

Genomic point of view for life

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Summary

This article addresses the nuclear weapon threat from a point of view closely linked to recent progress in the field of genomics, the study of all genes in all species. An important result of this relatively new scientific discipline is that all humans on our planet are closely related and thus form one large family. A second result is that biological life can only be understood if genes are studied over a very long time scale. The genomic point of view that has been emerging can be applied to the planetary problem of the existential threat posed by nuclear weapons. The genomic perspective is that any threat of nuclear weapon possession or use is suicidal because the so-called "adversary" is ourselves, and the 10-minute decision time for nuclear retaliation is completely contrary to the very long time scale of biological and cultural evolution on Earth. Some analysts, notably Nina Tannenwald, have observed that to a large extent nuclear war has been avoided so far because of the humanitarian instinct and good judgment of the people involved, and to a lesser extent by the concept of deterrence. The genomic perspective will favor the humanitarian initiative towards banning nuclear weapons.

-1. Introduction: Reality from a nuclear weapons point of view

In February 2018, acting under a mandate given by U.S. President Donald Trump, the Department of Defense published on-line its new agenda, the 2018 Nuclear Posture Review (NPR, ref. 1). Three salient elements of the Pentagon's 91-page 2018 NPR are the following (*italics added*):

- 1. On page II the Secretary of Defense Jim Mattis wrote:
“We must look reality in the eye and see the world as it is, not as we wish it to be. This NPR reflects the current, pragmatic assessment of the threats we face and the uncertainties regarding the future security environment”.
- 2. On page VIII of the executive summary a section is headed:
“Achieve U.S. objectives *should deterrence fail*”.
- 3. A request for more than one trillion dollars over 30 years to “modernize” nuclear weapons and their means of delivery.

It thus appears that the *Pentagon’s view of reality* is one of “threats we face” and justifies in their mind additional expenditures of more than one trillion dollars for the nuclear weapons system. This suggests having a look at *reality* from a scientific point of view. In the following, I take it for granted that the reality of life is of high interest to nearly everyone on our planet.

-2. Reality from a scientific point of view

What is typically called *modern science* was developed over the past five centuries, but it has deeper historical roots. Ancient Greek philosophers had introduced the idea that mathematics is the language of nature, an idea which to a large extent is the foundation of modern science. As an example, modern physics and chemistry can be understood by using mathematical symbolic representations, or models. Mathematical models can describe physical reality on both the invisible, often microscopic, scale and on the visible macroscopic scales. Thus, in the scientific view, reality can be seen on two levels, i.e. a symbolic one and an empirical one based on our senses. It is also important to note that the mathematical models developed by modern science frequently allow one to understand reality, that is nature, on many time scales ranging from attoseconds (one millionth of a trillionth of a

second), a time scale useful in laser and in particle physics, to billions of years, the time scale of biological evolution on our planet and of astrophysics.

In seeking to understand the reality of life, i.e. the nature of life, we need to look into the science of microbiology. In 1865 Gregor Mendel presented his work on the inheritance patterns of pea plants at a meeting of a local scientific society in Brno, Czechoslovakia. He used simple mathematics to explain what we call today the laws of Mendelian inheritance. He died in 1884. His work was ignored until 1900 when other biologists independently rediscovered the same laws and gave credit to Mendel for his discovery. It took a few decades for the scientific discipline of genetics to be considered important, but after the discovery of the double-helix microscopic structure of DNA by James Watson and Francis Crick in 1953, the field of genetics took off in a big way. One can say that in the four decades following the Watson-Crick discovery, the secrets of biological life were revealed to a substantial degree thanks in major part to genetics.

Genetics led to the development of genomics which is the study of the entire set of genes in the human and other species. In the 20 March 1989 issue of Time Magazine the late science writer Leon Jaroff published a remarkable article entitled "The Gene Hunt" in which he announced and positively commented the start of the human genome project under the sponsorship of the National Institutes of Health and the Department of Energy in the United States. Later, several other countries and the Celera Corporation joined the project so that it became the largest biological project in the world. By 2001 the nearly complete human genome of one person had been read out, or "sequenced", the word typically used by geneticists.

Figure 1 at the end of the present article is a highly simplified symbolic representation of a human body, the phenotype, shown as two horizontal lines. The body hosts inside its cells the genotype, ie the sequence of DNA bases represented by the letters A, for adenine, T for thymine, G for guanine and C for cytosine. Recall that our individual 46-chromosome genome comprises about six billion base pairs symbolized by the letters A paired with T, and G paired with C, arranged in stretches corresponding functionally to approximately 20 000 genes. In addition, there are numerous other stretches whose function is not yet fully understood. Almost every cell in our body contains within its microscopic nucleus our entire 6-billion-letter DNA all neatly coiled up, which constitutes our 46 chromosomes. Figure 1 shows a sequence of 20 letters taken from professor Katherine Pollard's article (ref. 3) where she displayed a 118-letter snippet of genetic code known as human accelerated region 1 (HAR1), found in the long arm of chromosome 20. I have added the complementary 20-letter sequence as one would find in the DNA double helix.

Figure 1 has been inspired by the artistic picture of a baby that was featured in Leon Jaroff's 1989 article (ref. 2). In that picture one could see the body of a young baby, into which the draftsman had added an artist's rendition of a short piece of the double-helix DNA. Figure 1 captures the same idea, namely the person seen as comprising the body and the DNA.

The human genome project reached the important goal in 2003 of having led to the nearly complete sequencing of all three billion "letters" (or bases) in a set of 23 human chromosomes. In the last decade, genome sequencing techniques have become so rapid and low-cost that today thousands of individual human genomes have been sequenced along with the genomes of numerous animals, plants, bacteria and viruses. Genomics has contributed

immensely to a better understanding of life and its evolution, in particular human evolution. Nevertheless, it may yet take another century or two before we fully understand our human genome, and other genomes, but one thing is clear already and that is the focus of the next section.

