CCXVIII.—*The Relationship between the Optical Rotatory Powers and the Relative Configurations of Optically Active Compounds. Part III.*

By GEORGE WILLIAM CLOUGH.

THE researches of Hudson, Levene, Freudenberg, and others have established the fact that the relative configurations of some optically active compounds may be determined by measuring the optical rotatory powers of the compounds in question or those of derivatives from them. An analysis of the optical rotatory powers of a number of derivatives from the optically active α-hydroxy-, α-amino-, and α-halogeno-acids led the present author to the view that those optically active derivatives from succinic acid commonly designated *l*-malic acid, *l*-aspartic acid, *d*-chlorosuccinic acid, and *d*-bromosuccinic acid possess the same configuration as *l*-tartaric acid. Similar deductions were made concerning the configurations of the optically active α-hydroxy-, α-amino-, α-chloro-, and α-bromo-derivatives of propionic and other acids (J., 1918, **113**, 526). Whilst the configurative relations of *d*-(" *l* ")-alanine, *l*-aspartic acid, *d*-(" *l* ")-lactic acid, and *l*-malic acid have since received confirmation by the comprehensive investigations of Freudenberg and his collaborators, further evidence has not hitherto been forthcoming in support of the above conclusion regarding the configurations of the optically active α-halogeno-acids.

It was therefore desirable that the optical rotatory powers of these compounds should be examined from a different point of view from that previously chosen by the author. The measurement of the optical rotatory dispersive powers of a large number of derivatives from optically active secondary alcohols resulted in Pickard and Kenyon's important discovery that the rotation values of many of these compounds could be recorded on one and the same " characteristic diagram." Patterson and Fulton have pointed out a direct consequence of this harmony, namely, that the difference between the rotation values for two colours of light is directly proportional to either value, if calculated from the point of intersection for these colours. This point of intersection is called the " rational zero " and the ratio of the optical rotatory powers (calculated from the rational zero) for the two colours is termed the " rational dispersion coefficient " (J., 1916, **109**, 1184; 1925, **127**, 2435). The component lines of a characteristic diagram are not always straight, nor do the rotation values when measured under different conditions always fall on the lines of the diagram. It is not always possible, therefore, to assign one constant rational zero (for two given colours of light) to the optical rotatory powers of derivatives from the same optically active compound. Moreover, it is not to be expected that the rational coefficients of optical rotatory dispersive power will be quite constant for all the derivatives from a given compound. Although this mode of treatment will frequently be of great service in correlating the optical rotatory powers of many derivatives from a given compound, it is evident that it will not be of universal application, for Fischer and Brauns effected the transformation of *d*-*iso*propylmalonamic acid into its optical antipode by reactions which resulted in the interchange of the carboxyl and amido-groups (*Sitzungsber. K. Akad. Wiss. Berlin*, 1914, 714). The rational zeros of these enantiomorphous forms would, of course, be numerically equal but opposite in sign, unless they were identical with the absolute zero.

That the configuratively related compounds methyl *d*-("*l*")-lactate, *d*-("*l*")-alanine, methyl *l*-malate, *l*-aspartic acid, and *l*-asparagine (each containing four chemically dissimilar groups attached to one asymmetric carbon atom) would exhibit approximately the same rational zero and approximately constant coefficients of optical rotatory dispersive power was an expectation which has been experimentally realised. In Table I are recorded the ordinary and the rational coefficients of optical rotatory dispersive power for the wave-lengths Na 5893 and Hg 5461. The mean value for the rational coefficients (calculated from the rational zero — 2·5°) is 0·844.

TABLE I.

