

# Running and Swimming World Records\*

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"In the data of athletic records we have a store of information available for physiological study."

A.V. Hill in "The Physiological Basis of Athletic Records", The Scientific Monthly, 1925.

Analyses of current world records (Table I) show that the decline of speed with distance is greater in running than in swimming. Figs. 1 and 2 indicate the magnitude of the decline expressed for each world record (WR) as percentage of velocity of the 100 m speed. <sup>1</sup> In terms of their duration, the 1,500 m running and the 400 m free style

swimming events are comparable: Within less than 4 minutes runners lose about 30% velocity, swimmers only 10%; within about ¼ of an hour runners lose 37% (see Putteman's 5000 m WR), swimmers only 17% (see Goodell's WR).

The differences in rates of decline of velocity become greater with increasing distances. On the whole runners lose speed at rates about three times greater than swimmers.

What are the causes of this discrepancy? The answer has come from recent investigations into the state of weightlessness, a problem of major importance for space medicine. During immersion of the body in water which simulates the state of weightlessness, the heart enlarges and forwards more blood with each systole. Since the swimmer lies in the water horizontally his heart's ability to forward blood is further enhanced. Also, the cool environment causes blood to be diverted from the skin to the central circulation.

The roentgenograms in figure 3 were obtained by Professor Roger Otto Gauer of Berlin,

\* To Professor Archibald Vivian Hill on the occasion of his 90th birthday.

<sup>1</sup> Running: 9.95 sec. men, 11.01 sec. women.  
Swimming: 49.99 sec., men (new record by J. Skinner of 49.44 sec. pending), 55.65 sec. women.

<sup>2</sup> 1,500 m running WR: 3:32.2 men, 3:56.0 women.  
400 m swimming WR: 3:51.93 men; 4:09.89 women. (WR).

TABLE I

|      | MEN             |                          |                      | WOMEN              |                       |                 |                    |
|------|-----------------|--------------------------|----------------------|--------------------|-----------------------|-----------------|--------------------|
|      | Distance meters | Name — Year              | Record time          | % maximal velocity | Name — Year           | Record time     | % maximal velocity |
| RUN  | 100             | J. Hines (1968)          | 9"05                 | 100,000            | W. Tyus (1968)        | 11"07           | 100,000            |
|      | 200             | D. Quarrie (1971)        | 19"81                | 100,454            | I. Szewinska (1974)   | 22"21           | 99,685             |
|      | 400             | L. Evans (1968)          | 43"86                | 90,743             | R. Salin (1974)       | 50"14           | 88,313             |
|      | 800             | M. Fiasconaro (1973)     | 1'43"70              | 76,760             | S. Zlateva (1973)     | 1'57"50         | 75,370             |
|      | 1 500           | F. Bayi (1974)           | 3'32"20              | 70,335             | L. Bragina (1972)     | 4'01"40         | 68,786             |
|      | 3 000           | B. Foster (1974)         | 7'35"20              | 65,576             | G. Anderson (1975)    | 8'46"60         | 63,065             |
|      | 5 000           | E. Puttemans             | 13'13"00             | 62,736             |                       |                 |                    |
|      | 10 000          | D. Bedford (1973) (1972) | 27'30"80             | 60,274             | C. Vahlensieck (1975) | 34'01"40        | 54,227             |
|      | 42 200          | D. Clayton (1989)        | 2 h. 08'34"00        | 54,432             | J. Hansen (1975)      | 2 h. 38'19"00   | 49,179             |
|      | SWIM            | 100                      | J. Montgomery (1975) | 50"59              | 100,000               | K. Ender (1975) | 58"22              |
| 200  |                 | B. Furniss (1975)        | 1'50"32              | 91,715             | K. Ender (1975)       | 2'02"27         | 91,960             |
| 400  |                 | T. Shaw (1975)           | 3'53"31              | 90,618             | S. Babashoff (1975)   | 4'14"76         | 88,271             |
| 800  |                 | S. Holland (1976)        | 8'02"91              | 83,808             | J. Turall (1975)      | 8'43"48         | 85,917             |
| 1500 |                 | S. Holland (1976)        | 15'10"89             | 83,309             | J. Turall (1974)      | 16'33"94        | 84,844             |

an authority on the subject. Cardiac volume of the person standing was 698 ccm; after adoption of the supine position, 771 ccm; and following immersion, 922 ccm.

