**Human energetics**

# Making headway in Africa

*from R. McNeill Alexander*

WOMEN of some African tribes carry huge loads, up to 70 per cent of their body mass, on their heads. Luo women balance the load on top of their heads, and Kikuyu women let it hang behind their backs, supported by a strap that runs across their foreheads. In either case, the feat seems remarkable. It seems even more remarkable in the light of a physiological investigation by Geoffrey Maloiy and colleagues, which is reported on page 668 of this issue.

The authors measured the oxygen consumption of Luo and Kikuyu women walking on a motorized treadmill with and without loads on their heads. Loads of up to 20 per cent of body mass have no perceptible effect on oxygen consumption and, presumably, on energy cost. Loads of 70 per cent of body mass increase oxygen consumption by 50–60 per cent. Army recruits carrying backpacks perform much less well: 20 per cent loads increase oxygen consumption by 13 per cent and 70 per cent loads by nearly 100 per cent.

IMAGE UNAVAILABLE FOR COPYRIGHT REASONS

R.F. Ker

A woman carrying a load in Malawi.

But do not assume that you would find it more restful to carry your suitcase on your head. Experiments with people who are not accustomed to carrying loads on their heads show that the energy cost of carrying a load is the same whether the load is carried on head or back, and is much more than the cost to the African women. Further, inexperienced people cannot safely manage more than 15 per cent of their body mass on their heads.

How can African women carry loads so economically? Have they discovered some behavioural or physiological trick? Maloiy and colleagues make an interesting suggestion. The energy required to move a load at constant speed over level ground is, in principle, nothing. Walking requires energy largely because we raise and lower, and accelerate and decelerate, our bodies at each step, which makes muscles do work, producing potential and kinetic energy. The energy is then discarded and the process repeated. A lot of the energy that would otherwise be needed for walking is saved by shifting energy back and forth, pendulum fashion, between the kinetic and potential forms.

Maloiy *et al.* suggest that a load on the head does not rise and fall or accelerate and decelerate as much as the rest of the body. If the load moves steadily along, as if on wheels, it can, in principle, be carried without energy cost. There are no data that show whether the African women make their loads move steadily, and, in any case, steadiness would give no energetic advantage if it depended on bending and extending the back by muscle action.

It might be possible to achieve steadiness in another way, for example, by using the principle of vehicle suspension systems. To give a reasonably comfortable ride, an automobile must be mounted on springs. The wheels may bounce up and down on a rough road but the body will move much more steadily if the springs are compliant enough to bring the natural frequency of the vehicle well below the frequency of the vibrations.

Perhaps the African women use some

# W.S. Stiles (1901–1985)

**WALTER Stanley Stiles died on 15 December 1985. A physicist and mathematician by training, he spent most of his professional life in the Light Division of the National Physical Laboratory at Teddington, Middlesex. In his early days, great store was laid by photometry — after all, it was the division of light, not of radiation — and Stiles's life-long interest in the eye developed under the tutelage of Guild and Walsh.**

**Stiles was better equipped to establish rigorous criteria for the control of visual stimuli than to come to terms with the vicissitudes arising from biological variations. In the early 1930s he examined parameters of glare and, with B.H. Crawford, established the concept of veiling glare. This introduced a powerful method for monitoring the response of the eye that has stood the test of time. The precision of his thinking, coupled with his imperturbable courtesy and tact, made him a good choice for general secretary of the International Commission of Illumination; he maintained an interest in it for over 25 years.**

**J.W.T. Walsh, the head of the Light Division, appreciated the young man's original mind and so allotted his duties to permit him to carry out time-consuming experiments, an act which Stiles was to acknowledge handsomely even decades later. These studies dealt with the relationship between the stimulating power of light and the angle of incidence of light on the retina, particularly at the visual centre of the retina, the fovea. This is known the world over eponymously as the Stiles – Crawford effect. There had been earlier hints that the effective illumination of the retina was not proportional to the pupillary area, but the various physiological parameters — retinal location, level of adaptation and stimulus wavelength — were tackled in exemplary detail by Stiles and Crawford.**

**Stiles's third major investigation, in the 1950s, was of the colour mixture functions of 'normal' observers, using a large (10°) test-field. Guild and Wright had previously produced standard data for a 2° field, and extending these observations to another operational level was important. Although the difference between the two standards was relatively small, Stiles and Burch's great effort helped to provide about two thirds of the characterization needed for a complete understanding of human chromatic performance.**

**In two respects, Stiles anticipated the work of others. He grappled with the quantal nature of the visual stimulus before this was done by Hecht, Shlaer and Pirenne but, as he told me, failed to see before they did how wavelength dependence was involved. Furthermore, during the war he attempted to determine a density-difference spectrum for the living human retina using fundus reflectometry. He came literally face-to-face with his subject but his visual photometry was not accurate enough to detect changes that were later easily quantified with photoelectron multipliers. None of this work was ever published but presumably remained in the notebooks he used to amass under his arm whenever air-raid sirens sounded.**

**In his later years, Stiles continued to refine the two-colour method of the thirties (Π-mechanisms) and unremittingly helped younger followers in his footsteps. His advice was in great demand and, a few months before he died, he was delighted to be invited to and to attend a meeting in Madrid.**

**He has left us the legacy of precision. His earlier seminal papers, including those published just after the war, presented the data in terms of curves. "In those days", an expert in colour recently remarked acidly, "one did not publish data points." When Stiles changed tack and started publishing both data points and curves, the smoothness of the latter remained unimpaired. This cannot be said of many workers in his field.**

R.A. Weale