

From Natural Selection to the Sentient Symphony of Life: A Chaotic Reading of Wertenbaker's *After Darwin*

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ABSTRACT

Darwin's theory of evolution was shaken to the core by the discovery of the second law of thermodynamics and entropy. While it accentuates that the world has evolved from simple to complex, and it moves from disorder to order, the second law preaches the opposite totally. Such inconsistency remains unsolved until the advent of chaos theory, which emphasises that the universe has the capacity to renew itself from within through a process called self-organisation. As a new paradigm shift in science, it pushed scientists to re-read Darwinism from an entirely different perspective. The paper intends to trace the various interpretations of Darwinism in Timberlake Wertenbaker's *After Darwin* (1998) through characters' responses to evolution, utilising chaos theory as a theoretical and methodological framework. The play, which offers a Darwinian-Dawkinsian vision of competition, ends by embracing Margulis and Sagan's view of cooperation inspired by the new science of chaos. As the only species endowed with an independently functioning brain, Man is able to adapt and turn the table against the brutality of natural selection to establish his own values.

Keywords: evolution theory; thermodynamics; entropy; chaos theory; self-organisation

INTRODUCTION

The universe is not made, but is being made continually. Henry Bergson

THE STORY OF CHAOS AND ORDER

Since the dawn of civilisation, humanity tended to adopt order and reject chaos as something undesirable and evil. From Hesiod to Plato to Newton, the Western mentality was shackled by the metaphysical dualism and reductionism: to dissect and see things in simple dichotomies. To the West, chaos was "associated with the unformed, the unthought, the unfilled, [and] the unordered" (Hayles, 1990, p. 19). At this juncture, chaos was not the

opposite of order but had no relation to order at all. Such a view was enhanced by Newtonianism which presented a clockwork model of a universe reigned by the unchangeable laws of cause and effect. Due to the discovery of the second law of thermodynamics and entropy during the 1850s, chaos was recognised as the opposite to order. It is no longer that formless matter existed in the universe before creation. However, it is still situated in the same semantic network of chance and randomness. Thermodynamics along with quantum physics shifted the focus from order to disorder. They shattered Western intellectual sureness in Newtonian ordered, deterministic and predictable model that had ruled since the Enlightenment. While chaos theory is still almost a century ahead, these discoveries made chance, disorder, and uncertainty functioning words in describing the universe. They presented disorder as the law of nature and offered nothing but pessimism and purposeless life.

Conversely, chaos theory introduced a nonlinear dynamic view of the world that embraces both order and disorder, and, like order, the disorder has a structure, too. To theorist N. Katherine Hayles (1991), there are two views towards chaos. Chaos “may have a deep structure of order encoded within it” or chaos may lead “to order, as it does with self-organising systems” (p. 3). The first is well presented in James Gleick *Chaos: Making of a New Science* (1987) and the second is well revealed in Ilya Prigogine and Isabelle Stengers *Order out of Chaos: Man’s New Dialogue with Nature* (1984). The key concepts tackled by Gleick are the butterfly effect, strange attractors and recursive symmetries. The butterfly effect sheds light on one of the key facets of chaos: tiny, insignificant changes in the input may lead to dramatic consequences in the output. The other two concepts, i.e. strange attractors and recursive symmetries reveal the second facet of chaos: there is an order in seeming disorder. Equally, the key idea Prigogine and Stengers emphasised on is self-organisation. Chaos can beget order without any intervention from outside. It is entirely an internal process. At this stage, chaos is no longer seen as a dustbin into which man tosses things he cannot comprehend. It is a partner of order. It promotes a universe that can combine both order and disorder, and, it also embraces a holistic, not a dualistic, reductionistic view towards life.

Thus, it is widely spread and utilised in different disciplines, including literary studies. To Wilcox (1996), owing to the similarity between modern scientific enquiries and postmodern performance techniques characterised by repetition, juxtaposition and fragmentation, the science of chaos can provide not only a methodology, but also a mindset to probe productions “fall outside the boundaries of traditional theatre criticism” (p. 708). *After Darwin*, in fact, is not structured around a traditional storyline where events are fitted chronologically and spatially into a linear causal process rather introduced in a disordered fashion. This is why it appears chaotic to a casual observer. Hence, chaos theory is deemed to be an appropriate method to probe this notable drama as elaborated on in the method section.

CHAOS BEGETS ORDER: THERMODYNAMICS AND EVOLUTION THEORY

Thermodynamics describes the relation between heat and other various forms of energy. While the first law of conservation stresses that the full quantity of energy will stay the same, the second law of dissipation affirms that the quality will not. Some energy will be lost. The second law depicts our universe as a one-way street moving in one direction from order to disorder. Such process, called entropy, is unavoidable and irreversible. It promises nothing but death and dissipation. It undermines Newton’s clockwork model; how the world works, and Darwin’s interpretation: how it evolved. It states openly that an eternal machine is just a myth, and the fate of the universe is heat death. John Gribbin (2004) sums it up poetically:

“all the energy will end up as heat, and all the temperature differences will smooth out to leave a bland and featureless system where nothing interesting happens” (p. 25).

While 19th-century biologists believe that the universe is evolved from simple to complex and moves from disorder to order (Capra, 1996), the second law reveals it is heading down towards disorder and dismantling. Such a dilemma remains stable until recently when some chaologists look back over the second law in the light of recent discoveries in science and the concept of negentropy. Negentropy or negative entropy indicates that life as an open system can decrease its entropy by feeding on negentropy obtained from the environment. The pioneer of this field is Ilya Prigogine whose research on dissipative structures during the 1960s and 1970s expound how it is possible for the disorder to create an order.

