pressures of 10^{-2}–10^{-4} mm. can be measured with as much precision as those of 10–100 mm. Direct measures of the equilibrium swelling or the total heat of mixing are difficult with 'hard' plastics, such as polyvinyl chloride, as equilibria are reached very slowly.

For the above reasons, it has been necessary to develop indirect methods of estimating ΔH, and even so, only relative results can be obtained. One method relies on the assumption that the polymer-plasticizer heat of mixing is proportional to the corresponding monomer-plasticizer heat effect. This is a pure assumption, though a reasonable working one, and can perhaps be checked later by heat of dilution measurements on a low polymer. The problem then becomes a measurement of the mixing heats between plasticizer and monomer, which is feasible experimentally; with vinyl polymers, the saturated monomer is preferred to avoid double-bond complications, for example, ethyl benzene for polystyrene. A second method uses the concentration variation (c) of the specific viscosity ($\eta_{sp.}$) of dilute solutions of polymers as a measure of ΔH. Alfrey, Bartovics and Mark[12] found that, for a given polymer, both the limiting value of $\eta_{sp.}/c$ at zero concentration and the slope of the $\eta_{sp.}/c - c$ line were dependent on the solvent; 'good' solvents increased both the slope and the intercept, whereas 'bad' ones depressed them. The concept of 'good' and 'bad' solvents can be formulated thermodynamically and a semi-quantitative treatment of the viscosity effects has been developed[13]. It is not often possible to measure dilute solution viscosities in pure plasticizers; to get over this difficulty, the polymer is dissolved in a mixture of 'indifferent' solvent ($\Delta H = 0$) and plasticizer. The slopes of the $\eta_{sp.}/c - c$ lines vary with the plasticizer used in the solvent mixture and are in agreement with their known plasticizing properties with a given polymer. Though the theory of the effect is admittedly not complete, the method is probably the most convenient one for estimating relative interactions. The light scattering of polymer solutions[14] is a possible means by which interactions might be studied in the future, but the technique is still in its infancy; the published results suggest a strong dependence of the effect on solvent type.

So far, discussion has been confined to polymers which are completely amorphous. For crystalline bodies, the total free energy change for the solution process can be split into two stages: (1) melting of the crystals to give an amorphous polymer ($\Delta G_{melt.}$); (2) mixing of the amorphous polymer with the plasticizer ($\Delta G_{mix.}$). For amorphous polymers, (2) is the only relevant process and the factors governing $\Delta G_{mix.}$ have already been discussed. If the melting range of the crystalline polymer is above room temperature, then $\Delta G_{melt.}$ will be positive; its magnitude will depend on the interval between room temperature and this range. For a high-melting polymer $\Delta G_{melt.}$ can become larger than $\Delta G_{mix.}$ for most solvents, in which case the crystals will be completely insoluble at low temperatures, as the total free energy change is positive. For this reason, crystalline polyethylene is insoluble in nearly all solvents at room temperature. As the temperature is raised, the melting range is reached in which there is an appreciable proportion of amorphous material in thermodynamic equilibrium with the crystalline regions[15]; this amorphous polymer is miscible with solvents, and the rapid increase in polyethylene solubility in nearly all solvents at about 70° C. is due to the operation of this factor. In such circumstances, a plasticizer will tend to dissolve in the amorphous regions and leave the crystalline ones untouched; only a strong relative attraction ($\Delta H < 0$) between plasticizer and polymer link will cause the crystalline regions to dissolve.

In the foregoing paragraphs, an attempt has been made to give the thermodynamic background of the polymer-plasticizer compatibility problem. Such an approach does not give any information at all about the relative plasticizing efficiency of two compatible substances—this is not surprising as it forms a completely unrelated problem. The efficiency of a plasticizer is now suspected to be almost completely determined by the size and shape of its molecule, but a large amount of accurate data is required before this problem can be pursued further.

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OBITUARIES

Dr. D. S. Raitt

THE tragic death of Douglas Raitt as the result of a motor accident on October 4, 1944, at the early age of forty-one, will be deeply regretted not only by marine biologists but also by the general public, for apart from his scientific attainments, he had wide cultural interests and was recognized as a successful broadcaster and as a composer of Scottish songs. In particular, fishery research has lost a most promising worker, who had a brilliant career before him.

Born in Aberdeen on January 18, 1903, Raitt was educated at Robert Gordon's College there and at the University of Aberdeen. In the University he came under the influence of Prof. J. Arthur Thomson, who undoubtedly did much to foster in him originality, precision in workmanship and a philosophic outlook on life. Immediately after graduating B.Sc. in 1926, he was appointed a probationer naturalist on the scientific staff of the Fishery Board for Scotland, being placed on the established grade two years later.