Thus the heart of swimmers enjoys three advantages: *weightlessness, the horizontal body position, and the cooling effect of the water.*

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*"That people think to some degree in logarithms, although unconsciously, is*

*shown by the fact that the records which men have thought worthwhile to make are distributed approximately uniformly if thus plotted."*

A. V. Hill. 1925

The progressive limitation of speed with increasing distances reveals a biological law whose determining influence is expressed by the parallelism of the two lines in fig. 4, plotted on double logarithmic scales using the pre-Montreal world records. One line depicts the decrease of *running* velocities

**MEN**  
**Decline of Running and Swimming Speed with Distance Based on World Records in Swimming (100 m - 1500 m) and Running (100 m - 5000 m)**  
**Expressed as Percentage Values of Maximal Velocity per Unit of Time**  
**August 1976**  
**100 m World Record = 100 % Maximal Velocity**

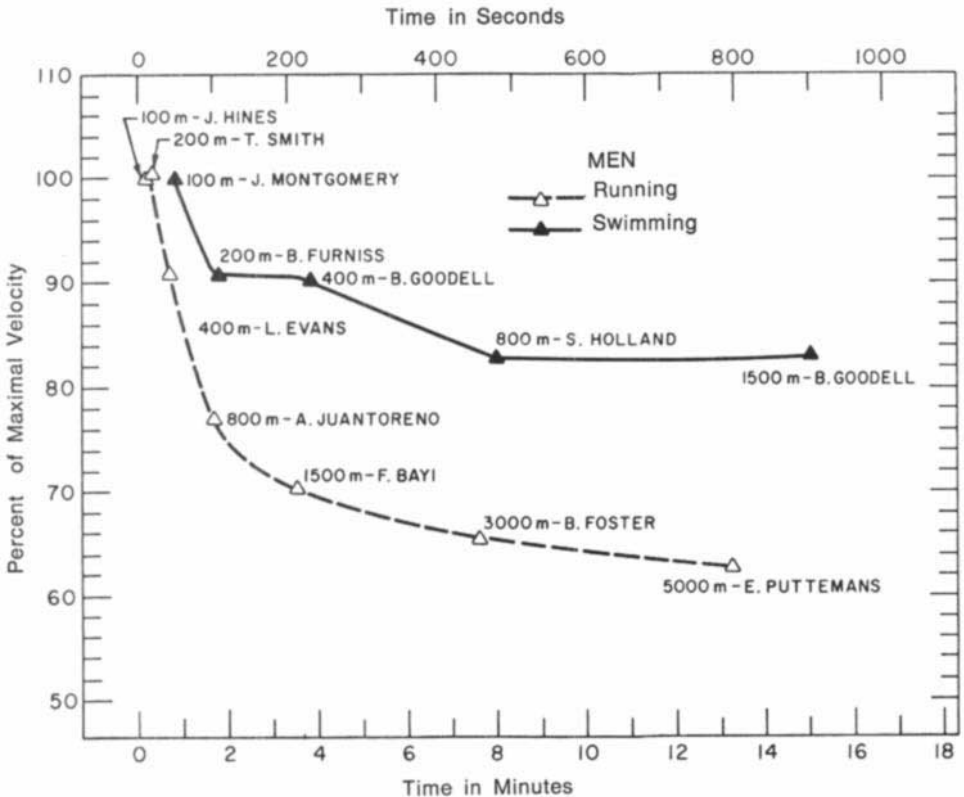


FIG. 1

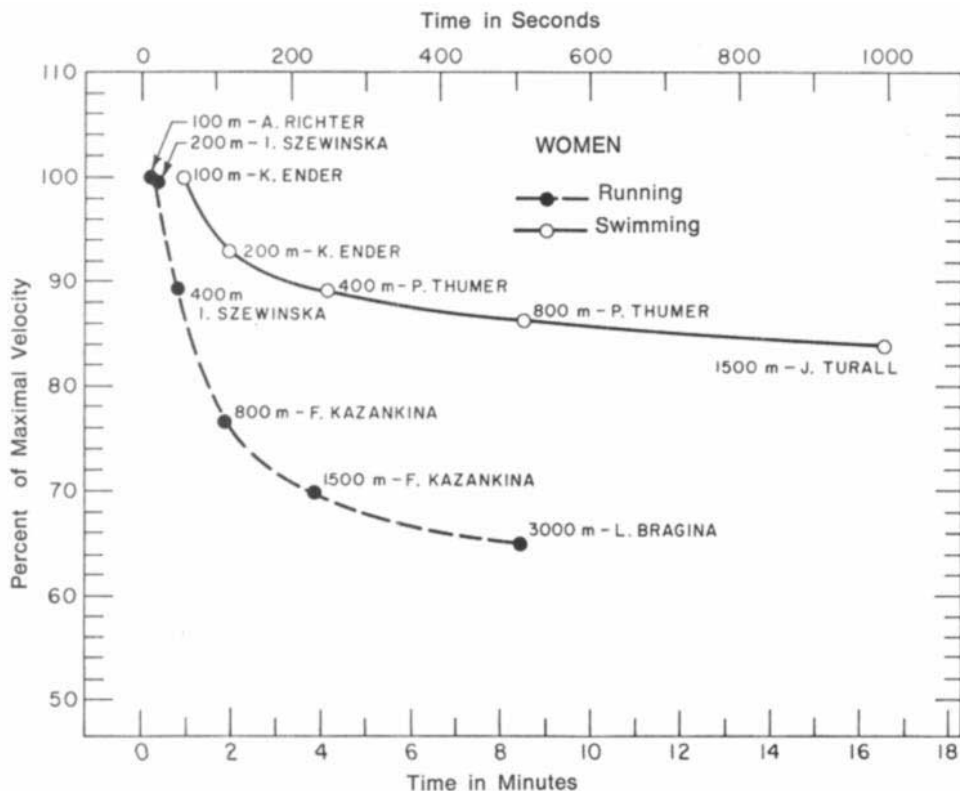
from 100 to 5,000 m; the other that of *swimming* velocities from 100 m to 1,500 m. The law thus identified pertains to rates of production of kinetic energy. Irrespective of the physiological differences between swimming and running, the time relation of the two clusters of world records is modified by a common metabolic determinant, a fact recognised 50 years ago by A. V. Hill, the great British physiologist. The time relations of running and swimming are the same for the post-Montreal records shown in Table 1, also in respect of the computations for figs. 5-7.

In figs. 5 and 6, swimming and running records for men and women are plotted in relation to distances, again on double logarithmic scales. Surprisingly the mathematical progression demonstrated with the data presented in fig. 4 applies to races up to 42,000 m. Percentage rates of velocities assessed from women's WRs are slightly lower than those assessed from men's WRs. (Fig. 7.).

Hill was the first to ponder the fact that the decrease of speed with increasing time occurs in accordance with mathematically

### WOMEN

**Decline of Running and Swimming Speed with Distance Based on World Records in Swimming (100 m - 1500 m) and Running (100 m - 3000 m) Expressed as Percentage Values of Maximal Velocity per Unit of Time August 1976**  
**100 m World Record = 100 % Maximal Velocity**



