重建世界—基因工程引起的倫理問題《續》

Redesigning the World: Ethical Questions about Genetic Engineering (continued)

易象乾 博士 文 BY RON EPSTEIN, PH.D.
孔果憲 中譯 CHINESE TRANSLATION BY TERESA KUNG

霍京的主張至少還是利人的。在短期內或許更危險的，是所謂「藍圖基因」，及其預期的商業用途，以改造基因來變更我們後代的外表，使能更符合文化的價值觀與潮流。當我們改變了我們後代的眼睛顏色、身高、體重，以及其他身體特徵時，我們又怎麼知道還有什麼也被改變了呢？基因，不是只有單純一對一互應關係的孤立個體。[註19]

一些具體困難

以下幾個例子列舉基因工程目前所作的嘗試，可能會令我們重新思考它所標榜的利益。

基因工程擾亂生態圈的自然生態系統之隱憂

當每年已有估計爲數五萬的生物種類預期會絕種時，任何進一步對自然生態系統平衡的干擾，都可能造成極大的破壞。基因工程改造的生物帶著全新、非自然組合的基因，擁有獨特的能力來擾亂我們的環境。由於它們是活的，能在環z境中繁衍、突變和移動，當這些新的生命型態遷入現有的棲息地時，可能會破壞我們目前所認知的大自然，對我們的自然界造成長遠而無可挽回的改變。[註20]

有過小水族箱的兒童，都知道魚、植物、蝸牛與食物必須保持均衡，水才會澄清，魚才會健康。自然生態系統更複雜，運作方式卻大同小異。不論

Hawking's notions are at least altruistic. Perhaps more dangerous in the short run are projected commercial applications of so-called 'designer genes': gene alterations to change the physical appearance of our offspring to more closely match cultural values and styles. When we change the eye-color, height, weight, and other bodily characteristics of our offspring, how do we know what else is also being changed? Genes are not isolated units that have simple one-to-one correspondences.[19]

SOME SPECIFIC DIFFICULTIES WITH GENETIC ENGINEERING

Here are a few examples of current efforts in genetic engineering that may cause us to think twice about its rosy benefits.

The Potential of Genetic Engineering for Disrupting the Natural Ecosystems of the Biosphere

At a time when an estimated 50,000 species are already expected to become extinct every year, any further interference with the natural balance of ecosystems could cause havoc. Genetically engineered organisms, with their completely new and unnatural combinations of genes, have a unique power to disrupt our environment. Since they are living, they are capable of reproducing, mutating and moving within the environment. As these new life forms move into existing habitats they could destroy nature as we know it, causing long term and irreversible changes to our natural world.[20]

Any child who has had an aquarium knows that the fish, plants,

我們認爲大自然是有意識的，或是無意識的，它都是一個具有自我運作機制和組織的系統。[註21]爲了保障這個系統持久延續，這些機制確保各個重要的平衡態的維持。近來，人爲的極度環境污染，與其他人爲的活動，令這種自我調節機制「吃不消了」。不過，當水族箱出了問題時，我們可以看得出來；同樣的，我們也可以學會對自然的警訊變得敏感，知道自己什麼時候危害到大自然維持平衡的機制。水族箱，我們可以清楚地透視，但在探測非自然，不易觀察到的改變這方面，很不幸，我們的感官有其極限，因此在造成廣泛的破壞之前，我們可能不會察覺到對環境嚴重的危害。

經由「深生態學（deep ecology）」[註22]與「蓋鄂理論（Gaia theory）」的引領，環境系統互動與互倚的性質，得到了大眾的認知。[註22a]我們不再認爲自然界中發生的事件是孤立的，每一事件都隸屬於一個互爲因果的大網，也因而在生態系統中有著廣泛的後果。

如果我們接受生物圈有自我矯正機能的主張，那麼我們必須檢視它們如何運作，和它們結構上的限制。加之於生態圈自我組織系統的干擾愈是強，它的自我矯正就愈猛。認爲各個系統最後必能克服一切，不論威脅有多麼嚴重，此說毫無科學根據。沒有證據顯示生命與人類的福祉，在這些自我組織系統中占有優先權，也沒有證據顯示在這些自我組織系統中，有什麼可以與基因工程改造的生物所可能呈現的威脅相抗衡。爲甚麼呢？因爲這些系統，從未處理過這些生物，本來這些生物是絕不可能以天然的方式構成威脅的。問題的根本，在於許多基因學家否認基因工程改造的生物是偏激的、新的、非自然的生命形態，因此在進化已達平衡的生態圈裡，沒有它們容身的餘地。

