

Ask Doctor Darwin

The focus group “Evolution and Medicine” wants to intensify collaboration between biologists and physicians

by Carl Gierstorfer

Next year will be the 200th birthday of Charles Darwin and the 150th anniversary of his publication on the origin of species. Biologists of all branches but also psychologists and even economists will underscore the degree to which understanding the eternal cycle of variation and selection has influenced their own research. Only one discipline probably won't join the celebrations: medicine. For it has its own ideas about the human body and its diseases. Much to the astonishment of some physicians and many biologists only a small fraction of what evolutionary theory has to offer has found its way into medicine.

A conference organized by Fellows of the focus group “Evolution and Medicine” at the Wissenschaftskolleg zu Berlin aimed at investigating how medicine and evolutionary biology can be integrated in order to benefit from each other. The prerequisite for this is probably a visionary and organizer like Randolph Nesse, Professor for Psychiatry and Psychology at the University of Michigan and the Convener of this group. Nesse always saw his patient's illnesses – from mood swings to clinical depression – in the light of evolution. Why do we whoop for joy today and feel deathly depressed tomorrow? Nesse knows all too well that much depression is a terrible disease, but he understands it better every since he realized that the capacity for depressed moods has an evolutionary significance and should be understood as an adaptation. For it forces us to change our present life style if it turns out to be a dead end.

But Nesse's vision goes far beyond psychiatry. He wants evolutionary theory to finally be taught at medical schools and for Darwin's ideas to find the space they deserve in the curriculum. He believes that the prevailing opinion among physicians – that the body is to be understood as a machine built in accordance with a construction plan – is fundamentally false. Rather, the body should be understood as the product of its evolutionary past, an organism in which adaptations to a very broad spectrum of challenges have become a unity. As a result every living being is anything but “perfect”: our bodies are rather a bundle of compromises. “Understanding the body as a product of natural selection, not design, offers new research questions and a framework for making medical education more coherent.” says Nesse.

Where the physician sees only disease, the biologist suspects the consequences of an adaptation. This gap is clearly revealed by the differing understandings of the biggest killer in the Western world: cardiovascular diseases. More than 200,000 people in Germany died of cardiovascular diseases in 2006 - a quarter of all disease-related deaths. Experts agree that the causes are to be found in “the modern style of life”: nutritional excess combined with a lack of physical exercise. But could it be that there is a deeper explanation that casts a completely new light on the epidemic dimensions of cardiovascular diseases, diabetes, and obesity not only in the Western world, but also in the developing countries?

Fifteen years ago, British epidemiologists made a strange discovery when studying birth and disease registers in several English counties. They found that there is a correlation between the weight of a newborn and the probability that it will suffer from cardiovascular diseases, diabetes, or obesity later in life. The lower the birth weight, the greater the likelihood of succumbing to one of these diseases. How can this be? A theoretical explanation has been provided by evolutionary biology. Sir Patrick Bateson, a biologist at the University of Cambridge, has devoted much of his research to the phenomenon of “phenotypical plasticity”. By this process, the embryo can gain information about the environment in which the mother lives. Water fleas of the genus *Daphnia*, for example, are born with armored heads if their mother is exposed to many predators. If this is not the case and the mother is undisturbed by predators, then the embryo does not develop such armor. “The embryo acquires information about its future environment and adapts,” says Bateson.

There is much evidence that the weight of a newborn baby is influenced by similar factors. In Third World countries, birth weight is generally lower than in the Western world. The fetus cannot expect a life in abundance, and therefore minimizes its demands from the outset. But if conditions change after birth, this strategy proves fatal. The abundance of nutrition poses huge problems upon the organism. The result are obesity, diabetes, and cardiovascular diseases.

This is especially dramatic in developing countries, for example India. While the embryo in the womb still receives the information that the environment is one of scarcity, the adult ends up in nutritional abundance – an excess of fat and proteins that is unique in the evolutionary history of *Homo sapiens*. Since shortage had been the norm in most of our evolutionary past, our bodies are true masters in hoarding an excess of supply. And as everybody knows who wanted to lose a few grams: our bodies are extremely loath to give up even the tiniest amount of fat.

