TABLE I

Limits of Refractive Constant of Whole and Skimmed Cow and Buffalo Milk

	Density (20° C.)		R I. (40° C.)	Refractive Constant	
	Whole	Skim.		Whole	Skim
Cow	1·0274–1·0314	1·0342–1·0376	1·3458–1·3471	0·2065–0·2075	0·2059–0·2065
Buffalo	1·0258–1·0330	1·0324–1·0410	1·3471–1·3492	0·2076–0·2088	0·2058–0·2065

the value of the refractive constant. It was felt that elimination of fat, the most variable constituent of milk, might further narrow down the limits of the refractive constant. From the resulting data it would be possible to assess the advantage or otherwise of this value as compared with the refractive constant of whole milk.

45 samples of cow and buffalo milk of various grades of refractive index and density were used for this experiment. After taking the density (lactometer reading) of whole milk, the latter was separated in a hand-worked cream separator up to an upper limit of 0·2 per cent. fat in the skim milk. The density and refractive index (Abbe' refractometer) of the skim milk was then tested. The determinations on both skim and whole milk are given in Table I.

The data show that the limits of the refractive constant of average samples of milk are appreciably lowered and narrowed down by skimming. While for samples of whole cow milk the limits ordinarily lie between 0·2065 to 0·2075,[3] for defatted milk they lie between 0·2059 to 0·2065. For buffalo whole milk the constant lies between 0·2076 to 0·2088,[3] for defatted milk it is narrowed to 0.2060 to 0·2065 for average samples.

Now, it will be observed that the range of variation of the constant of skim milk of both cow and buffalo are almost identical. This is, of course, to be expected, as the solids-not-fat of the two milks do not differ to the same degree as do their fat contents. But this overlapping in the range of the constant of skim milk robs the advantage of distinguishing the two types of milk, possessed by the non-overlapping refractive constant of whole milk.[3] Further, the determination of the constant for skim milk denies the chance of detecting even gross adulteration with skim milk or of defatting.[2]

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VISCOSITY OF LIQUIDS AND TEMPERATURE

A SIMPLE exponential relationship between viscosity and temperature has been proposed by different authors[1] in various forms, *viz.*,

$$\eta = A.\, e^{B/T}$$

where η = Viscosity
A and B are constants characteristic of each liquid.
T = absolute temperature.

Recently, certain limitations of this equation have been pointed out by Leontieva.[2]

In the present note, an empirical relationship between viscosity and temperature has been proposed. When viscosity is plotted against temperature, a curve is obtained. The curvature is substantially diminished on plotting logarithm of viscosity against temperature. On plotting logarithm of logarithm of viscosity against temperature, straight lines were obtained for many liquids. An equation of the following type is, therefore, proposed:

$$\log(\log\eta) = A - BT$$

where η = Viscosity in millipoises,
A and B are constants for each liquid
T = absolute temperature.

In the following table some typical examples are taken and the maximum differences between observed[3] and calculated values recorded:

TABLE I

Compound	Temperature range in ° C.	A	B×10³	Maximum Percentage Difference +	Maximum Percentage Difference −
Octane	0–100	0·8036	3·20	1·4	0·7
Nonane	0–100	0·8568	3·16	0·2	1·0
Benzene	0 70	0·9353	3·50	0·3	0·5
Chloroform	0–60	0·6283	2·57	0·5	0
Acetone	0–50	0·7953	3·71	1·4	0·3
Ethyl Iodide	0–70	0·6018	2·45	0	0·2
Ethyl Formate	0-53	0·7864	3·43	1·0	0·1
Butyl acetate	0–100	0·8628	3·16	0	1·0
Acetic acid	25–95	0·8085	2·63	0·8	0·3
Methyl alcohol	0–60	0·9710	3·70	1·8	0·7
Trimethyl carbinol	32–77	1·9385	5·80	1·1	0·5
Ethyl propyl-ether	0–60	0·9470	4·26	2·3	1·0

The case of water deserves special attention. Andrade[4] found that equation (1) expresses

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1. Rangappa, K. S., *Curr. Sci.*, 1946, **15**, 230. 2. —, (in Press). 3. —, *Proc. Indian Acad. Sci.*, B, 1947, **25**, 86. 4. —, *Nature*, **160**, 719.

the viscosity of water within 0.5 per cent. from 100° C. to 60° C. Equation (2) gives the viscosity of water fairly correctly between 100° and 20° C. as may be seen from the table below. Lewis and Macdonald[5] have measured the viscosity of heavy water between 5° and 35° C. which also agree very closely with the calculated values:

