (Regan, 2007). History unfortunately proves that stronger animal dominates on the weaker. The plenishment and greed is treated as a rule beyond any morals by some humans. Humans swing between "*kalos kagathos*", the ideal of gentlemanly personal conduct where (in ancient Athens) the pursuit of an ideal man-type (anthropotype) has gone beyond literacy, and, disturbed personalities (malice, immoral, ferocious, cheeky, exploitative, selfish, instinctive, irrational) beyond rational and ethical principles viewed as renounced persons. Humans drive along their destiny having spells in history of stability, altruism, justice, freedom under the constitutional rules. The anthropic principles or values are considering human life, as such, and do not go beyond every other life of matter in the so called our universe (Mosterin 2005; Bostrom, 2002).

"War, father of everything" used to say the 6th/5th c. B.C. philosopher Heraklitus, implying the destiny of our cosmos is the synthesis from the collision of opposites ("*War is the father of all and the king of all and some made them gods, others humans; some made them slaves, others free", Heraclitus, Ex. 53*), and further continues and explains the essence of collectivity and connection to the devine: "*Those who speak sagaciously must rely on what is common to all, that a city must abide by its law, and with much more confidence; because all human laws are nourished by one law, the divine; because it has as much power as it wants and not just enough for everyone, but remains and a balance" (Heraclitus, Ex. 114)*

City dwellers had lived in crowded, unsanitary conditions for most of history. The earliest settlements also had one surprising characteristic in common with the virus outbreaks: humans lived close to animals, sieged castles had been exposed also on purpose to poisoning water by attackers. In post -industrial era, bioweapons are developed, and laboratories of virology are close to urban sites.

2. SOME REPORTED HISTORICAL PANDEMIC DISEASES

- **Plague of Athens**, from 430 to 426 BC. During the Peloponnesian War, typhoid fever killed a quarter of the Athenian troops, and a quarter of the population over four years. Thucydides' description (in *Histories*, The Peloponnesian war, *Book* 2.47-49) of the plague (*loimos)* that struck Athens in 430 BC is one of the great passages of Greek literature. This disease fatally weakened the dominance of Athens, but the sheer virulence of the disease prevented its wider spread i.e. it killed off its hosts at a rate faster than they could spread it. The exact cause of the plague was unknown for many years. Analyzed teeth recovered from a mass grave underneath the city, confirmed the presence of bacteria responsible for typhoid (Papagrigorakis et al., 2008; Littman 2009) (Fig.1a, b)
- **Antonine Plague**, from 165 to 180 AD. Possibly smallpox brought to the Italian peninsula by soldiers returning from the Near East; it killed a quarter of those infected, and up to five million in all. At the height of a second outbreak, the Plague of Cyprian (251–266 AD), which may have been the same disease, 5,000 people a day were said to be dying in Rome (Bruun, 2007; Littman and Littman, 1973; Harper 2017; Haldon et la., 2018) (Fig.2a, b).

- **Plague of Justinian,** from 541 to 750, was the first recorded outbreak of the bubonic plague (*Yersinia pestis*). It started in Egypt, and reached Constantinople the following spring, killing (according to the Byzantine chronicler Procopius, *Persian War* II.22–23; Dewing, 1954, 451-473) 10,000 a day at its height, and perhaps 40% of the city's inhabitants. The plague went on to eliminate a quarter to a half of the human population that it struck throughout the known world. It caused Europe's population to drop by around 50% between 550 AD and 700 AD (Mordechai et al., 2019; Smith 1996) (Fig.3a).
- **Black Death**, from 1331 to 1353. One of the most devastating pandemics which killed an estimated 75–200 million people in the 14th century (Little, 2006). Eight hundred years after the last Justinian bubonian plague outbreak, the plague returned to Europe. Starting in Asia, the disease reached Mediterranean and western Europe in 1348 (possibly from Italian merchants fleeing fighting in Crimea), and killed an estimated 20 to 30 million Europeans in six years; a third of the total population, and up to a half in the worst-affected urban areas. It was the first of a cycle of European plague epidemics that continued until the 18th century (Aberth, 2016; Wagner et al., 2014)(Fig.3b).