濾過性病原體

植物、動物和人類的濾過性病原體，在形成生物圈的生態系統中扮演著重要的角色，有些人認爲它們是進化改變的主要因素之一。濾過性病原體能夠穿透它們寄生主的基因物質、自我分裂，然後與寄生主的基因物質重組，而產生新的濾過性病原體的能力。新的濾過性病原體再感染新的寄生主，從

snails, and food have to be kept in balance to keep the water clear and the fish healthy. Natural ecosystems are more complex but operate in a similar manner. Nature, whether we consider it to be conscious or without consciousness, is a self-organizing system with its own mechanisms.[21] In order to guarantee the long-term viability of the system, those mechanisms insure that important equilibria are maintained. Lately the extremes of human environmental pollution and other human activities have been putting deep strains on those mechanisms. Nonetheless, just as we can clearly see when the aquarium is out of kilter, we can learn to sensitize ourselves to Nature's warnings and know when we are endangering Nature's mechanisms for maintaining equilibria. We can see an aquarium clearly. Unfortunately, because of the limitations of our senses in detecting unnatural and often invisible change, we may not become aware of serious dangers to the environment until widespread damage has already been done.

Deep ecology[22] and Gaia theory have brought to general awareness the interactive and interdependent quality of environmental systems.[22a] No longer do we believe that isolated events occur in nature. Each event is part of a vast web of inter-causality, and as such has widespread consequences within that ecosystem.

If we accept the notion that the biosphere has its own corrective mechanisms, then we have to look at how they work and the limitations of their design. The more extreme the disruption to the self-organizing systems of the biosphere, the stronger the corrective measures are necessary. The notion that the systems can ultimately deal with any threat, however extreme, is without scientific basis. No evidence exists that the life and welfare of human beings have priority in those self-organizing systems. Nor does any evidence exist that anything in those systems is equipped to deal with all the threats that genetically engineered organisms may pose. Why? The organisms are not in the experience of the systems, because they could never occur naturally as a threat. The basic problem is a denial on the part of many geneticists that genetically engineered organisms are radical, new, and unnatural forms of life, which, as such, have no place in the evolutionarily balanced biosphere.

Viruses

Plant, animal and human viruses play a major role in the ecosystems that comprise the biosphere. They are thought by some to be one of the primary factors in volutionary change. Viruses have the

而將新的基因物質轉移給新的寄生主，當寄生主繁殖時，基因的改變就已經產生了。

如果細胞經基因工程改造了，那麼當濾過性病原體進入這些無論是人類、動物或植物的細胞時，部份基因工程改造過的物質，可以被轉移到新產生的濾過性病原體，再傳給這濾過性病原體的新寄生主。我們可以假設，普通濾過性病原體無論有多大的致命力，只要它們是自然產生的，在一個生態系統中都扮演著一個角色，同時也被這個生態系統所管制。當人類將它們帶離它們天然的生態系統，就可能引發問題；無論如何，所有在生態圈內的生態系統，都可以假設是共有著某些防禦的特性，含有基因工程改造物質的濾過性病原體，既然絕不可能來自天然的生態系統，也就無從保證有天然的防禦措施來因應它們。因此，它們可以導致人類、動物或植物大量的死亡，繼而暫時，甚至永久地破壞生態系統。某一種植物突然大量死亡，這絕不會是一樁孤立的事件，這能影響它的整個生態系統。對許多人而言，這也許屬於頗爲理論上的顧慮，而像基因工程改造的濾過性病原體，會導致人類突然大量死亡的這種明確的可能性，或許較會引起廣泛的注意。[註23]

附註：

19. 見前文「何謂基因」項下。

20. 「我們熟悉的世界的結束：環境爲基因工程所付的代價」 http://www.greenpeace.org/~comms/cbio/brief2.html。

21. 這是蓋鄂理論的中心思想，其理論主張整個星球的生態圈，構成一個活的生物體，或自我調節系統。蓋鄂理論家分爲兩個主流派：一派認爲地球是一無意識、自我組織的物質系統；另一派認爲地球有自我意識或覺知。

22. 「『深義生態學』一詞是艾恩・奈斯發明的，來自他一九七三年所發表的『淺與深，長遠的生態運動』文章。奈斯要形容的是一種更深、更靈性化的對待自然的方式…。他認爲此種更深層的方式，源自於對我們本身，及我們周遭非人類的生命，一種更敏感的開放態度。」比爾・德瓦（Bill

ability to enter the genetic material of their hosts, to break apart, and then to recombine with the genetic material of the host to create new viruses. Those new viruses then infect new hosts, and, in the process, transfer new genetic material to the new host. When the host reproduces, genetic change has occurred.

If cells are genetically engineered, when viruses enter the cells, whether human, animal, or plant, then some of the genetically engineered material can be transferred to the newly created viruses and spread to the viruses' new hosts. We can assume that ordinary viruses, no matter how deadly, if naturally produced, have a role to play in an ecosystem and are regulated by that ecosystem. Difficulties can occur when humans carry them out of their natural ecosystems; nonetheless, all ecosystems in the biosphere may presumably share certain defense characteristics. Since viruses that contain genetically engineered material could never naturally arise in an ecosystem, there is no guarantee of natural defenses against them. They then can lead to widespread death of humans, animals or plants, thereby temporarily or even permanently damaging the ecosystem. Widespread die-off of a plant species is not an isolated event but can affect its whole ecosystem. For many, this may be a rather theoretical concern. The distinct possibility of the widespread die-off of human beings from genetically engineered viruses may command more attention.[23]

NOTES:

19. See "What Are Genes" above.

20. "THE END OF THE WORLD AS WE KNOW IT: The Environmental Costs of Genetic Engineering" <http://www.greenpeace.org/~comms/cbio/brief2.html>.

