D R. E V E R I N G H A M ' S C A R B O G R A M S

Dr. Douglas Nixon Everingham of Sydney has devoted much time to the problem of an inter-linguistic symbolism and this interest brought him into contact with Bliss. It is interesting to note that both Everingham and Bliss have been stimulated by the symbolism of chemistry. However, Everingham went one step further and realising the difficulties in presenting complex organic formulae, evolved a system of much simpler symbols, which forms a new "shorthand" for organic chemical formulae. When a student at the University of Sydney he published the attached pamphlet titled "Chemical Shorthand for Organic Formulae". In view of the fact that this new symbolism could be a valuable addition to Semantography, this pamphlet has been incorporated in the Semantography Series. Dr. Everingham has in mind to enlarge upon this idea in a brochure to be published at a later date.

CHEMICAL SHORTHAND

FOR ORGANIC FORMULAE

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D. EVERINGHAM.

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 1943.

MY THANKS ARE DUE TO -

Mr. Lionel K. Murphy, of final year Science,

Mr. G. K. Hughes, lecturer in Organic Chemistry,
and others who made valuable suggestions and criticisms.

Dr. H. S. H. Wardlaw, for the 'lead' he supplied in his Biochemistry lectures, explaining the structural classification of d - and l - sugars by means of a scheme of "skeleton" formulae;

and

Mr. T. Stanley Summerhayes, whose new era in SHORTERhand helped to convince me that this system, with some extensions as yet unpublished, could be evolved.

CORRESPONDENCE.

Any criticisms, or suggestions for the application or extension of this system, or for the development of similar ideas, will be most welcome.

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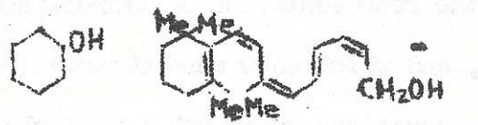
For laboratory or academic notes, organic formulae are perhaps most conveniently represented at present by the relatively compact "rational" system. This, however, must be replaced to some extent from time to time by "graphical" formulae, which allow the representation of stereo-isomerism and H-bridge formation, and which show more clearly the relations of compounds in equations or in schemes of classification by structure. The system described below embodies the advantages of these two systems, and has added clarity, brevity and compactness.

For a resonance hybrid, of course, it ordinarily represents only one or other of the arbitrarily selected "unperturbed forms"; there is no modification of the conventional structures. The "shorthand" system starts with the assumption of the invariable tetravalent C, monovalent H, divalent O, and trivalent N atoms, and is applicable to any of the known organic formulae. It is in effect an abbreviated "graphic" system, but because it rarely requires the use of letters as symbols it practically eliminates confusion and failure to recognise compounds when formulae are set out in alternative forms or new orientations to demonstrate different types of reaction (see for example Pinene and Atropine, p. 9A). I have found that these formulae are most readily recalled to mind in their spatial forms, even when no effort is made to memorise them, as well as being more easily recognised in new surroundings. All valency bonds are represented and it is by their characteristic pattern that the molecule is identified. The eye trained to this method picks out molecular structure in terms of valency bonds, automatically identifying the constituent atoms and

radicles as with the "rational" system. This is in many ways preferable to the placing of letters and numbers in an arbitrary pattern, essentially remote from any actual notion of atomic relations, and read only with difficulty if the formula is turned around (in part or whole).



