

degeneration as our preliminary observations would suggest, the hypothetical cord factor, if not identical with the hæmopoietic liver principle, must at least be closely allied to it chemically.

<sup>1</sup> G. R. Minot and W. P. Murphy, *J. Amer. Med. Assoc.*, **87**, 470-476; 1926.

<sup>2</sup> G. R. Minot, E. J. Cohn, W. P. Murphy and H. A. Lawson, *Amer. J. Med. Sci.*, **175**, 599-622; 1928.

<sup>3</sup> F. W. Peabody, *Amer. J. Path.*, **3**, 179-202; 1927.

<sup>4</sup> S. Fenwick, "On Atrophy of the Stomach and on Nervous Affections of the Digestive Organs". (London: J. and A. Churchill, 1880.)

<sup>5</sup> W. B. Castle and E. A. Locke, *J. Clin. Invest.*, **6**, 2-3; 1928.

<sup>6</sup> W. B. Castle, *Amer. J. Med. Sci.*, **178**, 748-764; 1929.

<sup>7</sup> W. B. Castle and W. C. Townsend, *Amer. J. Med. Sci.*, **178**, 764-777; 1929.

<sup>8</sup> W. B. Castle, W. C. Townsend and C. W. Heath, *Amer. J. Med. Sci.*, **180**, 305-335; 1930.

<sup>9</sup> W. B. Castle, C. W. Heath and M. B. Strauss, *Amer. J. Med. Sci.*, **182**, 741-764; 1931.

<sup>10</sup> C. C. Ungley and G. V. James, *Quart. J. Med.*, **3**, 523-548; 1934.

<sup>11</sup> W. B. Castle, *Ann. Int. Med.*, **7**, 1-5; 1933.

<sup>12</sup> K. Singer, *Wien. klin. Wchnschr.*, **45**, 1063-1064; 1932.

<sup>13</sup> D. K. Miller and C. P. Rhoads, *New Eng. Med. J.*, **211**, 921-924; 1934.

<sup>14</sup> J. Gröen, "Klinisch en experimenteel onderzoek over anaemia perniciosa en voorwaardelijke deficiëntie". (Amsterdam: Scheltema et Holkema's Boekhandel, 1935.)

<sup>15</sup> F. Reimann, *Med. Klin.*, **27**, 880-881; 1931.

<sup>16</sup> P. J. Fouts and L. G. Zerfas, *J. Amer. Med. Assoc.*, **101**, 188-192; 1933.

<sup>17</sup> M. B. Strauss and W. B. Castle, *New Eng. J. Med.*, **207**, 55-59; 1932.

<sup>18</sup> L. Wills, *Lancet*, **1**, 1283-1286; 1933.

<sup>19</sup> L. Wills and A. Naish, *Lancet*, **1**, 1286; 1933.

<sup>20</sup> F. Diehl and J. Kuhnaü, *Deutsch. Arch. klin. Med.*, **176**, 149-153; 1933.

<sup>21</sup> H. C. A. Lassen and H. K. Lassen, *Amer. Med. Sci.*, **188**, 461-472; 1934.

<sup>22</sup> L. Klein and J. F. Wilkinson, *Biochem. J.*, **23**, 1684-1692; 1934.

<sup>23</sup> J. F. Wilkinson, *Proc. Roy. Soc. Med.*, **26**; 632-634; 1933.

<sup>24</sup> E. Meulengracht, *Proc. Roy. Soc. Med.*, **28**, 841-868; 1935.

<sup>25</sup> W. B. Castle, *Science*, **82**, 159-164; 1935.

<sup>26</sup> E. J. Cohn, T. L. McMeekin and G. R. Minot, *Trans. Assoc. of Amer. Physicians*, **45**, 343-349; 1930.

<sup>27</sup> M. Gänsölen, *Klin. Wchnschr.*, **9**, 2099-2102; 1930.

<sup>28</sup> W. B. Castle and F. H. L. Taylor, *J. Amer. Med. Assoc.*, **96**, 1198-1201; 1931.

<sup>29</sup> H. D. Dakin and R. West, *J. Biol. Chem.*, **109**, 489-522; 1935.

