# Animal behaviour intelligently designed!

***Animal Algorithms: Evolution and the mysterious origin of ingenious instincts***
*Eric Cassell*
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The author of this enjoyable book from the Intelligent Design (ID) stable enjoyed a successful career as an aircraft systems engineer. Eric Cassell is also a past consultant for both NASA and the Federal Aviation Administration (US). A navigations systems expert, he is well qualified to have written *Animal Algorithms*, which probes the workings and origins of complex animal behaviours: feats of navigation, architectural constructions, complex insect societies, and more. Detailed references and endnotes for each of its eight chapters are found towards the end of the book, plus a general index.

Evolutionary writers refuse to consider ID explanations for life's diversity and complexity. ID advocates, conversely, have comprehensively and compellingly shown that a commitment to methodological naturalism "renders evolutionary theory not an inference to the *best explanation* but, less impressively, an inference to the *best allowed explanation*—in this case, the *best purely materialistic explanation* [emphases in original]" (p. 168). On the contrary, as the concluding sentence of this book puts it, "the design inference is not the end of science, as claimed by opponents of ID. Rather, it opens the door to a wider range of scientific investigation" (p. 206). By applying these tried and tested design principles to all sorts of animal behaviours, Cassell has made a unique contribution to the debate.

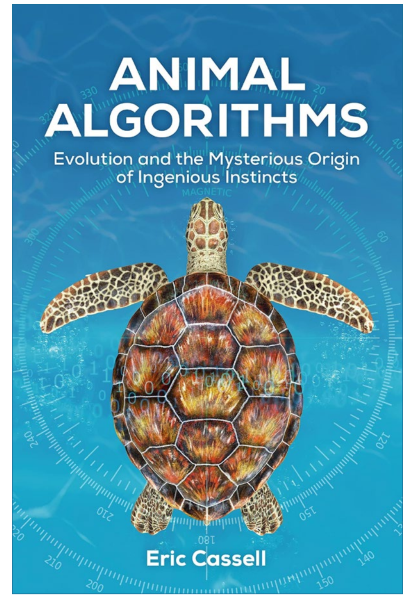
## Why algorithms?

The word 'algorithm' immediately calls to mind computational programming. Algorithms are at the heart of many branches of mathematics and engineering, and are essential to modern everyday life:

> "Today we find algorithms being used all around us. Examples of algorithms are found in internet search engines such as Google, which … search the internet for any term that users query. Smartphones include algorithms in GPS route navigation, voice recognition, and various other applications. Route navigation applications employ complex algorithms to compute the most efficient route to the desired destination. In most cases, there are several possible routes, and the algorithm determines which one is likely to be the fastest. Such algorithms are, of course, never the result of a blind material process" (p. 162).

Therefore, it is apposite for ethologists (students of animal behaviour) to speak of algorithms in relation to such things as animal compasses (p. 47), bee navigation (p. 62), honeycomb construction (p. 125), and other complex programmed behaviours (p. 154).

The author uses the descriptor *complex programmed behaviours* (CPBs) in preference to talking of *instinctive* or *innate* behaviour. Many animal




behaviourists dislike the perceived teleological connotations of words like 'instinct' because of their aversion to design, purpose, and goals in biology—and Cassell wants his arguments to be considered on their scientific merits. Moreover, the term CPB limits the discussion to particularly striking examples of animal behaviour.

That information-rich algorithms underlie CPBs is undeniable. By exploring with his readers all sorts of fascinating CPBs, Cassell makes his case with copious references to the scientific literature. Just as attempts at elucidating instances of biochemical complexity demand that engineering design explanations are allowed—think *Darwin's Black Box* and other book titles in a similar vein—efforts to explain the origin of CPB algorithms arguably more so.

Of course, even comparatively simple forms of animal behaviour have a genetic basis.