To Prigogine (1984), the order can emerge from disorder in the form of dissipative structures through a spontaneous process called self-organisation: a sort of behaviour in an open system that expels or dissipates entropy into environments and imports negentropy, life-producer. It is entirely an internal process without any influence from the outside. Prigogine states that “in far from equilibrium conditions, we may have transformation from disorder, from thermal chaos, into order” (p. 12). He utilises the new mathematics of chaos, as Capra (1996) emphasises, to reassess the second law by drastically “rethinking traditional scientific views of order and disorder.” It ultimately helps “him to resolve the two contradictory nineteenth-century views of evolution” (p. 49).

In classical evolutionary biology, irreversibility is not possible and time moves from the past to the future; however, Prigogine’s research proves the opposite. Irreversibility is quite possible because it is an intrinsic feature of the matter. To Hayles (1991), self-organisation was known to the people of the 19th-century, but it is Prigogine’s efforts that put it “in a context that suggested the universe has the capacity to renew itself.” Under certain circumstances, systems of high entropy can “engage in spontaneous self-organisation” process. Entropy here is depicted as driving force “toward increasing complexity rather than toward death” (p. 13). To Capra (1996), Prigogine’s genius concept of dissipative structures has introduced a radical shift by revealing how “dissipation becomes a source of order” in an open system (p. 89).

Two brilliant minds support Prigogine’s innovative concept. Physicist, cosmologist, and astrobiologist Paul Davies in *The Cosmic Blueprint* (1988) shows a firm belief in order come from chaos. He states: “it is possible for the universe to increase both organisation and entropy at the same time”. He adds that these pessimistic and optimistic “arrows of time can co-exist” as our world is capable of displaying “creative unidirectional progress even in the face of the second law” (p. 85). Similarly, theoretical biologist Stuart Kauffman asserts that life is the product of both natural selection and self-organisation. He employed the edge of chaos concept to explain self-organisation. He argued that biological systems move naturally to the brink of chaos where complexity and change can thrive. The edge of chaos, the border zone between order and disorder, can secure sufficient disorder to generate new information and to allow evolution to take place. In his seminal book *At Home in the Universe* (1995), Kauffman argues that natural selection is not the only tool of order. Life is so complicated and cannot be determined by one factor. Like Prigogine and Davies, he believes that man is in “need to paint a new picture,” and to reread previous assumptions (p. 9).

These three accounts place emphasis on a holistic view of life: instead of looking at the parts, one needs to focus on how these parts interact. They also promote self-organisation as a process that leads to the emergence of order out of chaos, casting light on the edge of chaos as a phase transition where chaotic behaviour can take place. Finally, they present a reconciliatory suggestion that the relation between order and chaos is a complementary one. To Longa and Lorenzo (2014), natural selection and self-organisation are not “rival evolutionary mechanisms, [but] complementary pieces or a single multifaceted process” (p.

131). Likewise, American physicist James P. Crutchfield (2011) strongly argues that chaos is very necessary for life as an entirely “ordered universe... would be dead” (p. 23).

All in all, the problem posed by the second law has finally found a solution with chaos theory that reveals entropy as an essential positive characteristic of open systems. Hayles (1990) argues that entropy is a creative element in an open narrative scheme as well. It reverses the implication of entropy in producing order and meaning not only in science but also in literary criticism. It is a constructive feature rather than a destructive negative one. Critics argue that the same principles rule the conduct of an open biological system can be applied to social ones. Such view is highly supported by a number of scientists who agree that this concept is applicable for both. Paul Davies in *The Runaway Universe* (1978) states clearly that the history of humanity “is a story of the struggle to preserve order against the natural tendency to collapse into disorder” (p. 16). Brooks and Wiley in *Evolution as Entropy* (1988) emphasise that “behaviour embodied in the second law of thermodynamics” is not only restricted to science, but also can extend to social life (p. xiii). Marcelo Alonso (1990), as well as Prigogine and Stengers (1984), believes that both the living and social systems are open and can exhibit a self-organising behaviour.

MODERN TO POSTMODERN BIOLOGY: LADDER VS. BRANCHING BUSH AND SYMPHONY OF LIFE

The huge advancement in science and the discovery of the DNA pushed the scientific community to reconsider seriously the essential elements of Darwinian orthodoxy. By the mid-1960s, biologists began to view things in terms of dynamic complexity. They started to incorporate ideas like complexity, holism and self-organisation into their models. In modern and postmodern periods, biologists have modified Darwinism in the light of these new findings and discoveries. The most prominent figures are Richard Dawkins, Stephen Jay Gould, Margulis and Sagan.