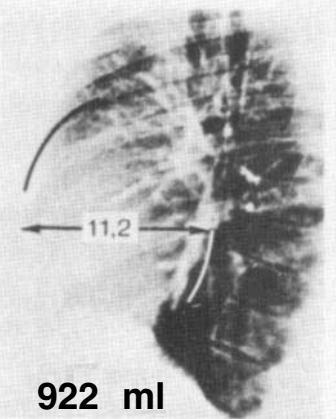
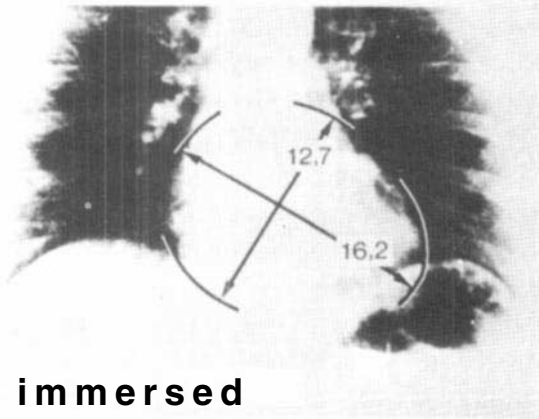
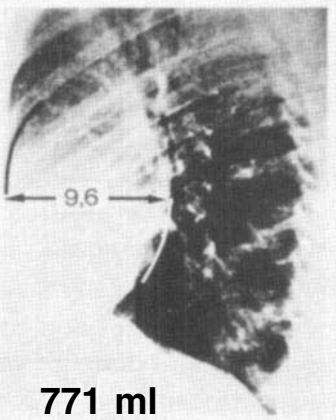
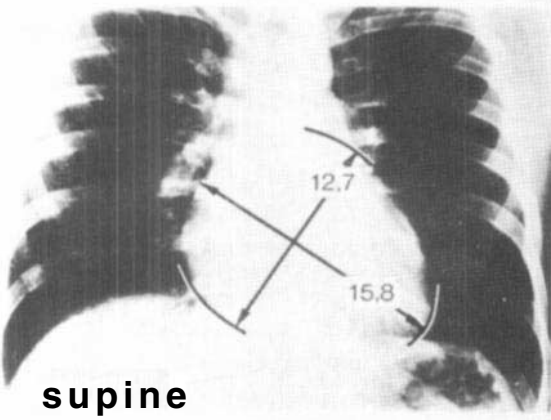
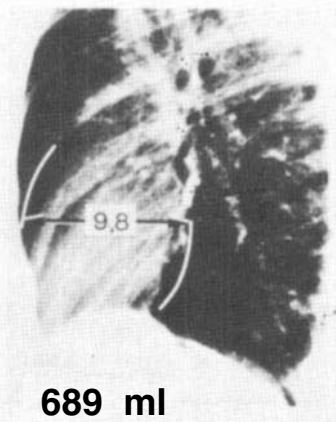
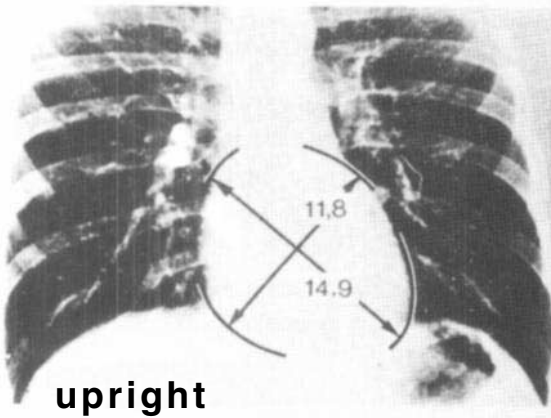


FIG. 3

identifiable laws. The latter he deduced from the world records of the early twenties which were of course very different from what they are today: At the 1920 Olympic Games at Antwerp Charlie Paddock won the 100 m sprint in 10.8 sec. Duke Kahanamoku came first in the 100 m free style swimming race in 1:01.4. The women's gold medal in the same event went to Ethelda Bleibtrey who clocked 1:13.6. The 100 m race for women was introduced into the Olympic

programme at Amsterdam in 1928: Elizabeth Robinson won in 12.2.

The mathematical relationship between velocity and distance computed from world records was of the same order in 1925 as it is now. To illustrate the growth of performance during the past decades we present fig. 8. Petra Thumer's WR time of 4:09.89 surpasses Don Schollander's WR of 1964. Jenny Turall's 1974 1,500 m WR time of 16:33.9 is better than that of all winners of

**Women's World Records in Running (100 m - 3000 m) and Swimming (100 m - 1500 m)  
June 1976  
Double Logarithmic Scales**

