Empedocles to Darwin

Suzanne Roux

How does the diverse variety of well adapted and apparently purposive creatures come about? Charles Darwin and Alfred Russel Wallace answered with their discovery of the theory of evolution by natural selection. More than two thousand years earlier, Greek philosophers had considered this question and in their speculations put forward many of the key concepts of central importance to this great scientific discovery.

Empedocles (c490–460BCE) outlined a four stage system of evolution of living things. The system begins with the spontaneous generation of anatomical parts and ends by the chance combination of parts resulting in "whole-natured forms".

Aristotle rejected Empedocles' claim that "whole-natured" creatures were generated by the chance combination of parts. He argued that chance may account for occasional events in nature but any consistent and regular events are not due to chance but purpose. For Aristotle, all natural events and objects have a purpose and that purpose is to achieve its end form.

> *It is interesting to contemplate an entangled bank, clothed with many plants of many kinds, with birds singing on the bushes, with various insects flitting about, and with worms crawling through the damp earth, and to reflect that these elaborately constructed forms, so different from each other, and dependent on each other in so complex a manner, have all been produced by laws acting around us* (Darwin, [1859] 2003:397).

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When we see the world filled with living things all seemingly well adapted to their environment the questions arises: How does that diverse variety of well adapted and apparently purposively constructed creatures come about?

Early Greek philosophers reflected on this problem and, whilst observing the world around them, attempted a naturalistic answer rather than the mythical interpretation of earlier days. The Milesian philosopher, Thales (circa 600 BCE) is credited as the first of the Ancient Greeks to seek for laws and principles that might govern the natural world rather than the actions of gods. Following Thales, others reflected on the origins of the universe and on the origins and diversity of organic life.[1] Two opposing answers to the question about the origin of life have been produced; the teleological solution, whereby life as we know it is purposively designed either by an external creator or from within the very nature of the species;[2] and the chance scenario, in which the many and varied life forms have been produced as the result of chance and there is no purpose in them.

1 Anaximander claimed that life was spontaneously generated and that humans grew as embryos in fish-like creatures. At puberty they burst forth able to nourish themselves.

2 Plato expounded an external teleology in which all organic life was initiated by a divine creator, whereas Aristotle proposed an immanent teleology in which all species and individuals of that species possessed an immutable essence, an unchanging character, which was the thing's nature, and it was this very nature which was the cause and the purpose of that individual and the species.

Empedocles and the origin of species

Empedocles (c. 492–432 BCE) claimed that the origin of living things well adapted to their environment was a matter of chance. According to W. C. Guthrie, Empedocles embodied the transitional age between myth and science.

> His outlook is at times so rational and scientific, and at others so steeped in poetry and mystical religion, that scholars have argued endlessly over the question whether he kept his science and his religion in separate compartments of his mind (Guthrie, 1957:42).

There are more than 2,000 fragmented lines of Empedocles' work as well as references to Empedocles in Plato, Aristotle and others which comprise all we know of Empedocles' cosmogony and zoogony.

Empedocles held that the primary elements of the universe were earth, air, fire and water which were eternal. They were not created nor could they be destroyed, and nothing else could be created. The combination and separation of these elements enabled all the substances in the world to be formed. Love is the principle by which the substances are combined and Strife is the principle by which they are separated. Thus the four eternal elements and the two motive forces of Love and Strife constitute the whole of the world:

> From these things sprang all things that were and are and shall be, trees and men and women. Beasts and birds and water bred fishes, and the long-lived gods too, most mighty in their prerogatives. For there are these things alone, and running through one another they assume many a shape; so much change does mixing effect (Kirk and Raven,[3] 1957:328–29).

The gods did not create Empedocles' universe, as the gods, like the universe and all living creatures are a combination of the four primary elements. The power to form all substances was vested in the primary

[3] I have used the translation of Empedocles' fragments in this work, *The Presocratic Philosophers,* by G. S. Kirk and J. E. Raven.

elements moved by the principles of Love and Strife.

Empedocles introduced a four stage cycle of the evolution of organic life, clearly described by the Greek doxographer Aetius:

> Empedocles held that the first generation of animals and plants were not complete but consisted of separate limbs not joined together; the second, arising from the joining of these limbs, were like creatures in dreams; the third was the generation of whole-natured forms; and the fourth arose no longer from the homoeomerous substances such as earth or water, but by generation, in some cases as the result of the condensation of their nourishment, in other, because feminine beauty excited the sexual urge; and the various species of animals were distinguished by the quality of the mixture in them (Kirk and Raven, 1957:336).

