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THE LOCOMOTION OF THE HOMINIDS

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As a biologist and a Jesuit I am rather not acquainted with dancing. Being invited to talk at a scholarly Symposium on Dancing I was looking for a dictionary, to make sure I do understand the essentials of dancing.

The Random House College Dictionary (1973) is my favourite source of knowledge. It explains that:

> *„Dancing consists in moving one's feet, or body or both, rhythmically in a pattern of steps, esp. to the accompaniment of music"* (Such, 1987/340).

For many years I have studied the anatomical and physiological aspects of hominid locomotion. So I have decided to limit my talk to some questions concerning the bipedal locomotion of our Plio- and Pleistocene ancestors.

Our hominid ancestors lived in Africa and their system of locomotion – almost identical with our locomotory behaviour – made them particularly adapted to dancing.

The word „hominid" means the man-like populations that lived during the glacial epoch, or even earlier, in the Pliocene. The fossil remains consist of teeth (ca 60%) and bones (ca 30%). They are very much like man's teeth and bones, and quite evidently unlike the teeth and bones of other animals – including apes.

The oldest remains of hominids have been found in Southern and Central Africa. They are dated 3, 4 or probably even more than 5 million years ago (see Fig. 1; cf. Lenartowicz & Koszteyn 2000).

Man (a hominid *par excellence*) while moving, constantly balances his whole body on the relatively small platform of his foot. In other words, the vector of the gravitational tendency to fall, is constantly and skilfully shifted in such a way, that man walks or runs without falling to the ground. Many birds do the same. Both men and birds use their locomotory skill in presumably the non-utilitarian behaviour known as dancing.

One has to ask whether the dancing of a Heather Cock or a Black Cock, and the dancing of man has the same background and the same meaning. Mating displays in birds are *necessary means* to find a proper consort. In men the dancing can reflect some deeper emotions and deeper ideas.

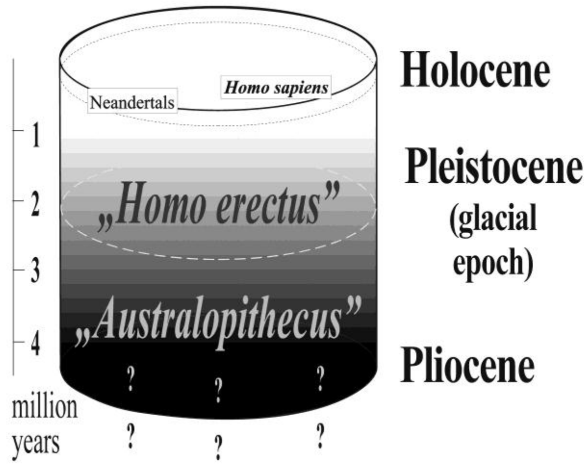

Fig. 1. Modern ecotype forms of man constitute a shallow layer at the top of the glacial (Pleistocene) and preglacial (Pliocene) hominid lineage.

The above mentioned locomotory behaviour can hardly be found in our officially authorized „cousins" – I mean the apes. The apes move on four legs and four feet. Until the 19th century apes were called *quadrumana* i.e. four-handed creatures, while Men was classified as *bimana,* meaning two-handed creature.

Fig. 2. One can ask if the human way of locomotion really recalls the locomotion of other Primate forms.

Figure 2 may help us to realize that the human (hominid) locomotory system and behaviour is not as evidently ape-like as some textbooks might suggest.

At this point one should admit that we look like animals and we behave like animals. This likeness is different when one looks at a snake, and different when one looks at a monkey or a bird. Nevertheless in the case of locomotion we are much more like an ostrich, a heron or a stork than a monkey (see Fig. 3).

Fig. 3. The dancing herons.

Modern people (see Fig. 4) from Inuit to Australia aborigines and Bushmen, in spite of their anatomical peculiarities and differences all belong to a single natural species of *Homo sapiens*, and share the same intellectual potential (cf. Henneberg 1987, 2010).