In *The Selfish Gene* (1976) Richard Dawkins, the leading figure of modern evolution, presents a gene-centric view. His model places genes at the centre of evolutionary theory. He states that natural selection works at the level of the genes and the living organisms are only “survival machines, robot vehicles blindly programmed to preserve the selfish molecules known as genes” (p. xi). These genes are selfish, and their primary goal is just to copy their blueprints to survive. The genes, he adds, control us, “not directly with their fingers on puppet strings, but indirectly like the computer programmer” (p. 52). Dawkins also introduces the concept of memes: a bundle of cultural information passes from one generation to another utilising the same mechanism of evolution. Thus, we are not only programmed genetically, but culturally as well. He describes them as the ““ideas, catch-phrases, clothes fashions, ways of making pots, or of building arches.” Like genes, their survival relies on replication. He asserts, like genes, that “propagate themselves in the gene pool by leaping from body to body via sperms or eggs, so memes propagate themselves in the meme pool by leaping from brain to brain via a process... called imitation” (p. 192). However, Dawkins also confirms that we are the only species endowed with a brain that can work independently. Hence, man can challenge not only “the selfish genes of [his] birth,” but also “the selfish memes of [his] indoctrination.” He admits that: “We are built as gene machines and cultured as meme machines, but we have the power to turn against our creators.” He concludes that “we, alone on earth, can rebel against the tyranny of the selfish replicators” (pp. 200-201).

Stephen Jay Gould in *Wonderful Life* (1989) introduces a different reading for evolution. He presents chance, not fitness as a decisive factor in evolution. The long-established view that some species survived because they were well-adapted cannot work anymore, especially in a universe ruled continuously by natural disasters. He states that there

is no shred of evidence that the losers in the mass annihilation were inferior “in adaptive design to those that survived” (p. 236). To Gould, it is highly difficult to tell in advance which pathway species would take owing to the unpredictable nature of natural phenomena. Thus, he adopted a third path: evolution is neither deterministic nor pure random: it is a determined chance. The third choice reveals that man cannot predict the future depending on knowledge of past due to evolution’s sensitivity to initial conditions, a concept quoted from chaos theory. The catastrophe motif he presents affirms not only the role of chance, but also questions the Darwinian concept of gradualism. The Darwinian metaphor of the ladder, upward linear movement, is replaced by the metaphor of the branching bush. In Gould’s views, it is more precise in revealing nature’s indifference. He states that “life is a copiously branching bush, continually pruned by the grim reaper of extinction, not a ladder of predictable progress” (p. 35). The man is just “a tiny twig on an improbable branch of a contingent limb of a fortunate tree” (p. 291). He believes that massive extermination had the upper hand in steering evolution. Briefly, to Gould, survival relies mainly on luck than on fitness.

Margulis and Sagan in *What is Life?* (1995) reveal life as a phenomenon relies basically on cooperative interaction rather than competition. Unlike Dawkins and Gould, they provide a holistic vision, presenting “life resembles a fractal” iterated continually over billions of years at different levels of complexity and organisation (p. 4). Man is just a tiny part of the cycle of life, and none of these parts is given a special status. Man is neither an end (Darwin) nor branch (Gould) of the evolution process. As he benefits from food, bacteria benefit from him, too. They argue that “The gulf between us and other organic beings is a matter of degree, not of kind” (p. 222). They also criticise the Western mentality as it is shackled to the notion of “metaphysical dualism” (p. 48). Such a mindset prefers to see life in simplistic dichotomies, i.e. human/nonhuman, living/non-living, mind/body, spirit/matter, etc. They believe it is the reason why we cannot comprehend the complexity of life. They recommend viewing life as an extensive dynamic process.

To conclude, the main difference between Darwin-Dawkins interpretation of evolution and that of Gould and Margulis and Sagan is that; while the first is deterministic, linear and reductionist, the second is indeterministic, nonlinear and holistic. Gould gives natural catastrophes and chance a significant role in evolution. He also tries to secure a middle-ground between determinism and chance by introducing contingency as an all-embracing term. To Gould, it is impossible to predict a long-term direction of evolution as initial conditions are beyond one’s control. Margulis and Sagan, on the other hand, call for a holistic vision: a fractal-like picture repeated continuously through the various phases of the history of life. Nature ‘red in tooth and claw’ presented by Darwin and promoted to some extent by Dawkins is mitigated by Margulis and Sagan, who see in nature a harmonious symphony of cooperation, not competition. Such a postmodern turn in biology is well-summarised by Longa and Lorenzo (2014) who describe it as a shift from gene-centric view (Genocentrism) to beyond-gene view (Epigeneticism) (p. 136).

METHOD

The paper traces the different interpretations of Darwinism in Timberlake Wertenbaker’s *After Darwin* (1998) utilising the two views towards chaos as a theoretical and methodological framework. While the first view; of chaos having a deep structure of order encoded within will work on the methodological level, the second; of chaos leading to order will work on the theoretical one to reveal not only how the play is structured but also the how the world is viewed. One can notice easily there is a shift in seeing the struggle in nature from an opportunistic competitive to a cooperative one which is quite apparent in Wertenbaker’s

drama particularly at the end. Thus, the primary facets of chaos theory, i.e. butterfly effect, strange attractor and recursive symmetry will go hand in hand with ideas like self-organisation and the edge of chaos.

Recognised by Edward Lorenz in 1962, the butterfly effect is no longer limited to weather-forecasting. All dynamic systems, including humans, reveal high sensitivity to tiny changes in their initial conditions. To Kellert (1994), its appropriateness to social and literary contexts is highly similar to that of scientific ones. The dynamic of the butterfly effect is an apt tool to explain some key historical events. History is replete with “examples of small events that led to momentous and long-lasting changes in the course of human affairs” (p. 5). Before the scientific recognition of the butterfly effect, inadvertent events were, as David Porush (1991) explained, dismissed as something “pertinent only to the realm of accident, coincidence, kismet, and messy human affairs” (p. 382). Now, they are part of reality. Due to the nonlinearity and sensitivity of social systems, as Alonso (1990) argues, it is very likely that “certain local fluctuations (inventions, discoveries, revolutions, wars, the emergence of political leaders, etc.) may result in major changes” (p. xvii).