<sup>30</sup> J. Vaughan, *Arch. Int. Med.*, **47**, 688-689; 1931.

<sup>31</sup> C. C. Ungley and F. J. Natrass: to be published.

<sup>32</sup> A. F. Hurst, *Brit. Med. J.*, **2**, 665-669; 1934.

<sup>33</sup> C. C. Ungley, *Proc. Roy. Soc. Med.*, **28**, 868-870; 1935.

<sup>34</sup> E. Mellanby, *Edin. Med. J.*, **40**, 197-222; 1933.

<sup>35</sup> E. F. Gildea, E. E. Kattwinkel and W. B. Castle, *New England J. Med.*, **202**, 523-527; 1930.

<sup>36</sup> W. Sargant, *Lancet*, **1**, 230-232; 1932.

## Fire-Walking

By Ernest S. Thomas

SOME forty cases of the ember-walk and the stone-walk (to distinguish the two forms by these terms) selected from a larger number, collected from a wide range of accredited sources, were analysed for a paper I wrote for the Society for Psychological Research (published in the *Proceedings* in December 1934).

These narratives, with very few exceptions, are characterised by a lack of essential details, and that over-emphasis of the sensational aspects of the performance which seems inseparable even from some would-be scientific accounts. This lack of essential detail is not at first sight apparent, and it was not until I tried the ember-walk on a small scale myself in socks that these defects became apparent: namely, on a trench 9 feet long by 12 inches wide and some 6 inches deep filled with red hot, flameless, firestick-embers. I was able several times to take four steps in threadbare woollen socks (treading the embers five times) in 3 seconds without singeing, scorching or blistering—or discomfort at the time, but my foot-soles burned and tingled for several hours afterwards.

I attribute the immunity of my socks to their brief contact with the red hot coals and probably in part to the coating of ash, and that of my 'uncallused' feet to the woollen substitute for callus. I am, it should be stated, slight in build, of light weight (barely 9 stone) and tolerably agile.

Most of the observers of the ember-walk note the presence of ash, as well as of the great heat of the furnace walked upon. Regarding the latter, the fact that the surface coals are loosely packed over the furnace should not be lost sight of; so that the heat radiates out between the interstices of the cooler (because rapidly cooling) surface. Where the ash is not mentioned in accounts, there was clearly time for it to form before the walk began. In many cases (and one may assume it in all the important Indian cases) the legs of the walkers before the performance are wet (and doubtless cold) after bathing and/or immersion in turmeric water, and often coated with mud.

In a number of cases more or less rigorous ascetic training with meditation and concentration has been undergone, designed doubtless to enhance the powers of protective auto-suggestion. In several instances, the walkers bore silver skewers transfixing the dorsal muscles and other parts of their bodies, and one performer prior to the walk sat on a swing-seat full of 3-inch thorns; they pierced his flesh, but there was no bleeding. Dr. J. H. Hunt noted the almost total absence of bleeding when fakirs pierced their necks and abdominal muscles with rapiers<sup>1</sup>. Dr. William Brown noticed this also in the case of Rahma and Tara Bey<sup>2</sup>. Such contraction of the blood-vessels, through self-hypnotism, would tend to lower the temperature of the legs and feet (apart from the

bathing), and, with the anæsthesia, enable the walkers to withstand the great heat of the large furnaces, as well as resist the tendency to blistering<sup>3</sup>.

The Fijian stone-walk seems at first sight to present features more baffling of a normal explanation than the ember-walk. The setting is more sensational with its blazing logs and white- and red-hot stones exploding and scattering with the heat.

The furnace prepared is usually round and a few feet deep, and varies considerably in size. In it dry poles are sometimes, if not always, set radially to support and heat the pile of large stones. In the performance witnessed by Prof. S. P. Langley (whose account given in NATURE<sup>4</sup> is the first attempt at a scientific record) the number of stones is estimated at 200, weighing 40–80 lb. each. Unfortunately, no account tells us how the fire is fed. If, as seems probable, fresh fuel is thrown on, clearly the heating effect would be small compared to that of the blazing logs below. In due course, all burning timber is withdrawn and the surface levelled with green poles held by men, and pulled with a stout creeper-stem. Then, according to one account, the stones are turned flat (split) side up on the surface. The rock used is a very vesicular augite-andesite which is slow to acquire (and lose) heat: hence, it has been argued, the flat faces are probably comparatively cool.