As a zoology student in the mid-1980s, I well remember several lectures on the sea slug *Aplysia californicus* (figure 1), studying the basis of simple reflex responses to artificial tactile stimuli. When investigators prodded the animal, it responded

**Figure 1**. The sea slug *Aplysia californicus*

by withdrawing its gill and syphon into the body mantle. A slug that was repeatedly stimulated showed a progressive lessening of its response (termed habituation). In other experiments, *Aplysia* exhibited different simple behaviours, like dishabituation and sensitization. This pioneering work led to neuroscientist Eric Kandel (1929– ) and two others sharing the Nobel Prize in Physiology or Medicine in 2000.[1]

Cassell observes that the simple habituation response in *Aplysia* "is accomplished through a network of approximately *three hundred neurons*, including sensory neurons, motor neurons, and interneurons [emphasis added]" (p. 153). If basic reflex behaviour is comparatively complex neurologically, "it is obvious that much more complex programmed behaviors correspondingly involve significantly more complex neural and related mechanisms" (p. 154). Quite! It is no wonder that evolutionists are mystified as to the origin of the underlying genetically coded algorithms and neurological controls for complex animal behaviours—navigation and migration abilities, nest building, hierarchical insect societies, and so on.

Moreover, when one considers just how miniscule the 'brains' of some of these animal marvels are (think: bees, ants, and termites), the unprejudiced must surely conclude with the author:

> "The optimization required to embed the algorithms in such small brains is best explained as the product of skilful engineering design" (p. 177).

Cassell refers to such "extraordinary mental feats" in small creatures with the delightful phrase "genius in Lilliput" (p. 15).[2]

Such conclusions are surely self-evident to advocates of ID, as well as to biblical creationists. Let us consider some of the many examples of CPBs reviewed in *Animal Algorithms.*

## Complex programmed behaviours defy evolution

What is known about each type of CBP is, needless to say, the culmination of many dedicated scientific careers and decades of research in ethology. Selected highlights follow.

### (i) Navigation and migration

Two chapters are devoted to the brilliance of animal navigation and migration. Chapter two details the following methods employed by various organisms: landmark navigation; dead reckoning (or path integration, where the animal keeps track of compass heading and distance travelled so it can compute a direct path home); a polarized light compass (determining the sun's position even on cloudy days); a celestial navigation compass (based on the positions of stars); and true navigation (a map sense and something akin to GPS). The latter is especially impressive and includes, in certain birds, the ability to detect the earth's magnetic field—both its intensity and (as research now indicates) its inclination angle, enabling the bird to establish its latitude. For example, the Manx Shearwater (figure 2) makes journeys of 6,000 mi (10,000 km) using a true map sense which is "an astonishing ten times more accurate than a commercial aircraft inertial navigation system!" (p. 56).

When creatures are navigating sizeable distances, the calculations are trickier because of the Earth's globe shape, so these animal navigators must be doing some sort of spherical geometry:

> "Spherical geometry is complicated by the fact that on a sphere there are no straight lines, so standard (Euclidean) geometry does not work. Human mathematicians perform the calculations using complex spherical trigonometry" (p. 48).

That animals accomplish with ease the sorts of tasks that normally fall to gifted and highly trained big-brained human beings is at once both astounding and humbling.

> "The precise specifics of how an animal's (sometimes tiny) brain performs such computations remain unknown, but again, it appears to involve *innate programming* [emphasis added]" (p. 48).

Explaining the origin of the genetic programming of complex migratory behaviours is indeed an eye-watering problem for evolutionists. For instance, consider the legendary migrations of monarch butterflies.[3] On their two-to-three-thousand-mile journey (which involves up to three generations of



**Figure 2**. A Manx Shearwater, *Puffinus puffinus*, one of many impressive bird navigators

butterflies) they navigate using a sun compass, even under overcast skies. How much information would have to be encoded in an alleged evolving butterfly genome?

> "Comparisons of migratory monarch genomes with the genomes of non-migratory monarchs has [*sic*] revealed that more than five hundred genes are involved in migratory behaviour" (p. 66).

Attempting a naturalistic explanation of systems that so clearly bespeak design is calculated to befuddle the mind.