Empedocles claimed that spontaneous generation of animal parts occurred when love was in ascendancy and the separate primary elements of earth, air, fire and water combined to form animal parts:

> Here sprang up many faces without necks, arms wandered without shoulders, and eyes strayed about alone, in need of foreheads (Kirk and Raven, 1957:336).

During this first stage the combination of the four elements was such that fragments of animals were formed by spontaneous generation.[4] It is not necessary to read this passage as suggesting that these fragmented parts were sentient, that eyes wandered in search of foreheads and arms wandered the world looking for shoulders, but rather that these incomplete parts were spontaneously generated.

In the second stage a new and important element, chance, is introduced to explain the diversity of species in the cycle of life:

> But as one divine element mingled further with another, these things fell together as each chanced to meet the other, and many other things beside were constantly resulting (Kirk and Raven, 1957:337).

[4] The belief in the spontaneous generation of life was held by many until the end of the Middle Agest and was finally put to rest by Louis Pasteur in 1862 when he presented his *Memoir on the Organized Corpuscles which exist in the Atmosphere* to the French Academy of Science.

More complete creatures are generated, not purposively, but by chance. Empedocles makes clear that as the primary elements combine in different proportions many different creatures are formed. Varying proportions of the primary elements generate all types of creatures and a period of monsters and deformities commenced. Strange creatures, such as centaurs, minotaurs and harpies, all compounds of human and animal parts abound in Greek mythology. Empedocles, it seems, was accounting for these creatures in his explanation of the origin of species. The four elements are combined and separated by the principles of Love and Strife, and there is no suggestion that there is any intent or purpose by these motive forces to generate any particular types of creatures. Love and Strife are eternal principles without purpose or intent, the creatures are formed by chance:

> Many creatures were born with faces and breasts on both sides, man-faced ox-progeny, while others again sprang forth as ox-headed offspring of man, creatures compounded partly of male, partly of the nature of female, and fitted with shadowy parts (Kirk and Raven, 1957:337).

During the third stage the chance combination of the four elements produced "whole-natured forms". The combination of elements, that spontaneously generated monsters and deformities, then combined in different proportions to generate creatures that were so well fitted together and well adapted that they survived, whilst those monsters and deformities, less well adapted, perished.

Simplicius, who wrote in the sixth century C.E., provides a clearer picture of the Empedoclean view of the origins of the species in which random combination and arguments for natural selection are clearly expounded:

> Empedocles says that during the rule of Love first of all there came into being at random parts of animals such as heads, hands, feet, and then there came together those 'oxen with the heads of men', 'and conversely there sprang up', naturally, 'men with the heads of oxen', that is, compounded of ox and man. As many of these parts as were fitted together in such a way as to ensure their preservation became animals and survived, because they

> fulfilled mutual needs — the teeth tearing and softening food, the stomach digesting it, and the liver converting it into blood. The human head, when it meets a human body, ensures the preservation of the whole, but being inappropriate to the ox-body it leads to its disappearance. All that did not come together according to the proper formula perished (Guthrie, 1965:204).

Well adapted organisms survived. Their well adapted forms had come together by chance not by design, they were naturally selected.The generation of whole natured forms able to survive depended on the chance combination of fragments which were well adapted both to the needs of the whole creature and to the environment. The account of the origin of species by Empedocles is the first recorded account of the theory of natural selection.

At first the "whole-natured forms" that survived were not sexually distinct and so could not reproduce:

> First sprang up from the earth whole-natured forms, having a share of both water and fire; these the fire sent forth, desiring to reach its like, showing forth as yet neither the lovely form of the limbs, nor the voice nor the organ proper to men (Kirk and Raven, 1957:338).

In the fourth stage, the sexes become distinct and begin to reproduce. It is said to be the stage in which we now live.

Empedoclean zoogony discounts divine intervention and accounts for the existence of living things well adapted to their environment by natural means. He claims that species are formed by the chance combination of animal fragments and that those that are best adapted, survive and reproduce. However the Empedoclean account begs the question: How is it possible that such an abundant and diverse variety of well adapted creatures are generated at one time by chance and are then reproduced in a different way?