Figure 1a. Plague in an Ancient City. The painting is believed to be referring to the plague of Athens or have elements from it (i.e. as per Plague in an Ancient City by Michael Sweerts, circa 1652, represents the Plague of Athens (oil on canvas), LAMCA https://collections.lacma.org/node/183358

Figure 1b. Reconstructed appearance of Myrtis, an 11 years old girl who died during the plague of Athens and whose skeleton was found in the Kerameikos mass grave, National Archaeological Museum of Athens (Wikimedia Commons)

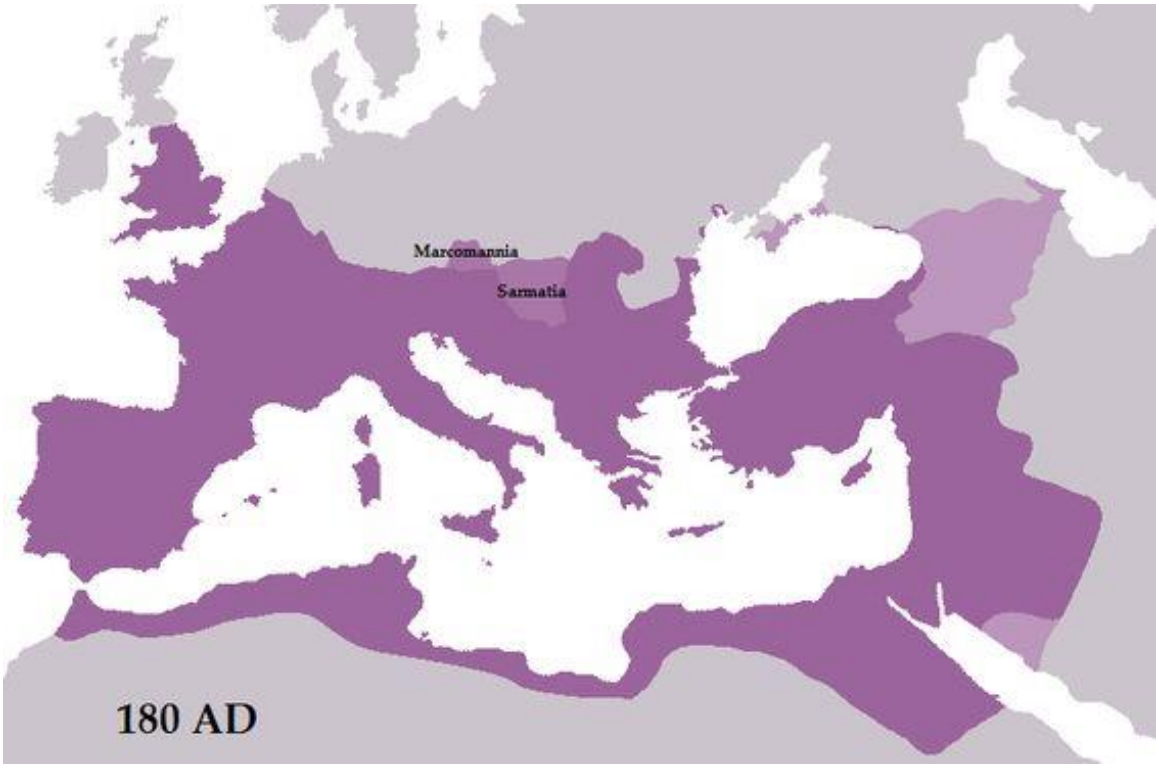

Figure 2a.The disease spread all across the Roman Empire, which was expansive under Marcus Aurelius (https://study.com/academy/lesson/the-antonine-plague-history-start-spread-facts.html)

Figure 2b. The angel of death striking a door during the Antonine plague of Rome; engraving by Levasseur after French academic painter Jules-Elie Delaunay 1828-1891. In the left background, the steps leading up to the church of S. Maria Aracoeli. To right, a shrine to Aesculapius with a statue and inscription "AESCVLAP[IO] SERVATO[RI] Delaunay, L. A. J. (2019, April 04). Plague of Rome. Ancient History Encyclopedia. Retrieved from https://www.ancient.eu/image/10363/