Compound.	Solvent.	t.	$[\alpha]_D$.	$[\alpha]_{gr}$.	$\frac{[\alpha]_D}{[\alpha]_{gr}}$.	$\frac{[\alpha]_D+2·5°}{[\alpha]_{gr}+2·5°}$.
Methyl *d*-lactate.	None.	20°	— 8·26°	— 9·36°	0·882	0·840
d-Alanine.	Hydrochloric acid (p = 5·6).	15	+14·7	+17·8	0·826	0·847
Methyl *l*-malate.	None.	15	— 6·80	— 7·62	0·892	0·840
l-Aspartic acid.	*N*-Hydrochloric acid (p = 7·98).	20	+25·5	+30·5	0·836	0·848
	0·2*N*-Sodium hydroxide (p = 2·58).	18	—15·8	—18·2	0·868	0·847
l-Asparagine.	*N*-Hydrochloric acid (p = 8·94).	24	+28·0	+33·7	0·831	0·843
	N-Sodium hydroxide (p = 12·44).	25	— 8·8	—10·0	0·880	0·840

The rational coefficients of optical rotatory dispersive power of *d*-chlorosuccinic acid and of *d*-bromosuccinic acid have been calculated on the assumption that the rational zero is approximately either — 2·5° or + 2·5°. The results embodied in Table II show that the mean value of the rational coefficients in the solvents chosen is 0·840 when the rational zero is assumed to be − 2·5°. This value is not far removed from the mean value (0·844) obtained for the compounds mentioned in Table I. Similarly, *d*-α-bromo-β-phenylpropionic acid appears to exhibit a negative rational zero of the same order of magnitude. The values given for this compound are deduced from the measurements of Senter, Drew, and Martin, who, however, made no claim that the acid they examined was quite free from the dextrorotatory isomeride (J., 1918, **113**, 158).

TABLE II.

Compound.	Solvent.	*t*.	$[\alpha]_D$.	$[\alpha]_{gr}$.	$\frac{[\alpha]_D - 2{\cdot}5^\circ}{[\alpha]_{gr} - 2{\cdot}5^\circ}$.	$\frac{[\alpha]_D + 2{\cdot}5^\circ}{[\alpha]_{gr} + 2{\cdot}5^\circ}$.
d-Chlorosuccinic acid.	Water (p = 9·35).	15°	+20·3°	24·7°	0·802	0·838
d-Bromosuccinic acid.	Water (c = 5·0).	15	+41·9	50·5	0·821	0·838
d-Bromosuccinic acid.	Sodium hydroxide; Aq., 2 mols. (c = 4).	15	+43·1	51·5	0·829	0·844
d-α-Bromo-β-phenylpropionic acid.	None.	17	+10·2	12·9	0·740	0·825

Evidently the optical rotatory dispersive powers of *d*-chlorosuccinic acid, *d*-bromosuccinic acid, and *d*-α-bromo-β-phenylpropionic acid are more closely related to those of the "*l*"-series of α-amino-acids and α-hydroxy-acids than to those of the "*d*"-series of these classes of compounds. The conclusion is therefore drawn that the above dextrorotatory α-halogeno-acids possess the same relative configurations as the "*l*"-α-amino-acids and the "*l*"-α-hydroxy-acids.

The influence of a rise of temperature from 15° to 40° on the optical rotatory power of *l*-chlorosuccinic acid in aqueous solution is similar to that on the rotatory power of *l*-α-bromo-β-phenylpropionic acid in the homogeneous state (Senter, Drew, and Martin, *loc. cit.*; see Part I, p. 544).

l-*Chlorosuccinic acid* in water,

$p = 3{\cdot}7$; $[\alpha]_D^{20^\circ} - 21{\cdot}0^\circ$, $[\alpha]_D^{42^\circ} - 23{\cdot}2^\circ$.

$p = 9{\cdot}3$; $[\alpha]_D^{15^\circ} - 20{\cdot}3^\circ$, $[\alpha]_D^{27^\circ} - 22{\cdot}1^\circ$, $[\alpha]_D^{40^\circ} - 23{\cdot}6^\circ$.

$p = 18{\cdot}9$; $[\alpha]_D^{20^\circ} - 22{\cdot}3^\circ$, $[\alpha]_D^{26^\circ} - 23{\cdot}2^\circ$, $[\alpha]_D^{32^\circ} - 23{\cdot}7^\circ$, $[\alpha]_D^{40^\circ} - 24{\cdot}5^\circ$.

The author's thanks are due to the Government Grant Committee of the Royal Society for a grant in aid of this investigation.

ROYAL VETERINARY COLLEGE,
LONDON, N.W. 1.

[*Received, March 2nd,* 1926.]