-3. The reality of life seen on two levels

Coming back to Leon Jaroff's Time Magazine article, he mentioned professor Robert Sinsheimer's view of the human genome as "the complete set of instructions for making a human being", an expression often used in the scientific literature. But Matt Ridley in his 2000 book (ref. 4) has pointed out that describing the human genome as a "blueprint" or "a set of instructions" cannot be correct. For, who is the person who follows these "instructions"? Neither is our DNA a blueprint. A blueprint is a set of two-dimensional drawings and describes the end product, for example a building. In contrast, our DNA, if it were uncoiled and stretched out along a line, would form a one-dimensional linear chain of base pairs approximately two meters in length. In his book Ridley describes how in our initial cell, i.e. in the fertilized egg, our DNA directs its own replication and it then goes on to gradually direct the differentiation and structuring of the embryo's multiplying cells, thus sequentially putting into operation various segments, or genes, of our DNA in correspondence with various parts of our body. In this embryological process there is no external agent reading "instructions". *Our DNA is architect and builder.*

In what can be called *the genomic point of view*, one's symbolic personal self-image may be seen as including one's individual genome, in addition to our cultural heritage, which includes the planetary human genome. It's important to note that the main features of our human genome probably

existed about one million years ago (refs. 4-6). Some of our individual genes go back a few hundred million years. In any case, including our DNA in our self-image extends our life into millions of years into the past, and hopefully equally far into the future. Numerous authors of books on genetics and genomics, and documentary film makers, have written along this line of thought (refs. 4-6). These authors often use a diachronic (across time) "we" extending all the way out to the beginning of evolution more than three billion years ago. The diachronic "we" can also be extended into the future as we see our lives prolonged in future generations.

Another discovery of genomics in the last two decades is that the overlap of DNA information between two same-sex persons on Earth is approximately 99.9%. Several scientists and authors (refs. 5-6) assert with a high degree of confidence that all persons on our planet belong to the same family as far as genetic evidence is concerned. Family tree studies, notably by Adam Rutherford (ref. 5), show that when we go back to about 1300 years BC almost all of us on the planet have the same ancestors. In Leon Jaroff's baby drawing, if we identify not only with our body but also with our DNA, then our biological identification considerably overlaps with that of everyone else on our planet. We are all "cousins", we are all part of one planetary family. In summary, an important point to retain is that a modern scientific view of life comprises two levels: the visible part, i.e. the body known in biology as the "phenotype", and the part invisible to the naked eye, known as the "genotype", our DNA. One's individual genome is part of what science calls "the human genome", an inclusive and unifying concept for all humanity (refs. 5-6). That is the reality of life.

-4. War seen as fratricide and as collective suicide, the role of fear

Historian and author Margaret MacMillan has well documented that starting and waging World War I was motivated in large part by the negative view that certain ethnic groups held toward other groups (ref. 7). The same holds for World War II. Today, there are still local wars waged between various ethnic groups on our planet. From a modern genomic point of view, war between any two groups of persons represents a fratricide, and if it were to escalate to the nuclear level it could well lead to a collective suicide. The discovery of the "nuclear winter" phenomenon by Alan Robock and Brian Toon in the 1980's has made the world fear that even a "limited" nuclear war between two nuclear powers could trigger worldwide famines causing billions of deaths (ref. 8). The discovery of nuclear winter has thus raised to an even higher level the role of fear in the present nuclear weapon situation.

The 2018 NPR document (ref. 1), while admitting that nuclear deterrence can fail, nevertheless wants to strengthen and prolong nuclear deterrence by additional expenditures of one trillion dollars over 30 years. The expression "nuclear deterrence" comprises in the word *nuclear* a reference to the atomic and hydrogen bombs which would surely work and kill tens or hundreds of millions of people, or more. But this expression also comprises the word *deterrence* which refers to the psychological state of an individual or a group of people *who want to make use of the fear* induced by nuclear weapons. It's important to note that the fear generated by the nuclear weapons of the nine nuclear powers affects everybody on our planet and has a negative effect on our universal quest for a feeling of security.

In January 2018 Professor Michael T. Klare wrote comments on the 2018 NPR document (ref. 9). Klare contrasted former U.S. president Obama's policy with current President Trump's policy. Obama sought to decrease the level of reliance on nuclear weapons for defense. In Prague on 5 April 2009, Obama had declared:

"Today, I state clearly and with conviction America's commitment to seek the peace and security of a world without nuclear weapons."

Obviously, President Trump's and the Pentagon's plans for "modernizing" nuclear weapons and their means of delivery justify professor Klare's title *Trump's Nuclear Posture Review: Back to Armageddon*. That is a fearsome translation of the Nuclear Posture Review.

In August 2018 author Andrew Cockburn published in Harper's Magazine an article on the command and control features of the U.S. nuclear arsenal in the period from 1945 to the present (ref. 10). He quoted many knowledgeable persons including anti-nuclear-weapon activist Bruce Blair, retired four-star general Lee Butler, and Air Force general John Hyten who is currently the supreme commander of the nuclear armed forces. Author Cockburn quotes General Lee Butler, who was once commander of the Strategic Air Command, in these words:

"I came to a set of deeply unsettling judgments. That from the earliest days of the nuclear era, the risks and consequences of nuclear war have never been properly understood. That the stakes of nuclear war engage not just the survival of the antagonists, but the fate of mankind. That the prospect of shearing away entire societies has no politically, militarily or morally acceptable justification. And therefore, that the threat to use nuclear weapons is indefensible."

