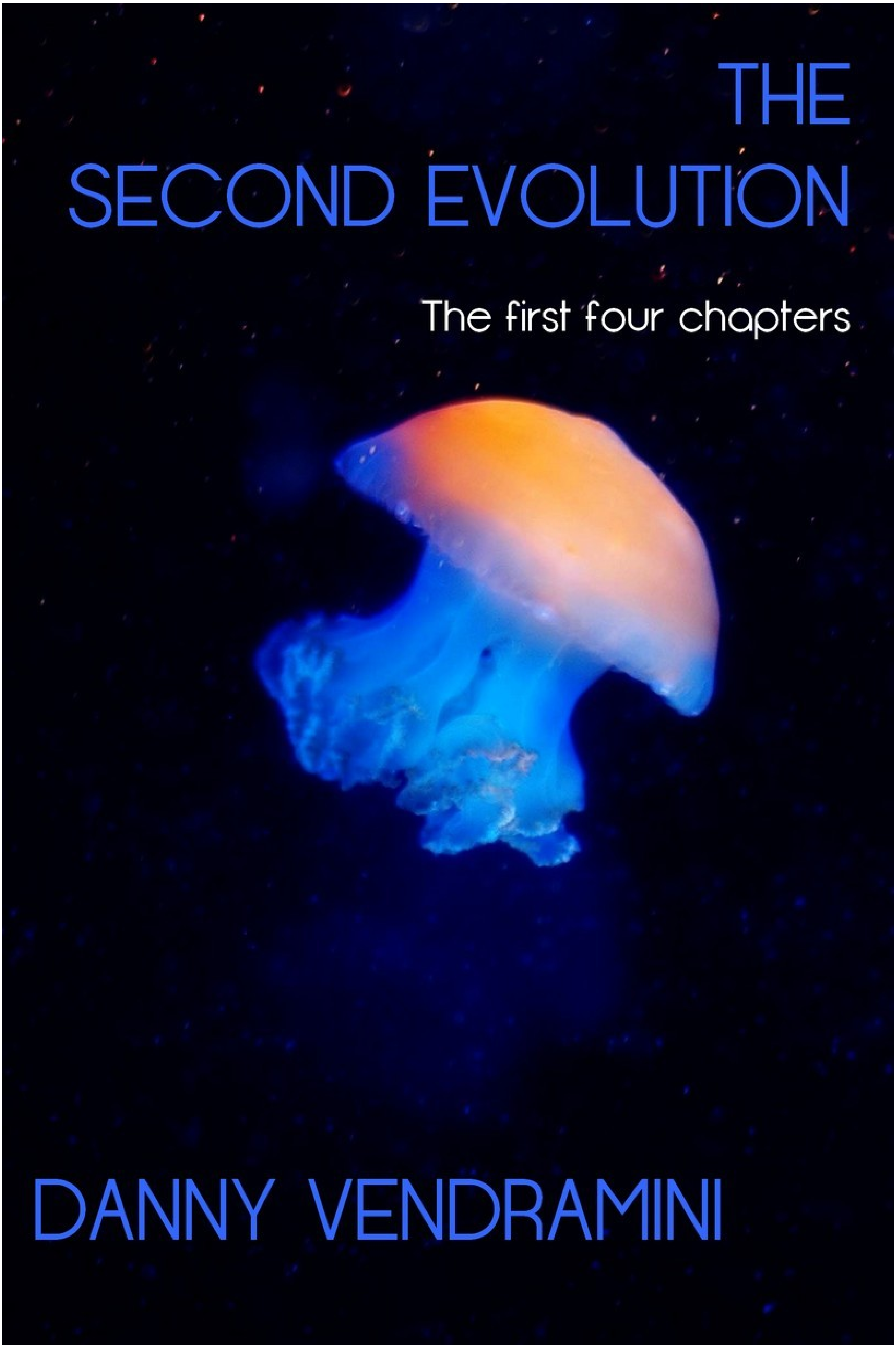
THE
SECOND EVOLUTION
The first four chapters
DANNY VENDRAMINI

THE SECOND EVOLUTION

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THE FIRST FOUR CHAPTERS

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This is a corrected draft manuscript of the first four chapters of The Second Evolution, and subject to change. As this is a work in progress, the author welcomes feedback: dv@thesecondevolution.com

If you would like to be notified when the book is published, send an email to info@thesecondevolution.com with the word – 'Info' in the subject line. An email will be sent to you in 2012 with purchase details for both the Ebook and print book. You email address will not be made public and no further emails will be sent.

To my daughters, Josie and Bella

ACKNOWLEDGEMENTS

In formulating these theories I am indebted to the many scientists, friends and family who offered to read material, provided invaluable feedback, advice and encouragement, and generally helped test and improve the theory. Top of the list is my wife, Rosie Scott, who was indispensable to this project and to whom I am eternally grateful. My thanks also to Tord Kjellstrom, Simon Conway-Morris, Jaak Panksepp, Helen Forlong, Larry Young, Coral Wynter, Daniel Blumstein, Stanley Salthe, Bruce Charlton, Richard Fortey, John Tyson, David Skibinski, Mary MacGibbon, Merlin Crossley, James Shapiro, Werner Meyer, David Featherstone, Kirk Winemiller, Fran Bonier, Robin Allott, Georg Striedter, Dayal Purohit, Roger Masters, Pierre Capy, Ross Crozier, Carl Schlichting, Bella Vendramini, Josie Vendramini, Mark Ragg, Emily Walker, Fiona Yih Ling Chan, Tony Bennett, Robert Trivers, Timothy Mousseau, Peter Richerson, Geoff Parker, James W. Grier, Mary Ann Brittain and Gerald Rowles.

Perhaps more than most scientific investigations, this work owes an enormous debt to the Internet. During the decade I have worked on the theory that a second evolutionary process exists, I downloaded over 7,000 scientific papers, articles and essays on dozens of subjects covered by the theory. This information was indispensable to the success of the project and remains a testament to the generosity and intelligence of the global web community.

CONTENTS

PREFACE

This book explores the theory that a second, undiscovered evolutionary process exists that regulates the creation and inheritance of instincts and emotions in multicellular animals. Briefly, 'teem theory' argues that extremely intense emotions (like those experienced as the result of traumatic personal experiences) can under certain conditions be permanently imprinted into an area of an animal's genome called *noncoding DNA* – so-called 'junk DNA.' Once encoded, these traumatic emotions can be inherited to offspring as emotions, innate behaviours and even complex instincts.

Initially, it appeared that this evolutionary process – which I called 'teemosis' explained how environmental information could be configured into new instincts and emotions and inherited. But as the evidence for teem theory accumulated, it suggested the teemosis process might also play a crucial role in the evolution of physical traits as well, including speciation (the creation of new species). This meant that big ticket items of evolution – what biologists call 'macroevolution' were not solely the preserve of natural selection as we've been taught for 160 years, but of a synchrony between natural selection and the teemosis process.

But it didn't stop there. Over time, evidence accumulated that this clandestine second process may also have been instrumental in the evolution of the major biosystems we're familiar with today – emotions, memory, personality, attention, perception, learning, communication, and motivation. Until now, these elemental systems have largely been taken for granted, partly because they cannot be integrated into a holistic theory of biology. They are like a herd of elephants sitting quietly in a corner of the room that nobody acknowledges because no one knows where they came from or what they're doing here. If correct, teem theory gives them a home, and in so doing stakes a claim as a 'unified field theory' – a simple explanation of the workings of nature that holds true over a wide range of exploration.

Of course, as Carl Sagan once said, 'Extraordinary claims require extraordinary proof' - or at least detailed and convincing scientific arguments that can be tested empirically. This began with the 2005 publication of my first paper on teem theory, *Noncoding DNA and the teem theory of inheritance, emotions and innate behaviour*[1] in the British journal, *Medical Hypotheses,* which outlined the core hypothesis and some of its medical implications. In 2006, I posted that paper, along with five others on teem theory on a website, and the feedback from some of the world's top life scientists is best described as 'cautiously positive' and I have included relevant comments in the book as well as on the website.

Some, like Professor Jaak Panksepp, Distinguished Research Professor Emeritus of Psychology and Adjunct Professor of Psychiatry, University of Massachusetts were willing to acknowledge that 'Darwin might have missed something.' Most, including Noam Chomsky, said the theory 'sounds interesting' but added qualifications similar to that of Professor Geoff Parker, who heads the Population and Evolutionary Biology Research Group at the University of Liverpool: 'How very fascinating! I've been worried for years about 'junk' DNA and its evolution. I guess first you need good evidence, and second, some plausible mechanism for how 'teems' evolve needs working out – it poses some problems.'

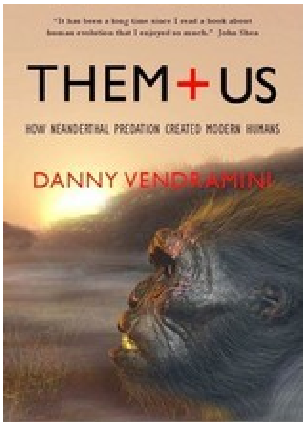
Along the same lines, Professor David Featherstone, who runs the Featherstone Lab in the University of Illinois at Chicago's Department of Biological Sciences said, 'Teem theory is an interesting idea,' and that, 'TEEM theory is all very scientifically addressable.' But he also noted, 'I think your scientific goal should be to determine the molecular mechanism(s) by which trauma can cause changes in DNA sequence (or otherwise isolate the heritable 'thing' left by trauma).'

Some, like Professor Roger Masters, President of the Foundation for Neuroscience & Society immediately picked up the implications for understanding human behaviour; 'My reaction: your approach makes very good sense because the ability of *Homo sapiens* to adapt to widely different environments (obviously a key feature of the species) will be greatly enhanced through the ability to shape somewhat the triggers of emotional responses in the manner you describe.'

Most of the scientists were sufficiently intrigued to want to read the detailed arguments promised in *The Second Evolution*: 'I will certainly look forward to seeing the publication of your book,' wrote Professor Simon Conway Morris from Cambridge University, 'not least because of some recently developed interests of my own on the evolution (and inevitability) of sensory mechanisms.'

What open-minded scientists want and justifiably expect from a theory that attempts to meddle with arguably the most venerated scientific paradigm of the last millennium are the molecular biochemical details, peer reviewed studies and tangible proofs as are available – hence this book.

Except I got sidetracked. New scientific theories (provided they're correct) are like skeleton keys that open all sorts of other doors, and I soon realised that teem theory had the potential to resolve not just the instinctive behaviours of insects, reptiles and mammals, but to also resolve some long-standing issues of human behaviour and evolution – how, why and when we became the distinctive species we are today and why we behave the way we do.



Intrigued and excited by the prospect of new discoveries, I used teem theory to formulate a new theory of human evolution, called Neanderthal Predation theory, which my publisher at Kardoorair Press thought would make a great book. The result was, *Them and Us: How Neanderthal predation created modern humans*,[2] (left) which was published in 2009.[i]

Putting *The Second Evolution* in a drawer for four years turned out to be a good idea. I was able to reassess the theory from a fresh perspective, and also factor in the feedback I'd received along with new evidence from recent studies in genetics and microbiology. I half expected the theory to collapse under the weight of new evidence but was relieved to find I didn't have to change anything. Even better, a number of new studies actually provided additional evidential support for the theory.

While I am confident enough in teem theory to 'put it out there', I'm aware that like any nascent new scientific theory it may contain both theoretical and practical errors serious enough to discredit the entire theory. So it's in my interests to expose the theory to the most rigorous scientific scrutiny so that any dead wood can be culled as quickly as possible. For this reason, I have decided

i Visit the website at: http://www.themandus.org/

to take advantage of the internet and publish *The Second Evolution* initially as an Ebook and invite readers (and particularly scientists in the life sciences) to critique it. Comments may be sent to dv@thesecondevoluton.com What (if anything) that survives this process will be the final version of teem theory which may then be published as a conventional book.

Having written five rather dense academic papers on teem theory, I've written *The Second Evolution* for an educated lay readership, which means I've kept jargon to a minimum, provided a Running Glossary plus Boxes to explain essential terms, and generally simplified the theory as much as possible. The Ebook also contains 12 Appendices which discuss pertinent but peripheral material and over one hundred illustrations. To assist academic evaluation, the Ebook also contains all my research references and copious footnotes, most of which will be omitted from the print edition.

Finally, despite the objective critique of Neo-Darwinism theory in the first three chapters, *The Second Evolution* is not another book out to disprove or discredit Darwin. Nor, despite its 825 references is it an undergraduate textbook or a journalistic review of the latest research. It is a speculative theoretical work and as such is almost guaranteed to contain errors, both in theory and in fact. I apologise in advance for these.


PART ONE:
A REASSESSMENT OF THE
NEO-DARWINIAN
BEHAVIOURAL
PARADIGM

1

ONE THEORY TO RULE THEM ALL

behaviour - the poor cousin of physical evolution

When biologists and laypeople talk about evolution, they are almost always talking about one specific aspect of evolution - *physical* evolution – the evolution of physiological traits like arms, legs, bones, blood and tissue – how new species occurred – how features like wings, eyes and camouflage evolved, and so on. Physical evolution is also the focus of most of the scientific research and education and it's what preoccupies internet bloggers, evolution forums and of course, creationists. So attuned are we to seeing only the physical affects of evolution, some may even scratch their heads and ask – what else is there?

Behaviour of course. All those heritable instincts, emotions and innate behaviours, from motivation and learning to memory and personality, that we see daily on display in nature and without which life could not flourish and survive. Behaviour represents the flip side of the evolutionary coin. This second evolutionary mechanism reminds us that birds have wings which they use to fly; wombats have claws to dig burrows; eagles have talons which they use to hunt; and spiders produce thread from which they weave cobwebs.

Some innate behaviours are simply prosaic; breathing, swallowing and locomotion for example. But others are infinitely more complex and inventive, cuckoos have an instinct to lay their eggs in another bird's nest – so that a hapless mother feeds and rears the newly hatched interloper as if it were its own. Ants are known to keep aphids as slaves and milk them of a sugary secretion which they eat. Some wasps inject their larvae into the body of a living caterpillar which then pupates and eats the caterpillar from within.

How Green sea turtles (Chelonia mydas) find their way to their feeding grounds on tiny Ascension Island in the middle of the South Atlantic 2,240 kilometres from their breeding grounds in far away Brazil is a mystery. Even more puzzling is how the first sea turtle to make the voyage was genetically programmed with the exact longitude and latitude of this tiny speck of an island (only eight kilometres wide) so that its descendants could repeat the journey?

And what could be more ingenious than hedgehogs (*Erinaceus*) that chew on the poisonous skin of toads then regurgitate the toxin to coat the tips of their quills. Even very young hedgehogs have been observed doing this so it's clearly instinctive.[3]

Behaviours like these provide an entry point into the fascinating and mysterious world of animal instincts, emotions, personality and other forms of innate behaviour. But how did nature come up with such ingenious adaptations?

The first person to speculate seriously on the evolution of instincts and innate behaviour was the distinguished French biologist, Jean-Baptiste Lamarck (1744 – 1829)[4] who proposed a theory of use and disuse – whereby behaviours practised during the life of an animal somehow became innate and heritable.

The next major advance came from Charles Darwin. Although the focus of *The Origin of Species,*[5] was the evolution of physical characteristics (what they then called *organic evolution*) Darwin also knew he had to at least attempt an explanation for instincts and other innate behaviours as well. It wasn't just that the Victorians considering behavioural evolution as important as physical evolution and therefore no less deserving of a scientific explanation. It was also because British agriculturalists, naturalists and cottagers were increasingly fascinated by new accounts of complex animal instincts, particularly, the social insects: things like aphid farming by ants and the perfect hexagonal cells that honey bees constructed for their hives. At the time, the only explanation (apart from Lamarck) for how these extraordinary behaviours first emerged came from theologists like William Paley (1743-1805) who famously pronounced that it was a 'benevolent God who fashioned every remarkable contrivance of the living world for the very purpose for which it is seen to be fit.'[6]

To explain the wide diversity of instincts, Darwin actually proposed two different theories: natural selection, plus an idea he borrowed from Lamarck that some lifelong habits could become heritable. Darwin thought his Lamarckian add-on was necessary to account for complex environment-specific instincts that his random process seemed unable to explain.

However, over the next fifty years, the heritable habits theory was increasingly challenged and marginalised. The German evolutionary biologist, August Weismann experimentally disproved Lamarckian inheritance by famously cutting the tails off 20 generations of rats without producing one tailless rat.[7] The death knell came from the Austrian ethologist, Konrad Lorenz who argued that the brain and its innate behaviours were 'equipment analogous to organs',[8] and evolved via natural selection 'exactly as organs do'.[9]

Once it was generally accepted that behaviour evolved solely by natural selection, all references to habits were dropped from Darwin's theory.

APPENDIX 1: THE QUEST FOR THE ONE TRUE THEORY

See Appendix 1 for a more detailed history of the current Neo-Darwinian theory of behaviour. It explores Darwin's attempt to explain complex instincts and how his theory was modified over the years. It provides a useful background to the discussion that follows.

The revised NeoDarwinian behavioural paradigm has become the nucleus of modern behavioural theory, espoused daily in university tutorials and text books, such as *Biology*, by Helena Curtis and Sue Barnes.

