governed by a separate gene closely linked in the chromosome and that simultaneous mutation of every one of these took place as a single step. Further, no cross-overs were noted in any of the 142 families studied.

A detailed account of this mutant will be published elsewhere.

M. ANANDAN.
V. KRISHNASWAMI.
Agricultural Research Station,
Aduturai,
June 25, 1934.

The Theory of Liquids.

IN a paper shortly to appear in the *Indian Journal of Physics*, the author has discussed a theory which considers a liquid as being composed of molecules, each associated with a spherical space, of which the diameter is given by the formula for the close-packing of spheres, namely,

$$\sigma_T = (1\cdot 32\times 10^{-8})\ \sqrt[3]{V_T} \qquad ..\ (1)$$

This diameter is the average distance of closest approach of molecular centres; it is the distance from the centre of a molecule within which on an average there will be no molecular centres, and outside of which on an average, there will be uniform distribution of molecular centres. Some molecules will approach more closely and there is nothing to prevent slow diffusion of molecules through the liquid. The average effect, however, is that of closely packed spheres. It is assumed that the molecules attract one another with a force given by μ/r^m where r is the distance between two molecules; μ is independent of temperature, but σ as will be seen from (1) depends on it; the space kept clear around a molecular centre increases as its thermal motion increases.

The theory has now been extended to molecules which attract with the force given above and repel with a force given by λ/r^n. The following formulæ have been deduced :—

$$\gamma = \frac{\mu}{1\cdot 31(m-5)\sigma^{m+1}} - \frac{\lambda}{1\cdot 31(n-5)\sigma^{n+1}} \qquad ..\ (2)$$

$$L_i = 4\cdot 22\times 10^{16}\left[\frac{\mu}{(m-4)\sigma^{m-1}}\left(1+\frac{T(m-4)\alpha}{3}\right) - \frac{\lambda}{(n-4)\sigma^{n-1}}\left(1+\frac{T(n-4)\alpha}{3}\right)\right] \text{ cals.} \qquad ..\ (3)$$

where γ is the surface tension, L_i is the molecular internal heat of vapourisation, and α is the coefficient of thermal expansion. These equations are to be applied to temperatures of low vapour pressure only.

Lennard-Jones[1] has shown that from the second virial coefficient of a gas it is possible to deduce an array of values of m and n. Table 1 shows values of m and n, and of the corresponding values of μ and λ deduced from the values of the virial coefficients of five gases. Tables 2 and 3 show the results of the insertion of these values in (2) and (3) respectively. It will be seen that values which satisfy the virial coefficient in the gaseous state give, when inserted in (2) and (3), values which agree with experimental observations for the liquid state.

It may be noted that the Schrödinger equation indicates that helium atoms attract one another with a force varying as the inverse 7th power of the distance and that the force constant lies between 7 and 9×10^{-60}. The value of n for helium here used is close to that indicated by the viscosity of helium in the gaseous state.[2]

TABLE 1.
Force Constants derived from the Equation of State.

Substance	n	m	λ	μ
He	$14\frac{1}{3}$	7	$2\cdot 41\times 10^{-115}$	$5\cdot 77\times 10^{-60}$
H_2	$14\frac{1}{3}$	8	$6\cdot 65\times 10^{-114}$	$2\cdot 33\times 10^{-66}$
Ne	25	7	$1\cdot 93\times 10^{-195}$	$2\cdot 55\times 10^{-59}$
Ar	31	8	$1\cdot 30\times 10^{-237}$	$1\cdot 41\times 10^{-65}$
N_2	31	8	$1\cdot 52\times 10^{-236}$	$2\cdot 02\times 10^{-65}$

TABLE 2.
Surface Tension.