Cockburn notes that in his retirement General Lee Butler has joined the movement to abolish nuclear weapons. Regarding the question of command and control of nuclear weapons, the author makes many disquieting comments that are pretty much in line with Eric Schlosser's watershed book *Command and Control, the Damascus Accident, Nuclear Weapons, and the Illusion of Safety* (ref. 11). Schlosser's book has been widely recognized for its thoroughness and credibility. Note that the last words of his subtitle again evoke fear. The next section will look at one way that would contribute to escaping the regime of nuclear fear.

-5. Probability of nuclear war, the nuclear taboo.

In May 2018 Andrew Lichterman and John Burroughs wrote an excellent article (ref. 12) in which they summarized the present status of the nuclear weapons confrontation between Russia and the United States. They quoted President Vladimir Putin's 1 March 2018 major address to Russia's Federal Assembly and the U.S. NPR 2018. Putin deplored the fact that the U.S. in 2001, under the George Bush Junior administration, withdrew from the Antiballistic Missile Treaty (ABM). If American ABMs work and if the U.S. launches a "pre-emptive" nuclear attack, then the Russian missiles may not be there to insure retaliation, and deterrence will have failed.

Much of the past discourse on nuclear deterrence could be described as *fear-based*. But another avenue has been in the works and culminated in July 2017 with the endorsement by 122 nations of the *Treaty on the Prohibition of Nuclear Weapons* (TPNW). Lichterman and Burroughs wrote the following (ref. 12):

‘The Treaty on the Prohibition of Nuclear Weapons was negotiated in 2017 by 122 states, not including, however, any nuclear-armed states. Its preamble “considers” that use of nuclear weapons would violate international humanitarian law and “reaffirms” that such use “would also be abhorrent to the principles of humanity and the dictates of public conscience”—factors with legal as well as moral value.

As the treaty’s reference to “principles of humanity” suggests, in many circumstances, certainly in attacks on cities, use of nuclear weapons goes so far beyond the boundaries of warfare that it likely would constitute not only violations of international humanitarian law but also crimes against humanity as most recently defined in the Statute of the International Criminal Court. ‘

In support of the TPNW is the easily verified observation that most people display a very strong reluctance to kill others. Empathy is an essential part of being human. There are countless examples of people caring for others beyond national borders. As an example, in July 2018 almost the entire world watched on television the rescue operations for 12 boys, members of a soccer team, and a young man, their coach, trapped in a flooded cave in northern Thailand. Expert divers from many countries, including the U.S., helped find the boys and rescue them. People the world over cared about the boys and were wishing for the success of the rescue operations. We all rejoiced when total success was achieved.

The world economy has become globalized. International tourism is the largest industry. When friends and relatives come back from a trip, we almost never hear that their lives were threatened by people in distant lands. Personal security is now a priority in most countries. The civil aviation industry gives an outstanding example of achieving security for its clients. When you board a flight the probability of your dying is only one chance in ten million. If you board ten flights per year on average your probability of dying in an airliner crash is only one chance in one million per year, or 0.0001 percent per year.

In 2008 well-known professor emeritus Martin Hellman of Stanford University published his calculations of the probability of nuclear war breaking out (ref. 13). He based his calculations mainly on what had been learned from the 1962 Cuban missile crisis. As an order of magnitude, Professor Hellman gave the estimate of one percent per year that nuclear war could break out given the present political situation on our planet. In the engineering context of making bridges and nuclear reactors which have a calculated probability of failure 10 000 times less than one percent per year, Hellman wrote the following:

'Possibility. Making the world 10,000 times safer than at present may sound utopian and infeasible, and until recently it was. But, with more than 25,000 nuclear weapons in existence today and the ability to build many times that number, the choice is between creating such a world and having no world at all. We are being challenged to adapt to a sudden change in our environment, and, fortunately, adaptability is one of our defining characteristics. Through adaptations of clothing and shelter, humanity has extended its range from a small tropical region to the entire globe, and even walked on the Moon. Through other adaptations, we have learned to fly far higher and faster than birds and to navigate the seas better than fish."

In September 2017 Simon Beard commented positively on the importance Hellman's 2008 work and other related papers (ref. 14). On 8 March 2018 another comprehensive paper on nuclear war probability was published by Seth Baum, Robert de Neufville and Anthony Barrett (ref. 15) who work at the Global Catastrophic Risk Institute. These three authors presented a scenario modeling method which is largely based on Martin Hellman's previous work. The trio pointed out that they could not yet give reliable probability numbers for lack of pertinent data. Nevertheless their paper

described 14 different scenarios that could lead to nuclear detonations, and they gave a list of 60 historical incidents with nuclear weapons that might have grown bigger if intentional or non-intentional escalation had taken place. The three authors drew important conclusions from their research. One of them is the following quote (ref. 15):

'The three intentional escalation scenarios are the traditional focus of nuclear weapons debates. These are the scenarios for which nuclear deterrence should be most effective. The other eleven scenarios all involve some sort of mistake, either in inadvertent escalation or in the false perception of a threat. The preponderance of inadvertent and false-belief scenarios raises questions about the reliability of nuclear deterrence. Exactly how reliable nuclear deterrence is requires quantification of the probabilities of the various scenarios, which is beyond the scope of this paper.'

One of the trio's stated goals is to find ways of reducing the probability of nuclear war. Both Martin Hellman and the trio have pointed out that given the importance of planetary security it is surprising that this topic seems to have received little attention so far. Here is another important conclusion that Baum et al. come to:

'Reducing tensions and improving relations with nuclear-armed states is a clear means of reducing the probability of nuclear war, and it could be an especially effective one. Another cross-cutting factor is the strength of the norm against nuclear weapons use. This norm appears to have played a role in the avoidance of nuclear war since WWII (e.g., Tannenwald 1999).