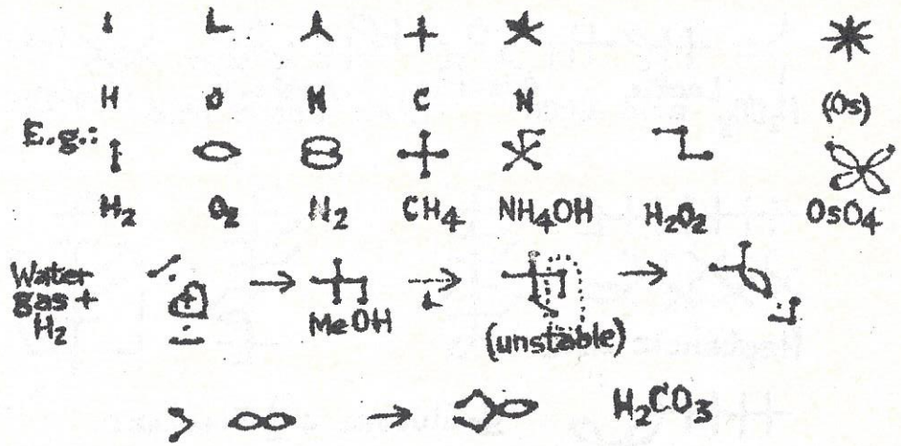
Phenol Vitamin A

A method of "graphic" abbreviation commonly recognised at present is illustrated here. It is limited, however, to compounds with at least three C atoms, and containing only C and H. in in the abbreviated portions. It shows only two of the valency bonds of each C atom; or three of which two are nearly superimposed. Terminal C. atoms must be represented in letters. The "shorthand" system represents all atoms in such structures and shows the relations of valency bonds more accurately (cf. PhOH and Vitamin A, p. 9 A.C)

Below are the valencies and the elements exhibiting them in organic work commonly:

		−		+				
1	2	3	4	5	6	7	8	0
H	O	N	C	N		(Cl)	(Os)	
+') unit								
−') chge.	S	P	S	P	S			

Taking the upper line first (C, H, O, N): if we abbreviate these symbols as far as possible we will have a dot. Is this sufficient to preserve their identity? Yes, if we signify the links between the dots by single lines --- the atom will then be recognised at once by its valency.

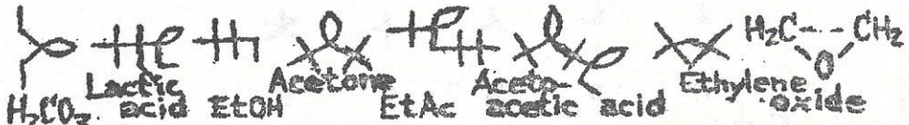


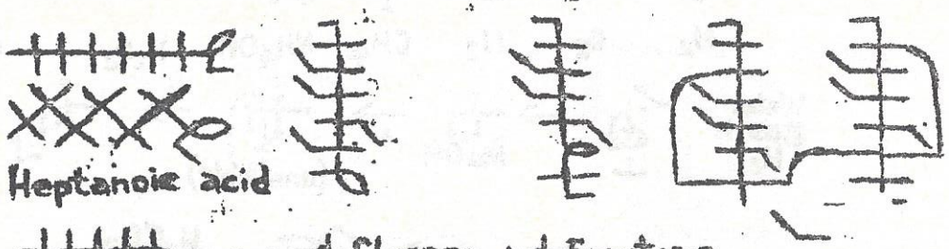
The approximate right angle shown between the two valency lines of the O atom simulates the actual obtuse angle between the axes of its bonds. The "+5 valency" of N is most conveniently shown as two lines crossing almost at right angles with the fifth valency jutting out between them. Three or four valency lines meeting however, should as a rule make nearly equal angles, curving them if necessary, to preserve the identity of the atoms clearly (see Purin and HCN - HNC p. 9B later.) An obvious exception will be found in the "perspective" ring type of formula (see α-d-glucose p. 9)

From the few line formulae shown with this convention we see that:

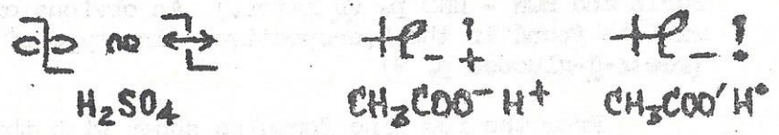
- Where four lines meet at a point there is a C atom, (two lines crossing)
- At all free ends of lines there is a H atom; (if no other letters or signs are given.)
- At all free 'angles' an O atom (two lines only meeting)
- Where either three or five lines meet a N atom;

and the lines present can tell us this without the need for drawing the dot itself;