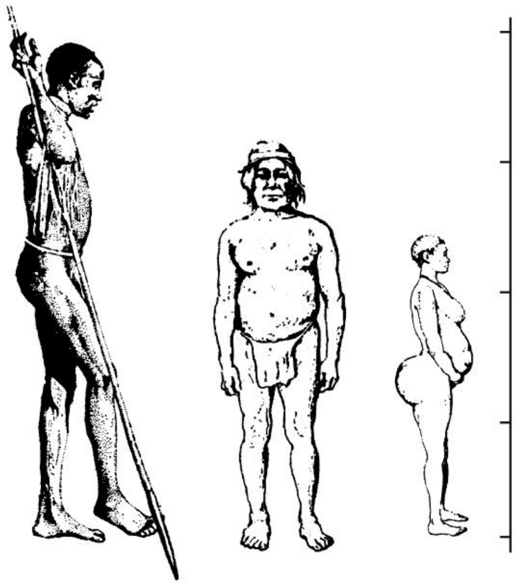

Fig. 4. Unity of the anatomically different human populations. From left to right: a Massai, an Inuit (Eskimo), a Bushman woman. Scale = 0.5 m (adapted from Bielicki 1976).

Thomist anthropology classified man as an *animal rationale*. I don't like this kind of classification. Animals behave in an evidently rational way. The architectural achievements of bees, termites, spiders, beavers or weavers are, without doubt, perfectly rational. The traditional Thomist classification has to be amended. Man is usually rational in his behaviour, like any other animal. But man is also spiritually gifted. We should call him *animal intellectuale.*

Man is able to produce stone tools, and use them in his biological behaviour. He can use the same tools to produce the objects of art, like sculptures or paintings. Man can use his unique system of locomotion to move around like an ordinary animal does. Man can also use his locomotory behaviour to dance – and this is an evident manifestation of his intellectual power.

How old is the typically human way of locomotion?

The oldest remains of a human-like skeleton were found in Central Africa, and some of them are dated to almost four million years ago. How do we know these fossil remains are man-like? To illustrate the idea of reconstruction from the fragmentary remains, let us imagine the structure of a bicycle. Suppose that one has found bicycle pedals, buried deep in the ground. In such a case it is legitimate to jump to the conclusion, that a whole bicycle did exist.

The fossil remains of the „Southern Apes" are fragmentary and represent many different parts of the hominid skeleton. Reconstruction of the whole is therefore extremely complicated. We will limit our narrative to just one aspect of reconstruction, namely the reconstruction of the locomotory mechanism which provides hominids with the capacity to keep balance of the whole body on just one leg.

The hominid thigh bone.

The human locomotory system is a kind of functional whole which works on specific physical principles, quite unlike the physical principles of the apish locomotory system. Man's thigh bone has two ends. The upper end, called the *head,* forms part of the hip joint. The distance between man's two hip joints is much bigger than in the apes. The lower end of the thighbone forms part of the knee joint and in a standing man the distance between the right and left knee joint is almost zero. The axis of the thighbone in man – therefore – forms an angle with the vertical axis of the human body. The angle is on average about 11 degrees. It is almost twice as big as the same angle in the great apes.

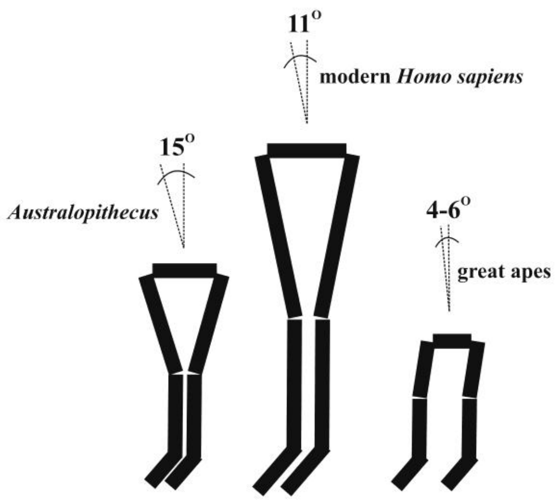

Fig. 5. A comparison of the spatial orientation of the thighbone (femur) in the „Southern Ape" (australopithecine), modern man and the great apes.