Plato's teleology

Can an answer be found in the works of Plato (c. 428–348 BCE)? Plato's account of the world's origins is made clear in the *Timaeus*. He

argues that the world is not eternal but "has come into being [...] all that has come into being or changes must do so owing to some cause" (28d).[5]

Plato claimed that there was a form or pattern from which the world was modelled and it was this form that was eternally unchanging and could only be apprehended by intelligence and reasoning. It is that which always is, whereas the world is an object of opinion and irrational sensation and is that which is always becoming but never is. Initially Plato distinguishes two forms of reality, an eternal and unchanging model and a visible and changing copy of it. Later on he adds a third form which even he describes as difficult and obscure. He calls this the third form the "Receptacle of Becoming" (48e–49a) though later on he refers to it as space which, like the first form of reality, is eternal and provides a situation for all things that come into being.

Unlike the Christian god who created the universe and all matter from nothing, Plato's demiurge (god) found chaos and transformed it from disorder to order; his purpose being to create a universe modelled on the highest and most completely perfect of intelligible things. As such Plato argues it cannot have a double and it resembles the perfect living creature in being unique and is and will continue to be his only creation.

The universe began when the demiurge formed the world out of chaos. The demiurge is akin to a craftsman who uses his skill to model and shape the material to the likeness of some ideal. Plato claims that the demiurge has reason and intelligence that the demiurge is good and he continues that it was because of this goodness that he created the world as like him as possible, both good and perfect. Order was better than chaos, so he created an ordered world; intelligence was superior to that without intelligence, so intelligence was part of creation. However Plato added that intelligence is impossible without soul, thus reason and soul was implanted in the universe:

5 The normal convention of referring to passages in Plato has been followed — i.e. page numbers and column letters of the standard edition of the works edited by Stephanus. These page numbers and column letters are repeated in Plato, 1965.

> And so the most likely account must say that this world came to be in very truth, through god's providence, a living being with soul and intelligence (Plato: 30b).

Plato claimed that the four primary elements used by the demiurge to create the world were earth, and fire and air and water.[6] Although the world was made of these four elements, in Plato's view they were not eternal but were created to form order out of the chaos. The world was modelled on an eternal and unchanging form and, in order to complete the model, living creatures had to be brought into existence within the world.

He further contends that there are four types of living creatures to be created, the gods, the birds, the water animals and the land animals. First the demiurge creates the gods, which are the heavenly bodies and then the gods or daemons, and not the demiurge, create humankind. Plato maintains that if the demiurge created humans then they too would be gods. In what may be seen as retro-evolution, man is created first and

> later on women and other animals would be produced from men, and that many creatures would need claws and hoofs for different purposes; so they provided the rudiments of them in men at their first creation, and for this reason and by these means caused skin, hair and nails to grow at the extremities of the limbs (Plato: 76d–77).

These original creations are so made that the rudiments of other species were already formed within them. It seemed the creator was already prepared to transform humans to other species. First man was created. However those men who were cowardly or immoral were reborn in the second generation as women and by creating man and woman, the gods, according to Plato, had constructed the desire for sexual intercourse and the ability to reproduce.

Plato further expounds on his retro-evolution. Humans who were empty-headed and harmless were transformed or degraded

6 These are the same primary elements used by Empedocles in his cosmogony.

from human to bird. Their witless nature led to the growth of feathers instead of hair. The lack of use of their intelligence resulted in a physical transformation. The less the intelligence the greater was the degradation. The most foolish and ignorant of all were transformed to animals that lived in water, as they were not considered worthy of breathing air. Plato's retro-evolution depends on behaviour. It is a behavioural trait which causes the flawed humans to mutate or transform into another species. In 1809 Jean-Baptiste Lamarck proposed evolution of the species by the inheritance of acquired characteristics in his *Philosophie Zoologique*:

> it is the habits, mode of life and the other influences of the environment which have in the course of time built up the shape of the body and of the parts of animals. With new shapes, new faculties have been acquired and little by little nature has succeeded in fashioning animals such as we actually see them (Lamarck, [1809] 1984:127).

Plato suggests species transformation is dependent on behavioural characteristics and the "mutation" was divinely directed not one that gradually evolved.

A. E. Taylor (Taylor, 1962:640), notes that Plato was not suggesting that his cosmology was an exact science but that it was akin to myth. Further he adds that Plato's account of the origin of species is frivolous and not the words of a man who is wholly serious.[7] Plato may have used the Timaeus to promote a seemingly mythological account of the origin of the universe and the origin of species, but, as Paul Feyerabend (Feyerabend, 1999:57) argues a myth is not merely an imaginative story or poetry that is superimposed on the facts, a good

[7] Professor Taylor argues that Plato does not necessarily accept the cosmogony as outlined by Timaeus but it is an account of the nature of the world belonging to a fusion of Pythagorean and Empedoclean views. This view is rejected by Francis Macdonald Cornford (Cornford, 1937:viii–ix) arguing that it was difficult to see why the greatest philosopher of the time would waste his time not on what he thought but on a pastiche of views with which he disagreed. The question must be asked of Professor Taylor — why does the *Timaeus* put forward one view whilst Plato holds another?

myth is one that will be able to cite many facts in its favour and it will be supposed that it is in agreement with the facts. Plato's account is a valuable addition to the body of literature concerned with the origin of species. As Gordon Campbell writes:

> There can be few more influential works on cosmogony and zoogony than Plato's Timaeus (Campbell, 2000:1).

