As ~~anyone knows~~ any physicist who has ever attempted to ~~converse c~~ talk to a biological scientist or vice versa knows, there is a great deal of confusion in attempts to accurately describe muscular motion and work. A large part of this difficulty stems from the incompletely known ~~action of~~ mechanism of muscular action. In attempts ~~try~~ to physically describe muscular mechanics one usually reaches some form of compromise by setting limits and definitions ~~that~~ on physical & mathematical descriptions. ~~that~~ These are usually ~~defined~~ set by our limits of precise knowlege of biological mechanisms. ~~If~~ There is no reason to believe that biological mechanics are ~~so~~ based on other than physical laws ~~so~~ every attempt must be made to use physical and mathematical descriptions. Unfortunately biological scientists still frequently rely on qualitative descriptions c a sprinkling of loosely applied physical terms.

One area in which this is particularly apparent is ergometry. The ~~lack of~~ application of precise definitions have led to what ~~is~~ might appear ~~st~~ to the many biological scientists as unusual results. ~~Ergometr~~ Since ergometry is concerned c work we can begin by defining this. Also let us add our first limits to keep the discussion manageable. We will define only exocentric, external work. 'Strange' results accrue from egocentric efforts or at least in our present efforts to describe them. Although internal work in muscular action may consume large amounts of energy we are in no position to accurately describe them all. Work is simply Force × distance. This is straight forward enough but what has been neglected in ergometry to date has been the effects of various types of forces — as we will show the ~~human~~ & animal muscular system is very sensitive to the types of forces (loads) which it must exert.

~~Lets~~ Defining the forces which are ~~available~~ most often encountered by ~~the~~ animals: Assuming our first ancestors were very small & ~~first~~ moved in liquids at very nearly their own specific gravity. ~~The first~~ Two forces ~~so~~ primarily exist under these circumstances.

1) Inertia –

$$\text{Force} = \text{Mass} \times \text{Acceleration}$$

2) Resistive –

$$\text{Force} = \text{Constant} \times \text{Velocity}^n$$

~~In~~ The inertial force has the property of storing energy ~~or~~ this attempting to maintain a ~~for~~ given velocity. The amount of energy stored is a function of mass and velocity.

$$\text{energy} = \text{mass} \times \text{velocity}^2$$

~~In the case of our small ancestors~~

There are actually a large class of resistive forces depending upon the value of the exponent n – Viscous resistance such as we have here typically has a value of 2 –

~~F~~ For example in fluid the complete expression is

$$\text{Force} = (C_D \, S \, \rho) V^2$$

where C_D is a constant depending upon shape, S is the frontal area and ρ is the density of the fluid. ~~In~~ However at low velocities the n may not be 2 but may ~~reduce~~ transition to 1 or less.

The effects of these two forces may be seen in the jerky, erratic motion of micro-organisms. The inertia of these small organisms is negligible since their mass is extremely small ~~indeed~~, i.e. the ratio of inertia to resistive forces ~~are~~ is small ~~indeed~~ such that movement is possible only when a propulsive force is applied and stops immediately upon termination of this force.

~~We encounter such resistive forces (called~~

~~we~~ ~~Lot~~ Fish and larger aquatic animal encounter these forces but in different ratios and ~~are~~ the difference in motion is obvious. The smooth glide of the fish or even the leap clear of the water are made possible by this change in ratio of forces encountered by the muscles.

~~Once~~ On leaving the water inertial forces remain however resistive forces are less often encountered. Viscous forces ($n = 2$) remain in moving through the air but only at high velocities since the density is greatly reduced. These forces are appreciable in running, more so in cycling