gram). An energetic coupling between the partners must necessarily be assumed, since for succinic and terephthalic acids even relatively long wave-lengths in the first absorption maximum (at 360 m μ) of the acridinic cation are photo-active for this process. This reversible photo-reaction cannot be duplicated by the application of heat.

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¹ Terenin, A., *Acta Phys. Chim. U.R.S.S.*, **12**, 617 (1940) ; **13**, 1 (1940) ; **14**, 566 (1941).

Derivatives of Pectic Acid as Models of Proteins

THE constitution and properties of pectic substances have been intensively studied¹. Pectins, when reacting with the bifunctional formaldehyde under acidic conditions, have been found to form three-dimensional networks. This process takes place much more slowly than the corresponding reaction with polysaccharides containing primary hydroxyl groups (for example, lichenin). An accelerated reaction of pectic substances with formaldehyde may be obtained by using the mono-glycol ester of pectic acid (I) instead of the natural methyl ester. The glycol ester is easily produced² by treating pectic acid with ethylene oxide. A greater reactivity with formaldehyde, even under neutral conditions, would be expected upon the introduction of primary amino-groups into the pectic acid molecule.

Carson³ described a simple method for the preparation of *n*-alkyl-amides of pectic acid by the reaction of their methyl esters with primary aliphatic amines. We have studied similar reactions with aliphatic diamines. Thus an amide of the following structure (II) was prepared by the action of ethylenediamine on the glycol ester of pectic acid (totally esterified) :

A complete conversion of ester to amide groups produces bases of high molecular weight, every link of the chain molecule carrying a branch with a primary amino-group at its end. The aqueous solution of this macromolecular substance is found to produce a gel easily when formaldehyde is added. These bases form insoluble salts with high molecular weight acids. Similar to the polyethylenimines⁴, these ethylene-diamine derivatives of pectic acid precipitate pectic acid itself.

If the conversion of ester to amide groups is incomplete, or if the amides formed undergo a partial hydrolysis, derivatives of pectic acid with a structure similar to that described above but containing a certain percentage of free carboxyl groups are obtained. In this case every chain molecule carries acidic carboxyl as well as basic amino-groups. These macromolecules possess a dipolar ionic structure, and in many respects show properties similar to those of proteins; for example, coagulation or minimum viscosity at the isoelectric point. Water-insoluble substances of this type can be rendered soluble by the addition of acid, alkali or even neutral salts. In order to characterize these ampholytes, the methods of protein chemistry have proved to be suitable (Van Slyke method, Sørensen titration, etc.).

Ampholytes with any desired proportion of carboxyl- to amino-groups, as well as ampholytes of different size, can be produced from esters of polyuronic acids. It should be possible to relate their properties (solubility, viscosity, electrochemical and optical behaviour, etc.) to the fairly well-established structure of these macromolecules, whereas with proteins such a correlation encounters, for the time being, much greater difficulties.

Further investigations are in progress.

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¹ Summary in Hirst and Jones, "Adv. Carbohydrate Chem.", **2**, 235 (1946). Pallmann and Deuel, *Chimia*, **1**, 27 and 51 (1947).

² Deuel, *Experientia*, **3**, No. 4 (1947).

³ Carson, *J. Amer. Chem. Soc.*, **68**, 2723 (1946).

⁴ Kern and Brenneisen, *J. prakt. Chem.*, (2), **159**, 193 (1941).

Detection of End Groups in Polymer Molecules

THE radical theory of vinyl polymerization is confirmed by the identification of so-called catalyst fragments in the polymer molecule. The usual method is to purify the polymer by repeated reprecipitation and to use a catalyst containing an easily identifiable element. Thus when tribromobenzoyl peroxide has been used as the catalyst and the molecular weight of the product is not too high, it is possible to identify bromine in the polymer after repeated purification¹.

A method has now been found by which the presence of an end group in styrene polymerized with sodium sulphite² is readily demonstrated irrespective of the molecular weight and without any special purification of the polymer. The radical in