To investigate order in an apparently chaotic activity, the tools used are strange attractors and recursive symmetries. The only difference between them, according to Hayles (1991), is that strange attractors deal with specific points. They cannot reveal clearly how these patterns or pockets of order emerge. Strange attractors are simply defined as any point(s) that attract the system to it. They work like magnets. They attract, restrict and force a system to follow a particular path. In the physical world, they take the form of physical properties, but in the human domain, they take the form of desires, emotions or obsessive thoughts (Yas, 2017). In a narrative text, according to Parker (2007), attractors are the attracting points, i.e. ideas, motifs, motivations... etc. that “concurrently attracts and repels the writer” (p. 28).

Recursive symmetries expose, as Hayles (1991) states, “orderliness amidst the unpredictability” (p. 10). These structures, according to Galatzer-Levy (1995), tend to “repeat basic features on several different levels of observation” (p. 1085). To Remer (2003), they “repeat themselves, not exactly, not perfectly, but still enough to be recognisable even on different scales” (pp. 12-13). Equally important, recursion also tells that a chaotic system has continuity, in a sense that it carries the original order throughout all levels of observation. So, like chaologists who look for recursive symmetries or self-similarities to map out the order in a chaotic system, this paper traces these similarities and recurring images in both narratives to reveal the order in apparent chaotic structure to a casual observer.

In a nutshell, the butterfly effect, the core of chaos, is utilised to explain the events of the play that trigger the conflict and push actions to a start. With its ability to attract and compel a system to follow the paths it chooses, the strange attractor helps to reveal the thematic concepts that compel the line of action to pursue a particular course. As they help scientists to show the order in apparent chaos by tracing self-similarities on various levels of observation, recursive symmetries are employed to map out the order in seeming chaotic plot. Unlike other plays tackled Darwin, *After Darwin* (1998) is not structured linearly, but rather, it presents more than one timeline. Scenes are highly overlapped, and characters who practice a double role are shuttling back and forth between the past and the present. Thus, one has to trace the recurring images in both stories to come up with the full picture as the story from the present is a reflection of the one from the past.

Hence, chaos theory is believed to be the best choice for the analysis of the play. This is because; conventional approaches, affected by Newtonian deterministic, reductionist and linear model of how the world works and Darwinian pessimistic interpretation of how it evolved, are unable to tackle the dynamic and the kaleidoscopic nature of postmodern science play. To Gillespie (2008), these traditional approaches are “too narrow to accommodate the

full potential of literary expression” (p. 3). Such methods, as Gillespie (2008) explains, concentrate only on central ideas, weighing the evidence, and try to balance opposing views to reach a conclusion. Things do not go with this limited view are classified as irregularities. Chaos theory with its nonlinear, holistic, and dynamic view of the world and its great asset of vocabulary can secure an alternative scope for literary interpretation.

AFTER DARWIN (1998): FROM NATURAL SELECTION TO THE SENTIENT SYMPHONY OF LIFE

First premiered at Hampstead Theatre, London in 1998, *After Darwin* by Timberlake Wertenbaker (1956) utilises Darwin’s *On the Origin of Species* (1859) as a source for both ideas and performance. To Barr (2006), the merge between form and content is “one of the defining characteristics of a good science play,” and *After Darwin* is one of the best examples of this merge (p. 6). Through few characters, simple props and scenery, the play links past with the present to stir up a debate over timeless questions about faith, friendship and man’s place in the universe. Like other successful science plays, such as Stoppard’s *Arcadia* (1993), Edson’s *Wit* (1995) and Frayn’s *Copenhagen* (1998), Wertenbaker’s *After Darwin* demonstrates how science can provide powerful theatrical metaphors, motives and ideas. The play leads not only the thematic shift in science play from physics to biology, but it is also a turning point in the playwright’s work from gender-related topics to science. Instead of discussing the consequences of Darwin’s ideas as the case with *Inherit the Wind* (1955) by Jerome Lawrence and Robert E. Lee, *Darwin’s Flood* (1994) by Snoo Wilson, *Evolution* (2002) by Jonathan Marc Sherman, and *Darwin in Malibu* (2003) by Crispin Whittell or focusing on Darwin’s life before and after the publication of *On the Origin of Species* as Peter Parnell and Craig Baxter did in *Trumpery* (2007) and *Re:Design* (2008), Wertenbaker dramatises young Darwin, i.e. the development of his ideas during his voyage in the 1830s and the conflict that erupted between him and God-fearing Fitzroy (Barr, 2008). Fitzroy is a Tory and a literalist believer of the Bible, while Darwin is a Whig with less enthusiasm for religion. This conflict is repeated at present (1998) through a play within a play to reveal the struggle for survival in both nature and society.