As we can see in Fig. 5, the above-mentioned angle in the australopithecine leg is even greater than in man. This angle can explain why man can relatively easily walk on a rope, practically without shifting his body to the left or to the right. A chimpanzee, strolling on two legs (a quite uncomfortable way of moving about) in order to keep balance of its body, must swing the body from right to left and back.

A walking man keeps the weight of his body on a single leg, and while moving transfers this weight onto the other leg. Therefore, in the case of man, „walking" means „losing balance" and restoring it again. Human thighs meet at the knee joints. Man, therefore, can swing the balance from one leg to another without a visible shift of his body to the left or to the right. Man can walk on a rope.

Children in testing and developing their capacity to keep balance, spontaneously jump on a single leg, and do pirouettes on a single toe.

There are several fossil fragments, which support the hypotheses that the „Southern Ape" walked like modern man.

Knee joint and the oblique femoral shaft.

Fig. 5 shows the oblique femoral shaft of man and early hominids. In this anatomical detail, the early hominids less resemble the apes than contemporary *Homo sapiens* (see Fig. 6).

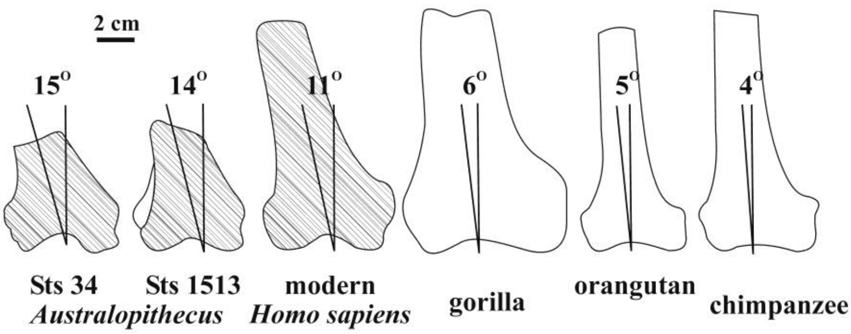

Fig. 6. The lower end of the thighbone in the australopithecine (both fragments are dated to roughly 3 million years ago), modern man and the great apes (redrawn from Lovejoy & Heiple (1970/fig. 2).

The construction of the knee joint in man's leg can be easily distinguished from the shape of an ape's knee joint (see Fig. 6). The structure of the miniature remains of the „australopithecine" knee joint allow us to reconstruct (mentally) the rest of the locomotory structures of the „African ape". Even older remains of the miniature knee joint (specimen Al 129) dated to about four million years ago, do not look ape-like (see Fig.7).

Fig. 7. Knee joint Al 129. Its evidently oblique, like in humans, femoral shaft, indicates human-like bipedalism.
(After <http://www.msu.edu/~heslipst/contents/ANP440/boisei.htm>)

Pelvic bones.

Several fragments of the pelvic bone, dated to more than 3 million years ago, look like a miniature of a typically human pelvic bone. The anatomical differences between ape and man are evident (see Fig. 8 and Fig. 9).

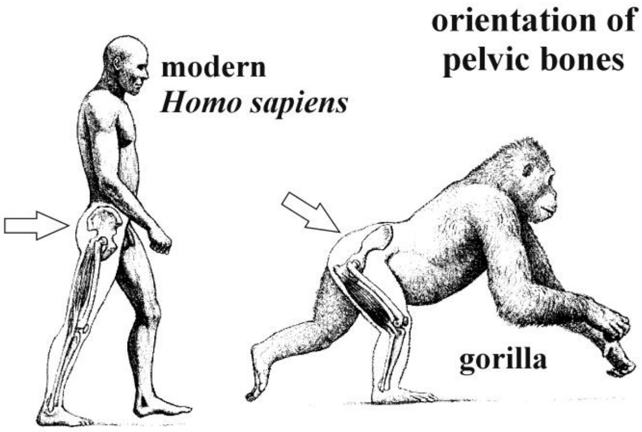

Fig. 8. The evidently different orientation of the pelvic bones in man and in the apes (after Arsuaga & Martinez 2000/100).