Compared to monarchs, bees navigate far shorter distances, but their home area is nevertheless "as much as 150 square miles around a nest." Their behavioural talents are impressive: "they use several methods of navigating, including visual landmarks, sun compass, and polarized light compass. Each is employed depending on the circumstances [e.g. cloudy or sunny]…" (pp. 59–60). Back at the hive, a scout bee's 'waggle dance' then communicates precise information to other bees—the compass heading and travel distance to suitable flowers. All this from a creature with a brain of just 950,000 neurons, compared to a human being's 85 billion! Cassell comments:

> "… it is unclear how a Darwinian process can be a plausible explanation. There is a suite of individual capabilities and behaviors involved (including navigation, data processing, mathematics, and communication), requiring *an engineering process* as well as the development of *computational algorithms*, which are encoded in the brains of honey bees [emphases added]" (p. 62).

As with monarch butterflies, the inference to design is clear. Programming of this sophistication and systems of such microminiaturization cannot be accounted for by a purposeless, blind step-wise process. While not mentioned by the author, it is now understood that honey bees have a solution to the fiendishly complicated 'Travelling Salesman Problem'. This is yet another indication of insect ingenuity, because software engineers have yet to achieve the computational performance required to solve this.[4]

Desert ants exhibit 'genius in Lilliput' too. Their brains are a quarter the size of honey bee brains, yet studies of their foraging trips have demonstrated an intrinsic path integration ability, something that is not learned or taught. Their repertoire of navigational competencies is mesmerizing:

> "Desert ants employ … visual landmarks, vector memories of route segments, and path integration. In addition, they use chemotaxis in close vicinity of a food source by the detection of odors. They also use a combination of sensor information sources for path integration, including a sun compass, biological clock, and two forms of odometers" (p. 63).

Research has shown that they are programmed to select whichever navigation method suits the particular circumstances; e.g. if "the environment is visually enriched, they will use landmark navigation; otherwise they will use path integration" (p. 64).

Cassell explains that experts in the field of animal migration acknowledge it involves a high level of integration of these 'instruments' and behaviours. All these systems are somehow encoded in the genomes of these butterflies, bees, ants, sea turtles, birds, and other animal navigators. This imposes a further insuperable constraint upon evolution. Accounting for any one navigation system is challenging enough. But how could a slow and gradual incremental process account for the integration of so many different systems? And the problems do not stop there, for, as Cassell notes:

> "There is some evidence for a role of epigenetics in migratory behaviour. … If both genetic and epigenetic mechanisms are necessary to control behaviour, this suggests that *multiple coordinated changes are necessary* for a trait before it can confer some advantage—precisely the sort of multi-component trait that challenges a Darwinian explanation [emphasis added]" (p. 78).

Quite how it is that so many precise, sophisticated, coordinated genome changes could occur through a blind, purposeless process is anyone's guess. Believing it occurred is not a crime, but it does not qualify as science. To conclude that the inference to design is a superior explanation is to enormously understate things.



**Figure 3**. Asiatic honey bee, *Apis cerana*

(ii) Complex animal societies

In chapter six, the author continues to regale the reader with fascinating facts and figures regarding CPBs of social insect colonies, notably bees, ants, and termites. We will continue to focus on the neurological and computational aspects here. Take bees for instance:

> "With honey bees … there is abundant evidence of *innate developmental programs* for physiology and behaviour related to age and in the service of labor. Also notable is the fact that the bees can perform various tasks in the division of labor, including foraging (which requires navigation and an ability to memorize numerous cues about flowers), finding new comb locations, building the comb, and cell cleaning and repairing [emphasis added]" (p. 93)

The neurologically wired programs underlying both a bee's individual behavioural traits and its ways of integration in the hive society are ultimately digitally encoded in the DNA. Incredibly:

> "A study of the highly eusocial Asian honey bee (*Apis cerana*) genome found 2,182 unique genes out of a genome consisting of 10,651 genes—about 20 percent of the total genome. In addition to these genes not being shared with other non-social insects, the closely related western honey bee (*Apis mellifera*) also does not share commonality with these genes. That is surprising, since it is believed the two species diverged from a common ancestor only one … or two million years ago" (p. 114).