Figure 3a. St Sebastian pleading for the life of a gravedigger afflicted with plague during the 7th-century Plague of Justinian. (Josse Lieferinxe, c. 1497–1499) (https://commons.wikimedia.org/wiki/File:Plaguet03.jpg)

Figure 3b. Pieter Bruegel's The Triumph of Death (c. 1562) reflects the social upheaval and terror that followed the "black death" plague that devastated medieval Europe. (Pieter Bruegel the Elder - Museo del Prado, https://commons.wikimedia.org/wiki/File:The_Triumph_of_Death_by_Pieter_Bruegel_the_Elder.jpg)

Earlier on, *Homer's Iliad* (around 700-800 BC), commences with a description of a plague that strikes the Greek army at Troy. Agamemnon, the leading prince of the Greek army, insults a local priest of Apollo called Chryses (Blickman, 1987).

In managing an outbreak there are two main strategies: *Containment and mitigation*. *Containment* is performed at the early stages of the epidemic and is intended to track and isolate infected individuals within a group to prevent the disease from spreading to the rest of the population. When it is evident that the spread of the disease can no longer be controlled, it will then move on to the mitigation i.e. a prevention level, whereby action is taken to minimize the spread of the disease and alleviate its effects on the health care system and community. In fact, both containment and mitigation steps can be taken simultaneously to control an outbreak.

A key issue for epidemiologists is helping policy makers decide the main objectives of mitigation—e.g, minimising morbidity and associated mortality, avoiding an epidemic peak that overwhelms health-care services, keeping the effects on the economy within manageable levels, and flattening the epidemic curve to wait for vaccine development and manufacture on scale and antiviral drug therapies (Anderson et al., 2020). (Fig.4).

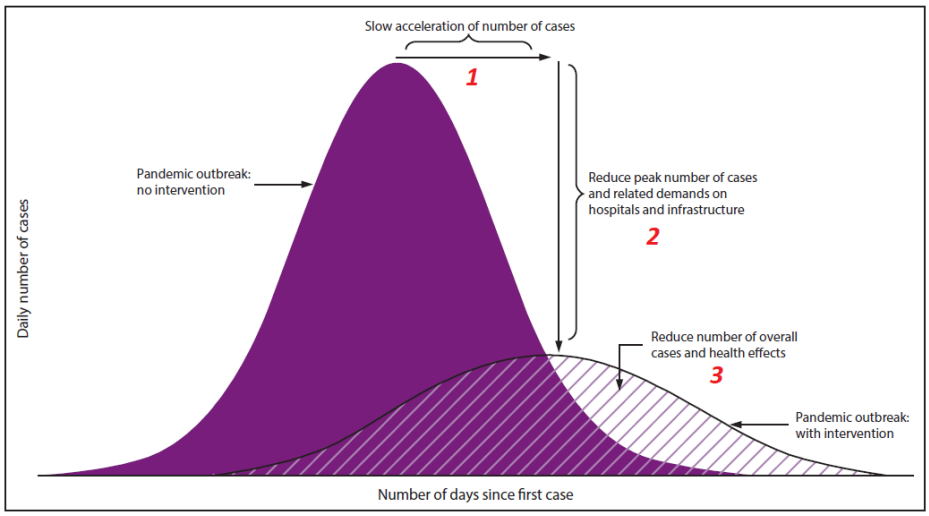

Figure 4. The goals of community mitigation: (1) delay outbreak peak; (2) decompress peak burden on healthcare, known as flattening the curve; and (3) diminish overall cases and health impact (MMWR 2017; Anderson et al 2020)

3. THE COMPLEXITY IN HUMAN HISTORY

Multi-factorial agents have shaped past human cultures with subsequent slow resilience to stability. Natural disasters from the remote past echoes the restart with a new era, and a new genealogy, involving heroes and symbolic labors. The inter-combined effects of such environmental or human agents are not that simple to interpret. It seems that superimposed quasi-periodic agents causing global disasters form a non-liner development (Liritzis et al., 2019).