> The behavioural characteristics of an organism – its sensitivity to particular stimuli and its patterns of responses to those stimuli – are as much the product of natural selection as the shape of a tooth or a feedback loop that regulates blood pressure… The factors governing the evolution of behavioural characteristics are the same as those that apply to any other trait.[10]

'To the extent that behaviour is genetically determined', confirm William Purves, Gordon Orians, Craig Heller and David Sadava in, *Life: The Science of Biology*, 'it is subject to natural selection.'[11] If the new behaviour provides a net gain in reproductive success, what biologists call being 'adaptive' (see Box), there is a good chance the gene that codes for that behaviour will be retained and spread to fixation. Conversely, if the new behaviour causes the premature death of the animal (maladaptive) or appreciably reduces reproductive success, then the genes for that behaviour will be removed from the gene pool.

ADAPTIVE AND MALADAPTIVE

An adaptation is any kind of heritable trait, behaviour or feature that, for whatever reason, increases an organism's chances of surviving and reproducing in its local environment. An adaptive trait is one that increases reproductive success.

the current behavioural paradigm

The Neo-Darwinian theory of instincts and innate behaviours is based on the premise that 'genes blatantly specify the assembly of the nervous system and the components that underlie the function of the cells in that system.'[12] Implicit in the genetic theory of behaviour, writes University of Toronto psychologist, Ann Jane Tierney, 'is the notion that somewhere in the genome there exists a specific segment of DNA (or set of DNA segments) that specifies the neural circuitry responsible for a given behavior.'[13]

> In this view, certain genes construct the discrete neural structures that underlie species-specific behaviors. Such behaviors can be

> altered by mutations of their genetic blueprint, and as a result behavioural evolution may occur.[14]

Tierney herself takes a more nuanced view, arguing that, 'behavioral change is not always constrained by genetic change, since the ability to learn allows individual animals to adaptively change their behavior in response to environmental challenges.'[15]

Tierney makes a good point that instincts, no matter how complex are often enhanced and modified by learning. Still, this does not discount the component of instincts that is wholly innate – hard wired into the nervous system – like knowing how to instinctively identify and find food, courtship rituals, migration routes, nest building, avoiding predators, catching prey and so on. We humans call these inherited behaviours, instincts and innate behaviours in other animals, but celebrate and distinguish our own innate behavioural repertoire as human nature. It sounds better.

Whatever we call it, the suggestion that these behaviours emerged via natural selection sounds like common sense. After all, if natural selection can create complex new physical traits like kidneys, lungs, immune systems, haemoglobin and opposable thumbs, then it seems logical that it could also create adaptive heritable behaviours. The mutational process would create behavioural circuits, neuronal networks, cerebral modules, instincts, emotions, motivations etc. and the adaptive ones (that increase reproductive success) would be retained and inherited.

Although there's continuing debate about whether instinct applies to humans to the same degree as non-human animals, and also to what extend learning affects instincts, when it gets down to it there is only one evolutionary process and it can explain both physical and behavioural evolution. When biology teachers are asked to explain how instincts evolve, they use the same theory to explain how physical traits evolve – natural selection.

Of course, just because something sounds logical and is taught in universities doesn't necessarily mean it is correct. In Galileo's day, it seemed logical that a ten kilo weight would fall faster than a one kilo weight. It also seemed logical that the earth was flat. Such cautionary tales confirm what Professor Anthony Barnett's reminder that in biology, 'nothing can be taken for granted, not even fundamentals of biological theory'.[16] In light of this, it won't hurt to take a fresh look at natural selection, to put it under the microscope and examine precisely how it achieves these remarkable results.

natural selection as a two-step tango

A London cabbie can spend a lifetime acquiring the Knowledge of the city's roads and suburbs. But despite years of study, the route from Piccadilly to Mayfair won't be passed on genetically to his kids. Why? Because that information is not encoded in his genes so can't be inherited. When he dies the information goes with him to the grave. His favourite routes, shortcuts, the best fish and chips en route to Heathrow and how to avoid traffic lights are all culturally acquired and not subject to natural selection.

Applied to behaviour, this means firstly that only a behaviour encrypted into one or more functional (protein-coding) genes can be inherited. Secondly, the new behaviour has to be in the germ cells – the part of the DNA that codes for sperm and egg cells and passed on to offspring. If the behaviour is encoded instead in somatic cells (that form the actual body of the organism) via a somatic mutation*,* it won't be inherited, and what's more, will most likely result in a cancer.

Once properly encoded in a heritable germ-line gene, behaviours are subject to selection in precisely the same way that physical characteristics are. Additionally, they can be modified, shuffled and improved by new mutations and ongoing selection. For example, just as a new mutation in a gene that controls a stag's shin bone may result in a shorter, longer, thicker or denser bone, so too a mutation in a gene that codes for aggression in a stag may cause the next generation to be slightly more or less aggressive. And just as selection will eventually select the optimum size and shape of a stag's shin bone, so too it will determine the optimum level of aggression. Stags that are not aggressive enough face the possibility of missing out on a mate, while stags that are too aggressive risk being killed or injured in constant and overzealous rutting competitions.

Significantly, though, in both the case of the physical evolution of shinbones and behavioural evolution of aggression, this kind of evolutionary modification only occurs once the new trait has been encoded into a heritable form – a gene that codes for proteins – which in turn codes for cells and tissues - from which shinbones and everything else is made of. But this raises an interesting question - how is something as intangible, ephemeral and complex as a new innate behaviour or instinct first encoded into the nucleotides of a gene?

The usual answer is natural selection. But if you put Darwin's natural selection process under a microscope, you see it's not a single process as the term implies. It actually requires two distinct steps to create evolutionary change.

The first step is the production of what Darwin called 'variables', 'variations from the typical form', 'slight deviations of bodily structure' and 'hereditary elements of unknown causes' that result in physical differences between individuals. Of course, in Victorian times nobody knew anything about genetics (except of course, for Gregor Mendel (right) and his revolutionary but almost unread paper on inheritance) so Darwin's understanding of the molecular biology underlying the nature of his 'variations' was non-existent. Today of course, we know his 'favourable individual differences and variations' are actually caused by heritable mutations in Deoxyribonucleic Acid or DNA.

Mutations are errors that mainly occur when DNA (the molecule of inheritance) reproduces itself. Instead of making an exact copy of a gene, something goes amiss. The most common type of mutation is called a point mutation which is when the smallest element of a DNA molecule (called a nucleotide) is replaced by a different nucleotide or is inserted in the wrong position. Point mutations only affect one base pair (a single rung of the DNA ladder.) More serious mutations involve the duplication, deletion or transposition of a whole chromosome.

Mutations can also be caused by cosmic rays, radiation, toxic chemicals and other mutagens that alter the DNA or prevent its successful reproduction. Whatever their cause, these randomly occurring errors in DNA are the key to evolution because they provide genetic alternatives that can be tried out in the real world. Without them, evolution would grind to a halt.

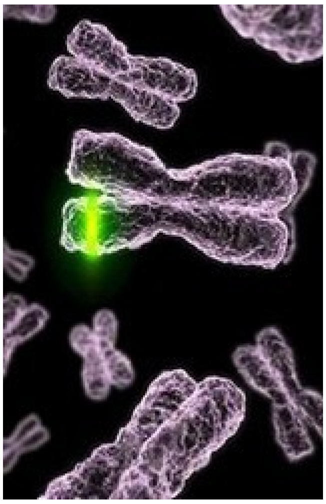
The second step has often been described as market forces:[17],[18] the relentless rat race that sorts the winners from the losers: where when the going gets tough, the tough get going and ultimately where only the toughest survive. Except that in biology, the measure of success is not economical clout or physical toughness, but fitness - a term that doesn't actually mean physically fit, but is simply a measure of an organism's ability to survive and successfully reproduce in its present environment. It refers ultimately to how many offspring an organism produces.

The second step (selection) is what Darwin mainly concentrated on in his book, partly because he was the world expect on it, but also because its survivalist ethos was simple (and brutal) enough for the Victorians to understand.

In this second step, adaptive (or beneficial) mutations that increase reproductive success tend to be selected, which means they're retained and inherited by the next generation. On the other hand, maladaptive mutations – those that reduce the chances of siring offspring – inevitably die with their luckless host. This is called, being 'selected against'. In other words, the second step involves either retaining or eliminating spontaneous mutations that periodically occur.

Evolution by Darwin's natural selection process is mostly – though not always – a slow and gradual process, but in the end, it can achieve remarkable physical results. Given enough time, Darwin reasoned it could turn microscopic organisms into blue whales. It can increase the thickness of an animal's fur in winter (animals with thin wool simply die out – thin wool is selected against) and it can result in camels going without water for weeks because countless droughts have left only the fittest alive. In this way, organisms have evolved, cell-by-cell, mutation-by-mutation from the primordial ooze to Angelina Jolie.

mutants lead the way



Significantly, while natural selection is comprised of two distinct and separate steps, (random genetic mutations and selection) the two steps *always* occur in the same order. The great Darwinian theorist Ernst Mayr realised the significance of the two sequential steps involved in natural selection and perceptively called step two, 'natural selection proper' (NSP) to distinguish it from Darwin's generic term 'natural selection' which can lead to confusion because it refers to both steps one and two. (See Box.)

NATURAL SELECTION PROPER

‘Natural selection proper’ (NSP) is Step Two of Darwin's natural selection process. It describes what happens when a heritable mutation is ‘field tested’ during the organism’s life and in its unique environment.

NSP does not itself produce the mutation, that is a different biological process altogether. All it does is describe whether or not the mutation killed the organism, did nothing (was neutral) or enabled it to produce more offspring.

‘Natural selection proper,’ Mayr wrote, ‘deals with the previously produced variation and is not a process which itself produces variation.’[19] Mayr observes that the two steps are easily mistaken as one process because they perform their functions in a very close (and almost indistinguishable) chronological sequence. ‘The first step of the variation is completely independent of the actual selection process, and yet selection would not be possible without the continuous restoration of variability.’[20]

Understanding that the two steps always occur in the same sequence is vital if we are to unravel the deepest secrets of behavioural evolution. Jeffrey Schwartz in, *Sudden Origins: Fossils, Genes and the Emergence of Species*: 'Only after mutation created something new would natural selection act, weighing each new feature in terms of its relative degree of advantage or disadvantage to both the individual and the individual’s species.'[21] Similarly, cultural historian Jacques Barzun stressed how important it was that, 'Darwin came to see - that selection occurs after the useful change has come into being.’[22]

The importance of natural selection’s two-step process and its rigid chronological sequence (mutations always come first, selection proper always follows) seems to have been largely overlooked, forgotten or not considered relevant by many evolutionists. Consequently, the fallacy that mutation and selection is a single process has been prevalent in the biological literature since its inception and is now so prevalent it distorts biological thinking like a flawed lens. This is unfortunate because within the subtle distinction between mutation and selection lie the deepest undiscovered truths of biology. I am of the view that for any detailed discussion of Darwinian evolution, a generic term like natural selection is more a hindrance than help and is one reason why Darwinian evolution is still so misunderstood.

THE MUTATION-SELECTION PROCESS

This distinction between mutation and selection is so crucial to understanding how evolution works, that from now on when I refer to 'natural selection' I implicitly mean both steps. Often I will actually call it 'the mutation-selection process' which provides a more accurate and functional name.

If referring to Step One alone, I will use the term 'mutation' or 'the mutational process' and when referring just to to Step Two, I'll refer to it as either 'natural selection proper' (NSP) or simply 'selection'.

implications of the two step model

When we apply 'the Two Step' model to the evolution of new innate behaviours, we see that the only way a new behaviour can be encoded into genes is by the same process by which new physical traits are first encoded into genes – the mutational process (Step One in Darwin's mutation-selection process.) As the Darwinian champion, Conrad Waddington put it, 'We know of no way other than random mutation by which new hereditary variation comes into being.'[23]

So evolutionary biologists are not strictly correct when they claim that new behaviours are the result of natural selection. Rather, they are created solely by the mutational process – Step One. Ernst Mayr again:

> It must not be forgotten that mutation is the ultimate source of all genetic variation found in natural populations and the only new material available for natural selection [proper] to work on.[24]

Theodosius Dobzhansky adds his considerable weight to this important detail of Darwinian theory: 'The process of mutation is the only known source of the new materials of genetic variability, and hence of evolution.'[25] His point is endorsed by biologists George Gaylord Simpson & W. S. Beck; 'Mutations are, indeed, the ultimate source of all new genetic materials... In the final analysis, all evolutionary change depends on mutations... all organic evolution is contingent on it.'[26]

Here we get to the nitty gritty - Step Two (NSP) does not create *new* behaviours. Nor does it create *new* physical forms. Nor does it create proteins, hormones, enzymes, bone, cartilage or tissue. In fact, it creates nothing at all. Marc Kirschner and John Gerhart in, *The Plausibility of Life* reiterate this tenet. 'There are limits to what selection can accomplish,' they write. 'We must remember that it merely acts as a sieve, preserving some variants and rejecting others; it does not create variation.'[27]

Step Two of Darwin's mutation-selection process explains that some new heritable physical and behavioural mutations increase survival rates and some don't. Some mutations allow an individual to produce more offspring while others impede reproduction and some are neutral. Some mutations are adaptive, and some are deleterious. NSP is simply a description of evolutionary consequences of the mutational process.

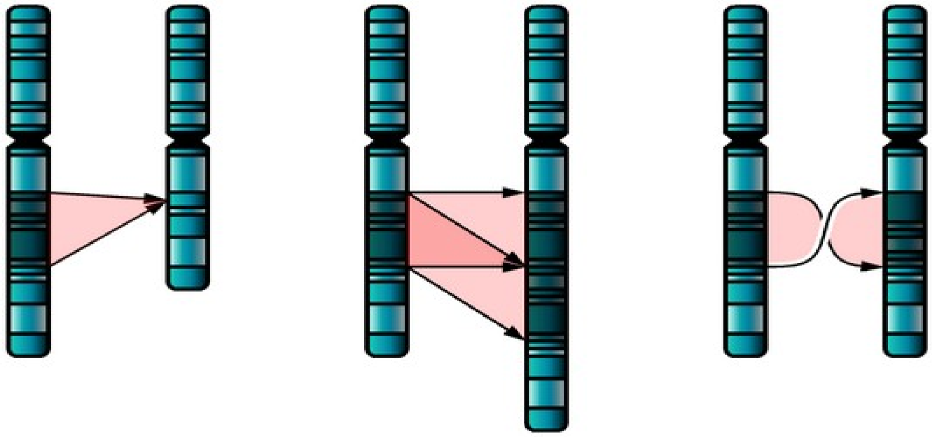
What does all this mean? It means that as the mythical Atlas was forced to carry the whole world on his shoulders, so too the burden of creating the world's pool of new heritable innate behaviours with all their magnificent variety and complexity falls (according to Neo-Darwinian theory) squarely on the shoulders of mutations alone – with no help whatsoever from NSP. This prevailing orthodoxy asserts that even the most complex, sequentially convoluted instincts are created solely by mutations while natural selection proper tests their adaptive value and passes on the most adaptive to subsequent generations neatly encrypted in genes.

So, the orthodoxy under review is not whether natural selection creates complex new instincts and other wonders of behaviour, but whether genetic mutations *on their own* create complex new behaviours?

the blind toss of the dice

And here's the rub. When we talk about mutations, one feature is implicit, significant, but often overlooked – mutations are random. If, when and where a single simple point mutation, a chromosomal duplication, insertion, deletion, inversion or any other form of mutation occurs during the process of DNA replication or translation is all completely a matter of chance. It's as arbitrary as dripping water.

First demonstrated by the Nobel Prize winning experiments of Max Delbrück and Salvador Luria with bacteria in the last century,[28], this blind randomness has since been confirmed by modern geneticists in a wide range of genomes. Even when DNA is exposed to damaging concentrations of radioactivity, man-made toxins, chemical carcinogens, noxious mutagens and chemical stressors, we cannot predict if mutations will occur, much less where or when or how many, or in what configurations. For example, mutations in bacteria can be caused by X-rays, ultraviolet light, nutrient starvation or chemical toxins but there is no pattern to these stress induced mutations, or any guarantee that they will occur.[29],[30]



Three types of common chromosomal mutations; deletion, insertion, and translocation.

Although it has been known since the 1940s that the mutational process is random,[31,32] it's surprising how many biologists and lecturers still teach that evolution is not a random process, and they point to step two of the Darwinian process - NSP - as proof. And it is entirely true that Step Two is non-random. However, Step Two is not the mechanism that generates evolutionary novelties. It actually creates nothing, and is certainly not responsible for creating the variations which drive evolution. It simply selects from variables that have already been randomly supplied.

Secondly, the part of the process that does create the variation (the mutations) is completely random. Even if only step one of the two step process is random, that's enough to compromise purpose, intent and design in the Darwinian system. If instead of two steps, natural selection involved 100 separate steps, it would still only require one random step to introduce chaos and uncertainty into the system and undermine any purposive outcome.

The evidence that evolution is driven by a random mechanism is irrefutable and its significant implications must be acknowledged. For a start, because mutations occur randomly, they obviously cannot anticipate an evolutionary need. They don't occur because they're necessary for an organism to survive in a particular environment at a specific time. Their random nature is not affected one iota by how important a mutation might be to the organism's survival. 'Mutation,' biologist Douglas Futuyma reminds us in his seminal work, *Evolutionary Biology*, 'is random in that the chance that a specific mutation will occur is not affected by how useful that mutation would be.'[33] It doesn't matter how useful a new thumb, an improved liver or a new dilating pupil would be to a species, this will never affect the mutational process. Nor will it cause it to be any less random.