TABLE II

Water: $A = 1{\cdot}23$; $B = 4{\cdot}3 \times 10^{-3}$

Temp. in ° C.	Observed viscosity in millipoises	Calculated viscosity	% diff.
0	17·93	16·56	−7·6
10	13·09	12·71	−3·0
20	10·06	10·00	−0·6
30	8·00	8·048	+0·6
40	6·57	6·613	+0·7
50	5·50	5·534	+0·6
60	4·71	4·71	0
70	4·07	4·069	0
80	3·57	3·566	−0·1
90	3·16	3·162	+0·1
100	2·84	2·837	−0·1

TABLE III

Heavy Water: $A = 1{\cdot}431$; $B = 4{\cdot}74 \times 10^{-3}$

Temp. in ° C.	Observed viscosity in millipoises	Calculated viscosity	% diff.
5	19·88	19·95	+0·4
10	16·85	16·87	+0·1
15	14·51	14·49	−0·1
20	12·60	12·65	+0·4
25	11·03	11·02	−0·1
30	9·72	9·74	+0·2
35	8·64	8·62	−0·3

The application of this relationship at high temperatures will be discussed in a later communication.

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June 12, 1948.

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1. Raman, *Nature*, 1923, **111**, 532; Dunn, *Trans. Farad. Soc.*, 1926, **22**, 401; Andrade, *Nature*, 1930, **125**, 309; Sheppard, *Ibid.*, 1930, **125**, 309. 2. Leontieva, *Acta physicochimica U. R. S. S.*, 1947, **22**, 279. 3. "International Critical Tables and Landolt Bornstein Tabellen." 4. Andrade, *Nature*, 1930, **125**, 583. 5. Lewis and Macdonald, *J. A. C. S.*, 1933, **55**, 4730.

HEAT CONDUCTIVITY AND MOLECULAR COMPLEXITY OF WATER-PART II

THE author has shown previously[1] that the heat conductivity K of water decreases sensibly linearly with its degree of association n. That the data can be represented by the equation $K = 0{\cdot}002282 - 0{\cdot}0002389\, n$ is evident from the following table:

t (° C.)	n	$K_{obs.}$	$K_{calc.}$
10	3·86	0·00136	0·00136
20	3·60	141	1422
30	3·40	1455	147
40	3·24	1493	1508
50	3·12	1527	1536
60	3·01	1563	1563
70	2·90	1589	1589

The variation with t of K for water[2] follows the equation $K = 0{\cdot}001325\ (1 + 0{\cdot}002984\, t)$.

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Benares Hindu University,
June 8, 1948.

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1. Mohanty, *Curr. Sci.* 1947, **16**, 339. 2. Jakob, *Ann. der Phys.*, 1920, **63**, 537.

DARLUCA FILUM (BIV.) CAST., A HYPERPARASITE OF *PUCCINIA GRAMINIS* AND *PUCCINIA TRITICINA* IN THE GREENHOUSE

IN INDIA, Butler and Bisby[1] recorded the occurrence of *Darluca filum* on uredinia of *Puccinia polygoni-amphibii*, Ramakrishnan and Narasimhalu[2] on *Puccinia purpurea*, *P. penniseti* and *Uromyces setariæ-italicæ*, Padmanabhan and Rafay[3] on *P. kuehnii* and Padwick[4] on *P. chrysopogi*, *Uromyces inayati* and *U. andropogonis-annulati*. During the course of the study of wheat rusts at Simla, the writer observed the pycnidia of *Darluca filum* on the uredinia of *Puccinia graminis* and *P. triticina* every year in the greenhouse in July, August and September when humidities are high (80-100%). It was found to be fairly troublesome in maintaining rust cultures since, in some cases, the pustules were almost destroyed. The pycnidia which are small, black, spherical and shiny, are found scattered amongst the uredospores. When put in a drop of water on the slide, long tendrils of colourless spores are seen to ooze out through circular openings of the pycnidia. These spores are either aseptate or uniseptate, oblong and straight, with or without small cilia at the ends and measure 3-5 × 9-25 μ.

Inoculations made in the greenhouse during July-September on wheat seedlings with infected material of *Puccinia graminis* and *P. triticina* resulted in the appearance of the rust pustules on which the pycnidia of *Darluca filum* were formed within 4-5 days in every case. Finally the infected pustule fell off from the leaf leaving a shot-hole. When these plants were removed from the greenhouse to a dry place soon after the formation of shot-holes, the rust continued to develop round the shot-holes and *Darluca filum* disappeared. If the plants were removed to a dry place before the formation of shot-holes, the uredinia were