Complexity is defined as the non-linear process that is a prerequisite, although not a sufficient, condition, for chaos and self-organisation. On the other hand, linearity - monotonous trends in the course of time - implies the superposition principle. A non-linear evolutionary cultural trend is characterized by three factors: a) attractors that determine the stable state, b) recurrent changes in environmental phenomena, and c) a chaotic combination(s) of superimposed cyclic variations with a phase difference.

We have proposed (Liritzis, 2013) that every theory should rest upon diverse dynamical factors derived from the three following prominent concentric interdependent systems—circles (A, B, C) (Fig.5)

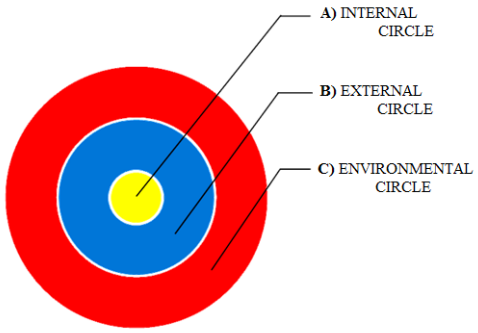

Figure 5. Three interacting circles that drive any culturally organized system (A: one system, B: a neighbor system, and, C: environmental/natural system).

The interactions between the A, B, C systems are due to the intense phenomena coming from the three circles and the unpredictability of the events (social/environmental) (Fig.6).

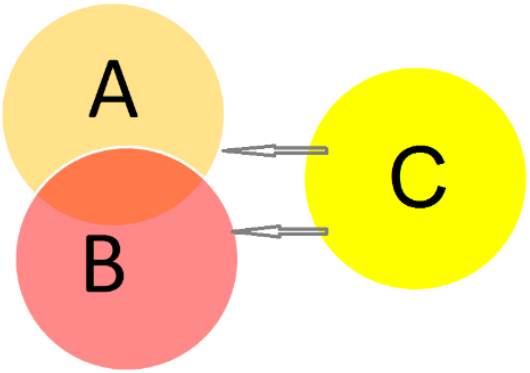

Figure 6. The three interdependent system impacts A, B, C that shape cultures/societies—A and B in between and C with A and B.

The course of a culture is driven by the influence of the internal and external (viz- environmental) variations (δ). Near equilibrium these (δ) have no impact, whereas far from equilibrium they lead to instability, namely, to non-deterministic prediction. Thus, these δ "determine" the next transition, that is, a phase which takes place in the thermodynamic domain, and which leads the cultural centre (a city, a region) to other domains and dimensions of transient stability (Fig.7). Therefore, even if the internal conditions and the boundary conditions that characterize a given culture are known, *we cannot predict its course per se* because there are many possible situations from which the cultural centre is able to assume through the process of variation (See Fig. 7, domains α1, α2, c1…, c6….). The term assume in this case refers to the fact that the macroscopic description does not favor a particular end-point or solution. Therefore, probabilities become important to the emergence of macroscopic order, visualized in large societal nuclei, as caused by fluctuations of microscopic interactions of constituent family nuclei (NB: the recent COVID19 advent in Wuhan, Hubei, China, and its bifurcated diffusion; which with applied strict measures can be statistically predictable to a some extend and hopefully eliminated. To that end new medication reinforces an expected transition to phase 3 of Fig.4]. The unpredictability (but interpretability) becomes more intense with the intrusion of variable impacts from the 3rd environmental variable; for a pandemic that could be a synchronous destructive seismic activity, increased frequency of meteoric showers / asteroid fall, or, hostile manoeuvres caused by lunatics originated in circle (system) B (Fig.5, 6).

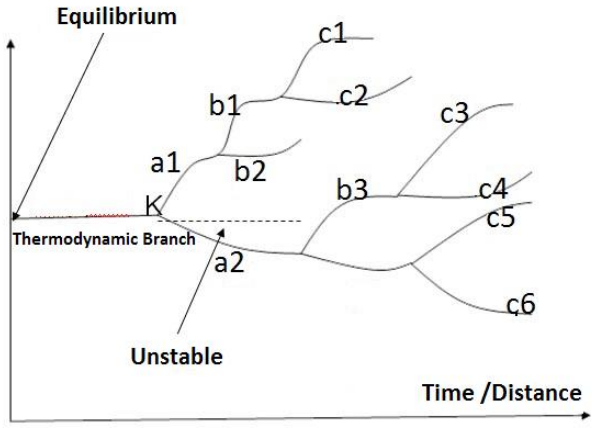

Figure 7. The thermodynamic domain for a human system far from equilibrium, stable domains, bifurcations and the unforeseeable but determining potential courses of evolution in the next phase (stage).