MUTATIONAL HOT SPOTS

Some DNA is known to have mutational hot spots that are more prone to random mutations. Noncoding DNA for example mutates far more frequently than nucleotides within coding genes. However, this doesn't negate the fact that when, where and how often any mutation occurs is still random.

evolution with two hands tied behind its back

The inexorable randomness of the mutational process means the organism's environment can not directly influence the kinds of behaviours that emerge. There is no possibility of any environmental interactivity – no input, help, amelioration or direction – no instruction – no matter how slight – from the animal's environment. It doesn't matter if the animal lives under water, in the air, in freezing cold or high altitude, it matters not a jot if the environment is so extreme it kills 99.9% of the population, it will never affect the kind or frequency of mutations that occur. 'As far as we know,' Douglas Futuyma wrote, 'the environment does not evoke the appearance of favourable mutations, nor can a population accumulate mutations in anticipation of a change in the environment.'[34]

Conventional Darwinian wisdom asserts that the all-important survival needs of the organism – the specific dangers that threaten it, the climatic conditions that affect it, its requirements for food, sex and shelter – have no impact or influence on the mutational process – and consequentially on its evolution. Behaviours like nest building, predator identification and animal migration must arise solely via an accretion of favourable random mutations. Indeed this is a linchpin of modern behavioural genetics and a prevailing orthodoxy of evolutionary biology for nearly 100 years.

Despite the apparent logic of all this, the Darwinian evolutionary dynasty can only endure if this core tenet stands up to periodic re-examination based on the latest evidence. In the next chapter, I undertake such a re-examination but only one simple question needs to be answered – can random mutations of protein-coding genes create complex new, environment-specific innate behaviours and emotions? If it cannot answer this, that part of the paradigm is falsified, a scientific vacuum must be declared and new theories invited for consideration.

2

PUTTING MUTATIONS TO THE TEST

the protein problem

A fitting place to start this reassessment is to look at how random mutations create physical traits. For nearly 100 years it's been known that mutations drive the evolution of arms, legs, wings, scales and other physical forms by providing new variations to be tested by selection – the second step of the Darwinian process. But when you look at precisely what is being mutated, you see the useful mutations actually occur in nucleotides that code for twenty amino acids – often labelled the essential 'building blocks of life.'

The 20 amino acids combine to form long chain molecules called polypeptides that fold into proteins, and it is the proteins that actually produce the cells that become blood vessels, fur, talons, insulin, skin and other physical bits and pieces as well as the enzymes and hormones that regulate the chemical reactions needed to sustain life. Of course, not all genes code for proteins, some code for other essential functions like structural and regulatory RNAs, transcription, translation, chromatin condensation and so on. Nor do genes directly code for proteins. Instead, they code for an intermediary nucleic acid called *messenger RNA* (mRNA) which then synthesises the protein. Mutations are crucial to all this because they alter the DNA and RNA blueprint that manufactures the amino acids and consequently the proteins from which a living organism is miraculously assembled. This process by which the genetic code within a functional gene directs the production of proteins is called 'gene expression' is well understood and a bedrock of modern genetics.

That's not the problem.

The problem occurs because both the Darwinian and Mendelian theories assume that as well as coding for all the physical components of a living organism, proteins also code for innate behaviours as well as personality and emotions like romantic love, altruism and jealousy.

On the surface it may seem a natural and logical assumption, but ultimately it is only an assumption and therefore needs to be tested. To accept the assumption would require that DNA contains 'behavioural proteins' that code for the production of innate behaviour – and that these proteins were assembled into functional arrays by random errors in their parent genes. In practical terms, it means that peculiar innate behaviours, like that of the pearl-fish (*Carapus*), were initially encoded into its genome by a randomly occurring sequence of protein-coding nucleotides.

When threatened, the pearl-fish (left) hunts out the nearest sea cucumber and wriggles tail first through the sea cucumber's anus into its body. When the danger has passed, it leaves its host, but often not before indulging in a parasitic meal of its host's sexual organs.

This innate behaviour is complex in that it includes a 'non-genomic' interaction with an individual from a different species – the sea cucumber. It would require the DNA of the pearl-fish to have synthesised a 'sea cucumber protein' that programs specific sensory neurons with a 'picture' of a sea cucumber accurate enough to allow it to recognise one (without ever having seen one) and then direct it to identify and locate its anal cavity, burrow into it (but only when predators are about) and finally to abuse its host's hospitality by devouring its genitalia.

By any standard this is a tall order for a protein or enzyme, particularly when all available evidence from genome sequencing proves that proteins and the other macromolecules that help the cell assemble the proteins, only code for *physical* things: molecular compounds, chemical reactions, antibodies, hormones, and of course the actual cells that build skin, muscle, hair, tissue and organs.

For example, gene ALB, codes for the protein, Serum albumin that produces human blood plasma. Gene IL10 Interleukin 10 codes for cytokine which is an anti-inflammatory protein. Gene CCR5, codes for the protein chemokine which provides resistance to infection. And so on. While the function of every gene is not known, all those that are known code only for proteins. And all the proteins identified so far code for physiochemical compounds and reactions.

Not surprisingly then, when a mutation occurs in a gene, the consequences are also physiochemical. For instance, a mutation in gene PHF8 disrupts its protein manufacture and usually results in deformities like cleft lip and palate and mental retardation. A mutation in CFTR that prevents its protein production will result in Cystic Fibrosis. If a mutation occurs in the DHFR gene, its protein can't manufacture folate. If the gene, LEP is damaged by a mutation it is unable to manufacture the hormone protein Leptin that normally regulates energy expenditure, appetite and bone mass. Proteins are so precise and so essential to biological functionality that even a single point mutation can disrupt their function and cause serious disease or death.

Proteins come in various forms (including antibodies, enzymes, messengers, structural, transport and storage) with each type performing a specific physiochemical function. Structural proteins build body cells and tissues, messenger proteins provide communications while enzymatic proteins regulate the countless physiochemical reactions that biological systems rely on. As a result of sequencing the human genome, geneticists have identified 1200 different transport proteins, 900 DNA replication/repair proteins, 5200 energy metabolism proteins, 900 structural proteins and 1050 defence proteins.[35]

And yet the study of proteins is still in its infancy. The term 'proteome' (a mix of protein and genome*)* was only coined in 1994. So far, 16,800 proteins and their functions have been fully identified and sequenced in the human genome and every one of them relates only to a physical-chemical function.

This would explain why no behavioural protein has been discovered that regulates the kind of complex instincts that baffled Darwin and confirmed Reverend Paley's belief in God. That's not to say that proteins don't affect behaviour – hormones for example (which are protein products) affect mood, emotions and behaviour, while other proteins affect memory and learning.

What is missing from the protein explanation is the biochemical matrix linking proteins with complex instincts like that of the Indian Tailorbird (*Orthotomus sutorius*). These ingenious artisans construct their nests (*right*) by stealing spiders' thread which they use to curl a large leaf over on itself. They then pierce tiny holes along the edge of the leaf with their sharp beaks and delicately sew the edges together using fine fibres from bark, grass or spider thread. This little abode is then lined with kapok or other soft fluffy stuff.

random mutations and purposeful behaviour

Despite all this, the Darwinian behavioural theory could be quickly and simply confirmed by demonstrating that even one mutation (either in a 'behavioural gene' or protein product) has resulted in a complex functional instinct or innate behaviour.

Experiments to observe the mutational process creating adaptive new behaviours first began 90 years ago, but the most systematic and rigorous experiments were carried out by the eminent Russian biologist and founding father of evolutionary biology, Theodosius Dobzhansky in the 1930s and 40s. He began his famous experiments with fruit flies (*Drosophila*) fully expecting to demonstrate how random genetic mutations created adaptive new behaviours as specifically predicted by Darwinian theory. But when Dobzhansky exposed literally millions of flies to stressful environmental mutagens (toxic chemicals and heat known to cause random mutations) he was much surprised by the results. Firstly, he found that the mutations in his fruit flies were no different from those that occurred by chance in unstressed animals.[36] Secondly, he found that the mutations were invariably deleterious:

> The classical mutants obtained in Drosophila usually show deterioration, breakdown, or disappearance of some organs. Mutants are known which diminish the quantity or destroy the pigment in the

> eyes, and in the body reduce the wings, eyes, bristles, legs. Many mutants are, in fact lethal to their possessors. Mutants which equal the normal fly in vigor are a minority, and mutants that would make a major improvement of the normal organization in the normal environments are unknown.[37]

Thirdly, despite identifying over 400 different mutational features, no new species appeared, causing Maurice Caullery to conclude in, *Genetics and Heredity*, 'It does not seem, therefore, that the central problem of evolution can be solved by mutations.'[38] This cast serious doubt about how mutations might create new species.

Fourthly, and here we get to the nub of the matter, while nearly all the mutations deleteriously affected physical traits, a few did affect basic behaviours. Significantly though, of the mutations that impacted on behaviour, not one resulted in a functional new behaviour. In what may be the most counter-productive experiment in the history of Darwinism, all the mutations caused deleterious disabilities like paralysis and hyperactivity, which prevented the flies from flying properly, feeding and mating.[39]

In hindsight, it seems obvious that the flies' existing behaviours were optimally adapted – they were perfectly functional the way they are – so any mutation tended to disrupt the existing behaviour and render it non-functional. ‘In nature, new favourable mutations must be rare,' wrote Colin Patterson, senior palaeontologist at the British Museum, 'This is because existing species are the result of past selection, which will have brought them close to the best obtainable ‘adaptation’ to their surroundings, so that most mutations (changes) will decrease that adaptation.’[40] Although Patterson was talking about physical evolution, it obviously applies to behaviour as well.

Because Dobzhansky's research was so at odds with predictions, its significance has largely been ignored. However, by clinically demonstrating the inability of the mutational process to create viable new behaviours, it may also be reinterpreted as a persuasive evidential refutation of the Neo-Darwinian behavioural paradigm.

Since then, numerous similar experiments have been carried out to prove that the mutational process can create functional new behaviours, but so far, no new functional behaviours or emotions have been observed.

'Animal behaviourists,' concludes Robert Wesson, 'record no case of a mutation giving rise to a new behaviour, only to pathologies or distortions of behaviour.'[41]

why haven't behavioural genes been discovered?

Geneticists have spent millions of dollars sequencing genomes but so far have not discovered a single protein-coding gene for a complex, environment-specific instinctive behaviour. A gene that allows us to recognise and respond to spiders has not been discovered, nor has a gene that regulates humanity's obsession with decorating and adorning their bodies or our universal love affair with dogs.

The Human Genome Sequence cost nearly 3 billion dollars and sequenced 99% of the human genome's gene-containing regions with an accuracy of 99.99% Did this exacting analysis of the three billion nucleotides that make up the human genome reveal the gene for our fear of spiders? No, it didn't. Then what about the genes for music and dance – after all, they're ubiquitous human behaviours as much a part of human nature as smiling and crying. No, nothing. The same goes for fear of the dark, belief in God, art, being wary and fearful of strangers and genocide.

Geneticists have now sequenced over 250 genomes – many of them animals – and have revealed the function of thousands of genes and the proteins and polypeptides they code for. What they have discovered is that every gene in every genome sequenced codes only for proteins and RNA chains that spell out the formulae for amino acids and other macromolecules that in turn are assembled into body parts. In other words, every gene sequenced so far only codes for physical traits.

Writing in the journal *Nature* when the *Draft Sequence of the Human Genome* was released, Nobel laureate, David Baltimore praised the huge team of geneticists who had unravelled the most complex molecule in nature. But he also added a salutary reminder.

> Understanding what does give us our complexity — our enormous behavioural repertoire, ability to produce conscious action, remarkable physical coordination (shared with other vertebrates), precisely tuned alterations in response to external variations of the

> environment, learning, memory. . . need I go on? — remains a challenge for the future.[42]

I remember the week *The Initial Sequence of the Human Genome* [43] was released in a world wide blaze of publicity in February 2001. I had developed teem theory about six months earlier and it clearly predicted that innate behaviours and emotions would not be found in protein-coding genes. This was actually the first major test of the theory, and I was greatly relieved when not one of the estimated 30,000 sequenced genes turned out to code for a complex behaviour or emotion. In the ensuing ten years, the number of human genes has been revised down – to approximately 21,000 distinct protein-coding genes[44] but apart from that, nothing has changed.

you need legs to dance

The theory of behavioural genes and proteins also fails to take into account that a new behaviour often requires a complementary physical trait to function properly. Even if a whole sequence of favourable mutations occurred in a herbivore's genome and their resultant proteins allowed it to recognise a particular tree, along with additional mutations-proteins that motivate it to favour the taste of its leaves (resulting in a specific leaf-eating instinct) new physical traits may be required to actually make the new instinctive behaviour work. For example, the African Acacia tree is covered with sharp thorny spikes that only an animal with a specially designed and very tough tongue can cope with. An acacia leaf-eating instinct, without the wherewithal to deal with the tenacious thorns would be adaptively useless.

Amazingly, some species of fish have acquired a flying behaviour ('gliding' is probably more accurate because they don't actually flap their wings) which involves a very precise routine. With fins folded tightly against its streamlined body, a flying fish builds up speed under water and, just as it breaks the surface and spreads its wings, its still submerged tail beats rapidly to give the last thrust that takes it airborne. The glide itself can cover a distance of 600 feet (180 m).

Numerous physical traits are required to support this behaviour. Not only do the small pectoral fins need to be enlarged and stiffened, but so do the pelvic (posterior) fins. Some species, like the California flying fish (*Cypselurus californicus*) have added an extra pair of fin-wings. New muscles are needed to keep the fins stiff during flight. To provide extra thrust when the fish breaks surface, the tail must be modified to an uneven forked shape. Then the fish needs to be able to hold its breath while out of the water. In effect, the flying behaviour is possible only because of these additional complementary physical traits.

These examples illustrate that behaviour and physiology are not separate entities and do not operate in isolation. They are closely related and mutually interdependent biological systems. Most behavioural modifications would be ineffectual unless accompanied by the appropriate physiological trait. A chameleon's instincts for camouflage would be useless without its complex pigmentation physiology that enables it to change colours. An Australian frilled lizard's bluff display only works because it is able to flare out a mantle around its head to look ferocious. A leopard's predatory instincts depend totally on the evolution of teeth and claws able to catch and kill prey. And finally, herbivores like giraffes are able to eat the leaves of the thorny acacia tree, but only because they have evolved incredibly thick, leather like tongues. Their tongues make their acacia instinct viable.

It seems somewhat far-fetched that random genetic mutations create a rattle for a snake's tail, then separate mutations create the innate behaviour that causes the snake to rattle its tail to warn off predators or startle prey. Significantly, neither the rattle nor the shaking behaviour are adaptive on their own. They only function as a symbiotic unit.

At issue is what the celebrated Swiss biologist and psychologist Jean Piaget considered to be an insoluble problem for the Neo-Darwinian paradigm – why morphology (the physical features of an organism) is invariably accompanied by appropriate behaviour.[45]

Geneticist Mae-Wan Ho argues it 'stretches credulity to imagine that the woodpecker first got a long beak from some random mutations followed by other random mutations that made it go in search of grubs in the bark of trees'.[46] According to evolutionary biologist, Conrad Waddington, the inability to integrate behaviour into a holistic theory of organic evolution and the failure to identify the 'feedback' between behaviour and evolution are inevitable without a cogent new theory of innate behaviour.[47]

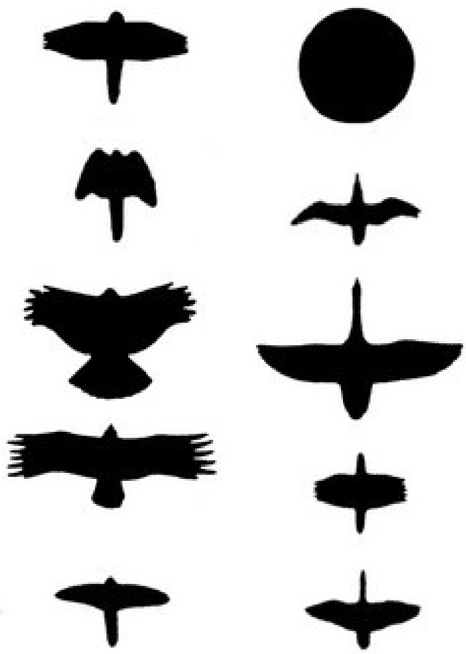
In this chapter, I have nominated several mechanistic impediments and challenges the random mutational processes faces in genetically archiving complex information like innate behaviour and emotions. In the next chapter, I turn the attention away from the *how* – the mechanics of heritable behaviours - to look at the *content:* the complex of environmental information that is the raison d'être of functional instincts, and ask whether this intricate and often nuanced data could really be the result of genetic errors.

3

THE VEXED QUESTION OF ENVIRONMENTAL INTERACTIVITY

the turkey and the hawk

In a series of inspired experiments, Nobel Prize winning ethologist, Nicholas Tinbergen flew models of different birds (*right*) along a wire over the top of a turkey coop. To his surprise newly hatched turkey chicks (straight out of their shells) instantly recognised the hawk shaped model and ran for cover as fast as they could. Amazingly though, Tinbergen reported that the chicks did not panic or run 'when the bird is a gull or duck, heron or pigeon'.[48] The innate behaviour is only triggered by something that looks like a hawk – which is hardly surprising because in the wild, hawks are the turkey's natural enemy. So adept were



the newly hatched chicks at recognising the shape and flight characteristics of hawks that when the hawk model was flown backwards along the wire, it had no effect on them.