..... Efforts that strengthen the norm against nuclear weapons use, such as the recent humanitarian initiative to stigmatize nuclear weapons (e.g., Borrie and Caughley 2013), could be another effective means of reducing the

probability of nuclear war. Strengthening the norm against nuclear weapons use may be an underappreciated benefit of the humanitarian initiative.”

The Borrie and Caughley reference is given below (ref. 16). What Baum et al. call “the norm against nuclear weapons use” has been studied extensively by Professor Nina Tannenwald (refs. 17-18). She has preferred to write about “the nuclear taboo” against nuclear weapons use, arguing that a taboo is a much stronger concept than a norm. Professor Tannenwald, and other analysts quoted by her, have observed that one of the most remarkable features of the period extending from the atomic bombing of Nagasaki to now has been the non-use of nuclear weapons in conflicts. Professor Tannenwald attributes this non-use to the birth and growth of what she has called “the nuclear taboo”. The brief text here below in reference 17 explains the concept of nuclear taboo. Here is a quote from reference 18 which describes the situation in the early part of the nuclear weapon era:

“The nuclear taboo was pursued in part against the preferences of the United States, which, for the first part of the nuclear era, opposed creation of a taboo because it would deny the self-proclaimed right of the United States to rely on nuclear weapons for its security. I argue for a broader explanation that emphasizes the role of a global antinuclear weapons movement and nonnuclear states, as well as Cold War power politics, in the development of the taboo. The model of norm creation here highlights the role of antinuclear discourse and politics in the creation of the taboo.”

In this quote, and in numerous other parts of her paper, professor Nina Tannenwald gives enormous credit to the anti-nuclear weapon activists for the birth and growth of the nuclear taboo. She also gives credit to others in this quote:

“Although Cold War power politics played a role, the rise of the taboo has been driven significantly by a grassroots global antinuclear weapons movement, the UN, and nonnuclear states. The taboo developed in the face of consistent, vociferous, and long-standing official resistance by the U.S. government and the other democratic nuclear powers to any efforts to ban the use of nuclear weapons.”

Professor Tannenwald mentioned that in 1995 the Nobel Peace Prize was awarded to Joseph Rotblat and to the Pugwash Conferences on Science and World Affairs. Another important quote is the following (ref. 18):

In doing so, antinuclear groups emphasized that nuclear policymaking could not simply be the prerogative of nuclear-armed governments because it legitimately engaged a global constituency. As the National Committee for a Sane Nuclear Policy put it in an ad in the New York Times in November 1957, the great “challenge of the age” was to move beyond traditional interests of the nation-state to “a higher loyalty”—a loyalty “to the human community.”

Professor Tannenwald also gave credit to the Soviet Union in its prolonged efforts to move the planet away from nuclear weapons. She wrote (ref. 18):

“This view emphasizes the key role of the Soviet Union in denouncing atomic weapons in the 1950s and beyond. Soviet efforts to stigmatize the weapons of the West indeed helped to scare people about nuclear weapons and nuclear war.”

Regarding the role played by the United States in the world Professor Tannenwald wrote the following towards the end of her article (ref. 18):

“Further, the identity mechanism operating in the taboo is that “we” do not use nuclear weapons—because of who we are and what our values are, because civilized states do not do this, and so on. The identity of the

adversary has become less relevant over time (this is true for the application of the laws of war generally). For this mechanism to change, U.S. identity and self-conceptions would have to shift significantly.”

Finally, in her conclusion, in the context of “Hiroshima Day” commemorative annual events, she wrote the following (ref. 18):

Such sites and practices keep alive the memory of the atomic bombings and the need to prevent the use of nuclear weapons ever again. This “sanctification of Hiroshima” further reinforces the nuclear taboo and, by associating it with religious practices, embeds it in deeper cultural meanings and our identities.

Professor Tannenwald’s deep analysis of the prevailing nuclear taboo ties in well with the major finding of modern genomics that we are all one ethnic family on the planet, descendants of common ancestors. The genomic point of view that modern genetics and genomics are bringing to light will enhance more and more our capacity to understand and care for others, across borders. The larger the extent to which military and political personnel in all nations see everyone else as themselves from a genomic point of view, the lower the probability will be that one or more military or political persons will want to launch nuclear weapons. I believe that this is to a great extent the prevailing situation.

The level of fear promoted by NPR 2018 has much to do with economic gains that are again planned for nuclear arms manufacturers. The vast numbers of people and the vast sums of money involved in the armaments industry could be devoted to other planetary problems such as international security through the United Nations, internal security, climate change,

hunger, pollution, epidemics, overpopulation and health care. The Science for Peace forum in Toronto on 30-31 May 2018 addressed six of our urgent planetary problems (ref. 19). A strong case was made by retired University of Toronto professor Metta Spencer that all major planetary problems are tightly linked together (ref. 19).

Two other authors have written about the will that has been observed in the last 70 years not to launch nuclear weapons, ie the nuclear taboo. Professor Jacques E.C. Hymans has written the following (Ref. 20):

The clear post-1945 perception of the enormity of the decision to use nuclear weapons—enormity in every sense: military, political, ethical—has been a major obstacle to any such decision. That perception of enormity is the essence of the so-called “nuclear taboo.” Before the perception of enormity existed, we dropped the bombs; after that perception of enormity came into being, we refrained from dropping them.

Nuclear security specialist James E. Doyle quickly responded to Hymans’ observation of a “nuclear taboo” (ref. 21). From 1997 until 2014 Doyle worked in the Nonproliferation Division of the Los Alamos National Laboratory, a well-known nuclear weapons research installation. In his first paragraph Doyle wrote the following sobering sentence:

“Current approaches to preventing nuclear warfare entail high risk, are prone to human and mechanical error, and are unlikely to succeed over the next several decades.”

Doyle recognizes that the first concept of “nuclear deterrence” and the second concept of the “nuclear taboo” have helped prevent a nuclear war.