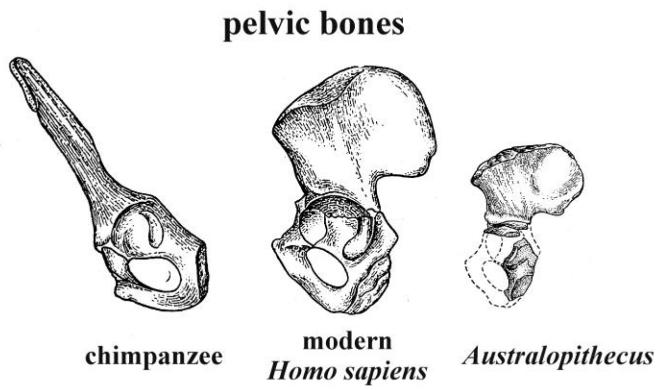

Fig. 9. The pelvic bones of the Australopithecus (specimen Sts 14) dated to about three and half million years ago. These bones are small, but otherwise they are man-like and not ape-like (after Roginskij & Lewin 1978/202).

Orientation of the foramen magnum.

The conserved elements of the vertebral column are not sufficiently numerous to reconstruct this column. However, the position of the *foramen magnum* has been preserved in many fragments of the early hominid skull, to prove the evidently man-like position of the head on the top of the vertical vertebral column.

In Figure 10 the difference in the orientation of the vertebral column and of the head are obvious.

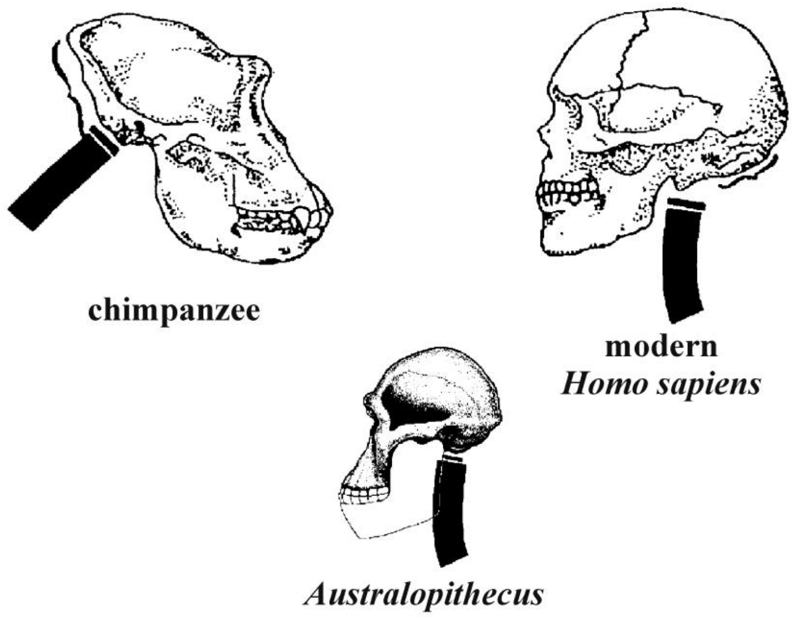

Fig. 10. The link between the vertebral column and the occipital region of the skull in an ape, in man and in the „Southern Ape". The quantitative proportion between the brain case and the system of mastication in the „Southern Ape" may, superficially, recall the apish system of mastication. However, the orientation of the spinal column and the type of dentition of the „Southern Ape" is evidently man-like.

Body size and intelligence.