Given what we now know about how the mutational process impacts genes, and how genes in turn direct the assembly of proteins, is it plausible that a cluster of random genetic errors generated a detailed picture of a flying hawk into an ancestral turkey's genes so that its offspring are able to recognise a hawk without prior exposure? And can the same random mutations assemble a cocktail of proteins that proscribe the convoluted behaviours displayed by female mason wasps? Although they have no contact with their parents (and so cannot learn from them Mixing her saliva with mud to make a mortar she then builds a series of separate cells in which she lays fertilised eggs, attaching one to the ceiling of each cell (*right*). She then hunts and paralyses caterpillars, which she uses to provision each cell before sealing it off with a wall of mud, repeating the process eight to ten times.[49]

That all this is instinct is undeniable, every mason wasp displays this behaviour even if it has been raised in isolation. That the behaviour would not be functional if even one step in the provisioning and construction process were deleted (or in the wrong order) is also self-evident. To achieve all this solely by an accretion of multiple random mutations that were placed into their precise nucleotide sequence and chromosomal location randomly appears if not impossible, then mathematically improbable.

But my favourite environmentally interactive behaviour may be that displayed by the diminutive New Caledonian cockroach wasp (*Ampulex compressa*) which uses a devilishly clever tactic to hunt cockroaches many times bigger than itself.[50,51] When a female wasp comes across a cockroach that is far too large to carry home, the wasp stings the cockroach twice. The first sting immobilises the cockroach for a few seconds to make it easier for a second surgically precise sting into the precise lobe of the cockroach's brain that controls its escape behaviour.[52] Once the paralysis from the first sting wears off, the roach doesn't try to escape because the neurons that control its escape strategy have been immobilised by the neurotoxin in the second sting.[53] Instead, the roach usually begins to groom itself, oblivious to the danger it faces. Now the tiny wasp can take the large roach gently by one of its antennae and lead it meekly off to its burrow. There it lays its eggs on the roach's underbelly. When they hatch, the wasp larvae begin munching on the compliant roach until its death about a week later.

Perhaps the wasp's fiendish skill-set accrued entirely by the random toss of the wasp's genetic dice. And yet, its detailed knowledge of roach physiology and neuronal circuitry, its multiple injection strategy using two different toxins, and its use of the cockroach as a living larder seem so detailed and exact it could only have been occurred via first hand, direct experience – information collected by some ancestral wasp under 'field' conditions.

The predatory behaviour of the New Caledonian cockroach wasp is not an aberration. There are over 200,000 species of parasitoid wasps and they've all evolved complex instinctive strategies to exploit other species. Have all these interactive behaviours accrued through the activity of random mutations and species-specific wasp proteins? Or has some clandestine environmental interaction taken place between the cockroach and the wasp's genome that instructs the wasp with information about its prey's physiology, lifestyle and – most importantly – strategic weaknesses?

It is not just insects that accumulate useful environmental information in their genomes. Somewhere in the genome of every lemming is a genetic sequence that recognises owls and foxes and directs the lemming to dart to the nearest burrow. Tucked into the DNA of every male crane are the dance steps that will impress a female. Stored somewhere in our own genome must be our fear of snakes, spiders and other creepy crawlies. And if human language can be demonstrated to be even partially innate (as suggested by Darwin,[54] Chomsky,[55, 56, 57, 58, 59] Pinker[60, 61] and others[62, 63]) then ensconced 'somewhere' in the labyrinth of our DNA must reside the basic rules of grammar and syntax – with all its head scratching implications.

But where?

The Neo-Darwinian synthesis points directly to protein-coding genes because – what else is there? And yet, biologists remain conspicuously silent on how these adaptive bytes of functional environmental data become encoded into protein-coding nucleotides and how the data is 'translated' (or transduced) into Guanine, Adenine, Cytosine, and Thymine nucleotide bases that make up DNA. But given that DNA is essentially a blueprint for the manufacture of proteins, the current paradigm has a scientific responsibility to at least try to explain how protein products store and express the kind of complex environmental data that instincts contain.

These of course are rhetorical questions because the authority of the Darwinian behavioural paradigm is such that these questions have not been seriously asked for nearly a hundred years. They have become part of a dogma that demands an act of faith not unlike that which binds our religious opponents to their own creationist beliefs. But even if my alternative explanation proves half right or completely false, these are still valid questions that will eventually need to be answered - if not by teem theory then by something equally grounded in biological science. Following Einstein's advice that 'the important thing is not to stop questioning,' the best way to maintain the credibility and relevance of a scientific paradigm is to keep asking questions of it, especially as new evidence and phenomena come to light.

So how did random mutations in sequences that only code for physical traits (and without any environmental input or influence) originally programme that first intrepid green sea turtle that made its way from Brazil to Ascension Island 2,240 kilometres away. And having got there, how did the co-ordinates become encoded into its genes to pass on to offspring so that they too could made the arduous voyage?

why nothing eats monarch butterflies

The monarch butterfly (*Danaus plexippus*) will lay its eggs in one spot only – the milkweed plant. This requires the newly hatched butterfly to scour its environment until it locates one specific plant – which it has never seen before – and know instinctively that it must lay its eggs on its leaves. This fastidious effort is undertaken for a good reason. When the monarch larvae hatch, the pupa and caterpillars eat the leaves of the milkweed plant which contain a cardiac glycoside toxin that the grubs are immune to, but which makes the pupa, the caterpillars and the butterflies all poisonous to predators. That's why most predators intuitively give monarchs a wide berth.

The monarch butterfly is able to intuitively recognise a milkweed plant without ever having seen one before.

The milkweed plant was originally as foreign to the butterfly's genes as an electric toaster is to ours and yet, somewhere in the evolutionary history of the monarch, their genes acquired the ability to recognise and exploit the plant and its toxins.

Yes, that's remarkable and yet another unexplained phenomena that NeoDarwinists must avert their eyes from. But for me, equally if not more perplexing is how every predator, from birds to lizards to snakes have all acquired the innate capacity to avoid the poisonous monarchs. How could a mutation – an error of chemistry that occurs inside a gene of a predatory bird learn not just to recognise a monarch from all the other butterflies, but to know it must avoid eating one at all costs – no matter how hungry it is.

What appears to stretch the Darwinian model to the point of incredulity is that amazingly, a few bird species (notably jays and orioles) instinctively know that the monarch's cardiac glycoside toxin is mainly concentrated in the abdomen and wings. They also know they can get around this by eating only the thoracic muscles and abdominal contents which don't contain as much toxin.[64] It's not difficult for the Neo-Darwinian synthesis to explain how this behaviour was learned (one starving bird took the chance and survived) but it is far more difficult – if not impossible – for it to explain how the newly learned predator's 'work-around' then found its way into a protein-coding gene and was passed on to its offspring.

Behaviours like this – and nature is full of them – appear to reflect, not just a degree of awareness of the environmental forces and conditions affecting the animal, but the ability to innately recognise specific *foreign* elements in the environment. By this, I mean physical, three-dimensional objects and circumstances that are external to the genome. The turkey chick's escape behaviour only works because somewhere in its DNA is a precise description of a hawk – accurate enough to distinguish hawks from non-predatory species. A cuckoo's parasitic behaviour only works if the newly hatched cuckoo knows it has to kill every other bird in the nest. A mason wasp is born with a mug shot of all its prey species pinned up on a tiny notice board in its DNA. Only one dance will arouse a female red-crowned crane (*Grus japonensis*) and these intricate dance steps are indelibly etched into the genes of every male crane. And of course, every female crane is able to instantly recognise and appreciate the dance even when it has never seen it performed before.

the volkswagen mutation

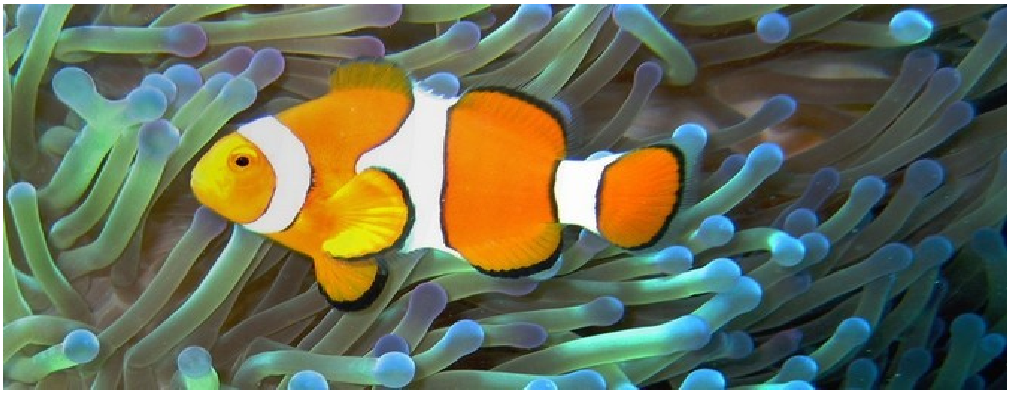
To assume that a monarch butterfly is born with a mutation that recognises a milkweed plant plus a preference to eat it, is like saying a child can be born with a mutated gene that recognises a Volkswagen and tells her how to drive it. Both the Volkswagen and the milkweed plant exist outside the gene, outside the chromosomes, outside the DNA – and ultimately, outside the organism itself. They are part of the environment and therefore physically isolated from the genome. The random scrambling of mutations simply cannot recognise extraneous objects. The idea of a human Volkswagen mutation that codes for a Volkswagen protein is no less illogical than a butterfly's milkweed mutation which would require the acquisition of complex and detailed environment-specific information – to which the mutational process is blind.

When a newly hatched herring gull (*Larus argentatus*) sees the bright red spot on its mother's bill, it triggers a pecking response. The chick's instinct to peck the red spot on its parent's bill could conceivably have arisen through a series of random mutations. But the parent gull also has an instinct to regurgitate food when its red spot is pecked. Together these two separate instincts form the basis of many avian feeding systems. But neither instinct is adaptive without the other. And in both cases, the genes of each animal appear to display an awareness of – and interactivity with – an element external to the genome which is invisible to its genes, proteins and the mutational process.

mutualism – the final nail

If these marvels of the natural world challenge the behavioural capabilities of the mutational process, then they are stretched to breaking point by the mystery of mutualism – the way two species interact so that each derives a fitness benefit.

Examples of these reciprocal behaviours abound in nature, but Darwin was particularly intrigued by the mysterious farming of aphids by sugar ants, involving as it does ants moving, corralling, grooming and protecting their captive herd of aphids as well as any farmer. In return, the aphids allow the ants to milk them (by stroking them with their antennae) to extract a sap-like liquid which the ants eat.



Clownfish defend sea anemones against butterflyfish and other predators that normally feed on anemones and in return, sea anemones provide a safe haven for clownfish against its own predators.

Similarly, Pilot fish (*Naucrates ductor*) accompany sharks and remove their ectoparasites, crabs and other parasites in return for the shark's protection from other predators.[65] For this mutualistic relationship to become established, it had to occur simultaneously in both species (it doesn't work if only one species plays the game) which would require complementary mutations occurring at the same time in both species. The more logical explanation is that the two instincts originated via some unknown feedback loop. Some kind of environment interaction occurred and was encoded into the genes of both species.

THE CROCRODILE AND THE PLOVER

The Nile crocodile (*Crocodylus niloticus*) the largest in Africa regularly comes up onto the riverbank and opens its mouth to allow Egyptian plovers (*Pluvianus aegyptius*) to zip inside for a quick dental treatment. The plovers, (or crocodile birds as they're sometimes called) delicately pick out rotting meat, leeches and other parasitic insects ensuring the crocodiles teeth are kept in tip-top condition. The plover dentists never fear being gobbled up as a tasty snack by their patients because the crocodiles instinctively know they're onto a good thing. Throughout their dental treatment, the crocodiles remain on their best behaviour.[66]

Explaining how this and other extraordinary complex instincts and innate behaviours displayed in the animal kingdom emerged was what Darwin was alluding to when he wrote, 'Many instincts are so wonderful that their development will probably appear to the reader a difficulty sufficient to overthrow my whole theory.'[67]

It was this bewildering display of environmental information that animals appear able to tap into and configure into adaptive instincts that prompted Darwin to spend a decade looking for a mysterious second evolutionary process that he believed must be responsible. And although he never discovered how environmental information was acquired by an individual, formulated into adaptive instincts, or inherited by its offspring, neither have his successors. Even armed with the wealth of Mendelian genetics and a precise understanding of the DNA molecule, scientists are no closer to understanding aphid farming than were the Greeks.

sexual selection – lusty lions and frisky ferrets

As perplexing, implausible and problematical as it is for Darwinian theory to explain complex instincts without recourse to environmental interactivity, last but not least there is the equally baffling question mark that hangs over sexual selection.

In his 1871 second masterpiece, *Descent of Man, and Selection in Relation to Sex*,[68] Darwin expanded on his revolutionary theory of sexual selection, in my view among his greatest scientific achievements and among the most ingenious scientific theories ever expounded.

Darwin himself described it as the 'struggle between the individuals of one sex, generally the males, for the possession of the other sex'. As University of New Mexico evolutionary psychologist, Geoffrey Miller puts it, 'evolution is driven not just by survival of the fittest, but reproduction of the sexiest.'

Darwin again:

> The sexual struggle is of two kinds: in the one it is between the individuals of the same sex, generally the males, in order to drive away or kill their rivals, the females remaining passive; while in the other, the struggle is likewise between the individuals of the same sex, in order to excite or charm those of the opposite sex, generally the females, which no longer remain passive, but select the more agreeable partners.

Although it's usually males that develop these features – such as elaborate plumage, (*left*) fighting prowess, large antlers, manes, distinctive displays – the preference for the feature invariably originates in the female. Significantly though, sexual selection only works because the female's sexual preference is innate, so instead of dying out when she does, it gets passed on to her offspring so tends to become more pronounced with each generation. Sometimes, the sexual trait starts to become maladaptive as when a bird's plumage makes flying difficult or prevents him escaping predators. When this happens, the trait obviously gets trimmed back by NSP.

It's a simple elegant theory with extraordinary explanatory powers. The only problem is that although sexual selection has been extensively studied in a wide range of species and phyla, so far, no-one has been able to adequately explain how the female's preference for a new trait or behaviour is actually encoded into its genes and proteins in the first place – so that it can be inherited by her offspring.

The one standard explanation – random mutations – is not intuitively convincing because the female's preference clearly originates in her physical surroundings: something in a male catches her eye, something aesthetically attractive, something – in the environment. And as we know, anything from the environment is expressly prohibited from affecting the genome according to Neo-Darwinian rules, and that includes instructing it with new aesthetic values.

heads in the sand

Some scholars realised twenty years ago that the evidence was pointing away from a single NeoDarwinian explanation of behavioural phenomena. In, *Beyond Natural Selection*, published in 1979, Robert Wesson began by acknowledging the complexity of heritable behaviours:

> An instinct of any complexity, linking a sequence of perceptions and actions, must involve a very large number of connections within the brain or principal ganglia of the animal. If it is comparable to a computer program, it must have the equivalent of thousands of lines. In such a program, not merely would the choice of improvement by accidental change be tiny at best. It is problematic how the program can be maintained without degradation over a long period despite the occurrence from time to time of errors of replication.[69]

He then discounted the Lamarckian idea that these complex instincts may have accrued from habit: 'Learning is not simply passed on to offspring. Experiments to demonstrate this have failed.'[70] But neither did he believe the Darwinian mutational theory of instinct was supported by any real evidence, concluding, 'Because of the extreme complexity of instincts, the probability of improvement by random mutation must be minimal.'[71]

You might expect Wesson's lone voice would soon be joined by others – or that it would at least generate a modest debate in scientific journals about potential shortcomings in the paradigm as it applies to behaviour. But this didn't happened. Wesson's work was largely ignored and no one since has taken up the cudgels. Why? One possibility is that while it is generally acknowledged that Weismann introduced a dogmatic element to NeoDarwinism, over the last few decades this trend has taken on many of the features of religious fundamentalism, which includes prohibitions against dissent, dismissing theoretical deviations as heresies and stigmatising opponents as apostates.[72,73,74,75,76]

This inhospitable, if not repressive climate appears to have stifled evolutionary debate, something the late Steven Jay Gould warned about in 1994, when he wrote about being, ‘saddened by a trend I am just beginning to discern among my colleagues. I sense that some now wish to mute the healthy debate about theory that has brought new life to evolutionary biology’.[77]

Gould’s concern that any curtailment of debate would provide ‘grist for creationist mills’[78] was I believe, a valid one, as was his warning to biologists that ‘if we ever begin to suppress our search to understand nature, to quench our own intellectual excitement in a misguided effort to present a united front where it does not and should not exist, then we are truly lost’.[79]

While Gould believed that 'Neo-Darwinian fundamentalism' as he called it, was a recent trend, in her Introduction to *Darwinian Heresies,* science historian at the University of Texas, Abigail Lustig suggests fundamentalist tendencies have older antecedents:

> The intellectual landscape of Darwinism for the last 150 years bears a certain resemblance to Germany during the Thirty Years' War. Sects and churches, preachers and dissenters, holy warriors, and theocrats vie with each other for the hearts of the faithful and the minds of the unconverted, all too often leaving scorched earth behind.[80]

Lustig admits overstating the case somewhat but her provocation was motivated by the need to jolt her colleagues out of their entrenched complacency and conservatism.

What are the implications? If geneticist, James Shapiro, Professor of Microbiology at the University of Chicago is correct, and 'Darwinism has become more of a faith than a science',[81] or if we accept Lustig's more extreme judgement that Neo-Darwinism is now 'reminiscent of the Spanish Inquisition',[82] what does it augur for evolutionary biology and particularly the debate on behavioural evolution? If, as I argue, Neo-Darwinian orthodoxy has resolutely clung to the view that only the mutational process creates new heritable behaviours, despite emerging evidence to the contrary, then it predicts that over the last twenty years, discussion and debate would gradually dry up.