But Doyle points out that the second concept somewhat weakens the first with the following words (ref. 21):

‘‘In other words, leaders of nuclear-armed countries must project their capability and willingness to break the nuclear taboo in order to deter potential rivals. As Eric Schlosser catalogs in his book *Command and Control*, this tension has contributed to a lengthy trail of close calls, misunderstandings, hair-raising false alarms, and miraculously avoided accidental thermonuclear detonations. Unless we fundamentally change the system, some day our luck will run out.’’

Eric Schlosser’s game-changer book is listed below as reference 11. I entirely agree with James Doyle’s conclusion and, along with numerous other observers, I totally endorse this last sentence:

‘‘Unless we fundamentally change the system, some day our luck will run out.’’

Towards the end of his article James Doyle wrote:

‘‘Scholarship and advocacy of nuclear abolition is important, but it is not enough. The psychology of nuclear deterrence is a mental illness. We must develop a new psychology of nuclear survival, one that refuses to tolerate such catastrophic weapons or the self-destructive thinking that has kept them around. We must adopt a more forceful, single-minded opposition to nuclear arms and disempower the small number of people who we now permit to assert their intention to commit morally reprehensible acts in the name of our defense. We must, as Pope Francis has said, ‘‘counter the logic of fear with the ethic of responsibility.’’ The practical next step is to demand negotiations on a global convention against nuclear weapons. One hundred and twenty-one nations have expressed their willingness to adopt such a ban

by joining the Humanitarian Pledge against nuclear weapons initiated by Austria in 2014.”

I especially like the quote of Pope Frances to “counter the logic of fear with the ethic of responsibility”.

A great many authors have come to a similar conclusion. We need not empty our pockets to fund a nuclear weapons system that generates a burden of fear for us and our children. Moreover, given the fact that complex systems are inherently unpredictable and hence subject to failure, and given the existence of malevolent individuals and groups, it’s obvious that the only solution to reach, and surpass, the airliner safety level is the elimination of nuclear weapons.

-6. Scientific American: The science of being human

The celebrated Scientific American magazine has devoted its September 2018 special issue to a topic advertised on its cover as “The Science of Being Human” (ref. 22). Many important conclusions emerge from the dozen articles written by scientists from various disciplines. One conclusion is that the science of genomics has clearly established that the human genome is essentially the same in all ethnic groups, so that we all belong to one family. A second conclusion concerns the much-debated question of whether warfare is part of human nature, to which anthropologist R. Brian Ferguson answers:

“Warfare Is Only an Invention – Not a Biological Necessity”.

Another important contribution is the lead article by professor Kevin Laland entitled "An Evolved Uniqueness, How humans became singular animals". Kevin Laland is professor of behavioral and evolutionary biology at the University of St. Andrews in Scotland. On page 34, Laland wrote:

"The emerging consensus is that humanity's accomplishments derive from an ability to acquire knowledge and skills from other people. Individuals then build iteratively on that reservoir of pooled knowledge over long periods."

This paragraph on cooperation pretty much describes the way that science and technology have developed and have reached the amazing performance level that we now observe and that could enable us to solve the many problems now facing our planet. One outstanding problem is the threat of nuclear war and the adverse psychological paradigm that it creates. Since it is in nobody's interest to suffer a nuclear war, or even to live under its fear, we should be able get the nuclear powers to cooperate closely in preventing an unauthorized nuclear bomb detonation, and beyond that, to work towards nuclear disarmament.

The theory put forward by professor Laland is that humankind's cultural evolution had an effect on our genetic evolution through feedback mechanisms. The following paragraph on page 38 is remarkable:

"Teaching and language were evolutionary game changers for our lineage. Large-scale cooperation arose in human societies because of our uniquely potent capacities for social learning and teaching, as theoretical and experimental data attest."

The challenge is to apply our human skills for large-scale cooperation to the big planetary problems facing us (ref. 19).

-7. Near-misses and fear-impaired judgment

As mentioned earlier, the executive summary of 2018 NPR has a section entitled "Achieve U.S. objectives should deterrence fail". Numerous war historians and analysts have pointed out that nuclear deterrence could fail. As is well known, it nearly failed during the Cuban missile crisis as the Pentagon's Joint Chiefs of Staff, under Curtis LeMay, were urging President John Kennedy to attack Cuba, where thousands of Soviet soldiers were already deployed along with nuclear-tipped missiles.

Less known are several near-miss incidents that author Eric Schlosser has reported in his 2013 well-documented book "Command and Control, Nuclear Weapons, the Damascus Accident, and the Illusion of Safety" (ref. 11). The book describes in detail several near-miss incidents and the inadequate safety measures that prevailed for a long time in the U.S. nuclear arsenal. Many observers have called Schlosser's 632-page book *a game changer*. The last words of Schlosser's book title, "the Illusion of Safety", constitute a strong conclusion that everybody, including those in the nine nuclear weapons establishments, ought to ponder.

A near-miss incident that is less known in the public mind is the Able Archer war scare of 7-11 November 1983 (ref. 24). NATO had planned and announced a large-scale military exercise that was meant to *simulate* a nuclear attack on the Soviet Union. The top Soviet leadership, still mindful of the sneak German attack on the Soviet Union in June 1941, feared that NATO's Able Archer exercise was a cover for a real nuclear attack. *This episode is quite revealing about fear tactics*. The Soviet fear emanated in large part from U.S. President Ronald Reagan's previous hawkish

declarations. In a speech to the British House of Commons on 8 June 1982 President Ronald Reagan had predicted (ref. 23):

‘the march of freedom and democracywill leave Marxism-Leninism on the ash heap of history ...’

On 8 March 1983, in a speech to the National Association of Evangelicals Ronald Reagan (ref. 23) had warned against ignoring

‘the aggressive impulses of an evil empire’, the U.S.S.R.