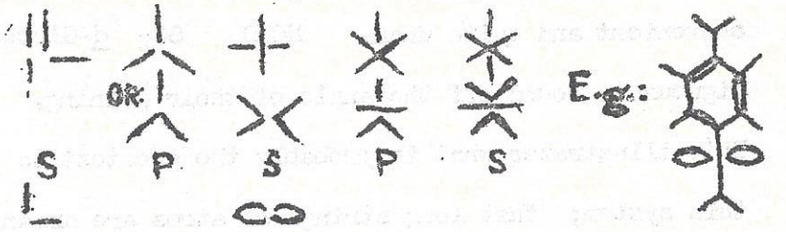


If use is made of the co-ordinate valency sign (→), it should be counted for the identification of the atoms concerned as equivalent to two lines; and in representing ions the atom which has received or given up electrons should be represented as bearing the charge at the end of a short valency line:



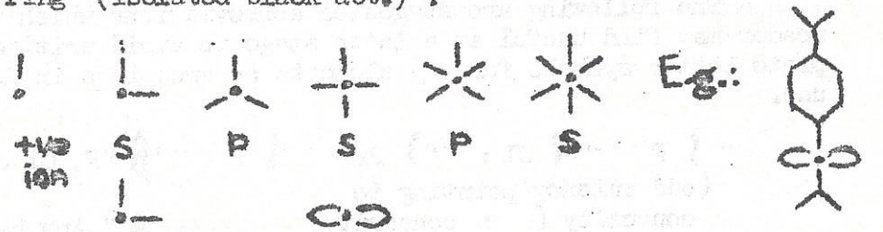
Now if we use a different kind of dot, we can simultaneously apply the same principles to distinguish S and P (for S has always even valencies, P always odd.) We may make use of this second kind of dot in the monovalent position to indicate an unused valency (positive charge). We have two or

three alternatives for this second kind of dot. The simplest is a "white dot" --- i.e. some or all of the valency lines are cut short before they reach the point of concurrence:



H_2S SO_2 Sulphanilamide

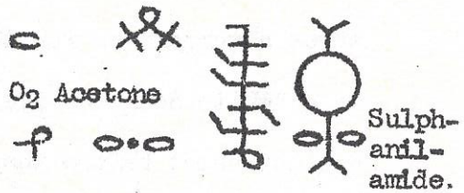
Perhaps the best alternative for one who is as yet not quite familiar with this valency symbolism is a "white ring" (isolated black dot.) :



H_2S SO_2 Sulphanilamide

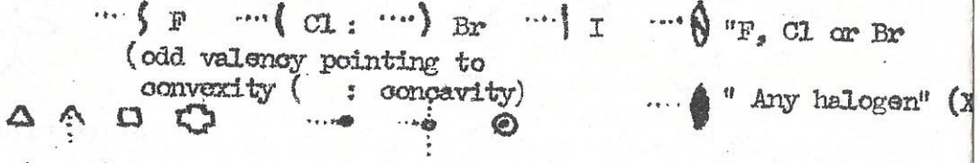
This will evidently come most naturally to anyone used to graphic formulae, which similarly have all valency lines interrupted at each atom; but the previous method is quicker, and eventually clearer.

Where two valencies of a double bond are not joined by any other bond, it is convenient and quite unambiguous to round off the angle of their joining.



This illustrates what is probably the greatest saving in this system; that long strings of atoms are drawn (and remembered in one stroke as a group or "backbone". (See Heptanoic acid, illustrating an aliphatic chain; Quinine, analysed to show this saving; and Haem, P. 10, with its striking pattern of side-chain groupings.).

The following are suggested abbreviations which the reader may find useful at a later stage to avoid writing complete letter symbols for any elements or groupings in frequent use.



etc., for any special work with certain uncommon elements or radicles.