The ancient hominids are usually classified as „sub-intellectual", „presapient" beings. Is it proper to evaluate their intellectual potential so low? The hypothesis of the pre-sapient human-like creatures is mainly based upon the fact that the „australopithecines" had an unusually small brain. It is necessary to stress that many australopithecine anatomical structures are also unusually small. They look like the structures of fairy-tale dwarfs. The estimated body weight of the early, Pliocene hominids was most probably quite proportional to their estimated brain size. They lived in the difficult climate of periodical glaciations, which led to radical changes in the flora and fauna of their environment. Technological progress was just starting. Nevertheless, they hunted relatively big animals. They used stone tools to dismember their pray (antelopes, warthogs, giraffes, etc.) in a way indistinguishable from the techniques of modern butchers. So there is no convincing reason to put in question their human intellectual capacities and call them „Southern apes" (*Australopithecus*).

The differences between the actual, Holocene ecotypes of mankind are no lesser than the differences between Cro-Magnon man and Neanderthal man. The differences between Neanderthal man and the *Homo erectus* population are no lesser than the differences between the anatomy of *Homo erectus* and *Australopithecus* . All these populations had essentially the same locomotory system and locomotory behaviour.

The main differences between the locomotory system of a chimpanzee and man.

These differences can be observed in different regions of the trunk and limb skeleton**.** The main differences are as follows:

The human foot has a radically different architecture than the flat hind leg of a chimpanzee. Human thigh and pelvic bones are radically different. Thighbones in the apes are almost parallel. A chimpanzee, walking on its hind legs (a rather uncomfortable way of moving around) in order to keep balance has to swing all his body to the right and to the left.

Laetoli footprints and the human way of bipedalism.

One of the strongest arguments in favour of a very early appearance of man-like locomotion among the „Southern Ape" hominids are Laetoli footprints. They are dated to about 3.5 million years ago. At that time the volcano called Sadiman, some 20 km from Laetoli (Tanzania, Eastern Africa), emitted a considerable amount of volcanic ash, which covered the Laetoli locality with the 15 cm deep layer of ash. The layer of ash was wet because of a soft rain. Consequently, the footprints of many different animals, which ran across the area, were perfectly preserved. The following chemical reaction and crystallization, prompted by the heat of the sun, cemented the prints and preserved them for million years. Finally, the winds removed the ancient layers of ash and revealed the trace of a prehistoric biocenosis.

How can one identify the man-like footprints from the handprints of other Primates?

First, man leaves just two footprints, right and left foot, alternatively. Apes leave four different „handprints", two foreleg prints and two hind leg prints.

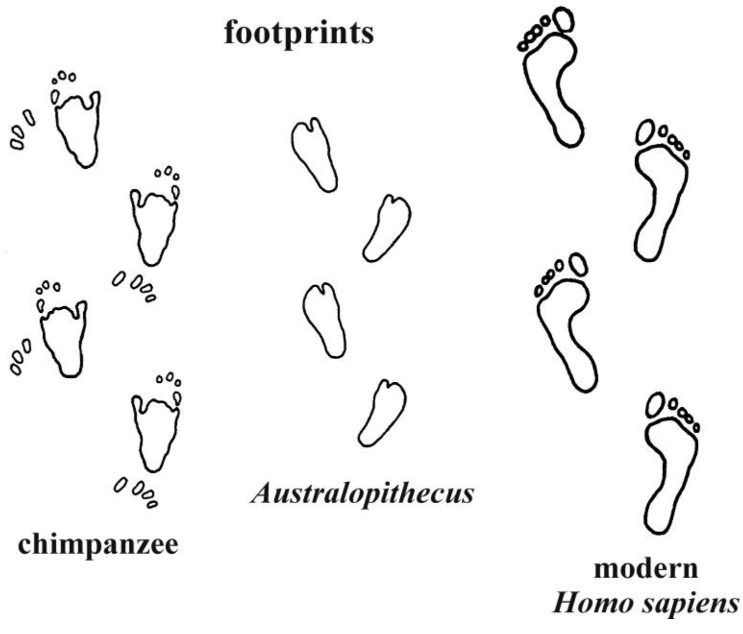

Fig. 11. The footprints of great apes and human beings (after Zihlman 1982).