The Soviet leadership had been struck by these declarations. In a recently declassified report of the President’s Foreign Intelligence Advisory Board (PFIAB) published on 24 October 2015 (ref. 25), one can read in its fourth paragraph the following:

‘According to documents reviewed by the Board and dissected in the declassified PFIAB report, by 1983 "The Soviets had concern that the West might decide to attack the USSR without warning during a time of vulnerability...thus compelling the Soviets to consider a pre-emptive strike at the first sign of US preparations for a nuclear strike." To counter this strike (which the West never intended to launch), Soviet leader Yuri Andropov initiated Operation RYaN, the Soviet human intelligence effort to detect and pre-empt a Western "surprise nuclear missile attack."

The report's authors conclude that this response

"strongly suggests to us that Soviet military leaders may have been seriously concerned that the US would use Able Archer 83 as a cover of launching a real attack."

The PFIAB report gives credit to Lieutenant General Leonard H. Perroots who became aware during the Able Archer 83 NATO exercise that the Soviet Union was moving some of its nuclear military units into a state of alert. But Perroots kept his cool and decided not to place NATO forces on increased alert despite increased Soviet readiness, thereby averting a potential nuclear exchange. The PFIAB report underlines the importance of Perroots's decision in these words:

'However Perroots sent the PFIAB and others a "parting shot" before retirement, a letter "outlining his disquiet over the inadequate treatment of the Soviet war scare." Fortunately, the PFIAB heeded his advice. A secret risk of nuclear war is still an unacceptable risk of nuclear war.'

The last sentence underlines the idea that military secrecy hides more risks than we are aware of. Regarding the enormously threatening concept of pre-emption, one can say the following: when one nuclear power, such as the U.S., keeps a first strike nuclear attack as an "option", other countries may believe in its plausibility, and as the Soviet Union did in November 1983 they may get ready to counter it through their own pre-emptive attack. Are the Donald Trump administration and the Pentagon proposing to increase the level of fear in the Russian leadership through a nuclear weapon 'modernization'? Has the lesson of Able Archer 1983 been forgotten, or been dismissed?

Another obvious flaw of nuclear deterrence is when nuclear weapons might fall under the control of suicidal insiders or terrorists. What is now somewhat surprising is that the Pentagon's NPR 2018 recognizes that nuclear deterrence might fail. How can you deter a suicidal insider or terrorist?

Regarding the topic of fear, the 2018 NPR document describes as "threats" new nuclear weapons and systems being developed by the Russians and the Chinese. Threats induce fear, as do counter-threats. Recently, President Donald Trump has announced his wish for the U.S. to occupy a dominant military capability in outer space. The 2018 NPR document mentions several times the need to negotiate with other nuclear powers from "a position of strength". Strength to kill millions of people on both sides? With the ever expanding modern technology, it's becoming obvious that the nuclear and conventional arms races have no physical limits. The limit must come from the humanitarian approach to managing our planet, an approach that will be strengthened by adopting the genomic point of view.

The divide that the 2018 NPR document seeks to emphasize is between citizens in Russia and citizens in the United States. A more relevant divide on our planet is between a small number of people drawing economic benefits from nuclear weapons and the much larger number of people in all countries who wish to eliminate nuclear weapons.

-8. Motivation for eliminating nuclear weapons

With three Nobel Peace Prize awards given so far to efforts to curb and eliminate nuclear weapons, and with 122 nations having signed in July 2017 the Treaty on the Prohibition of Nuclear Weapons (TPNW), there is a good momentum underway for nuclear disarmament. Let's assume, for example, that disarmament will start, say, in three years. Three years is a long enough period for an accident or a malevolent action to occur. Bruce Blair (refs 27-28), George Shultz and James Goodby (ref. 29), Bill Perry (ref. 30) and many others have argued that the nine nuclear powers should

collaborate in order to avoid an accidental or malevolent nuclear weapon detonation. Persons in the nine nuclear weapons establishments ought to realize that the unauthorized detonation of a single nuclear weapon, even over the ocean, could instantly tip the balance towards nuclear disarmament. These people ought to collaborate in order to avoid an accidental, inadvertent or malevolent nuclear detonation.

How will we motivate everyone on the planet to actively go in the direction of nuclear disarmament? The genomic point of view, already being promoted by many life scientists and film makers, is a good step in that direction. What does that change with respect to nuclear weapons? Everything, I believe. Modern genomics show that throwing nuclear bombs on foreign cities has the same effect, from a genetic point of view, as throwing them on your own cities. Moreover, identifying with one's genome, as part of the human genome, one can see one's continuity in all children, born and yet unborn. The physicist Erwin Schrödinger had fully understood and adopted this idea and expressed it as : "Du bist alles in allem", "You are all in all others". Albert Einstein had also expressed the same idea. In reference 26, page 59 he had said:

The old who have died live on in the young ones.

On page 170, regarding nuclear war, Einstein had said:

Past thinking and methods did not prevent world wars. Future thinking must.

The *divide* that documents like 2018 NPR seek to promote is between Russians and Americans, among others. But much evidence shows that probably more than 99% of people everywhere do not wish nuclear war. After 1945 nuclear weapons have been basically used to *induce fear* in others. With the Able Archer war scare we know how intense that fear can

become and *reduce* one's intelligence and good judgement. Almost all analysts have pointed out the need for a paradigm shift.

-9. John Polanyi: 'How to save our planet from nuclear annihilation'

On 30 May 2018 the Toronto Star published a remarkable article under this title by Nobel Prize Laureate John Polanyi, professor emeritus at the University of Toronto. Professor Polanyi ended his article with the following ideas:

"We have reached a turning point in history. The implications go beyond nuclear weapons. Military force can no longer arbitrate differences between nations. That new truth is becoming discernible.