A genomic analysis of *A. cerana* (figure 3) determined the average length of its genes to be 7,577 base pairs.[5] So for significant beneficial mutations to occur in over two thousand genes of this length would appear to pose a waiting time problem.[6]

Honey bees perform many vital tasks, such as choosing and synthesizing building materials for the comb, construction of the comb itself, repair and maintenance, and helping to control hive temperature. "All of these critical elements [for a thriving colony] are interdependent, meaning they arguably work as a kind of irreducibly complex system of behavioural systems" (p. 125). Cassell is surely correct in this assessment, to which we might well exclaim with Alice, "Curiouser and curiouser!"[7] Accounting for irreducible complexity of a system of irreducibly complex systems naturalistically propels an already hard job into the stratosphere. As with the case of animal migration, this interdependency and integration of so many programmed behavioural systems is a real killer as far as evolutionary theories are concerned, neo-Darwinian or otherwise.

Termites obviously differ from bees in many ways but have similarities in their eusociality.[8] Their impressive mound constructions are veritable cities in which they cultivate fungal gardens, cooperate to fend off intruders, and control ventilation to adjust moisture and temperature.[9] In fungus farming termites (Macrotermitinae) young termites ingest both gathered plant material and *Termitomyces* fungal spores. Then symbiotic gut bacteria help to partially digest the plant-fungus mix before it is defecated. The fungus continues to grow upon and break down new supplies of plant material which older worker termites are bringing inside. Upon reflection, this is a knotty problem for slow, incremental evolution:

> "In Darwinian terms this relationship [between termites, the bacterial community, and the domesticated fungus] is assumed to have developed through coevolution. However, this requires *the coevolution of three entirely separate genomes* (termite, fungus, and bacterium) to foster the symbiosis. This is an extremely complex relationship that involves numerous genes in each species [emphasis added]" (p. 101).

As Cassell justifiably comments, albeit rather downplaying things, it is "highly improbable" that such coordination of numerous gene mutations


**Figure 4**. The nest of an organ pipe wasp, *Trypoxylon politum*. The different colours result from different muds being sourced to daub the next at different times.

in three independent genomes could have occurred.

In contemplating the suite of complex behaviours seen in such eusocial creatures, it is worth labouring an earlier point. Evolutionists attempting scientific explanations for the origin of social insect CPBs face a truly gargantuan task. We are not talking of a modest number of gene mutations here, rather:

> "It is now known that the transition to social behaviour requires hundreds or thousands of modified or novel genes and their expression through epigenetic mechanisms" (p. 119).

The answer lies in the algorithms! The level of complex and highly integrated programming existing in the micro-brains of eusocial insects screams intelligent design. Is ID a science stopper? Not so. It is those who insist upon unguided, naturalistic explanations for such wonders who are guilty of stifling true scientific investigation. As Cassell says, much later in the book, "Design theorists are free to simply follow the evidence" (p. 192), and such evidence as we've highlighted here points in no uncertain terms to intelligent design.

### (iii) Animal architecture

This absorbing topic is the subject of chapter five, covering such creations as the nests of organ pipe wasps (see figure 4), weaver ants, and termites, the combs and hives of bees, and the webs spun by spiders. The author slips into using teleological language as he contemplates the latter:

> "Spiders are another of nature's master engineers. … For example, the golden orb-weaver spider has seven kinds of silk glands, with six spinnerets. Some is used for spinning webs, of course, but other types are used for wrapping prey and encasing eggs. Silk can be stronger than steel of the same thickness, can stretch more than rubber, and is stickier than most tape. … Despite great effort, humans have yet to produce anything functionally equivalent to silk" (p. 132).

Subsequent to the publication of *Animal Algorithms*, researchers at Johns Hopkins University have used fast-frame-rate infrared video to determine the entire web-building sequence in a small nocturnal spider species—the hackled orb weaver, *Uloborus diversus*.[10] Reflecting on their findings, team leader Prof. Andrew Gordus stated, "I think they're incredibly elegant, and it reminds me of watching a performer perform a dance."[11] All the sets of actions of the whole choreographed routine are executed in the same sequence by each *Uloborus* individual.