21. This idea is central to Gaian theory, the theory that the entire planetary biosphere constitutes a single living organism or self-regulating system. Gaian theorists are divided into two main camps, those who believe that the earth is a mindless self-organizing physical system, and those who believe that the earth has its own consciousness or awareness.

22. 'The term "deep ecology" was coined by Arne Naess in his 1973 article, "The Shallow and the Deep, Long-Range Ecology Movements." Naess was attempting to describe the deeper, more spiritual approach to nature.... He thought that this deeper approach resulted from a more sensitive openness to ourselves and nonhuman life around us.' Bill Devall and George Sessions, *Deep Ecology: Living as if Nature Mattered* (Salt Lake City: Peregrine Smith Books, 1985), p. 65.

Devall）與喬治・賽遜斯（George Sessions）著，鹽湖城「遊歷斯密斯出版社」（Peregrine Smith Books）一九八五年出版《深義生態學：自然在我心中》第六十五頁。

22a. 雖然「深生態學」與「蓋鄂理論」仍引起許多爭議，但美國的「瀕臨絕種生物方案」及「國家環境政策方案」兩案之立法，表現了對環境系統日漸增加的重視。

23. 首批基因工程師在一九七五年的「艾思路瑪宣言」（Asilomar Declaration）裡，要求頒佈延期法令，正因他們擔憂無意間創造新的濾過性病原體，和細菌病原體。他們最壞的預想可能正在變成現實。商業界的壓力，導致管理章程的製定--多數都是依據未曾經過測驗的假設，所有這些假設已經被當今科學發現所推翻。例如，實驗室中的一組生理上「殘障」的細菌，時常能在自然環境中存活，而與其他的生物互換基因。釋放自死的或活的細胞的基因物質（脫氧核醣核酸DNA），非但沒有快速地分解，事實上反而在環境中存活，並轉移到其他的生物。裸露的濾過性病原體的脫氧核醣核酸（DNA）感染性更強，寄生種類更多；可以抗拒而不被老鼠的腸胃消化，並進入血液感染白血球、脾臟、與肝細胞，甚而可能與老鼠的細胞基因集結合。（「科學家發現基因科技與傳染疾病復活有關。《獨立調查呼聲》。」一九九八年六月四日何梅文[譯音]教授發佈的新聞稿：http://home1.swipnet.se/~w-18472/prhortra.htm。）亦見何梅文[譯音]等著、登載於一九九八年五月刊、第十冊、第一期《健康與疾病的微生物生態學》第三十三至五十九頁的「基因科技與傳染疾病的基因生態」一文。

ᘐ待續

上人語錄 Venerable Master's Dharma Words

❖**知慧即電腦，充實知慧，人具神通。**

❖Wisdom is like a computer. When our wisdom is fully developed, we will be replete with spiritual powers.

22a. Although deep ecology and and Gaia theory are still somewhat controversial, the existence of such legislation as the Endangered Species Act and the National Environmental Policy Act in the United States is indication that there is an increasing awareness of the importance of environmental systems.

◎基因工程擾亂生態圈的自然生態系統

Genetic engineering disrupts the natural ecosystems of the biosphere.

23. The first genetic engineers called for a moratorium in the Asilomar Declaration of 1975, precisely because they were afraid of inadvertently creating new viral and bacterial pathogens. The worst case scenario they envisaged may be taking shape. Commercial pressures led to regulatory guidelines based largely on untested assumptions, all of which have been invalidated by recent scientific findings. For example, biologically "crippled" laboratory strains of bacteria can often survive in the environment to exchange genes with other organisms. Genetic material (DNA) released from dead and living cells, far from being rapidly broken down, actually persists in the environment and transfers to other organisms. Naked viral DNA may be more infectious, and have a wider host range than the virus. Viral DNA resists digestion in the gut of mice, enters the blood stream to infect white blood cells, spleen and liver cells, and may even integrate into the mouse cell genome. ("Scientists Link Gene Technology to Resurgence of Infectious Diseases. 'Call for Independent Enquiry,'" Press Release 6.4.98 from Professor Mae-Wan Ho: <http://home1.swipnet.se/~w-18472/prhortra.htm>).

See also Mae-Wan Ho et. al. "Gene Technology and Gene Ecology of Infectious Diseases" *Microbial Ecology in Health and Disease* 10:1 (May, 1998): 33-59.

ᘐTo be continued