As a further abbreviation for the (benzene) hexagon the Greek ϕ (Ph) is sometimes used. In the present system a large circle is permissible, the side-chains being attached

without showing the adjacent H atoms (as in Sulphanilamide on p. 6). Five-membered homocyclic rings may be abbreviated only if shown as the conventional pentagon or like a Gothic window (see Cholane p. 9C). To distinguish para-meta - and ortho - forms and partially unsaturated rings it is generally advisable to show all atoms (see alternatives for PhOH p . 9A). A ring should be kinked outwards to show O, N ("imino-" forms) and divalent S, but if for a start one omits this or the break in the line for S unwittingly, a heavy dot should be used for N and O and the letter for S, as a clear check on their identity in heterocyclic rings; "kinking" (forming an angle in the ring) with C is optional but is generally best restricted to rings of less than 6 atoms (see Ethylene oxide, P. 4, Cholane, cyclo-Hexane, and Barbitone p . 9); but where the ring contains a double bond, the ring should, in any case, pass straight through a C atom without kinking and kink inwards for a N atom, (see Vitamin A, Purine); while C joined by two bonds to an atom outside the ring should show kinking (see

Quinone and Haem.) These rules for legibility are all based on the principle of valency lines meeting at nearly equal angles, - in accord with Bayer.

With the "perspective ring" type of formulae the kinking for the two C atoms at the left and right respectively is invariable whether for furanoses (5-ring) or pyranoses (see α-d-Glucose, Sucrose).
On rare occasions it is found necessary to "kink" in other situations to avoid overlapping of valencies in complex three-dimensional ring forms (see Morphine especially the central C atom which is part of five rings of five to eight atoms each).

Care may have to be exercised at first to keep in mind the valency values --- otherwise of course confusion of atoms will result. This is the only essential new principle which has to be practised.

Similar abbreviations can be developed for other groupings by the reader according to needs and after preliminary experience with C, H, O, N, (S and P). Detailed examples of these may be published at a later date if it is thought justified.

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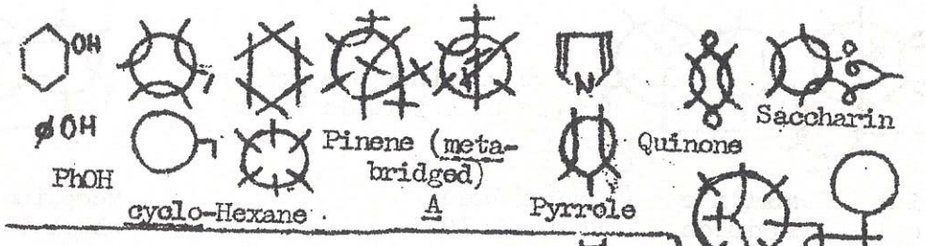
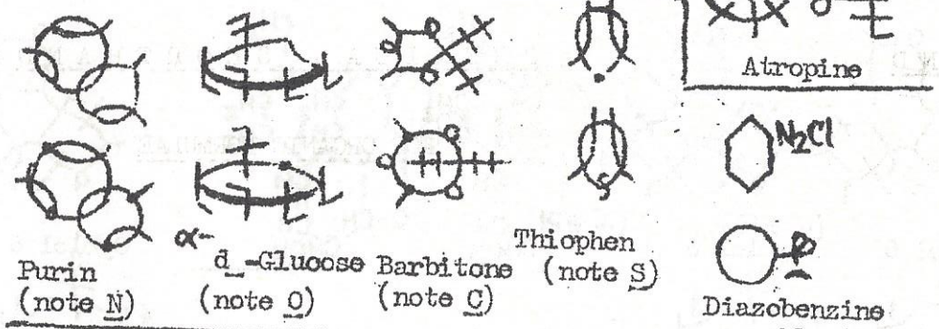
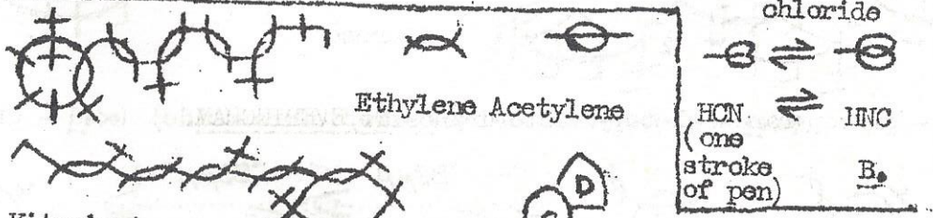
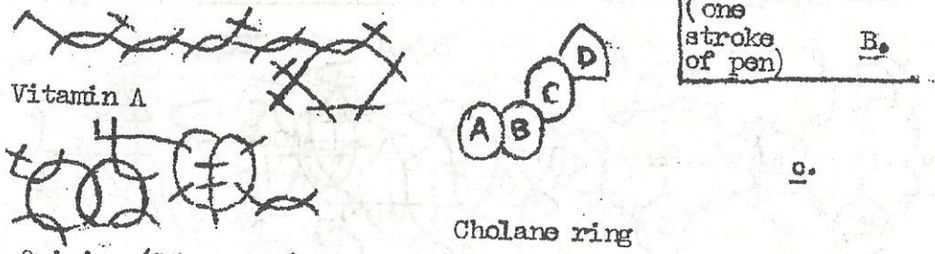