DESPAIR

Before setting sail, it is quite imperative to cast some light on scene i, the opening scene, scene ii, and scene iii. While the opening scene sets the tone, defines the conflict and presents the central theme, evolutionary theory, both scene i and scene ii give the audience a chance to peep at the two stories, i.e. the one from the past and the other one from the present. The play, in fact, starts where it should end. The playwright reverses things; first to shock the audience, and second to give some hope in the end. The opening scene, titled “Despair,” starts with Fitzroy aged 60 and Darwin 56. The place is Darwin’s study room, and the date is 1865; six years after the publication of *On the Origin of Species* (1859). Evolution theory is widely spread and highly solidified, while the Bible’s authority is badly shaken. Fitzroy is highly offended. He rails against Darwin’s anti-religion theory and brandishes his razor and Bible at Darwin. He yells in despair; “This is the truth. ... Natural Selection? We cannot live without The Book.” To Fitzroy, Darwin has brought nothing but a dark “future, without purpose, mockery of all that is sacred, no moral light.” Abruptly, he turns to blame himself. In the end, it is all his fault. He, himself, allows Darwin on board. This unintentional mistake unleashes the butterfly effect that “brought destruction on the world” (1.1.7). After Darwin, the world, as the title suggests, will never be the same. To Steenburg (1991), enormous dramatic outcomes “do not require big causes” to occur at all (p. 456). Writhing with guilt, Fitzroy commits suicide as he watches the whole system he cherishes collapse. It is him who pushes it to the edge of chaos by harbouring Darwin on board. To Roger Lewin

(1999), the edge of chaos is the critical zone between order and chaos. It is razor-thin. Any fluctuation or perturbation can shove and push a system into collapse. Fitzroy declares it openly that folks of his kind no longer exist. It is the time for Darwin's species: "No more like me... No more now. I leave nothing behind" (1.1.7). The scene ends with Fitzroy slitting his throat.

As the opening scene ends, the audiences are sent back to 1831. It is the beginning of Darwin's journey to the Galapagos Islands. The reality is still stable and intact. Young Darwin is quite enthusiastic to join the expedition as a naturalist. Fitzroy is bragging about places he has visited and the equipment he has on board. He intends to chart new waters. He believes this new trip will change both the world and souls (1.1.9). He tells Darwin that: during his previous voyage he has captured a few savages and brought them back to England for education. Among them is Jimmy Button who has a natural inclination for civilisation. He adds that both sailors and philosophers share the same goal: to trace "God's signature on earth." He firmly believes that their joint efforts "shall prevent spiritual shipwreck by mapping God's work" (1.1.13). It is rather ironic as poor Fitzroy is totally misled. It is his world that will change radically. He is unaware that he is harbouring the germ of his annihilation on board. Fitzroy, as Barr (2008) conceives, is a truly intriguing character, "with his tragically misguided belief in helping the natives, his adherence to the Victorian theory of physiognomy, his violent temper..., and his eventual suicide" (pp. 111-112).

Suddenly, the performance is interrupted by a short break, and the audiences are sent to future, 1998. It is not a play, but rather a rehearsal for a play talking about Darwin. The audience is introduced to Ian and Tom. Ian is an unlucky, middle-aged actor playing the role of old Captain Fitzroy, in order to survive in his dying career. He likes the drama, but dislikes being given the role of the loser, as Fitzroy commits suicide at the end. Young Tom, who plays Darwin, is a naturally talented young actor. However, he hates history. He has not read books given to him about Darwin to help him understand the man he is playing. Instead, he spends his time watching some videos about animals. He takes the role only to advance his career. He is reckless and a self-serving opportunist. Action movies, easy money and good food are his real passion. He will easily abandon his fellow-actors if an excellent opportunity in cinema shows up. The disparity in disposition and age between young Tom and middle-aged Ian is employed subtly to reflect Fitzroy- Darwin relationship.

STRUGGLE

As the play does not move linearly, but bounces between the past and the present where events shuttle back and forth between the 1830s and 1990s, one has to imitate scientists in recognising order in this disorder. Strange attractors are one tool, the other is recursive symmetries. As mentioned in the method section, a strange attractor is any point(s) within a system that attracts the system and compels it to follow a particular direction. Likewise, in a literary work, they reveal themselves through thematic concepts that propel the plot and compel line of action to pursue a particular path. In a scientific domain, they take the form of physical properties, in the human sphere; they take the form of desires, emotions or high thoughts. In *After Darwin*, Fitzroy commits suicide because Darwin's revolutionary ideas ruin his attractor, his world of religious stability, and creates a new one he cannot accept. Being deprived of his attractor is equal to be lost in an endless empty space. Similarly, in the play within a play, staging the drama is the strange attractor. It is a matter of survival for actors. They are ready to take any counter measurements and to give up any moral code to see it performed. Briefly, in both narratives, survival/attractor becomes the pivot of the conflict.

The play is made up of characters who exert great efforts to flee the grip of natural selection. Fitzroy-Darwin story is interwoven with the story of an African-American playwright, a Bulgarian émigré, a veteran actor, and a gay player. They all struggle to see their drama staged as it is the strange attractor of their existence; otherwise, all of them will perish. The director, Millie, came from a war-torn country. She is doing her best to join the English species as a dissident artist. She badly wants the drama to succeed to avoid deportation. Tom is a homosexual, unscrupulous and superficial hiding behind the camouflage of stupidity and indifference. However, he is ready to sacrifice his friends at the altar of his welfare. Ian is a dying species; a Shakespearean veteran fumed with jealousy and indignation. His "ornate skills," are similar to those of died out Irish Elks (2.1.50). He is superseded by actors, like the laid-back Tom, for whom the high art or even morality is a kind of "refinement that leads rapidly to extinction"(2.3.60). Lawrence is an African-American character from the slums of Washington. He performs the role of the playwright of the play within a play. Due to the play's intellectualism, everybody expects him to be white (1.11.38). By virtue of his mother, he succeeds to adapt and evolve better than anybody else. He is morally uncompromised, and his spiritual faculties remain unimpaired. He deals with the historical burden of race and colour openly and lightly.