Aristotle rejects Empedocles

The notion of chance implies an absence of purpose and it is this lack of purpose in Empedocles' zoogony that is rejected by Aristotle. In *On Physics,* Aristotle asks

> What is wrong with the idea that nature does not act purposively and does not do things because they are better?
>
> [...] Take teeth, for instance: what is wrong with the idea that the front teeth necessarily come through sharp and suitable for biting, and the back teeth flat and good for crushing food? Why should there be purpose behind this? And the same thing could be asked about any other part of the body which seems to have some purpose?
>
> [...] So where every part turned out to be just as it would have been if it had had some purpose, the creatures survived because, spontaneously, they happened to be put together in a useful way. But everything else has been destroyed and continues to be destroyed, as Empedocles says, of his cow-like creature with the heads of men
>
> [...] It is impossible for this (meaning by chance) to be the way things are. The point is that the things mentioned (teeth etc) turn out as they do either always or usually, and so does every other natural object, whereas no chance or spontaneous event does.
>
> [...] It follows that purposes are to be found in natural events and natural objects (Aristotle: 198 b23–99 a8).[8]

[8] I have followed the normal convention whilst referring to passages in Aristotle, which is to refer to page numbers and column letters of the standard edition of the works of Aristotle, edited by Bekker. These page numbers and column letters are repeated in Aristotle, 1996.

Aristotle rejects Empedocles' claim that creatures were spontaneously generated by chance and that "whole-natured forms" survived because, by chance, they were well adapted. He argues that there is an unchanging character in all natural objects and although some adaptations could eventuate occasionally by chance, when they are produced regularly and consistently it cannot be due to chance, it must be that they happen purposively. According to Aristotle all natural events and objects have a purpose and that purpose is to achieve its end form:

> The end is form and everything else takes place for the sake of the end, it is this form that is the cause, since it is that for which everything happens (Aristotle: 199a26–a33).

Aristotle argues that the end result is the purpose of natural processes so that all natural objects and events are predicated as achieving this end. "A thing's nature is its cause": the purpose for each natural object or event is inherent in its nature. Aristotle argues for an internal teleology unlike the external teleology espoused by Plato; the cause or purpose is directed by the nature of the natural object.

Aristotle raises a further objection to Empedoclean speculation when he argues that combinations such as "cow-like creatures", which were incapable of achieving an end (they perished), must have been produced because of a defect in their original source, just as defective seeds are responsible for deformities today. Aristotle held that creatures couldn't spring into existence; the "seed" must come first. Robin Waterfield (Aristotle: Introduction, xxvii) holds the view that Aristotle presents Empedocles with a dilemma: either species breed true, or they do not. Aristotle holds that they do. If they do, then Empedocles cannot claim that there was a spontaneous generation of species as they could only come from the seed of parents of like kind. If they do not then Empedocles must present an argument as why they have bred true thereafter. Empedocles did not recognise the dilemma as he simply held the view that species were spontaneously generated but thereafter bred true.

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Aristotle claims that there is an unchanging character in all natural objects. He presents a teleological view quite different to that of Plato. Whereas Plato argues that the purpose or the cause of all natural objects is provided by the gods, Aristotle places the purpose or the cause within the form of the natural object and claims that it is inherent in the object.

Darwin and Wallace

More than 2,000 years later Charles Darwin and Alfred Russel Wallace provided an answer to the question: How does the diverse variety of well adapted and apparently purposively ordered creatures come about? The answer was evolution by natural selection without divine intervention.

In November 1859 Darwin's *On the Origin of Species* was published and in it he wrote:

> If variations useful to any organic being ever do occur, assuredly individuals thus characterised will have the best chance of being preserved in the struggle for life; and from the strong principle of inheritance, these will tend to produce offspring similarly characterised. This principle of preservation, or the survival of the fittest, I have called Natural Selection (Darwin, [1859] 2003:175).