Needless to say that the lessons preventive medicine, in particular, can learn from such knowledge are enormous. But, as Professor Detlef Ganten, Executive Board Chairman of the Charité University Medicine in Berlin, says, “a better evolutionary understanding of early humans’ living conditions, for example the nutrition of hunter gatherers, is a rational biological basis for preventive measures. Evolutionary medicine is thus a starting point and an intellectual roof for modern preventive and individualized medicine.” Moreover, understanding the dynamics in nature is essential not only in preventive medicine. There are many physicians who believe that mankind is losing the battle against his biggest enemy: infectious diseases.

In August 2007, a train left the station at Point-Noire in Congo-Brazzaville with a shipment on board that may be the most effective answer in the fight against malaria. On old rails from colonial times, the locomotive puffed across savanna, rainforest, and steep hills on its way to the most remote villages with no doctors, electricity, or hospitals. The shipment, however, was not new medicines or insecticides; it was 500,000 mosquito nets, enough for every pregnant woman and every child in this country. In their fight against malaria, this is currently the epidemiologists’ best weapon. For all attempts to control the pathogen with medicines or insecticides have failed up to now.

A sobering perspective, especially with regard to a declaration of the American Department of Health some fifty years ago when officials solemnly declared that the war

against infectious diseases had been won. Half a century later, Andrew Read, Professor at the Center for Infectious Disease Dynamics at Pennsylvania State University and a Fellow at the Wissenschaftskolleg in 2006/07 said, “Infectious disease is the big problem of the 21st century. And we don’t do work to sort that out. I find that remarkable.”

The energetic New Zealander is astonished with which lack of evolutionary reasoning we treat bacteria, viruses, and sporozoa (like the malaria pathogen). After all, they are the evolution’s witches brew. A combination between an extremely short generational time and billions of individuals in a single host means that at some point the rise of resistant strains becomes a stochastic inevitability. “There are meanwhile mosquitoes that are resistant to every known insecticide,” says Read. Perhaps more worryingly there are also lab-strains resistant to the highly praised Artemisin, at the moment the most effective answer against malaria.

In the struggle against bacterial infections, medicine continues to rely on the targeted use of highly-dosed antibiotics. But Read has shown in the laboratory that it is smarter not to try and kill all the pathogens within a cell – because that increases the likelihood of producing resistant strains. It is better to lower the dosage. The effect is a struggle for survival among the evolving pathogens; this internal competition weakens the agents, to the benefit of the host.

Sylvia Cremer, also a Wissenschaftskolleg Fellow in 2006/07, knows what a great challenge parasites pose, especially to social animals. Like people, ants live in colonies of up to five million individuals. Under such conditions, the chance that pathogens will spread is enormous. Nonetheless, these insects have lived in a complex social system for at least 35 million years. Along with an optimized immune system, ants minimize contact among themselves, remove waste products as well as dead animals, and place infected members under lifelong quarantine. Extreme measures in a society where the individual counts little, but is very effective at keeping infections in check. It’s estimated that up to 15 percent of the colony’s energy is consumed for such activities.

This observation, in turn, underscores the fact that the greatest successes in medicine are probably due to hygiene and vaccination campaigns. In contrast, many diseases that we cannot control are a consequence of our evolutionary past. After all we are a part of nature and its intrinsic laws. Or, as Andrew Reid says, “Evolutionary theory is not a collection of facts. It is a way of thinking.” The symposium would like to see this conviction finally spread in the field of medicine.

Randolph Nesse

The Fellows of the focus group “Evolution and Medicine” are:

Hans K. Biesalski, Hohenheim
Catriona MacCallum, Cambridge
Randolph Nesse, Michigan
Robert Perlman, Chicago
Mark Thomas, London
Carl Bergstrom, Seattle

Dietrich Niethammer, Tübingen

Mosquito swarm

The hygiene and quarantine behavior of ant colonies is being investigated at Regensburg University.

Here a healthy and a fungus-infested red ant.