The struggle for survival begins as the butterfly effect hits the performance. Tom gets an offer to work in a movie, and he takes it (2.1.51). In doing so, he pushes the action to the edge of chaos. Everyone feels threatened, but Tom refuses to listen and rejects their definition of commitment and morality. He simply cannot "understand that word" (2.1.51). Like any chaotic system, human behaviour is extremely sensitive to tiny perturbations. It cannot be viewed as a linear, predictable causal process. It remains semi-stable until something happens; then, it begins bifurcating into an unpredictable one. M. R. Butz's (1993) presents a description of the individual's reaction to chaos via anxiety. He draws an analogy between the way people respond to chaos and the butterfly effect. Like any open system, any event, be it small or big, can change one's behaviour radically. Butz's analogy and survival techniques adopted by the characters can help grasp characters' different responses to the damaged caused by Tom.

This crisis brings the play to its climax, exposing characters' real past and unveiling the techniques they use to survive, i.e. fake identities, idiocy and false principles. Millie is not an artist. Her only background in the theatre was being hired to work as a caretaker after she had been dismissed from college in Bulgaria for proclaiming her Turkish heritage. To Millie, faking her identity is the best way to survive. She declares that; "the truth is not a good survival tool. It makes you vulnerable" (2.2.58). She confesses that "intellectual energy and passion" are inappropriate tools for survival. She starts wailing as the drama is about to be doomed as directors from Eastern Europe are no longer in fashion (2.3.61-62). It is hard for her to find another opportunity to stay in England.

Like Millie, Ian is also species en route to extinction. He is jealous of Tom, who is naturally gifted in acting. He almost exerts no efforts. Tom is also very lucky in both cinema and theatre. He tells him frankly that he is either "very lucky or very stupid to survive in two environments at once." Tom admits "stupidity" might be the "modern adaptation" (2.1.50). Through Tom, Wertenbaker attempts to break the Darwinian principle of survival is for the fittest. Tom is reckless, but a quite lucky person. This reflects Gould's (1989) argument that survival depends mainly on luck, not fitness. As a survival mechanism, Tom's stupidity is established early in the play. He does not read anything about Darwin. Instead, he only looks at the pictures. He does not adopt or support any ideology and doubts the authenticity of certain historical facts. He only lives and enjoys the present (1.7.24; 1.9.32). His survival technique is to hide behind the camouflage of idiocy and indifference. As confronted by Ian, he retorts: "I'm hungry, Ian, I want to go where there's lots of food" (2.1.51). When Ian tells

him that; people are not animals foraging food. His defence is quite simple, “that's what Darwin's saying here, isn't it?” (2.1.52). This reveals Fitzroy’s plea for Darwin, not to publish his views as they “will be an excuse for every excess.” To Fitzroy, Copernicus or Galileo is not as dangerous as Darwin because “there is still order and harmony” in the universe (2.4.66).

Tom is the embodiment of social Darwinism that favours winners only. Despite its negative implication, according to Midgley (1983), it is still, unfortunately, “the unofficial religion of the West” (p. 367). However, Ian’s Machiavellian intelligence succeeds to redirect evolution for the brainy, but for a while. Under the delusion of public interest, Ian sends an email to the film producer telling him that Tom is infected with HIV. It is fine for Ian to act immorally to attain moral ends as it is for the common benefit. Ian feels that Tom can do better in the theatre. Movie-industry, to Ian, makes artists lose “their sense of self” (2.1.50). In contrast, the struggle for survival is not all about selfishness. There is still room for altruism. Tom is aware that homosexuals have no progeny. He is also aware of the fact that some people are homophobic. They look at them as a perversion of biology. To save Millie from deportation, he offers her marriage. As Millie states that she "still can't believe in generosity without idealism." He replies, "that's because you're homophobic. How do you think we survive?" (1.9.33-34). Later in the play, he repeats his offer by adding some incentives; "We could even have children." He openly unveils his inner intention: to spread his genes (2.3.62). To Dawkins (1976), acts of seeming unselfishness are “selfishness in disguise” (p. 4).

As for the plot, the play is built as a recursive form to reveal the different interpretations of Darwinism throughout the characters’ actions and responses to evolution. To cover this time-span and to examine Darwin’s legacy on stage, the playwright cuts between the 19th-century, 1831-1865, and late 20th-century utilising the technique of a play within a play. To Ruddick (2001) such a division “functions to subvert traditional linearity, causality and teleology,” and to allow each period to comment on the other (p. 422). While the scenes in Act I alternate between past and present day, in Act II, they start overlapping. Action, jets back and forth between 19th and 20th centuries, and actors, who perform a double role, deeply explore how people become unspeakably selfish to survive. Although the drama is a verbal one, it depends mostly on performance. Wertenbaker not only plans to construe evolution, but also to perform it. According to Freeman (2002), the play not only presents evolution biologically but also poses “the capacity for engaging an imaginative, symbolic, and self-reflexive transformation in the past and the present” (p. 650).