What will take its place?

Economic force, no doubt. But beyond that, the force of opinion. It can be seen when world leaders resort to writing open letters. They appeal to the court of public opinion.

Simply stated, we have become too good at killing. This obliges us to use our vast new powers for caring."

An example of the power of public opinion was the critical influence of American public opinion in terminating the Vietnam war. An example of what an individual did to stop that war was the courageous action of Daniel Ellsberg in releasing the top-secret Pentagon papers to the newspapers and in participating in anti-war demonstrations.

-10. In Canada: Canadian Pugwash, Science for Peace, and film "Expo 67, Mission Impossible"

Regarding grassroots actions in Canada, the Canadian Pugwash group (ref. 32) was honored in December 2017 when one of its members, Mrs. Setsuko Thurlow, shared the Nobel Peace Prize with Beatrice Fihn who is director of the International Coalition for the Abolition of Nuclear Weapons (ICANW). The Canadian Network for the Abolition of Nuclear Weapons (CNANW, ref. 33) is a member of ICANW. The *Science for Peace* group at the University of Toronto has also been very active on many fronts in addition to nuclear disarmament (ref. 34). We can all rejoice in the thesis advanced by Professor Nina Tannenwald that as members of grassroots movements we have contributed to the nuclear taboo (refs. 17-18).

I now want to give a first example of an important – but sad -- film regarding atomic bomb tests in Nevada, and a second joyful example of actions in the life around us that highlight success obtained through extensive and strong cooperation. Film makers Guylaine Maroist (formerly president of *Artistes pour la paix*) and Éric Ruel published in 2007 a documentary film entitled "Time Bombs" (ref. 35). The film featured 40 Canadian soldiers who were sent in 1957 in Nevada to test their reactions to the explosion of an atomic bomb about one kilometer away. The soldiers had dug a simple trench for protection and had been assured that they would be safe. A short time after the explosion they were ordered to walk to ground zero, in air that was loaded with radioactive dust and debris. That mission was kept ultra-secret for decades until American soldiers, who had participated in the same bomb test, became sick enough to realize that their health had been impaired by radiation in the atomic bomb test. The film helped the few Canadian surviving – but sick -- soldiers to obtain a small

monetary compensation from the Canadian government. The film won the 2008 Golden Ribbon Award given by the Canadian Association of Broadcasters.

The second example is the story of the film *Expo67, Mission Impossible* because it constitutes an outstanding example of what extensive and strong cooperation can achieve in a short time.

Quote from Wikipedia (ref. 36) :

- The creation and organization of Montreal's 1967 universal exposition was a major challenge for the team in charge of its realization. The universal exposition of 1967 was initially supposed to take place in Moscow, but following the Soviet Union's withdrawal in 1962, Montreal became host. The event's organizers only had four years to make Expo 67 into a reality, which was a very short delay for such a massive project. Expo 67 Mission Impossible presents the entire process that led to the opening of Expo 67: the planning, the construction of the islands on which the event would take place, the recruiting of countries that would participate in the exposition, the opening, the success and closing day of Expo 67. Furthermore, the film shows how cooperation between team members of various generations and different backgrounds made this success story possible.

My comments. More and more observers find that an important aspect of human evolution has been cooperation on both a local scale and a planetary one. An example of a great and successful cooperation can be seen in the award-winning documentary film "Expo 67, Mission Impossible" by Guylaine Maroist, Éric Ruel and Michel Barbeau (ref. 36). The degree of cooperation between many different parties was astounding. The sense of participating in an epic is very well rendered in the documentary film. We

can present the nuclear disarmament worldwide effort as an epic that we invite large numbers of persons to participate in.

-11. Bill Gates, Hans Rosling and progress

Author and editor Sarah Begley interviewed Bill Gates in Spring 2018 and wrote about his view of progress in the 3 April issue of Time Magazine (ref. 37, page 23). Bill Gates had just read the late Hans Rosling's 2018 book entitled "Factfulness, Ten Reasons We're Wrong About the World – and Why Things Are Better Than You Think". The conclusion of her article was this recommendation by Bill Gates:

"If you want to improve something, look for ways to build better systems".

I have read Hans Rosling's book. He used his vast knowledge of world statistics to show that remarkable progress has been achieved in many fields, so that you would be justified to be optimistic about the future. Interestingly, however, was an absence in Rosling's book of the coming climate change problem, the ever present danger of nuclear war, and the need to protect our planet from asteroid impacts, the topic of the next section.

-12. Cosmic race to protect our planet from asteroid impacts.

The main reason for this last section is to underline the idea that potential dangers are best faced with action and not by denial. About 66 million years ago a meteorite some 10 kilometers in diameter hit the Earth near Chicxulub in the Yucatan Peninsula, Mexico. The energy produced by its cataclysmic impact was equivalent to millions of hydrogen bombs; note, however, that this asteroid was not radioactive. Some 70% of the species on land and in the oceans became extinct. This is when the non-avian dinosaurs

disappeared. Among the survivors of this massive extinction were the ancestors of primates, one branch of which evolved into us.

Much closer in time, on 30 June 1908, a meteorite about 100 meters in diameter exploded in the atmosphere in a forested area of Eastern Siberia near the Tunguska river, thereby flattening some 80 million trees over an area of 2000 square kilometers. The energy liberated was approximately equivalent to that of a 10-megaton hydrogen bomb, enough to destroy a large city.