Clearly, the behaviours behind the hackled orb weaver's architectural productions are algorithmically determined, thus encoded in the genome.[12] As with the other CPBs already discussed, numerous genes are involved. This confronts all who wish to explain how spider webs arose naturalistically, or the origin of the silk itself. Cassell further observes:

> "After decades of failed attempts to provide a causally adequate explanation, one can be forgiven for concluding that we have no compelling reason to assume that a step-by-step evolutionary pathway … actually exists" (p. 134).

Much more could be said about this most interesting subject. The CPBs involved in animal architecture evidence sophisticated programming and the author rightly points out that the vague evolutionary just-so stories are not worthy explanations.

## Final remarks

This review outlined the book's overall conclusions before laying out some of the many examples showcased by author Eric Cassell (chapters 2–5). The remainder of the book examines further conundrums facing those who attempt to explain the irreducibly complex systems of integrated CPBs exhibited in the enthralling field of ethology and demonstrate the superiority of ID over and against blind evolution (see table 1).

Space constraints prohibit discussion of all these points, but we will conclude with a brief mention of two of them. Firstly, the table indicates that Cassell sees ID as competing with blind evolution in explaining design flaws. However, his treatment of sub-optimal design (pp. 197–198) does not adequately answer the Darwinian challenge that the waste, dysfunction, and cruelty observed in the natural world are incompatible with a benevolent, wise Designer. It is true that design flaws do not negate design hallmarks pointing to ID. Moreover, human engineers cannot achieve perfect design, if "perfection is understood as a result free of trade-off restraints" (p. 198). Nevertheless, the author restricts his discussion to animal behaviour in the *present* world. Within the Creation/

**Table 1.** Comparison of discriminating factors for two competing explanations for the origin of CPBs (copied from Fig. 7.1 of *Animal Algorithms*, p. 169).

| Metric | Blind evolution | Intelligent design |
|---|---|---|
| Microevolution | ✓ | ✓ |
| Similarities across taxa | ✓ | ✓ |
| Design flaws | ✓ | ✓ |
| Abrupt appearance | | ✓ |
| Engineering design | | ✓ |
| Genetic change | | ✓ |
| Origin of information | | ✓ |
| Teleology | | ✓ |
| Convergence | | ✓ |
| Simple explanation | | ✓ |
| Predictions & Retrodictions | | ✓ |

Fall paradigm taught in Scripture, this world is subject to the Curse, but the Creator faced no constraints in His original "very good" creation of living organisms (Gen. 1:31). In his brief treatment of "the problem of 'evil' animal behaviour" (pp. 198–203)—e.g. infanticide, cannibalism of offspring, siblicide (one offspring killing another)—the author confesses the challenge these things pose for benevolent design. Mere design will always be a weak answer to evolutionists who highlight ID's inadequate theodicy. As Cassell says, the only satisfactory answer to a theological challenge of this nature is one which "is provided by Christian theology and the idea of 'the Fall' and entrance of sin into the world. In this theology the appearance of sin results in death, disease, and other maladies."[13]

Secondly, how do evolutionists respond upon observing markedly similar behaviours in social insects, or comparable navigational behaviours across creatures as diverse as birds, marine vertebrates, and insects? They are forced to invoke convergence, time and time again. Yet appeals to convergent evolution are excuses for ignorance, for they say nothing about *how* these complex traits might have originated through neo-Darwinian means. Convergence implies that there is a biological inevitability in such CPBs arising in disparate animals. Not so, argues Cassell. Rather, "the evidence indicates it is not inevitable but contingent" (p. 143). For example, most groups of bees, wasps, and ants are not social. A CPB, by its very nature, is not something deterministic, but evinces top-down design—this bespeaks systems engineering, not blind evolution (Table 1).

The author has presented a strong argument for ID based upon scientific *knowledge* about CPBs and their algorithmic encoding in DNA. How is it, then, that so many scientists continue to argue against ID tooth and nail? "Such an aversion is due," argues Cassell, "to teleophobia, meaning an aversion or unwillingness to admit the existence of design or final causes in nature, since they fit uneasily within the naturalistic paradigm" (p. 179). In so doing, they violate the spirit of true science.

## References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13. The quoted text appears in endnote # 62, p. 236 of *Animal Algorithms*.