To secure an overall picture of the plot, one has to trace the recurring images as the play is self-reflexive. Both narratives mirror each other. Chaos theory proposes a holistic vision towards things. Instead of focusing on parts, it suggests concentrating on how these parts interact with each other. Sally J. Goerner (1994) states that; “the order in chaos is holistic order and results from mutual effects.” In other words, it is an “order of the whole” (p. 198). Fitzroy and Ian stand for the dying species. They suffer a lot to keep their worlds intact. Darwin's ideas challenge Fitzroy’s Biblical hypothesis of mass extinction. To Fitzroy, it occurred because there was no room left on the Ark (1.8.26). Likewise, Ian is afraid of being a footnote in the history of art. He is jealous of Tom who performs Darwin: the “superstar of history, Mr Millennium” (1.7.22). As the play progresses, tension augments. Fitzroy feels so worried by the disturbing implications of Darwin's discoveries. He threatens him with his pistol. Ian, also, seems in danger as Tom tells him about his new role in a movie. To save the performance, he emails the film director warning him against Tom’s incurable disease. Both Ian and Fitzroy break their code. Fitzroy threatens an unarmed man and Ian acts in a Machiavellian way. Ian tries to justify himself as he argues that he does not “want another two years without work” (2.6.72). He wants to survive. Like Fitzroy, who desperately

wants his conviction to remain intact, Ian badly wants the performance to go on. However, both feel it deeply that the damage caused by Darwin/Tom is irrevocable. They unleash the butterfly effect that threatens Ian's world of great classics and Fitzroy's world of solid faith and pushes things to the edge of chaos.

Likewise, Jimmy Button, Millie and Lawrence are another recurring image. Jimmy and other two natives are brought to England by Fitzroy for education. On his journey with Darwin, Fitzroy takes them back to their country hoping Jimmy might be able to disseminate the Whiteman civilisation. Things, regrettably, do not go as he planned for. Jimmy is shunned by his tribe. He is forced to give up the English Habits. He adopts Englishness enthusiastically, but he has to readopt with an equal commitment the customs of his tribe. Fitzroy's battle with natural selection and evolution is unwinnable. Jimmy's tribe is "extinct" now (1.11.38). Fitzroy chooses suicide as he not only lets Jimmy's tribe down and cannot defend the Maoris of New Zealand, but he also lets the whole world down the moment he allows Darwin on board. Equally, Millie, who suffered the Turkish- Bulgarian hostility, is white. Owing to her Turkish background, she is persecuted by the Bulgarian communist authorities (2.4.64). She is forced to abandon even her name as authorities favour pure Bulgarian descent (2.2.57). She hopes to find a new life in England. She works hard to learn a new language, new codes of life and even new methods of expressing feelings. Briefly, she reinvents herself, but all her attempts are fruitless. She is always threatened by deportation (1.9.32-33). Conversely, Lawrence, the African-American playwright of the play within a play, succeeds in what Jimmy and Millie fail at. By virtue of a loving, supportive mother, he is directed to read Shakespeare and the classics. He succeeds in learning from Caliban (2.3.63). To Freeman (2002), he is "persecuted by racial prejudice and liberated by humanist art" (p. 654). He manages to fit in and to utilise his hybrid identity efficiently and constructively.

EVOLUTION

Time is decreasing as the two stories move towards the end. The final scene, "Evolution," is the opposite of the first "Despair." It is a highly momentous scene structurally and thematically. Structurally, it is the borderline where life and performance are met and blurred. Thematically, it is the area where all different interpretations of Darwinism are intersected. It also presents the playwright's view of man and evolution. To Wertenbaker, instead of resisting evolution, we have to learn how to be transformable and adaptable.

Lawrence, surprisingly, reacts normally with Tom, although he accepts the offer to work in movies and put the whole production in danger. Nevertheless, he refuses to endorse Ian's subterfuge, i.e. sending an email to film-producers telling them that Tom is HIV-positive. He says he "cannot accept Ian's gesture;" otherwise, he "would be colluding." He feels he is "responsible for [his] own integrity" (2.6.74). To Lawrence, if the production continued this way, it would be tainted. Like Fitzroy, he is stuck between fate and freedom (2.6.75). In the post-modern world, man is in need to look at the relationship between fate and freedom differently (Taghizadeh, 2016). To Sara Freeman (2010), the play reveals "that after Darwin: we understand fate and freedom with vivid new acuity" (p. 217). The play turns to be an object of destiny for everybody. While Ian writhes with embarrassment and Millie discloses all shameful things she has done, Lawrence reflects seriously over allowing the performance to go on or not. Millie does her best to dissuade him from calling off the production. She explains how they all desperately need the play. She also reminds him that his mother is here to watch his work as well. He asks Millie not to push him to break his "moral code." Millie replies angrily that "Ian's broken his; Tom never had one, what makes you think you can survive without getting your hands dirty" (2.6.75)?

Ian, on the other hand, laments himself and Fitzroy. He sees Fitzroy as: “a good man who gets it wrong” (2.6.71). To Lawrence, no one can be “tragic after Darwin” as Darwinism invalidates any moral struggle needed to support tragedy. Millie takes Ian’s head, and he responds: “love makes you ambitious and culture uses you to multiply. My question is: could you love me?” Millie answers, “I think it’s time for you to commit suicide” (2.6.77-78). Her answer, actually, does not imply no; but, she asks him to do his role in the play. Her reaction exhibits her faith in both Ian and the play.