Yet closer in time, on 15 February 2013 a meteorite about 20 meters in diameter exploded in the upper stratosphere over Chelyabinsk in Siberia. The energy liberated was equivalent to about 500 kilotons of TNT, ie about 30 times the energy released by the bomb dropped on Hiroshima on 6 August 1945. About 7000 buildings in the Chelyabinsk area were damaged, mostly in the form of broken windows. Over 1000 people were hospitalized. The reason that the damage was light compared to the Hiroshima bomb is that the meteorite's energy was spread out over a trajectory about 100 kilometers in length and was in the form of light and infrared energy, which are harmless. By contrast, gamma rays from an atomic bomb go through walls and are deadly.

The frequency of meteorites being observed in the Earth's atmosphere is surprisingly large: about once a day for a basketball-size one, and about once a year for a car-size one. For a Tunguska type of impact, ie equivalent to the explosion of a 10-megaton Hydrogen bomb, the probability is now estimated to be about 30% per century. On this topic I quote the following from the web site (ref. 38), a text that followed a 90-second video.

The nearly one and a half minute video displayed a rotating globe with the impact points of about 25 asteroids measuring more than one, and up to 600 kilotons of blast force, that struck the Earth from 2000–2013 (for comparison, the nuclear bomb that destroyed Hiroshima was equivalent to about 16 kilotons of TNT blast force). Of those impacts between 2000 and 2013, eight of them were as large, or larger, than the Hiroshima bomb. Only one of the asteroids, 2008 TC₃, was detected in advance, some 19 hours before exploding in the atmosphere. As was the case with the 2013 Chelyabinsk meteor, no warnings were issued for any of the other impacts.

Various space projects are tackling the two issues of detecting and later deflecting so-called Near-Earth-Objects (NEOs) which orbit the Sun and will come close to Earth at certain future times (refs. 38-39). Among the several organizations involved in the planetary protection projects are (ref. 38): NASA (National Aeronautics and Space Administration), the United Nations, the B612 Foundation, and the International Asteroid Warning Network (IAWN).

From the point of view of nuclear disarmament, there are six important features of the asteroid watch projects that are pertinent:

- 1. The NEO projects seek to protect all of humankind and therefore contribute to building up humankind's planet-wide solidarity.
- 2. Given the large potential damage caused by a Tunguska-size meteorite, namely destruction over 2000 square kilometers, national budgets granted to this effort should be much larger than at present. Out of the planet's total annual military budget of 1.5 trillion dollars, why not divert many billions of dollars to a true protection of humankind from asteroids?

- 3. The NEO projects are an example of human collective intelligence and empathy, namely, to build systems to protect all humans and not to kill and/or hurt great numbers of humans.
- 4. An important aspect of NEO projects is their long-term expectation described by a realistic look into a future measured in at least a few decades.
- 5. The cosmic aspect of these projects is important. Humankind has a fascination for space. Bruce Blair has referred to a decision to launch nuclear missiles as one with "cosmic consequences". If you were an astronaut orbiting the Earth, the doorstep to the cosmos, how would you react to seeing nuclear bombs explode over many cities? How would you react to a single nuclear bomb detonation over a city? Astronauts have pointed out that national borders are invisible from space. This could be part of a cosmic awareness.
- 6. The asteroid detection and deflection projects are in a race with the unknown massive objects in space that are potentially on Earth-threatening trajectories. The craters on the Moon, as well as the numerous craters on Earth, are a testimony to the fact that the probability of a large asteroid impact in the twenty-first century is finite and still largely unknown in its magnitude. The aforementioned projects are in a cosmic race to put equipment in place before a suspected but yet unseen kilometer-size asteroid strikes us. That is surely a most important lesson that the dinosaurs which perished 65 million years ago have left us.

Coming back to the nuclear question, a collectively intelligent way to deal with future threats is not to simply deny their existence, as many people now do, but to take measures to reduce and eventually eliminate them. Regarding denial, and as a transition to section 10, I quote here from Elizabeth Zelman (ref. 42, p. 332) :

“If we are to have a future at all, we must acknowledge that changes are happening quickly, that the future is hard to predict, that further change is inevitable, and that denial will only put us deeper into the hole that we have dug (if you’re in a hole stop digging). We have carried our burden of ancient tribalistic tendencies for too long. To move beyond tribalism into a viable future, we need a novel approach.”

A current example of digging deeper the nuclear weapons hole we find ourselves in is the trillion-dollar proposal to “modernize” nuclear weapons and their delivery means over the next 30 years (ref. 1). Such an expenditure would only prolong the present worrisome situation, thus increasing the probability of one or more nuclear detonations.

Conclusion

A great many observers have called for a paradigm shift if humanity is to avoid nuclear war and to solve many planetary problems now facing us. An eloquent plea for a paradigm shift is by author Jeremy Lent (refs. 40-41), who calls for business practices to go much beyond private corporate profit and seek humanity’s benefit. Moreover in his remarkable book ‘The Patterning Instinct’ Lent reviews humanity’s history from the point of view of modern cognitive science. Lent suggests that a critical transition could take place in the near future and propel humanity into a much better state.

Another author, evolutionary anthropologist Elizabeth Crouch Zelman, has published in 2015 a remarkable book ‘Our Beleaguered Species, Beyond Tribalism’ which also suggests that humanity needs to broaden its sense of empathy and extend it to the entire planet (ref. 42).

Broadly-based collaboration has proved itself throughout history. In contrast, unbridled competition, which has taken place in numerous wars, can no longer be allowed to govern our planet. Science and technology have provided us with the intellectual, physical, chemical and biological tools that we need to solve our planetary problems. As John Polanyi wrote "let us use our vast new powers for caring." The genomic point of view can help bring this about.

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T G A A A C G G A G G A G A C G T T A C

A C T T T G C C T C C T C T G C A A T G

Figure 1. The two straight lines symbolize the body or phenotype, while the two rows of letters represent a 20-letter segment of the 118-letter part of a gene, and its complementary segment on the DNA double-helix. If all six billion letters of the size shown were to be drawn, the string would extend from the North to the South poles.