With the resumption of fishery research after the War of 1914–18, the study of haddock in all its aspects was delegated to Scotland by the International Council for the Exploration of the Sea, and Raitt joined the Scottish team of workers so ably led by Dr. A. Bowman, then scientific superintendent. His first contribution to the series of publications was on the fertility of the haddock. After the transference to Newfoundland of Dr. Harold Thompson, who had carried out brilliantly the survey of the haddock material and laid the foundation of the work, Dr. Raitt was given the task of continuing the research and producing forecasts of the future yield of the stocks, largely for the benefit of the fishermen and the trade. This led to the appearance of a series

of valuable papers published by the International Council and by the Fishery Board for Scotland (now the Fisheries Division, Scottish Home Department), two of the most important being "The Haddock Stocks of the North-East Atlantic" and "The Rate of Mortality in the North Sea Haddock Stocks"—the latter a definite contribution to the overfishing problem. These researches gained for him the D.Sc. in 1937. In 1939 he was appointed Buckland lecturer for 1940 to deliver a series of lectures on the haddock, but owing to the outbreak of war the lectures were never delivered.

Raitt was a fellow of the Linnean Society and of the Royal Society of Edinburgh and published papers on various aspects of marine life in different scientific journals. In one of these he described a new species of sandeel from British waters—no mean achievement these days.

He had a great gift for organizing and staging shows and was largely responsible for two fishery exhibits put up by the Fishery Board for Scotland at Aberdeen and Glasgow, which were designed to illustrate the practical aspect of marine research as carried out by a Government department. The film "Sea Food", a record of the methods carried out at sea by the research vessels and in the laboratory, was also supervised by him.

During the present War, he was seconded to the Ministry of Home Security and held important posts under the district commissioners at Inverness, Edinburgh and Dundee.

He is survived by Mrs. Raitt and two sons.

R. S. CLARK.

Prof. Gustav Cassel

PROF. GUSTAV CASSEL, whose death at the age of seventy-eight occurred on January 14, was beyond doubt one of the outstanding figures in economic science during the inter-war period. His authority was second only to that of Lord Keynes, and his advice was eagerly sought on many occasions by his own Government and by foreign Governments. He played an active part at many international monetary conferences during the 'twenties and early 'thirties, and was head of the Swedish delegation to the World Economic Conference of 1933.

Prof. Cassel occupied the chair of economics at the University of Stockholm, and his "Theory of Social Economy" will always rank with the outstanding works on economic theory. First and foremost, however, he was a monetary specialist. His most important contributions to economic science were in the monetary sphere. In particular, he secured his place in posterity as the leading theoretical expert on foreign exchange during the chaotic period that followed the War of 1914–18. In his "Money and Foreign Exchange After 1914", he put forward the theory that under a system of inconvertible paper currencies the exchange-rates tend to represent the ratio between the internal price levels of the countries concerned; in other words, they tend to adjust themselves towards what he called their "purchasing power parities". When he first sought to popularize this conception, it was regarded as almost revolutionary, and the time-honoured theory according to which exchange-rates are determined by the trade balance died hard. He lived to see, however, the general acceptance of his principle.

In the sphere of monetary policy, Cassel was strongly opposed to deflation, and advocated low interest-rates during the late 'twenties and early 'thirties. As a member of the Gold Committee of the League of Nations, and in his various writings, he was concerned by the inadequacy of the volume of monetary gold to meet the requirements of expanding world production and trade. In 1937, however, Prof. Cassel, together with many other theoretical and practical experts, was misled by an apparent excess of gold supplies into a panicky advocacy of a deflationary policy.

Prof. Cassel did not believe in the device, so popular among many economists, of seeking to impress his readers by indulging in obscurantism. His books and articles were written for the most part in simple, clear language, understandable to the intelligent layman at the same time as being inspiring to the expert.

P. EINZIG.

Mr. E. Rothbart

ERWIN ROTHBART, acting lecturer in economic statistics in the University of Cambridge, who was killed in action in Holland in December 1944, aged thirty-one, was a refugee from Nazi Germany and an expert in economic theory and statistics; he specialized in the theory of industrial fluctuations and economic development.

Despite his originality, he had published little: his reticence and his horror of superficiality were such that his best work is probably to be found in the mass of unpublished manuscripts which he left. Some of these may be rescued for publication, but undoubtedly the more subtle of his ideas were still locked away in his mind. The quality of his thought was revealed in the penetrating book-reviews which he contributed to the *Economic Journal*, and in the formal and informal discussions on economic theory in which he took part with the younger economists at Cambridge and London.

Rothbart first became prominent in discussions in 1936 at the meetings held regularly by Profs. Robbins and Hayek at the London School of Economics. There, with A. P. Lerner, O. Lange, N. Keldor and M. Kalecki, he found himself one of a small group championing the latest theories of J. M. Keynes with an almost religious insistence. Two years later he was appointed research assistant in economic statistics at Cambridge, and in 1940 he took over the teaching of economic statistics, and continued it until he insisted on joining the Army.

Rothbart was a fine example of that combination of opposites, which is the rule rather than the exception in the workings of the human mind. Quick in thought, he was slow in action and self-expression. A self-taught mathematician, he delighted in the subtler turns of economic theory; yet his awareness of practical and political realities was no less acute. A lover of liberal values, his political sympathies were nearer to the hard discipline of the communists: with an impish love of life, he combined a recklessness that courted death. He leaves a widow and young son.

D. G. CHAMPERNOWNE.

WE regret to announce the following deaths:

Dr. Alexander Duckham, chairman and governing director of Alexander Duckham and Co., Ltd., lubrication technologists, on February 1, aged sixty-seven.

Prof. S. H. Gage, since 1908 emeritus professor of histology and embryology at Cornell University, on October 20, aged ninety-three.