Sporadically, within a cultural phase, paths may be linear but can gradually reach local outbursts and saturation, and proceed to the threshold of the next phase, which is established by complex fluctuations of the three interacting domains and the internal strange attractors of circle A (Fig. 8).

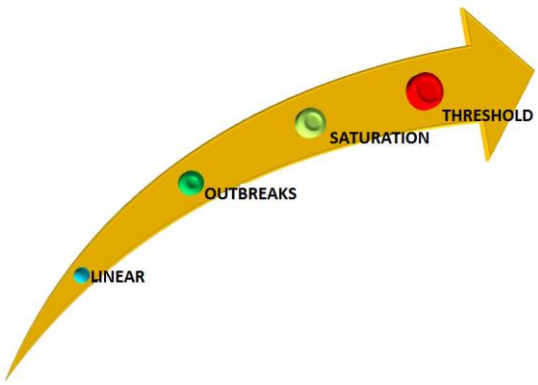

Figure 8. Trend of a cultural system towards the threshold of a new state

Therefore, the evolution of human societies (and human history in general) can be shown not to follow a linear trend, which on a steady state results to a "cultural hallmark", where Y increases as a function of time, T, where T= time scale, distance from equilibrium, Y = concentration/cultural level.

But evolution is based primarily on mutual interactions of different components f (t_i), at variable time interval (t_i= t_0 to t_1) derived from the

three factors (Fig.5). Therefore, the cumulative result could be expressed as eq.1:

$$Y(t_i) = \int_{t0}^{t1} f(t_i)d(t) \quad (1)$$

The parametrization of mathematical expressions is not an easy task and one has to define quantitatively the attributes that define cultural level per time.

The energy change over time in a culture is reflected in the change of entropy dS = dSs + dSi + dSp, where dSs describes the transport through the boundaries of social systems, dSi the entropy generated within the social system, and dSp the entropy (of this social system) with the environment (+ or – depending on the type of exchange). The 2nd law of thermodynamics certifies that dS > 0 (dS=0 applies for equilibrium). In cultural evolution the entropy production rate dS/dt is of interest, in conjunction with the rates and forces of various irreversible processes (wars, floods, earthquakes, fires, pollution, epidemics, pandemics, migration, trades, invasions and raids, etc.). The hermeneutics of cultural evolution overviewed with human or natural terms basically is founded upon the theory of complexity and applies either to a regional or global scale.

4. EPILOGUE

The evolution of human societies and in general of human history, do not follow a liner trend but rests mainly on mutual interactions amongst different components (biological, environmental-natural, human). Identifying the meanings of complexity in human processes which involve material, energy, and environmental factors, the cultural evolution is viewed via a complex system approach of a collective result of non-linear interactions making a series of successive transitional phases along a trajectory. The interacted multi-factorial issues derive from three concentric circles or dynamical systems, a) the internal (issues derived from within a given society), b) the external (issues derived from interaction with neighbor societies) and c) the environmental. Issues related to the context and The (a) and (b) pertain, amongst others, to the pandemic diseases.

The theory of chaos is intermingled with various identified attributes that define and affect the cultural evolution of a human organized system. The historically attested diseases of regional / global scale are sufficient to stress the need for targeted research for prevention and welfare. The classical philosophy aids humanity to regain equilibrium applying Aristotelian logic and Platonic vision.

In global pandemics humanity must a) exert altruism and solidarity, and, b) reprobate and self-defend any deliberate ulterior motive, if detected.

Beyond and over any economic interest or imposed global administration, for humans stems the right measure sourced in logic, because logic is a tool for reason and right thinking. From logic emerges and conscience. But any prudent person, using Logic, can lead to the measure (middle route), even if it is not obvious from the beginning. So, Aristotle answered Socrates' question: "*How should people live*?"; People should live virtuous life, leading to well-being and bliss.

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