Chapter 1

Introduction

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There is increasing interest in examining aspects of health and disease in the context of evolutionary theory [1, 2, 3], and the past decade has witnessed the rise of evolutionary or 'Darwinian' medicine as an entity distinct from anthropology, evolutionary biology or evolutionary psychology. Nonetheless, evolutionary concepts are often viewed as being tangential to medical teaching and practice, which tend to emphasise technical and proximate factors together with the treatment of the individual. Williams and Nesse [4] recognised early on that it would be not easy to persuade clinicians of the relevance of evolutionary medicine, regardless of the benefits brought by the approach. To this end, one major aim of this volume is that contributors should, where possible, indicate how their research and scholarship informs practical applications in clinical settings, health promotion or medical education.

The next eight chapters of this volume address topics that will be familiar to most students of evolutionary medicine: nutrition (Chapters 2, 3), Type 2 diabetes (Chapter 4), fertility and childbirth (Chapters 5, 6, 7), immune regulation (Chapter 8) and psychiatry (Chapter 9). In contrast to Chapters 2 to 9, that focus on evolutionary insights into particular aspects of health and disease and which have a long history of anthropological investigation, Chapters 10 to 13 consider in much broader ways how evolutionary medicine might be 'useful' for medical practice or education. NB: THIS

In Chapters 2 and 3 Elton and Ulijaszek examine 'Stone Age' diets from different perspectives. Elton, in Chapter 2, draws on examples from palaeoenvironmental studies, environmental archaeology and modern human and primate ecology to critique the concept of the 'environment of evolutionary adaptedness'. In doing so,

she concludes that given the inherent flexibility of the human diet, there is no obvious benefit to employing a dietary regimen based on 'Stone Age' principles, and points to alternative health promotion messages. Another issue to come out of this chapter as well as others (Chapter 4, Chapter 13) is the importance of tackling the impact of social inequality and marginalisation, which are often much greater risk factors for ill-health and disease than any mismatch between genetic (or cultural) heritage and contemporary environments. Thus, one opportunity for evolutionary medicine in the future is to show how it complements other approaches to the study of health and diseases. As Alan Goodman [5] has argued, long and hard, researchers working within traditional 'four field' anthropology are in a unique position to integrate biological and social studies of past populations with those conducted on contemporary human populations. Certainly, in the past few years, anthropologists – particularly those engaged in applied anthropology – have become increasingly interested in issues relating to socioeconomic development, migration, social inequality and marginalisation. And since anthropology is one of the disciplines from which evolutionary medicine emerged, it should provide a context in which it is possible to integrate different perspectives – including those based on evolution - in studies of modern human health.

In Chapter 3, Ulijaszek focuses on a single aspect of human diet – protein consumption – and examines how protein intake might have varied as a result of the transition to agriculture. In turn, he considers how this, on its own and through feedback with infectious disease, might explain the reduction of stature evident in several Neolithic populations on the transition from hunting to farming. These observations reinforce recent calls for increases in the recommended daily intakes of

protein, especially in places where infectious disease is prevalent. Ulijaszek's chapter also illustrates the breadth of approaches that can be classified under the heading 'evolutionary medicine', drawing as it does on palaeopathology, observations from the archaeological record and models based on modern human ecology. The burgeoning literature shows that evolutionary medicine comprises a number of diverse strands, beyond those that could be included here and encompassing anthropological, biological, biomedical and psychological approaches. Although not discussed explicitly in this volume, the potential breadth of evolutionary studies within medicine is brought further into relief by consideration of the facets of contemporary evolutionary theory – rather than natural selection alone - that might be brought to bear in the study and practice of medicine. Important concepts such as genetic drift, Neutral Theory, Evo-Devo and epigenetics can all be applied to research in health and medicine (see Chapters 10, 11, 12 and 13). Since all these emerged after Darwin, we preferentially use the term 'evolutionary' rather than 'Darwinian' medicine in this volume, to better reflect the complexities of modern evolutionary thinking. The use of contemporary evolutionary principles and ideas has already been shown to be highly profitable in at least one prominent contribution on evolutionary medicine [2], and also helps to counter the suggestion that evolutionary perspectives within medicine are all tied to simple adaptationist interpretations. Indeed, shifting the focus from 'adaptationism' is likely to provide opportunities not yet realised for evolutionary perspectives within medicine.