What makes a footprint look man-like? What might distinguish them from the footprints of an ape?

The human toe is rather short but it reaches the fore-end of foot. It is adducted, that is it is not specialized to grasp or hold a branch or a tool (see Fig. 12 d).

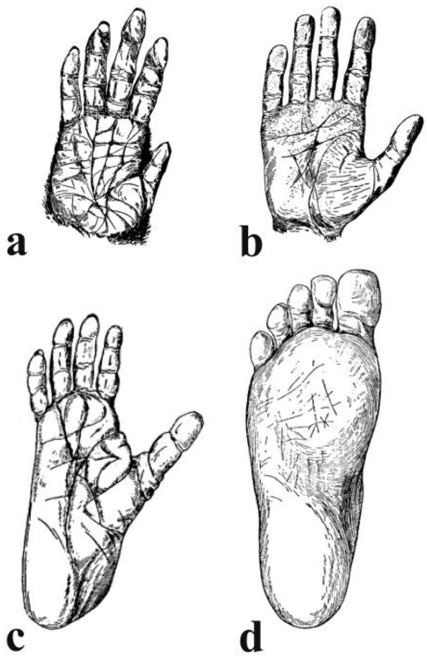

Fig. 12. Man has two hands and two feet. An ape has two forehands and two hind hands. Human feet are adapted to walking and running. Human hands are adapted to grip, to manipulate, but unadapted to locomotory function.

The human foot is not flat like in the case of a chimpanzee, gorilla or bear, but has the shape of an asymmetric bridge (see Fig. 13).

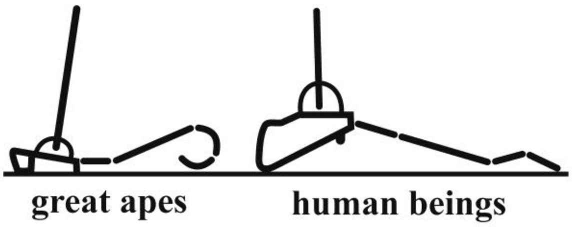

Fig. 13. The flat foot of the great apes and the arch of the human foot (after Weidenreich 1922).

A man’s footprint on the wet sand of a beach consists of a round rear depression (heel depression), a lateral narrow groove, and a front, broad depression produced by the front ends of the metatarsal bones and toes, including the big toe (see Fig. 14).

Fig. 14. Human footprint on wet sand.

Figures15 and 16 show the two series of outlines of man-like Laetoli footprints. These footprints are undistinguishable from the footprints of modern people who are walking barefoot. How are we to interpret these footprints?

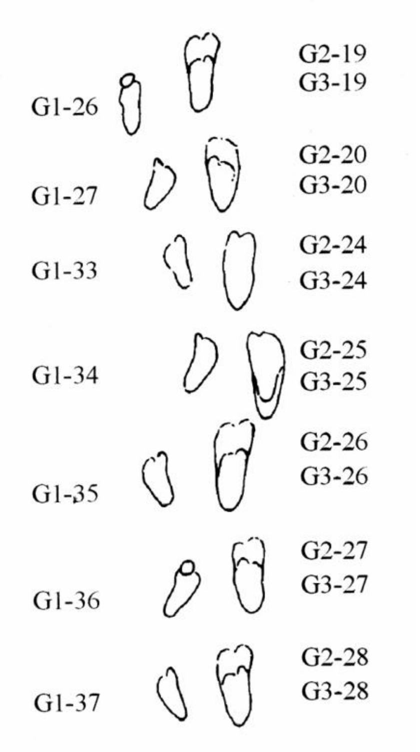

Fig. 15 shows the southern part of the human-like trail. Three kinds of footprints can be distinguished – the biggest, medium and the smallest one. The length of the steps of the biggest one (G2 trail) was the same as the length of the smallest, and presumably the shortest one (G1). The medium trail (G3) evidently demonstrates that the medium walker put his (or her) foot in the footprint of the G3, the biggest one, who led the small group. The behavior of the medium trail demonstrates perfect body balance. It is exceptionally clear when we look at the footprints G2/3-19, 20, 25, 26, 27, 28.