I found considerable evidence for this gloomy prediction when I went to the academic literature to research the biochemical mechanisms by which the random mutational process might create new innate behaviours, instincts and so on – how it might achieve behavioural complexity without environmental interactivity. The scientific literature is practically non-existent. There are a few vague assertions, nondescript prevarications and reiterations of well-worn but untested orthodoxies. But mostly, the evolution of behaviour is characterised by overwhelming omissions and neglect. A quick look through some of the books on evolutionary biology in my own bookshelf,[83,84,85,86,87,88,89,90,91,92,93,94,95,96] reveals not one mention of instinct or innate behaviour in any of their indexes. In Ernst May's classic *What Evolution Is*,[97] he acknowledges the importance of behaviour when he describes an adaptation as 'a property of an organism, whether a structure, a physiological trait, a behavior, or anything else that the organism possesses, that is favored by selection over alternate traits,' but then never examines behaviour, instincts or innate capacities again. Even Steven Jay Gould's magnum opus, the 1,433 page, *The Structure of Evolutionary Theory*,[98] (*left*) which was meant to be the last word on everything evolutionary doesn't index either behaviour or instincts.

One of the few university textbooks that does list instincts, *Strickberger's Evolution: the integration of genes, organisms and populations* by Brian Hall, Benedikt Hallgrímsson and Monroe Strickberger, devotes less than one of its 760 pages to the subject. Its cursory and simplistic treatment of the subject is obvious from its first paragraph:

> Relatively complex innate behaviors, often called instincts, may involve many behavioral components, as demonstrated in the courtship patterns of most animals and "dancing" patterns used by honeybees to communicate the direction and distance of food sources. Simple or complex, innate behaviors are often uniform within a species and, therefore, like other species-specific traits, seem to be entirely or almost entirely under intrinsic genetic control.[99]

Perhaps the most unexpected omission or deliberate exorcism of innate behaviour from the evolutionary debate occurred in February 2001 with the publication of the encyclopaedic *Draft Sequence of the Human Genome*.[100] This was the definitive statement on human evolution, a detailed sequence of all the genes that make us what we are. And yet, there was not one mention of behaviour – of any sort. An oversight? Perhaps. But three years later, the *Final Sequence* was published in *Nature;*[101] and although they sequenced a staggering 2.85 billion nucleotides (approximately 99% of the euchromatic genome) there was no mention of behavioural genes, instincts or any reference to behaviour.

It is as if those countless innate behaviours (including complex survival skills incorporating detailed and highly specific environmental information) and sexual preferences displayed by millions of species (including humans) do not exist as part of the biological matrix and have no place in the evolutionary process. And yet, they are palpably as innate, genetic and evolutionary as any arm or leg. This neglect is particularly striking as behaviour has long been identified as a major contributor to the evolution of physical traits.[102,103,104,105,106,107,108,109,110,111]

These omissions amount to more than an oversight, they are examples of self-censorship. The suggestion that scientists might choose not to publish controversial findings for fear of rocking the Darwinian boat is supported by interviews with science practitioners by the sociologist, Warren Hagstrom from the University of Wisconsin-Madison. Although Hagstrom found that scientists occasionally hold back controversial findings, he also found that 'scientists may deny the presence of controversies to strangers but not to themselves,'[112] Professor Hagstrom also confirmed social-control sanctions operating within the scientific community that maintain conformity to its norms by refusing to publish papers in professional journals and denying opportunities for occupational advancement.[113,114]

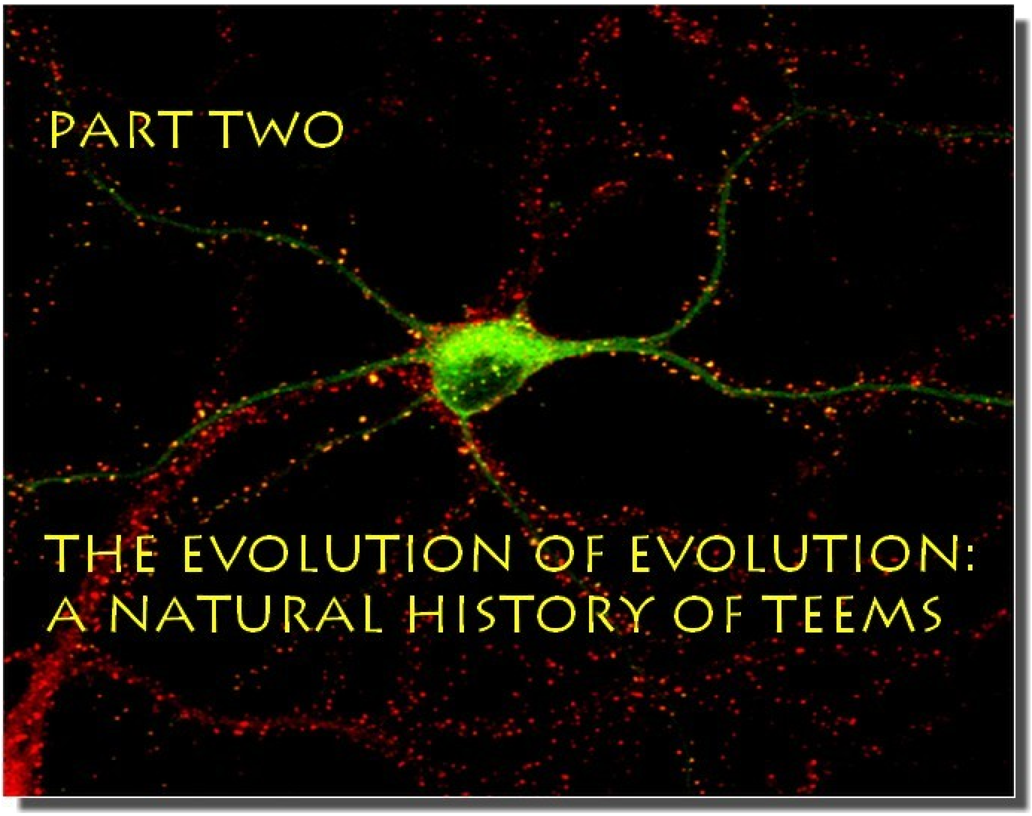
I believe this multi-faceted denial of conflicts in the NeoDarwinian behavioural paradigm may be unprecedented in the history of biology. It represents a significant unacknowledged failure of the life sciences, which has hampered a deeper understanding of evolution and allowed religious fundamentalists to fill the void with unscientific trumpery. But paradoxically, these omissions and marginalisations are also an important clue, and provide the strongest indication that something important is wrong with the Neo-Darwinian behavioural paradigm, a flaw so serious and yet so ill-defined that it has been dealt with by expurgation from polite scientific circles.

On closer examination these purposeful and pervasive omissions are a classic response to anomalies in a scientific paradigm. The science historian Thomas Kuhn showed that such states of denial frequently precede a shift to a new paradigm.

This raises the issue of paradigm change – and the challenge that teem theory obviously poses to a much respected and long-standing paradigm. In light of the a priori resistance against paradigm change that can prevent the impartial assessment of evidence supporting a shift, it would be remiss of me if I did not at least attempt to address and neutralise some of non-scientific objections before I outline my theory. I address this in Appendix 2.

APPENDIX 2 – PARADIGM SHIFT

Teem theory proposes a paradigm shift that will engender a priori resistance from both the Darwinist and creationists camps. To provide a level playing field where teem theory can be objectively appraised, it is essential to understand the problematical nature of paradigm change and other issues that impact on an objective assessment of teem theory.


PART TWO
THE EVOLUTION OF EVOLUTION:
A NATURAL HISTORY OF TEEMS

4

THE SECOND EVOLUTIONARY PROCESS

something else not yet thought of

My reappraisal of the mutational process as it relates to instincts, innate behaviour and emotions does not disprove it. And for some, no amount of proof could undermine their faith in any part of the Darwinian paradigm. For others, even a soundly based secular critique limited to one aspect of Darwinian theory – while acknowledging the soundness of the central premise – is still too much. So my intention is not to disprove anything, it's simply to demonstrate that the Darwinian model is sufficiently flawed to warrant consideration of plausible alternatives.

Having identified a problem in a scientific paradigm, proposing an alternative paradigm is almost obligatory. We abhor a scientific vacuum – perhaps it's simply hubris – but whatever the reason, most scientists will not abandon even a redundant paradigm unless there's a viable replacement. As Kuhn put it, 'a scientific theory is declared invalid only if an alternate candidate is available to take its place.'[115]

Until now, alternatives have been practically non-existent. The English biologist, John Maynard Smith once observed, ‘only two theories of evolution have ever been put forward: one, originating with Lamarck… the other, originating with Darwin’.[116] Over the last two hundred years, all serious academic debate has centred on these alternatives and the majority of biologists believe as

Richard Dawkins does, that Lamarckianism is not even an option. Dawkins summed up the prevailing gestalt when he said, 'I'm a Darwinist because I believe the only alternatives are Lamarckism or God, neither of which does the job as an explanatory principle. Life in the universe is either Darwinian or something else not yet thought of.'[117]

I couldn't agree more. But do staunch Darwinists really want 'something else not yet thought of' if it challenges the mutational theory of behaviour? I doubt it. Richard Dawkins has been defending Darwin all his life and the last thing he wants is 'something else not yet thought of' that contradicts any aspect of Darwinism.

This puts my advocacy of 'something else not yet thought of' in an invidious position and the history of science predicts the path for such a theory will be strewn with boulders. It probably won't assuage the a priori objections of some Darwinists, and yet my theory of behaviour doesn't claim that Darwin was wrong. All it claim is that there is more to evolution than what Darwin discovered. This is no more than what palaeontologist Stuart Kauffman ventured in 1993, 'It is not that Darwin is wrong, but that he got hold of only part of the truth.'[118]

One part is missing – this part: everything in nature has evolved – including the process of evolution. For 150 years it has been assumed there is only one evolutionary process regulating all life on Earth, but what if that single process could not achieve the diversity and complexity that life blindly aspired to? Darwin believed this. So did Lamarck. That's why Darwin supplemented natural selection originally with his habit theory and eventually with his flawed pangenesis theory, and that's why, in, *The Origin of Species*, he kept open to the possibility of a second process: 'I am convinced that natural selection has been the main but not the exclusive means of modification.'

This would mean that natural selection, as a mechanism of physical evolution evolved specifically to prevent the environment deleteriously instructing the genome with acquired physical traits. This leaves open the possibility for a second, separate mechanism of behavioural evolution to emerge, one that would purposefully allow the environment to instruct the genome with adaptive behaviours but not have any deleterious Lamarckian consequences. The evidence I have collated suggests this is precisely what happened. Importantly, the second evolutionary process that emerged to provide animals with heritable instincts and emotions was neither Darwinian nor Lamarckian – it was 'something else'.

As radical and heretical as a second evolution theory sounds, it not only agrees with the facts, it also appears to resolve most of the major problems and inconsistencies in the current Neo-Darwinian paradigm – both behavioural and physical. What follows is a simplified version of the second evolution hypothesis. The molecular and genetic details are left till later.

the power of memories

Imagine a dog hears a roaring sound it has never heard before. It cautiously walks to the edge of a tall cliff and looks down. In the canyon below, a river rages in full flood. The sound of the water rushing through the ravine and over cataracts is deafening. Then suddenly, the soft edge of the cliff gives way and the dog tumbles into the river. Within seconds, it's swept downstream, bashed against outcrops of jagged rocks, dragged under by swirling eddies and chilled by the icy water. Half drowned; it crashes into a submerged branch that tears a gaping wound in its leg. Seconds later it is dashed against a rock that splits its ear. Now only semi-conscious, the dog sinks under the swirling waters.

But just when the end is near, the dog bumps into a semi-submerged tree trunk and scrambles onto it. Inch by inch it crawls along the log to the bank where it collapses exhausted and bleeding. Gasping for air, traumatised, haemorrhaging, hypothermic and in shock, the dog's mental, emotional and physical systems are frayed and on the edge of collapse.

If you analyse this traumatic experience, you see firstly it was a product of the dog's environment. Each species' environment deals out these kinds of traumatic experiences on a regular basis. Things like accidents, misadventures, predator attacks, war, love, sex and natural disasters like earthquakes, bush fires, droughts and floods frequently cause these abnormally intense traumas.

Secondly, there are two main consequences to it – the physical trauma, and the emotional trauma. In this example, the physical trauma was not fatal, but the emotional trauma was so severe, so damaging to the dog's nervous system, that the animal is just as likely to die of shock as much as from its physical injuries. If the dog survives, the traumatic memory will be indelibly etched in its memory. Even years later, if the dog hears the distinctive roar of fast flowing water, or catches a glimpse of a river in flood, its body will be flooded with cortisol and other stress hormones that will cause it to re-experience some of the emotional trauma it suffered that day.

That's because, as well as the normal memory of the event (what's called declarative memory) another kind of memory has been imprinted; an emotional memory. This is simply the emotional responses to the trauma and is something that humans and other animals experience periodically as a response to a particularly intense emotional experience.

Unlike ordinary memories, traumatic emotional memories have several defining characteristics. Firstly, to all intents and purposes, they are never forgotten. Psychologists refer to these indelible and often traumatic emotional memories as 'flash-bulb memories.' (see Box)

FLASHBULB MEMORY

Flashbulb memories are powerful, extremely vivid memories of traumatic personal circumstances, historic events and momentous news. They are created instantaneously and retained for a lifetime. For example, most people remember where they were and what they were doing on September 11, 2001 when the Twin Towers were attacked. Flashbulb memories are sometimes described as 'snapshots' because of their ability to evoke powerful feelings and graphic details associated with the traumatic experience.

The phenomenon of flashbulb memories was first noted in relation to a 19th century study that showed that most Americans remembered exactly where they were when they heard that Abraham Lincoln had been assassinated.[119] *Similar studies reveal the same meticulously memory of the assassination of Dr. Martin Luther King Jr. and the Challenger space shuttle disaster.*[120] *And of course, most of us in the western world remember where we were on September 11th, 2001.*

The second unique feature of emotional memories is their sheer intensity. Emotional memories, particularly of traumatic personal events are so intense, they can disrupt homoeostasis and affect the health and well-being of the individual. In humans, this can result in the medical condition known as 'Post-Traumatic Shock Disorder' (PTSD).

People suffering from PTSD often have flashbacks and nightmares of the original trauma where they re-experience the event. This causes them to avoid situations that remind them of the trauma and to become subconsciously hyper-vigilant to those circumstances.

I suggest that from an evolutionary perspective, traumatic emotional memories like those that cause PTSD can have an adaptive value. In the case of the dog that was swept into the river, even years later, if it hears the sound of rushing water, or comes across a river in flood, the emotional memory will be triggered and it will re-experience some of the threat and fear it felt that day. This will keep the dog well away from any river bank.

And in the next valley, if a lemming is caught by a fox, and although badly mauled, manages to escape down its burrow, then this traumatic experience will also imprint an emotional memory of its near-death experience. This emotional scar is a gift or sorts because for the rest of its life, the lemming will be hyper-vigilant to the sight, sound and even smell of foxes – which will lessen the chances of being caught again.

An example of the adaptive functionality of emotional memories was reported to me recently by a man who was driving across and mountain range west of Sydney. As he began the steep descent, he suddenly had a frisson – a sudden feeling of apprehension and instantly slowed down as he approached the tightest hair-bin bend on the descent. Seconds later, he consciously remembered that this was the spot that ten years earlier he had lost control of his car and came close to crashing through the safety rail. That frisson – the result of a triggered emotional memory – resulted in a precautionary behaviour that appears to demonstrate the adaptive potentiality of emotional memory.

Emotional memories are not limited to negative events, they can be encoded by any intense emotional experience. In humans, partying, childbirth, babies, play, dancing, birthdays, wedding, sex and humour can all produce feelings powerful enough to create lasting emotional memories. Other animal species are no different. A gorgeous Blue-footed Booby (*Sula nebouxii*) that performs a virtuoso ballet to impress admiring females is likely to retain an emotional memory of his choreography if it's successful. Because copulation occurs on completion of the performance, the emotional memory of sex is fused with the emotional memory of the dance.

A pig that sniffs out and digs up a delicious truffle is likely to imprint a porcine emotional memory that includes the distinctive scent of truffles, the amazing taste, and the urge to dig them up to create an intuitive truffle hunting skill.

A male Blue-footed Booby performs its cute display for an admiring female.

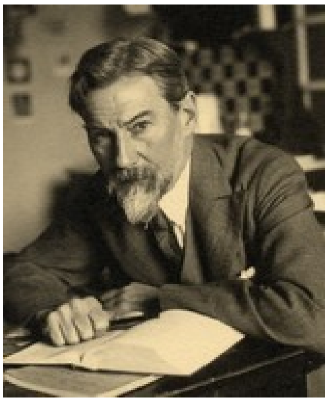
APPENDIX 3: EMOTIONAL MEMORY

For more background information on emotion memory, check out Appendix 3, which discusses the history of emotional memory in psychology as well as the molecular and biochemical mechanisms underpinning it.

the woman who forgot everything

There are two features of traumatic emotional memory that are pertinent to teem theory: firstly it is not reliant on cognitive (episodic) memory and therefore strictly speaking does not require a complex brain – an important factor when life was just starting out and brains as such still hadn't emerged.