Darwin and Wallace argued that chance variations in organic beings produced useful characteristics which could benefit certain individuals so that they would be better adapted than others to their environment. These characteristics would be passed on to their offspring who would also be better adapted to their environment. In the struggle for survival those individuals better adapted would be more successful and thus would have a greater chance of survival and of reproduction.

The Darwin/Wallace theory of natural selection can be simply outlined as

1. Variations occur in all organic life, these are not designed for a purpose but occur in nature by chance.

2. These variations are often inherited by their offspring.

3. There is a struggle for existence as more offspring are produced than can survive.

4. If variations occur which give an organism a better chance, even a slightly better chance to survive, then these organisms will survive and reproduce more successfully than those organisms without such variations, that is they will be naturally selected.

The Greek reply

Plato espoused a teleological view of the origin of life and of species. The universe was created by the Demiurge who instructed the lesser gods to create men and then proceeded to direct the transformation of men of lesser intellect into women, birds, land animals and water animals along a decreasing scale of intelligence. The retro-evolution of Plato resonates with Lamarck's view that the diversity of species was the result of evolution through the inheritance of acquired characteristics.

Empedocles, on the other hand, incorporates no teleological view and puts forward the understanding that life is spontaneously generated, first as animal fragments and then later as "whole-natured forms." The spontaneous generation of life was widely held until at least the end of the Middle Ages.

The Empedoclean cycle of life introduces a four stage cycle of life. In each stage there is no gradual evolution but rapid and spontaneous generation of life; firstly animal fragments, then deformities and monsters, which perished, then "whole-natured forms". The well adapted survived and were no longer spontaneously generated but began a process of sexual reproduction. Empedocles introduced the notion of chance into nature but offered no credible explanation for well adapted whole natured forms being spontaneously generated at one time and reproducing in a different way at a later time.

Aristotle rejected chance as he argued that chance may account

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for occasional events in nature but any consistent and regular events cannot be chance events but must be purposive. Aristotle also argued that species breed true and are immutable.

Plato expounded a type of evolution; Empedocles introduced the notion of chance in nature and the idea of natural selection; and although Aristotle rejected chance he argued that like reproduced like, that species breed true. So although evolution, heritability and natural selection were speculations considered by those early Greek philosophers, it was never the case that the idea of a gradual transformation of species could occur by the inheritance of naturally selected chance variations. It was two thousand years later, after the scientific revolution and the explosion of knowledge about geology, fossils and the biogeography of the world, that Darwin and Wallace combined the notions of evolution, chance in nature and heritability and answered the question: How does the diverse variety of well adapted and apparently purposive creatures come about? The answer they gave was evolution by natural selection.

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Bibliography

Aristotle

Aristotle, *Physics.* Trans. Robin Waterfield. Oxford: Oxford University Press,1996.

Campbell, 2000

G. Campbell, "Zoogony in Plato's Timaeus". In *Reason and Necessity Essays on Plato's Timaeus*, ed. M. R. Wright: 145–80. London: Duckworth and The Classical Press of Wales.

Cooper, 1987

John Cooper, "Hypothetical necessity and natural teleology". In *Philosophical Issues in Aristotle's Biology,* ed. A. Gotthelf and J. Lennox: 243–74. Cambridge: Cambridge University Press.

Cornford, 1937

F. M. Cornford, *Plato's Cosmology.* London: Routledge and Kegan Paul.

Darwin, [1859] 2003

Charles Darwin, *On the Origin of Species by means of Natural Selection,* ed. Joseph Carroll. Ontario: Broadview Texts.

Darwin, 1958

Charles Darwin, *The Autobiography of Charles Darwin,* ed. Nora Barlow. London: Collins.

Feyerabend, 1999

Paul Feyerabend, *Paul K. Feyerabend: Knowledge, Science and Relativism.* Cambridge: Cambridge University Press.

Guthrie, 1957

W. K. C. Guthrie, *In the Beginning.* London: Methuen.

Guthrie, 1965

W. K. C. Guthrie, *A History of Greek Philosophy, Vol II.* London: Cambridge University Press.

Kirk and Raven, 1957

G. S. Kirk and J. E. Raven, *The Presocratic Philosophers.* Cambridge: Cambridge University Press.

Lamarck, [1809] 1984

J. B. Lamarck, *Zoological Philosophy.* Chicago and London: University of Chicago Press.

Mayr, 1991

E. Mayr, *One Long Argument.* Cambridge, Massachusetts: Harvard University Press.

Plato

Plato, *Timaeus.* Trans. Donald Lee. London: Penguin, 1965.

Taylor, 1962

A. E.Taylor, *A Commentary on Plato's Timaeus.* Oxford: Clarendon Press.