Chapters 4 and 5 explore another mainstay of evolutionary medicine, insulin resistance, again from two different viewpoints. In Chapter 4, Pollard and colleagues discuss Type 2 diabetes in Asian populations and assess the genetic and

developmental contributions to the condition. They recommend that until potential thrifty or 'non-thrifty' genes have been identified with certainty, preventive strategies should be focused on the better-understood developmental rather than genetic factors that predispose to Type 2 diabetes. Shaw and Elton, in Chapter 5, also discuss the developmental influences on another condition of insulin resistance, polycystic ovary syndrome (PCOS), and present various evolutionary scenarios relating to climatic instability, seasonality and food availability that may explain the high incidence of the syndrome in populations throughout the world. The authors draw on Shaw's experience as a practicing clinician to suggest when and how it might be appropriate to use evolutionary explanations about PCOS in patient consultation. In particular, they argue that providing an evolutionary viewpoint may encourage general lifestyle modification rather than short-term dieting in women with the syndrome who are seeking fertility treatment.

In Chapter 6, Vitzthum's life history approach to understanding the regulation of pregnancy outcomes demonstrates the role of maternal resource availability, in a view that resonates with the ideas discussed in Chapters 4 and 5. Her insights, based on many years of fieldwork on the Bolivian *altiplano*, underline the potential importance of viewing early pregnancy loss in the context of evolution and life history, not least by helping to provide explanations that may reduce the feelings of inadequacy in those who have experienced it. Examining conditions or events that are commonly seen as dysfunctions through an evolutionary lens is one clear and stated aim of evolutionary medicine [1] yet translating such observations into health care policy and practice has proven to be far from straightforward, notwithstanding the promise of recent work, such as that described in Chapters 4, 5 and 6. Evolutionary and ethno-

paediatrics is one area within evolutionary medicine that has arguably had the most success in translating the results of research findings and clinical trials into medical practice. In Chapter 7, Ball uses an evolutionary and comparative approach to evaluate how best the needs of mothers and babies should be accommodated in hospital maternity wards, with particular reference to breast feeding. Her study, undertaken as a randomised controlled trial, demonstrates the importance of maintaining physical contact in the neonatal period. This and similar contributions reinforce the practical, political and research efforts of midwives and are helping to shift attitudes in the UK away from the medicalisation of pregnancy, birth and postnatal care. However, as Ball points out, there is far from universal adoption of the recommendations that have arisen from evolutionary paediatrics [6]. Nonetheless, encouraging such dialogue between anthropologists, life scientists and health professionals interested in evolutionary approaches is one important aspect of the development of evolutionary medicine.

Another is the need to move from ideas to hypotheses, and from there to experimental and empirical research. One criticism levelled at evolutionary medicine is that much of it is speculative and remains untested or even untestable [7, 8]. It has been suggested that generating and testing specific hypotheses is an important way of demonstrating the utility of an evolutionary framework within medicine [7, 8]. In this volume we endeavour to make at least a step in this direction by presenting studies grounded in empirical observation, of which Chapters 6 and 7 are excellent examples. In a time when randomised controlled trials are seen as the gold standard for clinical research, developing such studies is one of the next big challenges for evolutionary

approaches within the medical arena. Only by doing this can evolutionary research within medicine truly move from academic theory to clinical practice.

Chapters 8 and 9 examine two further topics, immune regulation and psychiatry, that have received considerable attention from those interested in evolutionary approaches to health and disease. Hurtado and colleagues, in Chapter 8, examine human parasite load in comparative, temporal and global perspectives and argue that living in modern, sanitized environments away from a diverse parasite fauna may result in several chronic conditions including asthma. Although this observation is not new [2], the authors draw on their previous work on life history in modern indigenous populations to present a novel interpretation of human-parasite co-occurrence, consequent adaptation and implications for global health patterns. In Chapter 9, Hagen discusses the potential strategic value of delusions, behavioural phenomena that may be 'adaptive' rather than 'insane'. Since psychiatry primarily focuses on illness, the tendency is to medicate people experiencing delusions. However, Hagen suggests that modification of social networks might prove to be a more effective 'treatment' than pharmacological alteration of thought processes.