Secondly, although nebulous and ephemeral, these high salience emotional memories nevertheless record, archive and recollect information – they remember 'something.' Both these properties are illustrated by an intriguing case study of a French woman who had lost her memory, a case study that coincidently has been cited as one of the first clinical demonstrations of emotional memory.[121]



In 1911 the brilliant Swiss neurologist, Édouard Claparède (*right*) described a patient with such severe short term amnesia he had to reintroduce himself to her each day because as soon as he left, she forgot she ever met him. Even if he left the room for a few minutes, she wouldn't remember him on his return. Finally, Claparede tried something quite ingenious. He put a pin in the palm of his hand and when they shook hands, she was jabbed and quickly pulled her hand away. Doctor Claparede then left the room, but when he returned a few minutes later, even though she failed to consciously recognise him, she wouldn't shake hands with him.[122]

This rare medical case suggests that the even though the area of the patient's brain that encoded declarative memory was damaged, she was still able to subliminally remember and recall emotional aspects of the pin-pricking event, which had a direct bearing on her behaviour. Fundamental to the patient's reticence to shake hands was her subliminal association of the doctor with pain. Doctor Claparede had become part of the same emotional memory as the pin prick, resulting in a simple cause and effect. This phenomenon – which I call 'teemic clustering' – as we shall see, has the most profound evolutionary implications.

once bitten, twice shy

As well as containing information about the organism's environment (be it a river in flood, a predatory fox, a truffle, a French doctor or a pin prick) it is not difficult to see that emotional memories can also subliminally engender behaviours that can increase survival rates and contribute to reproductive success. To return to the earlier example of the turkey chicks, just as the amnesiac associated the doctor with pain, so too a turkey chick that survives an avian attack can associate a hawk with a vicious mauling and know to run for cover if it ever sees one again.

I suggest that for these reasons, natural selection co-opted emotional memory as a fundamental component of its second evolutionary process. To become the cornerstone of the new evolutionary process, all it needed was for natural selection to work out how an emotional memory could be genetically archived, inherited and retrieved. It helped that the evolutionary stakes were so high. Success would mean a turkey chick's 'run for cover' stratagem not only provided the original turkey chick with an effective anti-predator stratagem, but all its progeny as well. What started out as a potentially life-saving learned behaviour would become innate – the recognition of hawks as life-threatening would become an instinct.

This is what I propose teemosis, the second evolutionary process accomplishes. Natural selection created this extraordinary biochemical process specifically to encode traumatic emotional memories into an organism's DNA so that under certain conditions, they can be inherited by their offspring.

The idea that Darwin's selectionist process invented a second evolutionary process to do a job it was biologically incapable of doing itself, is I believe, a beautiful example of evolutionary pragmatism, and natural selection's blind efficiency at its best. It recognised the limitations of NS as a selectionist process that specifically forbids environmental interactivity and invented a new one that did.

genetic memories are forever

Before I discuss how this genetic encryption occurs, one last word about the emotions teemosis uses. The key to the teemosis process is high salience emotions – they have to be powerful enough to create the kind of permanent flashbulb memories that last a lifetime. The potency of the emotional experience is absolutely crucial to the teemic process because it is the potency (or strength) of the emotional memory that activates a cocktail of stress hormones, including noradrenaline, cortisol, adrenalin and testosterone which initiates a complex biochemical process that encodes the emotional memory directly into certain highly sensitive nucleotides (or ‘bases’) of the organism’s DNA.

Significantly, teem theory asserts that the emotional memory is not encoded in the genes that manufacture proteins, polypeptides and physical cells. Indeed, the one part of the DNA molecule that emotional memories are never encoded in are protein-coding genes. One reason is that any teem inserted into the middle of a functional gene would deleteriously disrupt protein synthesis. But there is another reason and that takes us to the heart of the evolutionary process.

the divided dna hypothesis

Evolution is about changes that can be inherited and this requires a functional system of inheritance. For physical traits, that system is known today as Mendelian inheritance. This system evolved via natural selection to regulate the inheritance of physical traits and as part of that protocol, it expressly prevents the inheritance of any physical trait acquired during the life of the individual. Apart from toxic chemicals, radioactivity and other mutagens, the DNA molecule remains resolutely impervious to modification by environmental forces. This is known in biology as 'the central dogma' (a phrase coined by Francis Crick) and it means that under normal conditions, physical traits acquired during the life of an organism cannot be inherited to offspring.

At first sight, this seems a puzzling restriction as it would seem adaptive to inherit some traits acquired during the life of the animal as suggested by Lamarck. For example, if a tiger developed thick pads on its paws from walking on rough ground it would seem adaptive for its offspring to inherit them too. However, such a Lamarckian mechanism would also mean the lion's offspring might also inherit its herniated disk, arthritis or even a broken leg which were also acquired during the tiger's life. These acquisitions would gradually accumulate in the germline and eventually prove unsustainable and ultimately fatal.

So while some acquired traits may be advantageous, the risk of contaminating the genome with lethal acquired characteristics renders Lamarckian inheritance untenable.

This embargo against Lamarckian instruction is a problem for behaviour. Most of the dangers facing an animal come from its environment so acquiring information about the environment and facilitating the environment instructing the genome with adaptive new behaviours that would help the animal survive is crucial to any adaptive system of behaviour.

The solution can be found in the compartmentalised nature of the DNA molecule - or more specifically, Eukaryotic DNA - the DNA that all multicellular are made from. This more advanced form of nucleated DNA emerged between

2.1 – 1.6 billion years ago almost certainly from the more rudimentary prokaryotic DNA molecule.[123,124]

Eukaryotic DNA is made up of two parts: the main one contains the functional protein-coding genes that code for physical traits. But the second part (that prokaryotic DNA lacks) contains only non-protein coding material, called noncoding DNA (or ncDNA for short). ncDNA takes up most of the space within the DNA molecule but does not contain the genetic instructions (or recipes) for making the proteins that physical cells and body parts are made from.

For decades, it's been thought that ncDNA had no evolutionary function, which is why it was labelled 'junk DNA'. Importantly though, even though ncDNA doesn't contain functional protein or genes, it is still passed on to the next generation along with coding genes. This means that if an emotional memory is encoded into ncDNA by a trauma, it can be inherited without any deleterious impact on physical traits. The divided nature of eukaryotic DNA and its copious amounts of segregated ncDNA make it the perfect medium for the inheritance of teems.

The name I've given to an individual emotional memory encoded into ncDNA by traumatic environmental circumstances is a 'teem', which simply starts for 'Trauma Encoded Emotional Memory'. A teem is the basic hereditary unit of the teemosis evolutionary process.

Each teem is encoded individually into an animal's genome. One traumatic episode will encode one teem into the ncDNA of one individual. If a teem proves adaptive (by increasing reproductive success) it may eventually spread through the species population. Over millions of years, each species gradually accumulates a 'library' of teems which include all its instincts, emotions and innate behaviours. Teems are what define the behavioural repertoire of each and every animal species.

There are at least three reasons why teems and the teemosis evolutionary process became fixed throughout the animal kingdom:

the environment enters the genome

Firstly, teems are caused by situations and events in the organism's local environment so encode information about it in the organism's genome. A teem caused by a shark attack will encode information about what it felt like to be attacked by that specific predator in a particular circumstance. An attack by a leopard at night will create a different teem from a snake bite during the day. The teem encoded by the dog that nearly drowned will encode a different emotional memory than that encoded by hedgehog caught in a bushfire. An episode of food poisoning may encode a teem that provides an adaptive aversion to a particular food, including its unique taste and smell.

The range of environmental data that can be encoded by teems ranges from impressions of droughts, defensive strategies and mating rituals, to migration routes, predator defence, tastes, smells, camouflage techniques and mating behaviours. Basically anything that an animal can have a powerful emotional response to can be encoded into what I call the 'teemic trauma.' More about this in Chapter 13.

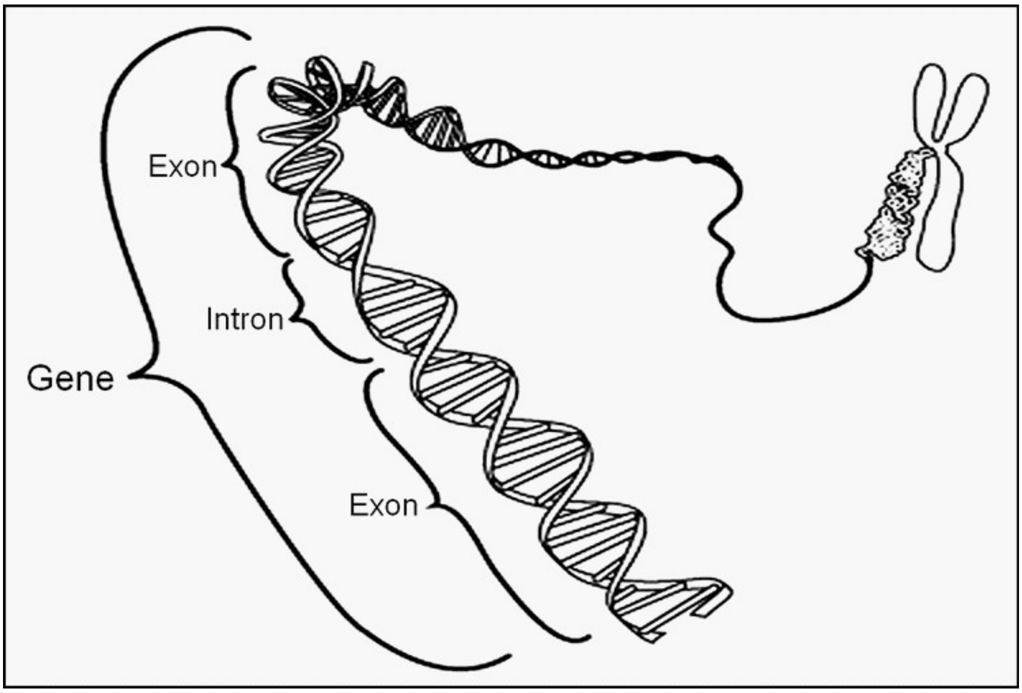
creating directed mutations in dna

Teems by their nature are fabricated from the kind of extremely intense emotions that an animal would experience only once or twice in its life. This emotional intensity is necessary to initiate the biochemical chain-reaction required to rupture genetic homoeostasis and imprint the emotional memory into noncoding sequences of DNA. In effect, the teemic trauma causes what is essentially 'a directed mutation' in the DNA. Importantly though, the mutation is not random, it is directed by the teemic trauma – and this is what distinguishes teemosis from natural selection. The way this molecular marvel occurs is explained in Chapter 19.

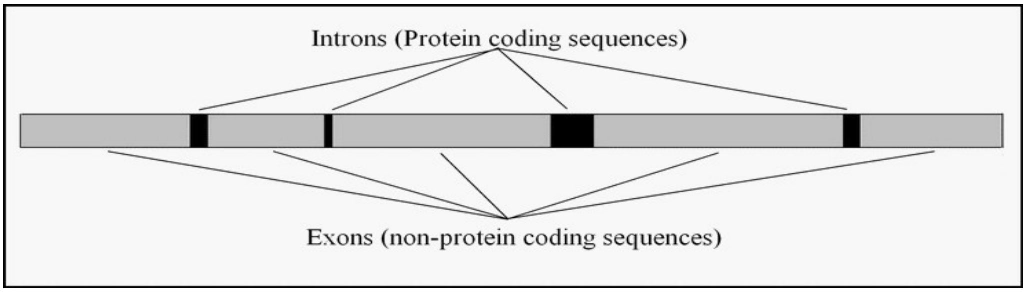
teems don't affect physical traits

Teemosis is an instructionist process, but paradoxically doesn't involve the inheritance of physical traits. The directed mutation does not occur in exons – strings of DNA that contain protein-coding genes so there can be no maladaptive Lamarckian consequences. It only facilitates the inheritance of environmental information in the form of emotional memories and only imprints them sequences of DNA that do not directly code for proteins.

To appreciate nature's selective ingenuity, we need only note that a traumatic experience, like falling out of a tree, being attacked by a bear or getting singed in a bush fire produces two responses; a physical and an emotional response. By encoding only the emotional response into ncDNA, any physical consequences of the trauma (such as injuries or pain) cannot be inherited. So although teemosis is an instructionist process, paradoxically it is entirely non-Lamarckian because no physical trait is acquired or altered during the life of the individual.



Expanding a stretch of eukaryotic DNA reveals that its genes are actually comprised of sections that code for proteins (called exons) and sections that don't – called introns.



the spider and the cricket

These are the bare bones of the second evolution hypothesis that explain in simple terms how a traumatic memory may be encoded into an animal's genome and inherited by its progeny. The detailed arguments and evidence supporting this left-field theory occupy the rest of the book, but I thought it would be useful to include here what I believe to be the first study to show a teem being created in the laboratory. After all, theoretical descriptions of drowning dogs are all very well but sceptical scientists will want to see teem theory in action under laboratory conditions.

In the March 2010 issue of *The American Naturalist*, Professor Jonathan Storm of the University of South Carolina Upstate and Professor Steven Lima of Indiana State University reported the results of a laboratory study which demonstrated that field crickets (*Gryllus pennsylvanicus*) traumatised by predatory wolf spiders (*Hogna helluo*) passed their newly acquired fears to their offspring.[125]

The researchers blunted the fangs of wolf spiders (*right*) with wax then put them in an enclosure with pregnant field crickets. The spiders immediately attacked the crickets but could not kill them. When the traumatised crickets eventually laid eggs, their offspring were 113% more likely to try to evade wolf spiders than control crickets that had not been traumatised. As a result they had higher survival rates. The researchers said that 'forewarned' crickets were also more likely to freeze when they encountered spider silk or faeces, which also helped them avoid detection.

Professors Storm and Lima reported, "Transfer of information from mother to offspring about predation risk, in the absence of any parental care, may be more common than one might think."

The researchers said they could not explain how the intergenerational transfer of environmental information occurred, and so far, no one else has either. The current Darwinian paradigm cannot accommodate the observed phenomena and rejects it as impossible – a violation of its core and most sacrosanct paradigm rules. For this reason, studies like this will be quietly ignored or relegated to a category of inexplicable anomalies, mute witness for paradigm change.

By contrast, the phenomenon of the cricket's inherited response is easily explained (and indeed predicted) by my candidate paradigm as a simple anti-predator teem, encrypted into its ncDNA by the emotional trauma of a predatory attack by spiders.

To my knowledge this is the first teem created in a laboratory under clinical conditions. Not only does it provide empirical support for teem theory, it graphically demonstrates how teems can be adaptive: the offspring inherited a teem that allowed them to recognise and evade a predator they had never seen before. Furthermore, as expected, the smell of attacking wolf spiders formed part of the emotional memory which explains why the 'teemic' crickets ran for cover even when they smelt wolf spider faeces.

alien concepts

Having outlined the essentials of the second evolution hypothesis, the onus is now on providing more evidential details – the molecular biochemical mechanisms by which something as ethereal and insubstantial as an emotional memory is chemically encrypted into molecular strings of ncDNA, replicated, transcribed and inherited to the next generation.

Of course it's considerably more complicated than that – and a great deal more interesting – which warrants a word of caution before proceeding. Teemosis was 'something not yet thought of' for a good reason. Like any new scientific paradigm, teem theory includes unfamiliar and alien concepts beyond our present experience and immediate understanding. Initially, the idea that the earth was round, the sun didn't revolve around the earth or that humans were descended from apes were alien concepts and they took some time to be assimilated. The British geneticist, John Haldane even suggested that some concepts will never be understood because, 'the universe is not only queerer than we suppose, but queerer than we can suppose.'[126]

Teemosis doesn't quite fall into that inscrutable category but its serpentine molecular pathways and biochemistry do present a few challenges. Clearly it creates demands on our ability to assimilate new concepts. As Edward De Bono might say, to understand the biology of the second evolutionary process, 'we need to think outside the square'. This reiterates the responsibility of advocates of paradigm change to not just describe their theory, but to explain the new and initially disconcerting concepts associated with it. For teem theory, the best way to do this is to show the evolutionary circumstances that led to the second evolutionary process.

By going back to the evolutionary origins of teemosis to examine how selection pressure built for a new evolutionary process, which adaptations natural selection assembled to create it, precisely when it all came together as a functional new system, and perhaps most importantly, how it impacted on the biosphere, I hope to place the second evolutionary process in its correct evolutionary, chronological and historical context.

But even before that, I will use the next chapter to describe exactly what a teem is, how it's produced, archived in ncDNA, and finally retrieved as an emotional memory. This simple anatomy of a teem serves as an introduction for a more detailed analysis in Part Three.