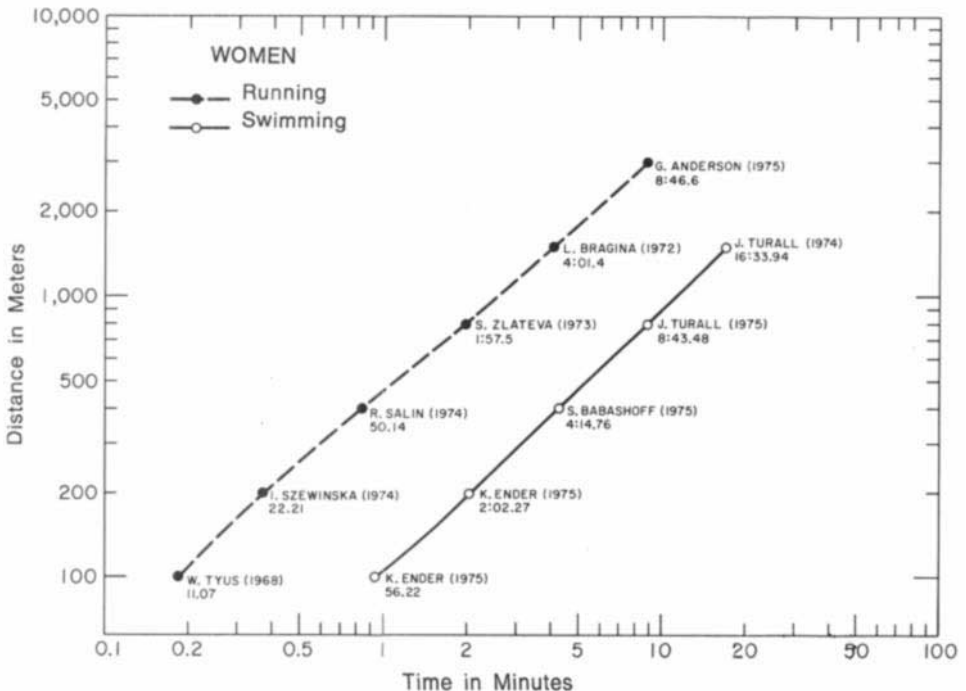
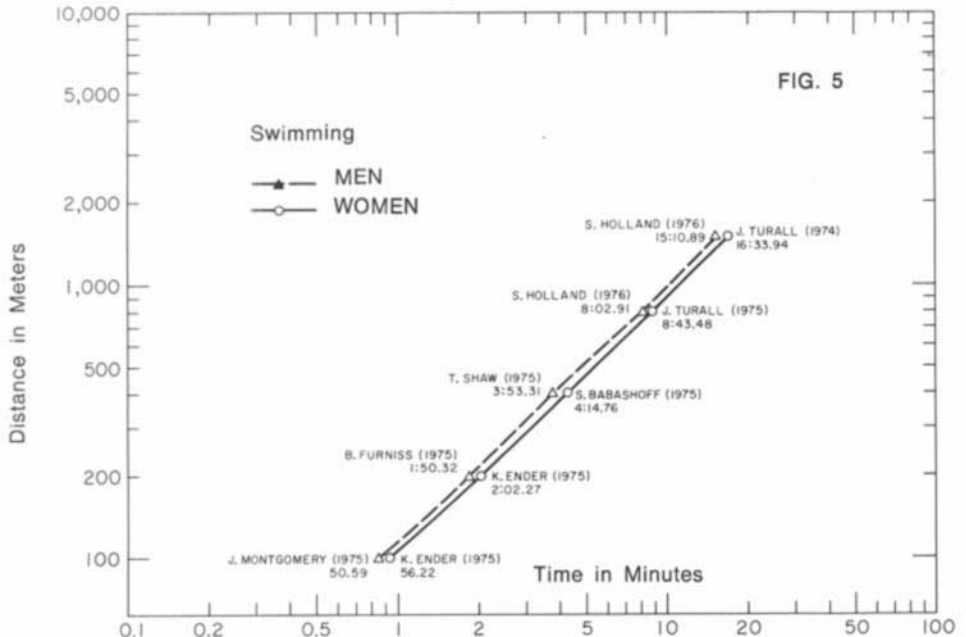
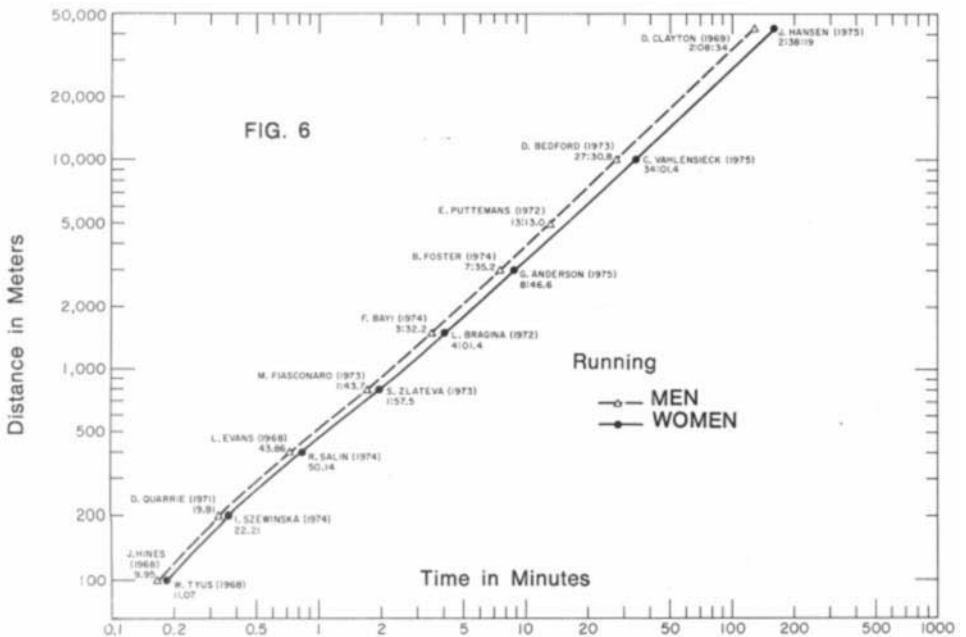


