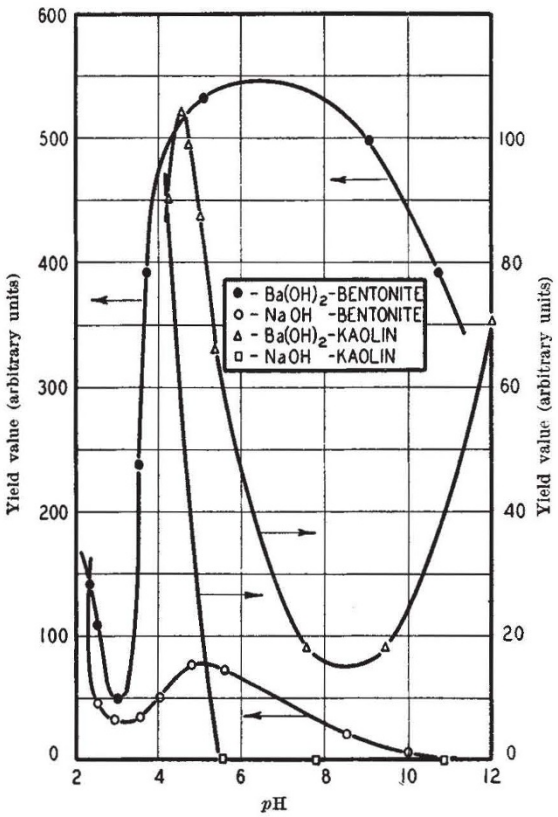
Viscosity of Clay Suspensions

CONSIDERABLE attention has been given recently to the thixotropy and viscosity characteristics of clays. During the course of a research programme now in progress, certain results of general interest have been obtained.

Fract. No.	Average equivalent spherical diameter	Mobility 25° C.	(cp.$^{-1}$ 50° C.)	Yield Value (dynes/cm.^{2}) 25° C.	50° C.	r (25° C.)
1	0·135 μ	0·580	—	34·5	—	1·93
2	0·28	0·625	1·64	22·6	32·0	1·79
3	0·45	0·862	—	0	—	1·30
4	1·05	0·950	—	0	—	1·18
5	0·55	0·950	—	0	—	1·18
6	2·2	0·991	2·94	0	0	1·13
7	8·5	0·991	—	0	—	1·13
2 (in 40·2 wt. % ethyl alcohol	0·28	0·276	2·14	69·5	48	1·52

Viscosity measurements, using a capillary viscosimeter (radius 0·0415 cm., length 9·33 cm.) were made upon seven samples of kaolinite of varying particle size, kindly supplied by Dr. H. Whittaker from fractionation of Kentucky ball clay (fractions 1–4) and Georgia kaolin (fractions 5–7). X-ray analysis indicated all to be essentially kaolinite, except fraction 4, which contained about 30 per cent silica. The results for suspensions of 10 weight per cent are shown in the accompanying table, *p*H being approximately constant at 6·5.



Deviation from normal behaviour, as indicated by yield value and relative viscosity at infinite shear, increases with decreasing particle size and was found to parallel plasticity. Rise in temperature caused an increase of yield value for aqueous suspensions, in contradiction of predictions[1] made on the basis of the attraction-repulsive force theory of Hamaker[2]. Alcoholic dispersions, however, showed a diminution in yield value with temperature, as did glass spheres suspended in an organic liquid and measured by a technique previously described[3].

The accompanying graph shows results obtained, using a MacMichael viscosimeter, when varying amounts of caustic soda and barium hydroxide were added to electro-dialysed kaolin and bentonite suspensions. The suspensions containing caustic soda showed little or no thixotropy, but it was very pronounced for barium hydroxide - bentonite suspensions from about *p*H 4 upwards. The results indicate the importance of the nature of the metallic ions associated with a clay and suggest that the presence of certain ions may be essential for thixotropy.

Complete data will be published elsewhere.

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Massachusetts Institute of Technology, Cambridge, Mass. June 21.

[1] Houwink, "Elasticity, Plasticity, and Structure of Matter", 351 (Cambridge, 1937).
[2] Hamaker, *Rec. Trav. Chim.*, **56**, 1 (1937), and other papers.
[3] Broughton and Windebank, *Ind. Eng. Chem.*, **30**, 407 (1938).

Estimating Numbers Without Counting

IN ecological work it is often necessary to have comparative estimates of the numbers of organisms in a large number of samples. An exact valuation may not be required, but an approximate numerical estimate is always preferable to statements in such terms as few, many, very many, etc. The following method was devised to furnish estimates rapidly and without counting of the numbers of a few of the more important species of the marine plankton where only one or two such species formed the bulk of the samples and *where an estimation within ± 15 per cent of the actual numbers would be sufficient.* Actually the plankton is as a rule so mixed that the method can only be applied to special series of samples and not to normal survey work. It is thought, however, that the method, which is believed to be new, may be of value to workers in other fields: perhaps for estimating the seed production of a large number of plants or samples of small insects all of one species.

The method is akin to the colorimetric method and the name proposed for it is the *plethometric method* (πλῆθος: an aggregation or multitude), kindly suggested by my colleague, Prof. T. E. Jessop.

A scale of dots is made as in Fig. 1. The dots are so arranged that when a mask with a circular opening is placed over the scale, the number visible will increase by a definite amount as the mask is slid from left to right. At *A* the number visible is 110, at *B* it is 230 and at *C* it is 270. From such a scale others can be made having, instead of dots, life-size photographic images of the objects to be estimated. A strip of glass coated with glycerine jelly is laid upon the original scale and one of the objects dropped into position over each dot, and then the whole is photographed and enlarged to natural size. Scales