30. Small steps in evolution

The main cannon of evolution is that it is progressing in small steps. At first glance it looks plausible because we could observed that some animals get bigger or smaller. We could see that some animals slowly adjust to environmental conditions. However when we look at the arising of completely new parts the mechanism of small steps is less convincing. For example, let us consider the first heart in vertebrates made during the Cambrian explosion. For the heart to be useful it must be the right size and the right strength right from the beginning. Any smaller or weaker heart would not fulfil its function and the animal would die. There is a minimum functionality of the part to be useful, therefore it must arise in one step. But this step requires the co-operation of several genes at the same time. For example, the first tetrapods which arrived on land already had lungs, four legs, strong muscles and a skeleton. If only one body part developed such an animal would die on land.

The theoretical explanation for why evolution should be by small steps is attributed to Fisher (1930). He believed that large mutations are more likely to have large deleterious effects than small mutations. Although Fisher did not know anything about DNA and its molecular structure he was aware of the danger of mutations. In the case of DNA it does not make much sense to talk about “large” mutations or “small” mutations, but the effect of mutations could be harmful, neutral or beneficial in different degrees.

Small improvements have to face several problems. Such an improvement might have a negligible effect on the reproductive rate, therefore how could it be fixed in the population? Normally in a small population, for example a few millions, a beneficial step will be followed by a deleterious or fatal mutation which will wipe out the improvement from the population. Only very large population of the order of many billions have some chance to accumulate several beneficial changes.

<u>Can genes have “small” mutations?</u>

The principle of gene operation is based on digital coding. Comparable digital codings are used in our mobile telephones, computers and television. In digital signals talking about “small” changes does not make sense. Even when one letter is changed in the code this may result in huge changes of the gene. It is the same as getting one letter wrong in an email address and the message will not get through. So the digital system operates on the principle good or bad. There is nothing in-between.

A one letter change in the code could result in a different amino acid being used in the protein. In such cases a protein will fold in a different way and will not link with another protein. Protein interaction is similar to the operation of a key in a lock. To open a lock a special key is needed. A small change in the key will not open the lock. So it does not make sense to talk about “small” changes if you cannot open the lock. We already know that one mutation can stop a

gene from producing protein, but we do not know how one mutation can slightly change the production of proteins.