Two open questions conclude the drama; first the relation between Millie and Ian, second; whether the production will continue or not. Yet, there is a feeling it will continue. Wertenbaker herself believes in the redemptive nature of theatre. To her, it is a new kind of evolution. Millie states that “the essence of drama is conflict, no? Struggle; evolution” (2.2.56). The play ends by looking forward to the future. Wertenbaker’s treatment of present and past facilitate the rediscovery of Darwin’s legacy, more precisely “reinventing Darwin” (2.7.80). The drama offers hope in humanity. It is slow but progressing. Although the drama employs the Darwinian-Dawkinsian view of competition, in the end, it embraces Margulis and Sagan vision of cooperation inspired by the science of chaos and complexity. Restoring order from within is quite possible. Our universe, as Hayles (1991) states; “has the capacity to renew itself” (p. 13). It is a fact that we no longer inhabit a stable universe; however, we can “thrive on disorder” (1.12.43).

Whether we are at the top of the evolutionary ladder as Charles Darwin deemed, a tiny twig as envisioned by Gould (1989), or part of a process as Margulis and Sagan (1995) conceived, we can revolt against our selfish genes since we have managed, as Lawrence declares, to develop a sort of moral sense. We do not know how or why, but we have it! It is what makes us a distinct species (2.6.74-75). The bleak stereotypical image of nature ‘red in tooth and claw’ introduced by Darwin and upheld by Dawkins is finally mitigated by Margulis and Sagan, who see nature as a harmonious sentient symphony built not on competition but, on cooperation. We might begin as animals and sometimes fight like animals, but we are still capable of tenderness. It is tenderness what has given “mammals an evolutionary advantage” (1.3.15).

To Wertenbaker, in an After-Darwinian world, man can survive if he embraces transformation as Lawrence did. Characters in the play respond differently to evolution. Those who cannot cope; they either choose suicide (Fitzroy) or hide behind a fake code of morality (Millie and Ian), while others prefer to use it (Tom) as long as it is in their favour. To Lawrence, Darwin’s real legacy is “empathy” (2.7.80). It can connect all people together. We can rise above our origin. We do not need to ape the nastiness of nature. If we cannot be the masters, as Goerner (1994) states, “we are not slaves to this process” either (p. 211). Lawrence states that we might “have come to the end of [our] evolution—some say we are even coming to the end of our knowledge, who knows, but... we will never come to the end of our imagination.” He adds that when he sees a character on stage, he stops and starts wondering: “where is he going..., is he a hybrid, a completely new form?” He admits that he can “never stop being excited by the human possibilities—that struggle for existence on this small space” (2.3.62).

CONCLUSION

Darwin’s revolutionary ideas of how life emerged and evolved still have their magic and impact. The rise of the new science of chaos and the discovery of the DNA structure encouraged scientists to re-examine Darwin’s legacy in the light of the new findings. Equally, science play did not stay aloof from this tremendous shift in viewing the world. It started quoting themes from biology, due not only to the public interest, but also to the moral and

scientific misgivings they create. Wertebaker's *After Darwin* is a shift in depicting Darwin. Unlike other dramas that dealt with Darwin before and after the publication of his book *On the Origin of Species* (1859) or focused on the consequences of his ideas, Wertebaker chose to portray the young Darwin; the beginning of the journey when his ideas began to formulate and interwove it with a modern story as she intends not only to construe the theory but also to act it. She presents the different views towards Darwin's ideas of adaptation, survival and evolution through two different prisms, scientific and social, in order to dramatise the struggle for survival in both nature and society. While the scientific part and its religious and philosophical implications are well revealed through the confrontation between young Darwin and Captain Fitzroy, the social one is well presented through four contemporary characters. By alternating between the natural and the social, the playwright tries to demonstrate how it is hard to live with some sense of moral integrity and authentic identity in a world its people become indescribably selfish to survive. Tom, Ian and Millie, for example, have no moral qualms. They justify every action on the basis of sheer survival.

As the play starts with a scene titled "Despair," it ends with a scene called "Evolution." The final scene is highly significant as all borders of time and place are blurred. Although Wertebaker employs the Darwinian-Dawkinsian view of competition, in the end, she concludes the play by embracing Margulis' view of cooperation inspired by the science of chaos. The soul-crushing stereotypical image of nature 'red in tooth and claw' presented by Darwin and supported by Dawkins is assuaged by Margulis, who sees nature as a sentient symphony promoted cooperation, not competition. In doing so, Wertebaker tries to reveal her belief in humanity and to give a glimpse of hope. Through Lawrence, the African-American playwright who managed to keep his spiritual faculties undamaged, Wertebaker presents Darwin's real legacy: it is 'empathy.' It is what gives mammals the evolutionary advantage and makes our world throb with life. Lawrence learns well how to adapt to the burdens of race and colour. He is the only character who succeeds in evolving and changing than anybody else in the play. Unlike Millie, who even reinvents herself to join the English species, Lawrence succeeds in utilising his hybrid identity efficiently. To Wertebaker, instead of fighting evolution, man has to be more adaptable and transformable. We might have evolved as animals and most of the time fighting like them over the decline of resources; however, we are still the only species that has developed a moral sense and possessed a brain that can work independently. Richard Dawkins (1976), the unwavering adherent of Darwinism, confesses that we are the only species entirely qualified to fight back the tyranny of the selfish gene. The play reveals at the very end what chaos theory promotes: as the universe can renew itself from within and resist the hideous implication of the second law, so can man. It is true that man inhabits an unstable world; however, he can thrive on disorder. Like any dynamic system, he can reshape himself internally and set new attractors.

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