CLINICAL HEMORHEOLOGY, Vol. 1, pp. 117-119, 1981
0271-5198/81/020117-03$02.00/0 Printed in the USA.

EDITORIAL

THE MEANING OF THE TERMS RHEOLOGY, BIORHEOLOGY AND HEMORHEOLOGY

Alfred L. Copley and Geoffrey V.F. Seaman

The term 'rheology' was coined by Eugene C. Bingham and formally adopted and defined at the Foundation Meeting of the (American) Society of Rheology in 1929 in Washington, D.C., USA as "the study of the deformation and flow of matter" (1). This definition was modified by Markus Reiner and George W. Scott Blair in 1967 (2) as a result of Reiner pointing out that the original definition was tautologous. Rheology was thus defined as "the study of the deformation of materials, including flow".

It should be noted that the literal meaning of the term rheology from the Greek root rheo: flow is the science of flow which does not emphasize deformation. The use of this restricted definition would not encompass a large area of the generally accepted term of rheology.

In 1948 at the First International Congress on Rheology, held at Scheveningen, The Netherlands, A.L. Copley introduced the term 'biorheology' for the study of rheological problems in biology (3-5). Biorheology is the science of the deformation behavior including flow of materials in a biological context. Biorheology is concerned with the study of processes in the living organism (in vivo) and with materials of biological significance originating from the organism (extracorporeal), as well as with materials of non-biological origin, employed in a biological system or setting. The interrelationship is stressed between rheological properties of biological systems and their various structural aspects. However, studies on substances of biological origin which belong exclusively to technology are not included. For example, the rheological pro-

perties of hydrocarbons from coal tar would not be per se within the purview of biorheology.

The term 'hemorheology' was introduced in 1951 by A.L. Copley in a survey on the rheology of blood before the Society of Rheology at the Twenty-Fifth Anniversary Meeting of the American Institute of Physics, held in Chicago, Illinois, USA. Hemorheology was defined by Copley as 'the study of the deformation and flow (i.e., rheological) properties of cellular and plasmatic components of blood in macroscopic, microscopic and submicroscopic dimensions and the rheological properties of vessel structure with which blood comes into direct contact' (6,7). Blood together with the blood vessels, in which it is contained, can be considered as an organ which, unlike any other organ, is ubiquitous. This very special organ has many different functions including those pertaining to the exchanges between the blood and the tissues. Thus, hemorheology is that branch of the science of biorheology which deals with the flow properties of blood and of the structures with which blood or its components come into direct contact, i.e., the vessel wall and the surrounding tissues and spaces.

Occasionally, a more restricted use of the term hemorheology than that given above is employed to mean solely the rheology of blood. This use appears to stem from a literal translation of the Greek origin of this synthetic word. However, the proponents of this restricted view of hemorheology should appreciate that the synthetic word rheology does not only mean its literal and rigid translation from the Greek, viz., the science of flow of matter, but rather, as mentioned above, the science of deformation of matter including flow. In this broader context, blood is not an isolated material, but one which interacts functionally and structurally with the system of which it is a part, viz., vessel structures with which blood or its components come into direct contact. This definition of hemorheology is contained in the Aims and Editorial Policy of CLINICAL HEMORHEOLOGY. Similarly, for instance, the term 'hemodynamics' is not limited to the dynamics of blood as one may assume by the literal translation of this term, but rather it is generally accepted to refer as well to the shape, size, diameter and length of the vessel in which the blood is contained.

Hemorheology, in summary, is the study of the deformation behavior including flow of blood and those materials of the blood vessels and surrounding tissues with which blood or its components come into direct contact. Additionally, it is also the study of the interaction of blood or its components and the vascular system with added foreign materials, such as drugs, plasma expanders, or prosthetic devices. Thus, hemorheology is the study of how the blood and the blood vessels can function and interact as parts of the living organism.

REFERENCES

1. SCOTT BLAIR, G.W. Elementary Rheology. London and New York: Academic Press, 1969, 170 pp.

2. REINER, M. and SCOTT BLAIR, G.W. Rheological terminology. In: Rheology. Theory and Applications. F.R. Eirich (Ed.). New York - London: Academic Press, 1967, Vol. IV., pp. 461-488.

3. COPLEY, A.L. Rheological problems in biology. In: Proceedings of the International Congress on Rheology, Holland, 1948. J.M. Burgers et al (Eds.). Amsterdam, North-Holland Publishing Co., 1949, Part I-47 to I-61; Part III-8 to III-11.

4. SCOTT BLAIR, G.W. An Introduction to Biorheology. Amsterdam, Oxford and New York: Elsevier Scient. Publ. Co., 1974, 222 pp.

5. COPLEY, A.L. Biorheology: Past, present and future (Biorhéologie: Passé, présent, futur). J. Biophys. et Méd. Nucl., 4, 125-132, 1980.

6. COPLEY, A.L. The rheology of blood. A survey. J. Colloid Sc., 7, 323-333, 1952.

7. SCOTT BLAIR, G.W. Hemorheology and the physicist. In: Hemorheology. Proceedings of the First International Conference. The University of Iceland, Reykjavik 10. - 16. July 1966. A.L. Copley (Ed.). Oxford - New York: Pergamon Press, 1968, pp. 21-24.

Alfred L. Copley

Laboratory of Biorheology
Polytechnic Institute of
New York
Brooklyn, NY 11201
USA

Geoffrey V.F. Seaman

Department of Neurology
University of Oregon
Health Sciences Center
Portland, OR 97201
USA

New York City and Portland
January 1981