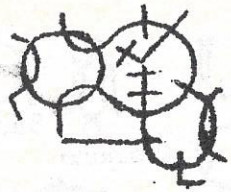




c.

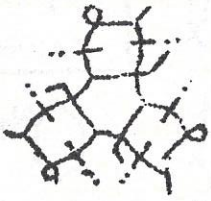
Molecular formulae are quickly checked
E.G.

20 line crossings - - -	C_{20}
24 "free" ends - - -	H_{24}
2 "free right angles" - - -	O_2
2 points where 3 lines meet -	N_2
Quinine: $C_{20}H_{24}O_2N_2$ Total atoms	48

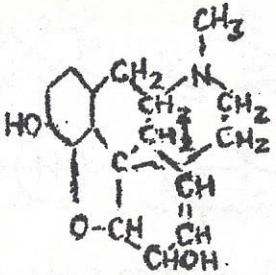


(Compare original formula below)

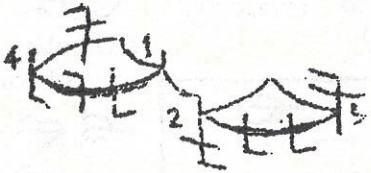
Morphine alkaloid (complex opium - Robinson 1925)



(··· =R)

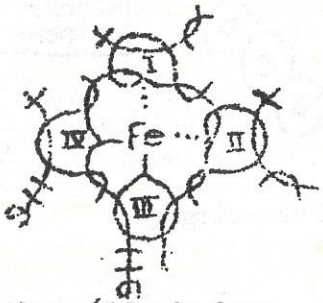


Cyclol 6

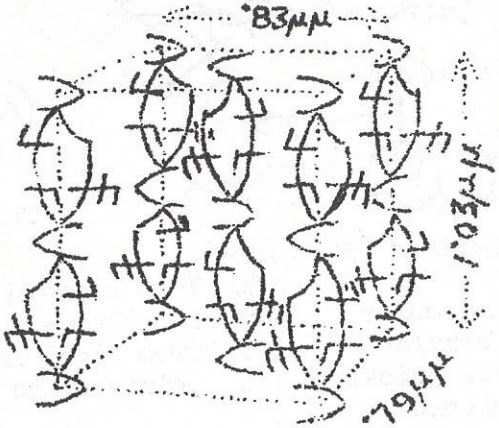


Sucrose

(α-d - glucopyranose-1-β-d-fructofuranoside)



Haem (19 strokes - 2 letters). Draw first the pyrrole rings: I and II identical with joining IV. - I (N) I - II (II) etc.



Cellulose (Clark)