The fire observed by Langley had burned for some five hours. The pit was 9 ft. × 21 ft. and 2 ft. deep, and the lower stones only were red-hot. The walker is said to have prepared himself by prayers and spells, and to have crossed the centre and returned, but the time taken to walk and to clear and prepare the surface are not given.

In Dr. R. Fulton's account (summarised in NATURE<sup>5</sup>) the furnace was 20 ft. in diameter and 2 ft. deep. The preparations began after the fire had burned for fifty hours. During this operation, the stones cooled from white to red and then lost their glow. He estimates the time taken as nearer two hours than one, but does not mention the heat-state of the surface stones. The pulse of the walker was 90 before starting; his hands cool, his feet cold, clean and odourless; the soles yellow-white like soft kid as they would be after the customary sea-bath, which is not mentioned. He walked deliberately across, according to some spectators, though Dr. Fulton did not think he crossed the centre, and twice round the stones (the latter would certainly be the cooler path). After the walk the pulse was 120, and the feet still cool if not cold, though the legs were of high-fever temperature. The time was estimated at 15 seconds, and 25–30 steps were taken. Thus the soles were not in contact with the stones for more

than half a second. (But there is clearly an error in the figures given if the steps cover two circuits; and from other accounts short steps of about a foot seem to have been taken.)

Fulton appears to think that the soles were not callused because they were soft, and attributes the immunity to the specific qualities of the stone. Experimenting with a block of olivine basalt about 4 in. × 4 in. × 3 in. and weighing nearly 4 lb., of approximately the same specific gravity (2.5 instead of 2.4) as the Fijian rock but less vesicular, I found that, removed after being heated in a coal fire (in a grate) for three hours, it lost its red glow in three minutes, and took about the same time to lose it when left on the fire after four hours heating in it. I finally heated it on the red coals in an anthracite stove for five hours and, on breaking it, found it was red only half-way through. I failed to get it above red heat in the fires at my disposal. A sphere of this rock weighing 60 lb. (the average of Langley's estimate) would take roughly thrice the time to cool: other shapes (such as oval) not so long. Thus, in fifteen minutes such red-hot stones would lose their glow. It seems certain then that the performers do not walk on red-hot stones, and probable that the surface stones are never red-hot right through. No observer has noted the time taken by the stones in cooling from white to red. These would be in the centre, the region usually hurried over or avoided by the walkers; also not at the surface.

In none of the accounts are we given full details of the duration of the fring, log-clearing, and stone-levelling, the duration of the walk, the manner of walking, the number of steps, and in none are we told how the fire is kept up.

In several accounts it is stated that cloths are thrown or placed on the stones, but not applied and withdrawn synchronously with one foot of the walker. In the case where an Englishman walked barefoot, no time details are given except of the heating.

A valuable paper on the Fijian firewalk by Sir J. Purves-Stewart and Prof. D. Waterston appeared in the *British Medical Journal* (Dec. 28, 1935). The fire is stated to have been burning on the stones for nine or ten hours and was almost out but glowing. Unfortunately, full details of the performance are assumed to have been given by other observers. Immunity is (*in summa*) attributed to the thickened soles, the raising of the threshold of pain by habitude, the momentary contact, and the autohypnotic effect of the preliminary ritual.

On the evidence, then, there seems to be nothing supernatural in the performance unless the possible effects of self-hypnosis as a protection from the mass heat of the furnace are so considered.

Are supernormal powers and conditions necessary to explain the immunity of Kuda Bux? Mr. Harry Price regards it as definitely proved that the ash plays no part as a protection. But ash forms very quickly as the surface-carbon oxidises away (especially under fanning?), and a very thin layer is a protection, as anyone can testify by experiment with a finger and a red-hot stick. The photographs<sup>6</sup> seem to show a plentiful supply of ash in his path unless the red glow has photographed white. Mr. C. R. Darling<sup>7</sup>, on the other hand, says the surface walked was not visibly red-hot. Regarding his foot-soles, to the medical man who examined them before the first experiment, the epidermis seemed rather thick (although Mr. Price considered it was thin and tender).