The use of the term 'medicine' implies application to patient care, and some prominent advocates of evolutionary medicine are indeed practising clinicians. However, much research and scholarship into evolutionary medicine is conducted by academics in anthropology and the life sciences who are not health care professionals. One way in which the field could be moved nearer to mainstream medicine is through increasing the interaction between those generating the concepts, ideas and case studies and those who are actively engaged in providing health care. The challenges

inherent to this are exemplified in this volume: only one contributor is currently a practicing clinician, although others are qualified in medicine or dentistry. However, many of the chapters have been reviewed by researchers who are also engaged in the delivery of health care, and their input has been especially important in reinforcing that contributors should indicate how their research and scholarship informs practical applications in clinical settings, health promotion or medical education. Bentley and Aunger, in chapter 10, describe how Bentley's interactions with medical and academic colleagues as well as her own students allowed them to survey opinions about the utility (or potential utility) of evolutionary medicine. Looking at five topics (racial medicine, epigenetics, emergency medicine, public health and obstetrics) that link evolutionary theory and medical practice, they argue that far from being without practical application, several areas of evolutionary medicine have the scope to improve clinical practice and treatment.

In a similar vein, Dean (Chapter 11) suggests that evolutionary biology is a vital part of the educational framework of prospective health care practitioners. He provides many examples of how adding evolution to topics in the curriculum not only brings new perspectives but also acts to energise the student experience. Dean also argues that the increasing marginalisation of evolution in medical education will have serious implications for the way in which disease is defined and treated in the future. Unfortunately, as Elton and O'Higgins describe in Chapter 12, and as discussed by others [4], the opportunities to organize curricula around an evolutionary paradigm are very limited. Nonetheless, it is possible - especially through elective programmes - to bring evolutionary medicine to the attention of students, with consequent educational benefits as well as future awareness in medical practice and research.

Most of the chapters in this volume bring out the positive aspects of evolutionary medicine, but the approach also has its detractors. It is vital to consider when and how an evolutionary perspective might not make an important contribution to medical science and practice. We feel that it is necessary to address this issue head-on, and to this end, in a thoughtful and occasionally provocative contribution, Jonathan Marks (Chapter 13) seriously questions the practical benefits for the patient of an evolutionary approach to medicine and rightly raises concerns about some uncomfortable associations between Darwinism and 'Big Pharma', as well as critically evaluating adaptationism. His chapter draws attention to the fact that medical research and clinical practice cannot be organised around a single set of theories. Medicine is an applied discipline which draws on, and quite properly supersedes, theoretical and empirical knowledge from a diverse range of natural and social science disciplines – including evolutionary biology. To overemphasise any one of these runs the risk of ignoring others and failing to identify where and how best to intervene.

The maturation of evolutionary medicine is dependent on critical, reflexive thought from within the field itself, and other contributors also question whether evolutionary approaches are universally appropriate or applicable. Elton (Chapter 2) highlights that human evolution has taken place over many millions of years and in many places, so fixing the origin (and therefore adaptations) of humans in the African Pleistocene is problematic. This is reinforced by research into epigenetics (Chapters 4, 5 and 10) and studies adopting life history and ecological perspectives (Chapters 6 and 8) which stress variation rather than universals. Another complex idea is that human health may

suffer because of ‘mismatches’ between the way human bodies were crafted by natural selection during our evolutionary history and the very different challenges posed by contemporary human environments. Identifying such mismatches could offer exciting insights for advancing clinical practice. One way would be though distinguishing between ‘natural’ and ‘pathological’ variation and thereby avoiding the unnecessary medicalisation of apparent dysfunction – be it polycystic ovary syndrome (Chapter 5) or delusional behaviour (Chapter 9) – that actually reflect beneficial or neutral adaptations for coping with (past) environmental challenges. Another would be by focusing attention on those aspects of contemporary environments (be they affluent or poor) that might be modified to better fit the short- and long-term needs of human bodies at the extremes of their developmental and physiological flexibility. Such flexibility, which encompasses cultural and behavioural adaptation as well as genetic and physiological responses, makes the study of adaptation in humans especially challenging. Thus, much future work will be required to identify which traits were selected for in which environments and to assess whether they were actually optimal – in, in fact, there ever exists an optimum fit between organism and environment.