Substance	T	σ $\times 10^8$	γ calc. (2)	γ obs.
He	2·5	4·02	0·32	0·30
H_2	20·0	4·05	1·9	2·0
Ne	24·7	3·38	5·7	5·6
Ar	90·0	4·07	11·7	11·9
N_2	75·0	4·34	9·4	9·4

[1] Lennard-Jones, *Statistical Mechanics*, by R. H. Fowler, Chap. X, 1929.
[2] Lennard-Jones, *Proc. Roy. Soc.*, 1925, **107**, 165.

TABLE 3.

Internal Latent Heat of Vapourisation (cals.).

Substance	T	$\sigma \times 10^8$	a	L_i calc. (3)	L_i obs.
He	2·3	4·00	0?	19·4	17·6
H_2	20·0	4·05	·014	169	177
Ar	87·1	4·05	·0046	1280	1326
N_2	63·1	4·23	·0048	1230	1330

T. S. WHEELER.

Chemical Department,
Royal Institute of Science,
Bombay,
June, 1934.

Efficiency of the Open Pan System of Making White Sugar.

IN these days of manufacturing sugar with the help of all modern appliances, still there are persons who think it worth while trying to improve the open pan system of manufacturing sugar.

The Mysore Department of Agriculture has done a lot of work in this direction during the years 1904-05 and 1906-07 and published the results obtained in the reports of the Agricultural Chemist for these years. The efficiency of the process on a commercial scale was tested on a private estate in 1911, and a summary of the results obtained was published.[1] Recently Sethi and Sarkar have published a note[2] on the single pan method of manufacturing 'Khandsari' sugar.

While the work was conducted on a commercial scale in 1911, a total quantity of 25,550 lbs. of juice were boiled and 2168 lbs. of sugar were recovered from it. Calculated on the quantity of sucrose contained in juice only 48·2% of it was recovered as sugar. Just for comparison, the proprietor of the estate boiled 11,850 lbs. of juice in his own pans and obtained 2,419 lbs. of jaggery from it. The weight of jaggery obtained worked out to 20·4% on the weight of juice boiled while the recovery as sugar was only 8·8%, *i.e.*, less than 45% of the weight of jaggery. In the process followed by Sethi and Sarkar the recovery of sugar from juice is only 8·28% against a recovery of 8·8% by the Mysore process. Calculating the recovery on the amount of sucrose contained in juice the recovery by the Mysore process was 48·2% against 46·8% by Sethi and Sarkar.

It is worth while considering whether sugar making by the open pan system will pay at all in competition with modern sugar factories working in India itself. With improved methods of milling and manufacture, modern sugar factories can and do surely recover much more sugar from cane than the open pan system ever can with the milling and boiling appliances at disposal.

Whether it is worth while spending further time and money on trying to improve the open pan system is a matter for serious consideration.

B. N. IYENGAR.

Department of Agriculture,
Mysore, Bangalore,
July 3, 1934.

[1] *Journ. Mys. Agric. & Exptl. Union*, 1924, **5**, No. 3.

[2] *Agriculture and Live-Stock in India*, **3**, Part V.

The Variation of Moisture in the Surface Layer of the Soil in Relation to the Diurnal Variation of Meteorological Factors.

IN a recent note[3] one of us referred to the decrease in the pressure of water vapour with height above bare soil during day and the reverse phenomenon at night. These effects were observed daily at Poona during the clear season, November to April, when the surface layer of the soil is dry and contains only hygroscopic moisture. Experiments with samples of the surface soil exposed under natural conditions (in the open) showed that there was appreciable loss of weight by evaporation during the day and that most of the moisture lost by day was regained from the atmosphere during the night. These results readily explain the humidity observations, for, during the day, owing to insolation and consequent rise in temperature, the soil surface gives up moisture to the atmosphere, whereas during the night it absorbs moisture from the air layers above it and thus reduces the vapour pressure in these layers.

Soil samples from a few other centres were next exposed in a similar manner and their weights determined at two-hourly intervals. The weights of the soils were of the order of 60 grammes, the area of cross-section of the vessels used being 30 square centimetres. Observations of air temperature, humidity, soil temperatures, wind

[3] *Curr. Sci.*, 1934, **2**, 445.