On the second occasion, Prof. Pannett found "the skin was not callous but soft as the skin of so many individuals who walk barefoot [*sic*]". The feet were also noted as cold and dry. But callus is *thickened*—not necessarily *hard*—skin. The softness therefore need not exclude thickness. The thickness was not tested. The coldness and softness may have been caused by water (cf. Dr. Fulton above), the coldness enhanced by 'self-suggestion'<sup>8</sup>.

Regarding Mr. Price's test with the calico-wrapped boot-last, it is not evident from the account that he raised and lowered it synchronously with one foot of Kuda Bux, that is, twice for half a second's contact. As the calico was scorched (he says) in one second and burned in two seconds, it seems indeed that the test was not properly applied. This lends force to Mr. Darling's findings as to the heat of the surface trodden.

Mr. Darling's positive evidence, then, regarding the heat of the trodden surface, and the uncertainty (*pace* Mr. Price) regarding the ash and the 'callosity' of the foot-soles of Kuda Bux, leaves the question of supernormality in the fire-walk very much where it was.

<sup>1</sup> "Indian Fakirs", *St. Bartholomew's Hospital Journal*, Oct.-Dec. 1934.

<sup>2</sup> "Psychology and Psychotherapy", p. 108 *et seq.*

<sup>3</sup> Cf. Dr. Hadfield's experiments (*Lancet*, Nov. 3, 1917) with a hypnotised patient, whose arm was only lightly blistered without hyperæmia when touched with a red-hot pencil-case.

<sup>4</sup> *NATURE*, 64, 397 (1901).

<sup>5</sup> *NATURE*, 67, 130 (1902).

<sup>6</sup> *Listener*, September 18, 1935.

<sup>7</sup> *Listener*, November 6, 1935.

<sup>8</sup> Dr. William Brown (*loc. cit.*) "Under autohypnosis the respiration can be slowed, the pulse-rate altered, the tendency to bleed diminished". Kuda Bux pulse rates and breathing rates have not been published, if they were taken.

## Obituary

### Captain S. R. Douglas, F.R.S.

THE death of Captain S. R. Douglas, on January 20, after a short illness, will be deeply regretted by all who are interested in medical research. He was born in 1871 and educated at Haileybury College and St. Bartholomew's Hospital. After taking the double diploma M.R.C.S., L.R.C.P. in 1896, he joined the Indian Medical Service in 1898 as surgeon lieutenant. He served with the Plague Commission in 1899, and with the China Expedition in 1900-1, being promoted captain. He was invalided home at the end of 1901, but in spite of poor health, he soon took up work at St. Mary's Hospital with Sir Almroth Wright. In 1903, Wright and Douglas communicated to the Royal Society an important paper on the role of the body fluids in phagocytosis, a paper which did much to stimulate new work on vaccines and vaccine therapy. In both these lines of study Douglas played his part.

On August 1, 1914, Douglas joined the pathological staff of the Medical Research Committee, but the War interfered with projected research schemes, and he joined the R.A.M.C. After a short period of research work in France, he was invalided home, and in spite of continued ill-health, he was busily engaged in the production of vaccines on a large scale, the study of

war wound infections and bacillary dysentery. In 1914, he described the method of preparation of a tryptic digest medium for cultivation of bacteria. This was of great immediate value for vaccine production, and has since proved to be of great value for general purposes.

From 1920 onwards to the close, Douglas was engaged in building up the Department of Experimental Pathology at the National Institute for Medical Research at Hampstead, and in pressing forward the work of others. In 1921, he was director of the Department, and in 1930 deputy director of the Institute. He was greatly interested in, and had an extensive knowledge of, virus diseases, and though he did not publish much on this subject, he did much to initiate new lines of work and assist his juniors. On occasion he started and guided an entire research, though his name did not appear on the final publication. He also did much during the period to assist in work with visible bacteria; for example, in 1922, he devised a special tellurite medium for cultivation of diphtheria bacilli, which is still of value to others. Again, he worked out special media (including synthetic media) for cultivation of tubercle bacilli, and he helped others to do valuable biochemical work with this organism. His wide knowledge, great