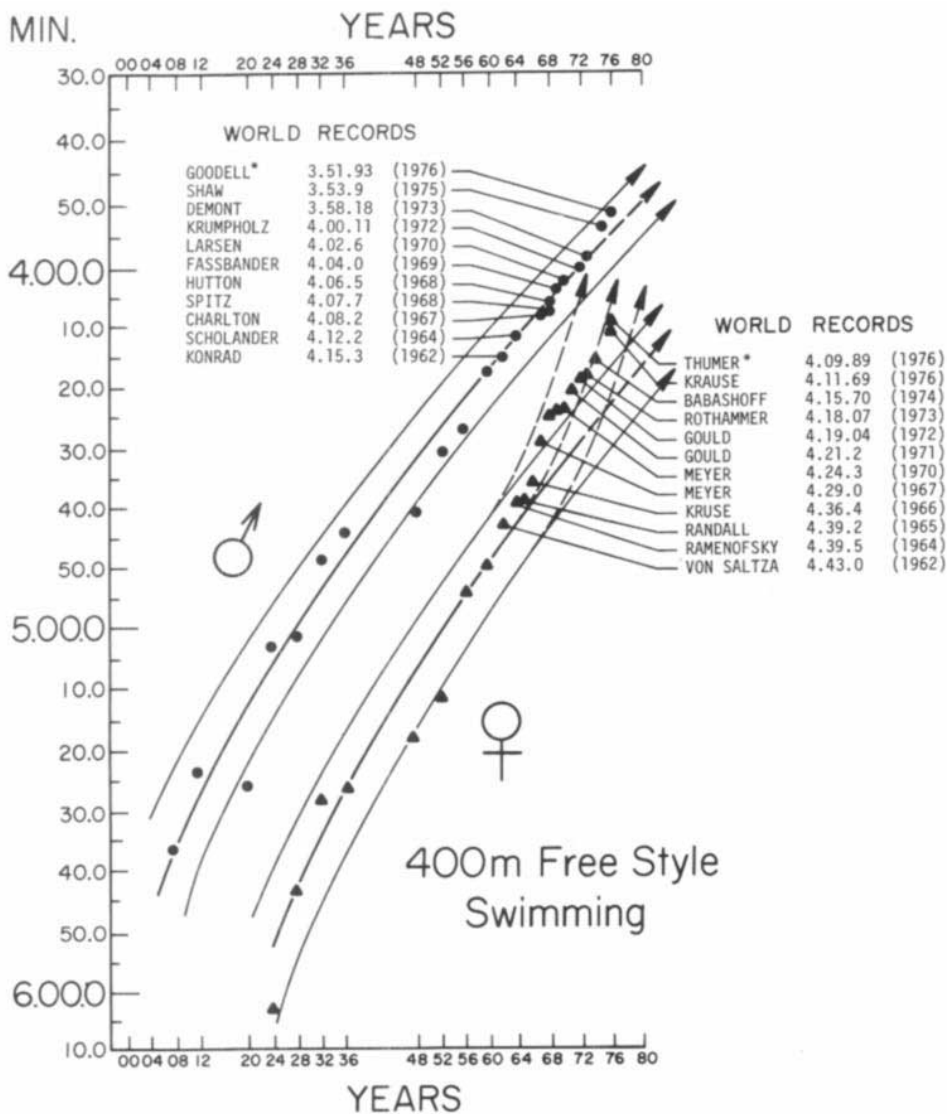
FIG. 4

**Comparison of Men's and Women's World Records in Swimming (100 m - 1500 m)  
June 1976  
Double Logarithmic Scales**



**Comparison of Men's and Women's World Records in Running (100 m - 42200 m)  
June 1976  
Double Logarithmic Scales**





\* Montreal 1976

FIG. 8

**Percentage Values of Maximal Velocities of Men and Women  
in Running (100 m - 42 200 m), Computed from World Records  
June 1976  
100 m World Record = 100% Maximal Velocity**

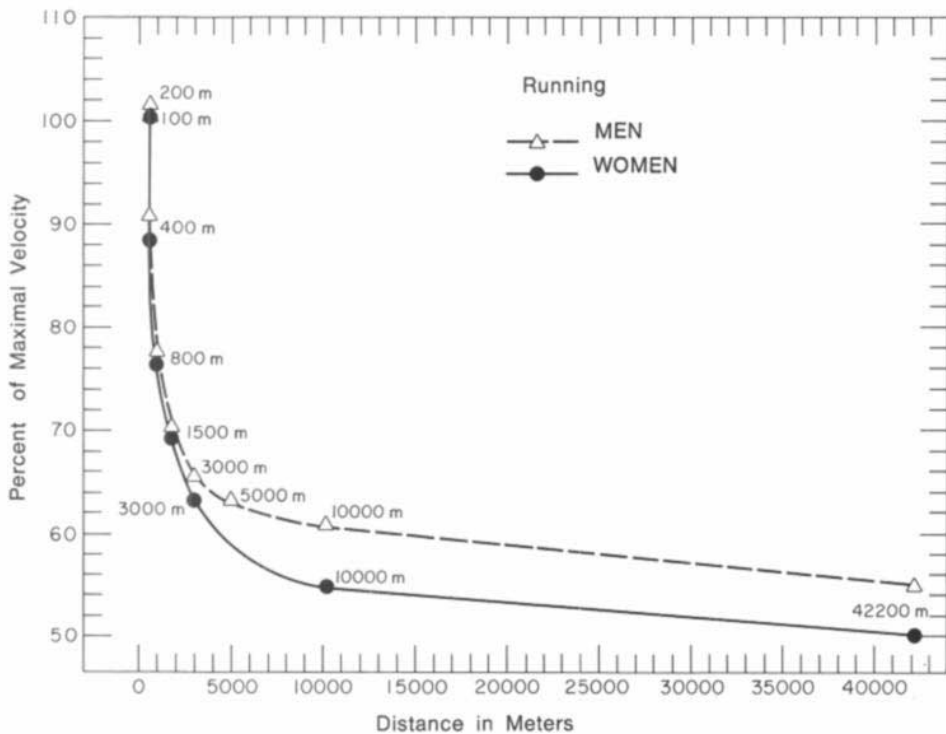


FIG. 7

the men's races at Olympic Games prior to 1972. It will soon be further improved. As regards running performances today we refer to Jackie Hensen's 1975 marathon WR of 2: 38.10 which would have sufficed to beat Olympic Gold Medallists Spiridon Louis (Athens 1896), Michel Theato (Paris 1900), John Hayes (London 1908), Kenneth MacArthur (Stockholm 1912), and Albin Stenroos (Paris 1924).

Most WRs are likely to be improved but at different rates. In a few athletic disciplines, e.g. the long jump, the limits of records seem to have been reached; in others, e.g. the sprints, their outlines are in sight; while some sports, e.g. swimming, are still in statu nascendi and an estimate of records is as yet not possible.

E. & P. J.

