Movement and Morphology in Nature: Inspiration for (future) Technology

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Ever since ancient times, the seeming ease with which animals perform in their natural habitats has been a source of wonder for man. Aiming at the development of (future) versatile machines, able to adjust shape and movement patterns 'on the fly' to move through continuously changing environments and terrains (substrate, structure, complexity, slope, available space...), the diversity of animals' morphology and behaviour is often considered the blueprint for generic design principles in robotics. However, from the biologists' perspective, this 'faithfulness' may be less evident than first expected.

Making use of examples taken from primate functional morphology, we want to address three mechanisms by which organisms may respond to changes in their environment. Each of these act on a different time scale and thus come with their own constraints, potentially interfering with the engineering goals and concepts.

1) *Through a behavioural response*: Based on perception of (a cue in) the environment, a proper neuro-motoric response, subject to extero- and proprioceptive feedback and exploiting the intrinsic dynamics of the system, is selected. The time-scale is 'quasi instantaneous'. Voluntary quadrupedal-to-bipedal transitions in baboons and alternative climbing strategies in bonobos will be used as an example.

2) *Through phenotypic plasticity*: An environmental cue leads to morphogenetic change optimizing performance. The time-scale is 'life-time'. Ontogenetic changes, though not a response to new environmental cues, may enable (better) exploitation of new habitat dimensions and can, therefore, be considered an analogue of plasticity. The effect of morphometric changes on locomotor performance in infant baboons and human toddlers will be used as an example.

3) *Through evolutionary adaptation* (by natural selection): random (genetically based) phenotypical variation in a population results in differential individual fitness in the (changed) environment. The time-scale is an 'evolutionary' one. Obviously, behavioural (repertoire) and neuro-motoric features or capabilities (control), as well as the potential for plastic response, may also evolve through natural selection. Unravelling the adaptive advantage of (morphological) characteristics is not always straight forward and requires a thoughtful and meticulous approach. The 'achilles tendon' in Hominoidea (gibbons and great apes, including humans) in relation to locomotor performance will be used as an example.

To open the discussion, the translation towards robotics of these response classes will briefly be addressed from the naive biologists' point of view.