Fig. 15. Footprints of three bipedal creatures marked G1, G2 and G3 (after Day 1986/184-185).

Figure 16 shows a part of the northern human-like trail. The distance between the G2 trail and the G1 trail is rather small. It would be impossible to walk shoulder to shoulder. The movements of the smallest individual are interesting.

The footprints G1-9 – G1-7 seem to indicate that this individual has turned his body to the left, (as if he was trying to see something he had left behind) and still moved to the north. This movement, however, was inadequate, so the individual had to jump forward (G1-7 – G1-4) as if he was pulled by the leader. Why not so by the medium individual (a female?)? The medium individual kept to accurately aiming at the prints left by the leading man, so she was independent of the movements of G1.

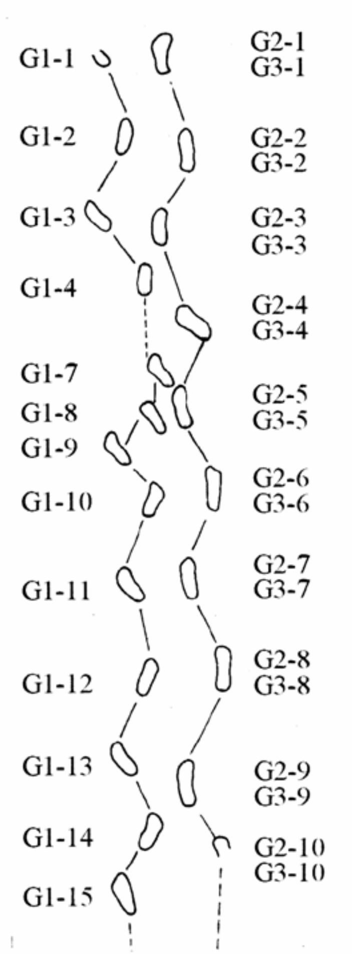

Fig. 16. A fragment of the northern human-like trail (after Day 1986/184-185).

Conclusions.

The main claims of my talk are as follows:

1. Present day, the Holocene human population is far from being homogenous. Ecotypes of *Homo sapiens* differ in the size and proportions of their bodies. In spite of it they are all considered as perfectly human creatures, possessing the full intellectual potential proper to man *(Homo sapiens)*
2. The full adaptive potential of the human species might have been the same during the Pleistocene and Pliocene epoch. However, the reconstruction of this potential is extremely difficult because of the fragmentary character of the anatomical and physiological fossil remains.
3. The major part of the fossil evidence is related to the masticatory system (over 50% of the fossil material). The remains which can help to reconstruct the hominid posture and locomotion add up to some 20%.
4. The principal empirical trait which is considered helpful in the reconstruction of hominid intelligence is the brain size and the brain anatomical shape. Neither of them seems rationally sufficient to provide evidence of a „pre-sapient" way of thinking and „pre-sapient" behaviour.
5. The earliest traces of the hominid stone-tool industry are dated to some 3.5 million years ago. They represent an early stage of technological progress. Nevertheless, these traces do not differ, essentially, from the stone-tool industries found among still living human populations. Up to now no Pleistocene or Pliocene traces of dancing have been found.
6. The fossil evidence concerning painting or body painting seems to indicate an upper kind of intelligence. The dating of this evidence, however, is extremely difficult and unreliable.
7. The remains of the oldest hominids leaves no doubt that their posture and locomotory behaviour provided them with all the anatomical and physiological equipment necessary to dance.

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