FEEDBACK

These four chapters are a work in progress and I would appreciate constructive feedback from readers. Sorry, but I'm not interested in getting into discussions on creationism. Please email your comments to: dv@thesecondevolution.com

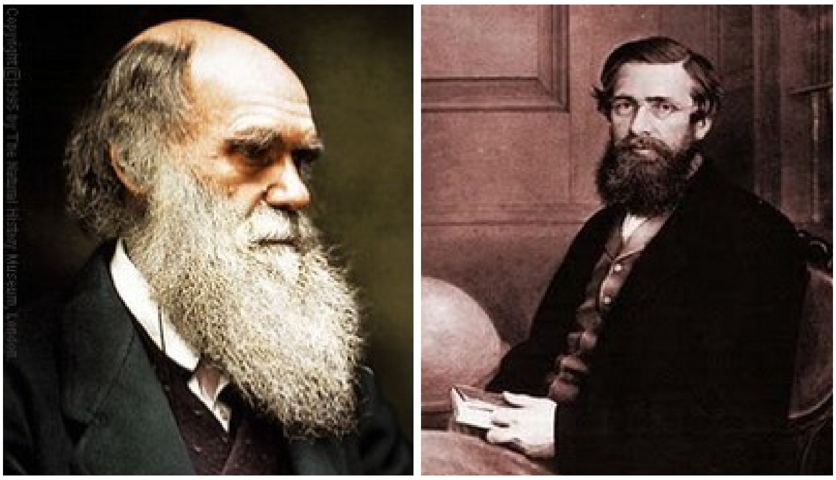
DV

APPENDIX 1

THE QUEST FOR THE ONE TRUE THEORY

Unlike today, in Darwin's Victorian times, the array of animal instincts and innate behaviours were recognised and celebrated as one complimentary half of an evolutionary duality with physical evolution. This holistic view featured prominently in Darwin's great book, *The Origin of Species*:

> ..it is far more satisfactory to look at such instincts as the young cuckoo ejecting its foster-brothers, ants making slaves, the larvae of *ichneumonidae* feeding within the live bodies of caterpillars, not as specially endowed or created instincts, but as small consequences of one general law leading to the advancement of all organic beings—namely, multiply, vary, let the strongest live and the weakest die.



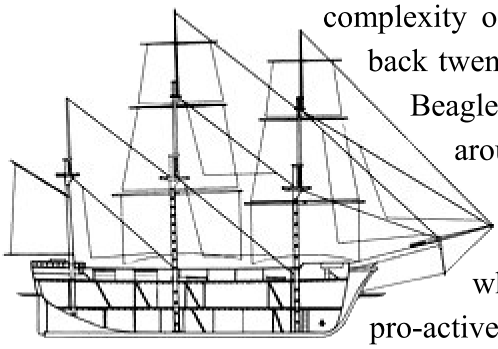
Charles Darwin (left) and Alfred Wallace who co-discovered the evolutionary process that Darwin called natural selection.

In other words, innate behaviour was an integral part of the master evolutionary matrix that regulated all evolution on earth. Back then, theologians, rather than shying away from the complex nature of instincts, gloried in their multiplicity and intricacy as irrefutable proof for the existence of God. For Darwin's theory to gain purchase, it had to answer questions like that asked by Paley: How could a newly mated sparrow know that the purpose of its nest building was to incubate eggs which it had never seen.[127]

Writing in the *Journal of the History of Biology*, Frederick Prete argues that this instinctive 'ability would have to be addressed and satisfactorily explained if one hoped, as did Darwin, to establish a general theory that could account for the evolution of complex behaviors.'[128]

What gave the issue greater urgency was Darwin's belief that natural selection was a kind of grand unifying theory that could (and should) be able to extend beyond physical evolution to explain instincts as well. The task was compounded of course by the sheer number, complexity and variety of innate behaviours observed in the field, in farms, laboratories and on expeditions to newly discovered parts of the Empire. Explaining such a broad evolutionary spectrum as instinct was clearly a formidable task, prompting Professor of the History of Science at Chicago University, Robert J. Richards to conclude, 'The difficulties presented by these socalled wonderful instincts so confounded his elaboration of evolution by natural selection that he believed his entire argument would crumble if they were not overcome.'[129]

Based on his notebooks, we now know Darwin was not entirely convinced his new theory of natural selection could adequately explain the range and complexity of instincts. This concern can be traced back twenty five years to his time on board HMS Beagle (*left*). During that epic five year voyage around the world, the young amateur naturalist-adventurer kept seeing examples of what he called ‘acquired adaptations’ – where the environment appeared to be pro-actively instructing the organism with new behaviours. These instincts appeared to include information that could only have been acquired during the animal's life and directly from its environment. Darwin was particularly struck by how new environmental threats and dangers were quickly incorporated into new instincts. For instance, he observed that large birds that had no contact with people didn’t fear humans, but large edible



birds that had been hunted by humans quickly developed an instinctive fear of people. This observation made it all the way to *The Origins of Species:*

> Fear of any particular enemy is certainly an instinctive quality, as may be seen in nestling birds, though it is strengthened by experience, and by the sight of fear of the same enemy in other animals. The fear of man is slowly acquired, as I have elsewhere shown, by the various animals, which inhabit desert islands; and we see an instance of this, even in England, in the greater wildness of all our large birds in comparison with our small birds; for the large birds have been most persecuted by man. We may safely attribute the greater wildness of our large birds to this cause; for in uninhabited islands large birds are not more fearful than small; and the magpie, so wary in England, is tame in Norway, as is the hooded crow in Egypt.[130]

Acquired adaptations like these suggested to Darwin that the environment in which the animal lived may be playing a far more significant (and non-randomised) role in its evolution than his theory predicted. Natural selection was based on the fortuitous chance occurrence of *favourable variations* that an animal happened to be born with and which were then selected (retained) or rejected (the animal died) or at least failed to reproduce. The accidental nature of these 'slight but useful variations, given to him by the hand of Nature,'[131] seemed completely at odds with non-randomised instructions that appeared to be emanating from the environment.

Darwin was so stumped by instincts and so desperate to explain them that for a while he even reverted to the prevailing Biblical explanation. In the chapter on *Instinct* in the draft manuscript of his *Species Book* (written between 1856 and 1858 and which formed the basis of *The Origin of Species*) we find, 'it is most natural to believe that the transcendant perfection & complexity of many instincts can be accounted for only by the direct interposition of the Creator.'[132] Fortunately, this was a short-lived regression and he deleted the sentence from the final draft of his great book.

In the years leading up the *Origins*, Darwin gradually moved towards an altogether different explanation for how new instincts are first acquired that made no mention of natural selection at all. He simply argued that *habits* acquired during an animal's life could somehow transform after prolonged use into heritable instincts. This idea had the benefit of including a role for the environment – in as much as habits are learned during the life of an animal within its current environment. At least it explained acquired adaptations.

darwin takes a stab at behaviour

When *The Origins of Species* came out, it did include a chapter on instincts (Chapter Eight) and he did provide a role for natural selection in the modification, removal and even the creation of new instinctive behaviours.

> 'Under changed conditions of life, it is at least possible that slight modifications of instinct might be profitable to a species; and if it can be shown that instincts do vary ever so little, then I can see no difficulty in natural selection preserving and continually accumulating variations of instinct to any extent that was profitable. It is thus, as I believe, that all the most complex and wonderful instincts have originated.'[133]

However, as a great scientist, Darwin was able to remain objective enough to recognise that natural selection seemed unable to adequately explain how 'acquired adaptations' occurred, nor the origins of complex instincts like the cuckoo chick's propensity to toss its foster-siblings out of the nest. To his great credit, he candidly admits his doubts:

> Many instincts are so wonderful that their development will probably appear to the reader a difficulty sufficient to overthrow my whole theory.[134]

Later in the same chapter he elaborates:

> No doubt many instincts of very difficult explanation could be opposed to the theory of natural selection – cases, in which we cannot see how an instinct could have originated; cases, in which no intermediate gradations are known to exist; cases of instincts of such trifling importance, that they could hardly have been acted on by natural selection; cases of instincts almost identically the same in animals so remote in the scale of nature that we cannot account for their similarity by inheritance from a common progenitor, and

> consequently must believe that they were independently acquired through natural selection.[135]

jean-baptiste mon ami

To plug what he felt was an obvious gap in his theory, and to explain the 'acquired adaptations' he had seen on the Beagle voyage, Darwin proposed a second theory – the old *habit hypothesis* he had played with years earlier in his *Notebooks*. In effect, he was having a bet each way. The idea was strangely at odds with natural selection but at least it acknowledged the environment and addressed the issue of ultimate cause – how new instincts first took hold.

He began by commenting on the similarities between *complex instincts* and *habits* – for example, habits, 'once acquired, they often remain constant throughout life'.[136] He then took what is nowadays considered an implausible intellectual leap to suggest that some habits and behaviours learned during the life of an animal, and which helped it survive, could somehow become innate and be passed on to offspring.

> If we suppose any habitual action to become inherited--and I think it can be shown that this does sometimes happen--then the resemblance between what originally was a habit and an instinct becomes so close as not to be distinguished.[137]

It seemed to Darwin that the habit theory provided a more cogent explanation for how a cuckoo's instinct for killing the host fledglings began:

> The first step towards the acquisition of the proper instinct might have been mere unintentional restlessness on the part of the young bird, when somewhat advanced in age and strength; the habit having been afterwards improved, and transmitted to an earlier age.[138]

In effect, he was covering his bet by asserting that habits acquired during an individual's lifetime are inherited play an initial role in the formation of *new* instincts, but that once the behaviour was innate, natural selection would 'take over', preserving, modifying, improving and disseminating adaptive instincts and deleting maladaptive ones. He supports this by citing numerous examples of 'how instincts in a state of nature have become modified by selection'.[139] This fusion of preDarwinian *instructionist* theory (see Box) to explain ultimate causation and his own freshly minted *selectionist* theory to explain modification and improvement appeared to provide a more holistic theory than natural selection on its own.

SELECTIONIST AND INSTRUCTIONIST

Darwin's natural selection process is said to be selectionist because favourable traits occur by accident and the useful ones (that increase fitness) are simply *selected* (or retained). By comparison the instructionist theory of evolution argues that the environment directly *instructs* the organism with physical traits and behaviours needed to survive.

He then went even further down the instructionist road, citing the two words that have long been considered the antithesis of Darwinian theory – *use* and *disuse*.

> As modifications of corporeal structure [physical traits] arise from, and are increased by, use or habit, and are diminished or lost by disuse, so I do not doubt it has been with instincts.[140]

Adding a *use* and *disuse* component to his selectionist theory cemented an instructionist role for the environment in as much as habits are products of the animal's environment. But as any student of evolutionary biology knows, terms like *use and disuse*, and *heritable habits* are synonymous with the flawed Lamarckian theory of acquired characteristics.

LAMARCKIAN INHERITANCE

The theory of *use and disuse* was first put forward by the distinguished French biologist, Lamarck in 1809,[141] (*left*) and is commonly called 'the inheritance of acquired characteristics' because it argues that a trait acquired during an organism's life (for example, by habit or prolonged use) may be inherited by progeny.

It is also called, 'Lamarckian inheritance', or 'the theory of use and disuse' and was very popular in Darwin's day because it credited the organism's environment with a role in the evolutionary process.

That Darwin had let the Lamarckian cat out of the bag by espousing, reinventing or even just dipping into a small portion of Lamarckian theory – it doesn't matter much which – will be hotly contested by some defenders of the Neo-Darwinian paradigm because the Frenchman's instructionism is fundamentally at odds with Darwinian selection. Modern Darwinists would point out to Monsieur Lamarck that no matter how well a dancer at the Folies Bergère learnt her balletic routine, her daughter will not automatically inherit her steps.

A tiger can be taught to jump through a fiery hoop but despite practising this circus trick all its life, its cubs won't inherit the skill. When the tiger dies, her acquired skill, along with any habits she acquired during her lifetime, die with her.

The Russian biologist Leonid Blacher points out that Darwin shows much less caution in returning to a Lamarckian explanation for the origins of a new innate behaviour.[142] But like Lamarck, Darwin opted for an instructionist behavioural addendum because it provided a more credible explanation for how animals acquire new environment-specific instincts. It also segued into his belief that the environment played a role in both physical and behavioural evolution.

From the day of its publication, the contentious headline-grabbing aspects of Darwin’s theory of physical evolution – and in particular, the inferred challenge to the prevailing Genesis account of creation, quickly dominated evolutionary discussion and shifted innate behaviour and instinct to the back burner. But this was also because Darwin's multi-faceted explanation of instincts sounded logical and covered all the bases so there was less imperative for a detailed debate. So without much discussion, Darwin's *instructionist-selectionist* fusion simply became part of the emerging Darwinian paradigm – albeit residing mostly under the radar – for the next forty years. That is – until the Neo-Darwinists came along.

the modern synthesis:

While Darwin wrote that 'natural selection can do nothing until favourable individual differences or variations occur,'[143] he had no idea what the *chance favourable variations* actually were or where they came from. There was still no such thing as Mendelian hereditary, nucleic acids, transcription, exons or mutations of alleles that were the real source of Darwin favourable variations. Still, when the new science of genetics emerged and began re-examining Darwin's theory as it applied to physical evolution in the late nineteenth and early twentieth century, it stood up surprisingly well. As could be expected, some of his Victorian terms were updated and many of the details filled in to take into account what had been learnt about genes, particulate inheritance and genetics, but essentially Darwin's nineteenth century theory of physical evolution was not only substantiated, but considerably strengthened. This fusion of Darwin's theory with 20th century genetics became known as 'the modern synthesis,' a term coined by Julian Huxley in 1942.

Even though Darwin's 'favourable individual differences and variations'[144] were renamed 'genetic mutations,' *the modern synthesis* is still very much Darwin's theory although it is now often called 'Neo-Darwinism' to recognise the important contributions of geneticists like Julian Huxley,[145] Theodosius Dobzhansky,[146] Ernst Mayr,[147] R. A. Fisher,[148] Sewall Wright,[149] J. B. Haldane[150] and others. For our purposes though, when Darwin talks about 'spontaneous variations of instincts,' or 'variations', read 'genetic mutations'.

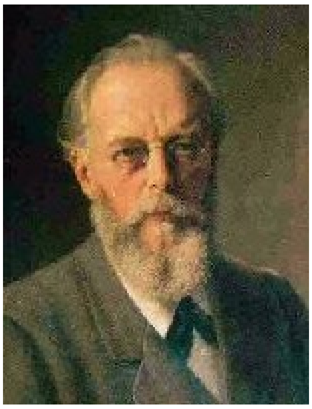
GENETIC MUTATIONS

A mutation is any sudden and spontaneous change in DNA, but the particular ones we're concerned about are mutations that are permanent and heritable. They mostly occur when the DNA molecule reproduces itself. Instead of making an exact copy of a gene, something goes amiss. Usually the error is confined to one 'letter' or nucleotide although some mutations involve the duplication, deletion or transposition of a whole chromosome. Mutations can also be caused by ionising and ultraviolet radiation, chemical mutagens and viruses. Randomly occurring mutations are the key to evolution because although most of them are deleterious, a few non-injurious ones supply the selection process with genetic alternatives that can be tried out in the thrust and parry of the real world. Without them, evolution would grind to a halt.

Having survived Watson and Crick's genetic revolution in the fifties, assaults from creationists who object to it a priori, not to mention the odd attack from respected biologists concerned about a few loose ends, Darwin's transcendent theory of *physical* evolution today remains the prevailing biological paradigm. The same however cannot be said for his hybrid 'instructionist-selectionist theory of instincts.

au revoir monsieur lamarck

Many converts to Darwin's theory embraced natural selection so completely they argued his instructionist add-on was superfluous: natural selection could stand on its own two feet as the sole explainer of both physical and behavioural evolution. They rightly pointed out that no proof had emerged that the Lamarckian process could turn habits into innate behaviours. Quite the contrary – new evidence suggested that acquired physical traits could not be inherited. Trained seals don't father trained seals. War wounds will not be inherited by a soldier's children. Graphic proof of this came in 1889 when the German embryologist, August Weismann (*right*) cut the tails off 20 generations of rats to disprove the Lamarckian prediction that the rats would eventually be born without tails. They didn't. Over 1500 rats were mutilated and not one was born without a tail.[151]



It turned out that Lamarck's instructionist theory contained a fatal flaw, which can be best explained by a theoretical example. If you could inherit your father's large muscles (which he acquired during his life through exercise and hard work) you could theoretically also inherit his tired old skin, ailing heart and lumbago, which he had also acquired during his life. Similarly, if you inherit your mother's callused fingers, they might be useful if like her, you dig for tubers most days, but the chance remains that you might also inherit her rheumatism or herniated vertebrate from years of stooping. So, while it would be advantageous to inherit *some* acquired physical characteristics, ultimately, the risk of contaminating the genome with deleterious acquired characteristics renders Lamarckian inheritance untenable. In other words, natural selection gave the thumbs down to Lamarckian evolution in respect of physical traits – whenever it occurred, it was selected against.

To provide his experiments with a theoretical basis, Weismann formulated a new 'germ-plasm theory' that envisaged an impenetrable barrier between the body (somatic cells) and the germ cells that carry heritable information, which prevents the transmission of any physical trait acquired during the life of the organism to its egg and sperm cells.[152]

This became known as the 'Weismann barrier' and from about 1940 onwards, it has been widely, if not universally accepted.[153] Although some prominent naturalists continued to believe complex instincts could not be explained without recourse to some form of instructionist mechanism, and notwithstanding that the originator of natural selection continued to believe an instructionist addendum was needed to complete his theory of instincts, the instructionist component of Darwinism was gradually exorcised from the paradigm.

Recognising Weismann's crucial role in reinventing 'Darwinism without the instruction', evolutionary biologist, John Maynard Smith acknowledges that 'Neo-Darwinism is essentially Weismannist.'[154] As the first 'ultraDarwinist', Weismann promoted the singularity of natural selection in papers like the appropriately titled 1893 essay, *The All-Sufficiency of Natural Selection* so forcefully that references to Lamarckianism and instruction in Darwin's behavioural theory were quietly dropped or ignored, leaving natural selection as the sole explanation not only for the selection (improvement, fixation, etc.) of instincts, but also for their origination.

the new and improved version hits the stands

In the middle of the Twentieth century, the new field of Ethology (the study of animal behaviour) took a fresh look at just how NS created inherited behaviours. The findings of Konrad Lorenz (*right*) that indicated that behaviour evolved 'exactly as organs do,'[155] helped confirm Darwin's behavioural theory and put the new science of ethology on a firm scientific footing. It also won Lorenz and his fellow ethologists Nikolaas Tinbergen and Karl von Frisch the 1973 Nobel Prize.