Contemporary environments and lifestyles are not necessarily less healthy overall than those prevailing during much of human evolutionary history [9], even if they are different. High income countries may well be facing an epidemic of obesity, but the ‘quality’ and ‘quantity’ of health therein has, arguably, never been better (albeit when measured by such crude measures as the prevalence of stunting and life expectancy, respectively). That is not to say that human health cannot be improved, by adopting a more sensitive and naturalistic approach to health and disease (which considers the

biological heritage of humans as extraordinary, imperfect and natural organisms) has no contribution to make to any improvements we can make. Vitzthum, in Chapter 6, argues that environments could be modified to reduce early pregnancy loss. Thus, there is an obvious role for evolutionary medicine in informing decisions about how we can improve the fit between human biology and environment – in short, by developing even better environments to live in than those we see today and those prevailing during our evolutionary history. To do this, as demonstrated in Chapter 6, we need to appreciate the range of human adaptability and how and under what circumstances humans – and their diseases – evolved.

An in-depth understanding of human evolutionary history is also vital if we are to discourage biological determinism or legitimising therapeutic programmes such as 'racialised' medicine that represent flawed and potentially dangerous interpretations of population histories and biological variation (see discussions in Chapters 4, 5, 10 and 13). Pollard and colleagues (Chapter 4) and Shaw and Elton (Chapter 5) caution against genetic determinism when considering differential susceptibilities to insulin resistance, and also highlight the important developmental aspects of Type 2 diabetes and PCOS. Thus, those working within evolutionary medicine have a crucial role to play in advocating the appropriate uses of evolutionary arguments and perspectives. However, as MacCallum [10] points out, we should be wary of dismissing all evolutionary viewpoints within medicine on the basis of a few inappropriate studies or clinical applications

Evolutionary medicine has the potential to contribute a number of interesting insights to healthcare, not only through health promotion and counselling but also in

developing novel therapies. However, it also faces substantial challenges, noted by Williams and Nesse [4] at the outset. The chapters in this volume demonstrate how compelling evolutionary perspectives on health, illness and medicine can be. Singly and collectively, they shed light on health and wellbeing in past, present and future humans, at the level of the individual as well as the population. In the process, they also explicitly or implicitly highlight areas in which evolutionary research in medicine might be improved, by developing more sophisticated models of past human ecologies, embedding evolutionary ideas within existing academic or clinical frameworks, and designing studies that can be tested using accepted research tools, such as controlled trials. Given that one recent study [11] has suggested that the term 'evolution' is actively avoided in the medical literature surrounding antibiotic resistance (even though many consider this to be the biomedical phenomenon which best reflects the relevance of evolutionary perspectives to contemporary medical practice), evolutionary medicine also plays a vital role in supporting the continuing presence of evolutionary theory in the medical curriculum and research arena.

References

1. Nesse, R.M. and Williams, G.C. *Evolution and Healing: The New Science of Darwinian Medicine,* Weidenfeld and Nicholson, London, 1995.

2., Stearns, S.C. *Evolution in Health and Disease*, Oxford University Press, New York, 1998.

3. Trevathan, W.R., Smith, E.O., and McKenna, J.J. *Evolutionary Medicine*, Oxford University Press, Oxford, 1999.

4. Williams, G.W. and Nesse, R.M., The dawn of Darwinian medicine, *Quart. Rev. Biol.*, 66, 1-22, 1991.

5. Goodman, A.H. Seeing culture in biology. In: Ellison, G.T.H. and Goodman, A.H. (Eds). *The Nature of Difference. Science, Society and Human Biology.* Taylor and Francis: Boca Raton; 2006, pp. 225 – 242.

6. Clift-Matthews, V., How much change in 50 years? *Brit. J. Midwif.*, 15, 64, 2007.

7. Bull, J.J., (R)evolutionary medicine, *Evolution* 49, 1296-1298, 1995.

8. Ebert, D. and Sokolova, N.V., Morning has broken: ten years after the dawn of evolutionary medicine. *J. Evol. Biol.*, 14, 194-196, 2001.

9. Gage, T.B., Are modern environments really bad for us? Revisiting the demographic and epidemiologic transitions. Am. J. Phys. Anthropol.,128, 96-117, 2005.

10. MacCallum, C.J., Does medicine without evolution make sense? *PloS Biology*, 5, e112, 2007.

11. Antonovics, J. et al., Evolution by any other name: antibiotic resistance and avoidance of the E-word, *PloS Biology*, 5, e30, 2007.