Around the 1970s, the new field of behavioural genetics emerged – specifically to examine the role of genetics in behaviour. Top of the agenda was a cursory re-examination of the idea that natural selection and the random mutational process were responsible for innate behaviours.

Taking the lead from French biologist Richard Alexander that 'genes are the most persistent of all living units, hence on all counts the most likely units of selection',[156] geneticists divided genes into behavioural genes and those that encoded physical traits (somatic genes.) Selection, proclaimed Alexander Alland in *Evolution and Human Behaviour* applies equally to both.

> Behavioural genes are subject to all the rules which apply to somatic genes. Mutations occur which alter behaviour; some traits are based on dominant genes, others on recessives, still others on codominance. Some traits are single-gene effects; others, particularly complex behavioural systems, are polygenetic.[157]

In the last years of the twentieth century, the nascent field of evolutionary psychology also put its stamp of approval on the Darwinian behavioural model, which it said could explain how humans acquired a raft of innate behaviours during their sojourn on the African savannahs. Evolutionary psychologists assert that the neural networks in the human brain that codify the innate behaviours manifested daily in the corporate towers of Wall Street, on the battlefield and in homes, were encoded in human genes by the combination of random genetic mutations and selection. Evolutionary psychologists Leda Cosmides and John Tooby explain:

> The brain came into existence and, over evolutionary time, accreted its present complex structure because, in ancestral populations, mutations that created or altered cognitive programs such that they more successfully carried out adaptively consequential information-processing tasks were differentially retained, replicated, and incorporated into our species' neural design.[158]

In effect, favourable mutations provide new or improved neural circuits in the brain that result in new innate behaviours, instincts and so on.

all done and dusted

Bolstered by a coterie of eminent biologists, ethologists, geneticists, and evolutionary psychologists, natural selection has arrived in the twenty-first century as the pre-eminent behavioural orthodoxy – the only plausible explanation for how stable new heritable behaviour, instincts and emotions emerge and are optimised.

Okay, so there are still a few problems. Ethologists point out that if genes are the sole determinant of behaviour, they should be inflexible. And yet, many animal behaviours demonstrate a degree of plasticity in relation to their environment. For example, most birds have an innate preference for a particular nest building material, but if it is unavailable, they will invariably select another material. And even among humans, it is known that early life traumas and abuse can affect the expression of a gene sequence that can result in increased risk for violence and antisocial behaviour later in life.[159] Still with humans, sleep is considered an instinct but there is considerable variability in how long each person sleeps due to physiological, psychological, emotional and other factors.

How environments can affect behaviour has coalesced into a new field – behavioural epigenetics, and some interesting findings are coming out – including a *Lancet* paper demonstrating that an impoverished diet of a woman during pregnancy can expose her child to a significantly higher risk of cardiovascular disease as an adult. However, even though the effects of stressful environments can temporarily alter the expression of genes, once the pressure is off, the DNA reverts to its original code. Because the effects are not permanent, it does not constitute evolution.

Yet another grumble with the genecentric view is that is does not adequately accommodate the glorious complexity, free will and self-determinism of human behaviour – which stands in stark contrast to the limited and rigid instincts of insects and even higher orders. Not to put too fine a point on it, we humans have demanded an exemption from the behavioural theory – inflexible behavioural genes are all well and good for other species – but we humans are above all that. We alone - 'noble in reason, infinite in faculties, the paragon of animals' – are able to rise above the genetic limitations inherent in the behavioural genes paradigm.

Admittedly, these issues have not been resolved except in broad terms - with behavioural geneticists asserting that the expression of behavioural genes can be moderated by environmental factors but that the primacy of genes for the repository and inheritance of innate behaviours remains axiomatic. Today, the prevailing gene based behavioural paradigm (with slight variations and emphasis) is taught daily in universities and classrooms and remains an integral, if under-emphasised component of the Neo-Darwinian synthesis. The certainty of its authority is such that for over 150 years, it has not been shown to be seriously flawed. But neither has it recently been critically re-evaluated in light of new findings.

RETURN TO TEXT

APPENDIX 2

PARADIGM SHIFT

like herding cats

Irrespective of whether teem theory turns out to be right or wrong (or as more likely, a bit of both) because it appears to challenge a solidly entrenched scientific paradigm, it must expect a priori resistance and a harsh reception from a few evolutionary biologists who have studied and taught Darwinism all their lives and who have built their careers on it. Some will inevitably see teem theory as a gratuitous affront to a scientific paradigm as cherished as any religious faith. To negate, or at least minimise a priori objection and provide a level playing field where the theory can be objectively appraised, it helps to understand the problematical nature of paradigm change.

In *The Structure of Scientific Revolutions*, the American philosopher and historian of science, Thomas Kuhn described *paradigm* as the set of practices that define a scientific discipline at any particular period of time.[160] Kuhn argued that if too many anomalies accumulate that cannot be explained by the prevailing paradigm, it creates a *crisis* in the discipline which in turn generates a scientific vacuum that draws new and possibly controversial theories into consideration.

When a new theory is proposed that challenges the underlying beliefs of a current paradigm, science historians like Brian Martin from Wollongong University can predict the consequences with uncanny accuracy; 'A person who challenges the conventional wisdom is likely first to be ignored, then dismissed and finally, if these responses are inadequate, attacked. The first stage is being ignored.'[161]

Gradually, as scientists begin to assimilate the new candidate theory and recognise that it might resolve anomalies in the old paradigm, philosophical warfare breaks out between them and the old guard who begin to lose faith in the paradigm that has led them into crisis. But they never completely renounce it.[162]

In practical terms, it means that those gallant academics who have staunchly defended Darwinism against the forces of creationism will be unwilling (and in some cases, simply incapable of) giving credence to a Kuhnian paradigm challenge. The psychological commitment of scientists to current ideas, especially their own ideas and the dominant ideas presents a major obstacle facing challengers.[163] This simply reflects that science, although ostensibly objective and evidence based, is also a human activity; prone to capricious vagaries, personalities, egos and other human foibles. You can get a sense of what is at stake in the email I received from Robert Trivers, Professor of Anthropology and Biological Sciences at Rutgers University and a recipient of the prestigious Crafoord Prize from the Royal Swedish Academy of Sciences: ‘If you are right,' Trivers wrote, 'nearly everything I know about genetics and development is wrong’.[164]

Whether confirmed or falsified, most new paradigm challenges are initially subjected to this knee-jerk repudiation. In the last chapter of *The Origin of Species*, Darwin predicted precisely this kind of opposition to natural selection: 'I by no means expect to convince experienced naturalists whose minds are stocked with a multitude of facts all viewed, during a long course of years, from a point of view directly opposite to mine'.[165]

The physicist Max Planck was even more fatalistic in his *Scientific Autobiography*; 'A new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die, and a new generation grows up that is familiar with it.'[166]

This fits with Darwin's resignation in *The Origin of Species*, that he had to wait for a new generation of 'young and rising naturalists who will be able to view both sides of the question with impartiality'.[167] That's all well and good, but it would be nice to skip the twenty years and go straight to the impartiality.

the question of qualifications

As well as the unconscious resistance to paradigm change that is entrenched in science (if not in human nature) a priori resistance will also come from my personal qualifications (or lack thereof) to challenge such a respected bastion of science. Professor Brian Martin has studied the impact of paradigm change and puts the position of the outsider (and in particular the autodidact) into grim relief; 'Although the rhetoric about science is that it is ideas that count, not who expresses them, in practice ideas are commonly judged by their source. Ideas are given much more credibility if they come from a respected source. Outsiders have an uphill battle.'[168]

Paradigm change is extremely rare but when it occurs it is almost always at the hands of university academics. But perhaps that's why it's so rare. Academics are ideally suited to assessing the evidence for a new paradigm once it has been formulated and presented. But for this type of high level theoretical science - science that ventures beyond the known, there can only be one real qualification for its origination - and that will come as a surprise to many - imagination - that which Einstein rated more important than knowledge.[169]

It may seem anathema that the sober methodical progress of science can be advanced by leaps of imagination, fantasy and reverie, but when Richard Dawkins asked, 'What would it feel like if you were the victim of a mind virus?'[170] he was applying imagination as a scientific tool in the same way as Einstein when he wondered what it would feel like to travel on a trolley car at the speed of light, or when Stephen Hawkin imagined what would happen if you were sucked into a black hole. Before Charles Darwin conceived the structure of natural selection in the autumn of 1838, there was nothing to think about, it possessed no logical substrate that could be analysed or discussed so the normal laws of science, logic and falsification did not apply. And it was only an act of superhuman imagination that allowed James Watson and Francis Crick to see that the shape of the DNA molecule – and the secret to its self-reproduction – was a unique double helical chain, with each chain coiled around the same axis but travelling in opposite directions. Such virtuoso leaps of imagination provide the only entrée to the dark void beyond current knowledge. But imagination is also egalitarian and democratic and it can also be applied by lesser mortals to solve smaller problems in the backwaters of science. For this reason, Einstein espoused, 'knowledge is limited, whereas imagination embraces the entire world, stimulating progress, giving birth to evolution. It is, strictly speaking, a real factor in scientific research.'[171]

Of course, imagination and inspiration without empirical verification are of little use, so the real test of teem theory is whether the arguments made on be-half of the teemic concept and the 800 scientific references cited in support are sufficient to warrant further investigation. That remains to be seen.

teem theory vs god

Receptivity to paradigm change is also hindered by continuing assaults on evolutionary biology by creationists. These incessant attacks have rendered biologists so defensive, many have closed ranks and refused to consider legitimate revisions least the debate be cherry-picked by fundamentalists to advance their evangelical cause. There's also the suspicion that theories like mine, although ostensibly scientific, contain a hidden agenda. Scientists still remember biochemist, Michael's Behe's *intelligent design* critique of Darwinism in *Darwin's Black Box*[172], that turned out to be a creationist wolf in sheep's clothes.

To prevent my scientific baby getting tossed out with the creationist bath water, I should get this out of the way first. Does teem theory support creationism? And is it out to discredit Darwin or advance the case of an intelligent designer or God? The short answer is no. I'm an atheist with no agenda other than a passion for theoretical biology and a robust curiosity. While I delight in the creativity and storytelling virtuosity of creation myths, laden as they are with rich symbolism, vivid characters and allegorical wisdom, it is an untenable abuse of science and mythology to elevate one creation myth (itself derived from an earlier Mesopotamian myth)[173] to the status of science fact. So, no, I am not trying to promote a non-scientific theory of origins.

To assuage any lingering doubts as to my bona fides, I could add that since 1994 I have hosted a Charles Darwin tribute website (an educational resource mainly for school children) and work with a framed picture of Darwin on my desk. My admiration for Darwin is such that I won't remain silent if his great theory is stretched beyond its explanatory capacity.

rats in the ranks

The armoured exterior that some biologists present to revisionists like myself is not due solely to assaults from biblical literalists. It's also a response to the mumblings of reputable life scientists, and especially palaeontologists who for thirty years have called attention to demonstrable discrepancies between the fossil record and Neo-Darwinian theory. Over the last decade the whisper of minor complaints, niggling doubts and outright scepticism have quietly accumulated and form an increasingly vocal chorus of dissent that threatens to engulf Neo-Darwinian theory in a haze of uncertainty. Whole books have been devoted to documenting these problematical areas.[174, 175,176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188] The number of scientific papers, articles, books and dissertations criticising aspects of the Neo-Darwinism far exceeds any other scientific paradigm, extending from the most fantastical creationist tracts to the well reasoned concerns of eminent biologists. Anthropologist, Tom McIver's scholarly 1988 bibliography of anti-evolution books, pamphlets, and tracts includes a disturbing 1,852 entries.[189] The failure of the current paradigm to answer the questions asked of it (discussed in detail in Part One) or to explain the plethora of phenomena and data that daily accrues from genetics labs and fields trips suggests there may be real and meaningful gaps in the current paradigm.

This would explain why recent surveys in the United States reveal that evolutionary biology is the least respected and most challenged of all the sciences. One 2011 survey of 926 American high school biology teachers showed that only 28% consistently and 'unabashedly' taught Darwinism in the classroom, while 13% explicitly advocated intelligent design and/or creationism.[190] Not surprising then, in December 2010, a US Gallup poll found that only 16% of Americans think Darwin's 'godless' view of evolution is correct, while 40% believe the biblical version of creation.[191]

These statistics are of grave concern to educationalists and by extension to the broader scientific community, but the answer is not to turn Darwinism into its own fundamentalist dogma as some believe has occurred in the United States,[192] nor to erect ever higher barricades around the paradigm, and especially not to become hyper-sensitive to critiques from Darwinists like myself whose ultimate goal is to strengthen the paradigm. Rather, evolutionists should fearlessly acknowledge and objectively address possible gaps in the paradigm and if necessary amend the paradigm to fit the facts. And yet, despite palaeontologist, Niles Eldredge's exhortation for true Darwinists 'to tweak the great man's vision, bringing it into line with the facts of the matter,'[193] the Darwinian paradigm remains still largely hands-off as the sacrosanct central dogma of biology. In support of this blind acceptance it has been argued that the paradigm has stood the test of time for 150 years – proof enough- but might this be due as much to complacency and servile acceptance than re-verification and renewal? Has biology forgotten its core values that prohibit dogmas, that require even paradigmatic edifices to be periodically re-examined, retested and where necessary, re-configured to accommodate new data. Irrespective of teem theory's candidacy, Darwinism needs to prove its continuing relevance to 21st century science.

This brings us to the one reason why teem theory should receive an impartial appraisal. If the Neo-Darwinian paradigm is flawed, if the gaps really are a sign of a paradigm in crisis, then remedies need to be urgently considered and even welcomed. It should be no affront that Darwinism is asked to stand alongside any and all contenders and prove again the supremacy of its explanatory power.

This kind of 'play off' is important because a Kuhnian paradigm shift cannot occur until the old paradigm is shown convincingly to be deficient. This necessitates devoting the first four chapters of this book to errors and omissions in the Darwinian paradigm. So despite my admiration for the great man, before I outline my alternative paradigm and demonstrate how it might resolve a number of truculent evolutionary problems with greater quantitative precision, I have to join the besieging hoards at the gate and launch my own assault on Darwin's fortress – or at least on those palisades that appear to contain dead wood. For those readers who do not need convincing, you can jump straight to Chapter Four which outlines teem theory.

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APPENDIX 3

EMOTIONAL MEMORY: A BACKGROUND

As early as 1889, the great French psychologist Pierre Janet suggested that intense emotions affect the way events are remembered. In what was perhaps the first description of the present use of the term 'emotional memory,' Janet postulated that strong emotions interfere with the integration of the experience into memory, causing them to be dissociated from consciousness and instead, stored as visceral sensations.[194] He also noted traumatised patients often reacted to reminders of the trauma in ways that would have been relevant to the original trauma, but which had no bearing on current experience. (See also [195] and [196])

Other luminaries like Freud and Pavlov also described the way strong emotions affected memory; Freud with traumatised war veterans,[197] and Pavlov in relation to conditioned reflexes in traumatised subjects.[198]

By the early seventies, the area of the primate brain involved in emotional memory was narrowed down to two almond sized nodes deep in the anterior portions of the temporal lobes known as the amygdala.[199] (See picture.)

The amygdala is among the oldest and most primitive parts of the brains of humans and other primates. It exists in different forms among all teemic organisms, and is, I suggest, one of the areas of the CNS (along with the Septohippocmpal System and the Thalamus), that regulate and process emotional memory.

the amygdala

As well as being associated with our emotions generally,[200] and with recognising fear in particular,[201] the amygdala is primarily involved in the formation of emotional memories,[202],[203],[204] as well as the evaluation of the emotional meaning of incoming stimuli.[205],[206] In effect, it assigns meaning to incoming sensory perceptions and conveys that meaning to other parts of the brain (e.g. the hypothalamus and hippocampus) where they are further processed.[207],[208],[209],[210] In cases where the amygdala is damaged (by a stroke or accident, for example), people lose their ability to store long-term memory of emotionally arousing material.[211],[212]

Because the human amygdala doesn't show up well on either PET or MRI scans, and very few patients have amygdala damage without other parts of the brain being affected, studying this enigmatic little part of the brain has been extremely difficult. However, neuroscientists persisted, and by the eighties and nineties, they began to finally unravel the physiological circuits and neuronal networks that 'emotional memory' is based on. It was these often creative experiments that slowly built up a picture of how the human amygdala operates.[213,214,215, 216,217,218, 219]

Research on humans in the last ten years has confirmed that the amygdala isn't directly involved in the creation of explicit or declarative memory.[220] But it does appear to perform two major functions: emotional memory,[221],[222] and the evaluation of emotional stimuli.[223],[224],[225] although even these tasks are shared with other parts of the brain.[226]

In conclusion, although it is a relatively new concept in psychology, research into emotional memory is now well established (thanks to the work of researchers like Larry Cahill, James McGaugh, Stephan Hamann, Joseph LeDoux, Elizabeth Phelps, Jeff Muller and others.) However, most researchers see emotional memory as part of cerebral memory rather than an archaic separate memory system. This view is of course completely understandable because emotional memory does frequently contribute to declarative memory and in laboratory experiments with brain scans is usually seen functioning in conjunction with declarative memory. Notwithstanding this, only by placing emotional memory in its correct evolutionary perspective (as the first true memory and the father of all subsequent memories) can we see it originally evolved as part of the teemosis evolutionary process.

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