dried alone weighed 25 cwt., a single plate (the longest one) weighing 9 lb. 5 oz. How much the other parts weighed is uncertain, but the following are their dimensions; namely, pectoral fin, length externally, 8 feet 2 inches; breadth, 5 feet 1 inch; caudal or tail fin, breadth from tip to tip about 24 feet; epidermis, thickness, ¾ of an inch; while the thickness of the blubber that buoyed up these parts and made it possible for the lungs to bring the body into equilibrium with the water displaced, was 15-18 inches (on the body or over the muscular parts) and yielded 25 *tons* of oil.

In the young Greenland whale the epidermis is even thicker than in the adult, and the blubber relatively thicker as well. In a calf examined by Scoresby the epidermis was 1¾ inches thick: "It was so extremely fat," says this trustworthy witness, "that we obtained a quantity of blubber from it calculated to yield six *tuns* of oil, a produce equal to that of a 'size fish' of six or seven feet bone . . . and the body when stripped of the fat, that is, the blubber, was so small as to be quite within the power of our tackles (to heave up). In another 'sucker' or 'calf,' 19 feet in length, the blubber on an average was 5 inches in thickness, the largest of the whale-bone measured only 12 inches, of which about one-half was imbedded in the gum."

During adolescence, and until the adult stage is reached, the epidermis and blubber (and consequently the yield of oil) both diminish in thickness; the first absolutely, the second only relatively.

Seven young animals captured in the Greenland Sea in 1886, with the 'sample' or longest plate of whale-bone averaging 6 feet in length, yielded only 36 tons, or on an average about the same as Scoresby's calf; and in another killed in 1888—42 feet in length, with the longest plate of whale-bone 7 feet 6 inches in length—the thickness of the epidermis was less than an inch, that of the blubber being 8 inches.

Except in early life, the weight of oil yielded by the blubber is definitely related to the length of the longest or sample plate of whale-bone and to the total weight of the marketable whale-bone—in other words, the thickness of the blubber is in proportion to the size of the animal.

Robert W. Gray.

Exmouth, Mar. 24.

Photochemical Clustering.

In a paper describing experiments on the photochemical decomposition of nitrous oxide (*J. Chem. Soc.*, 1; 1928) Dr. James Younger Macdonald finds among other things that four molecules of N_2O decompose for each quantum of energy absorbed. The striking agreement between this value of $M/h\nu$ and the value obtained for M/N in the α-ray reaction suggests, according to Lind (*J. Phys. Chem.*, **32**, 575; 1928), a similarity in the mechanism of decomposition, namely, *clustering* about an excited N_2O molecule on one hand and about an ionised one on the other. This suggestion deserves consideration, especially in view of the failure of mechanism proposed by Macdonald, namely,

$$\begin{aligned} &(1)\ N_2O + h\nu &&= N_2O' \\ &(2)\ N_2O' + N_2O &&= O_2 + N_2 + 2N \\ &(3)\ 2(N + N_2O &&= NO + N_2). \end{aligned}$$

The second step, according to the best data, requires at least 80,000 calories more energy than is available. In view of this, Dr. Macdonald, who originally used a minimum value for the energy of dissociation of nitrogen, has now abandoned the special mechanism which he put forward (private communication). The clustering, however, of three molecules about an active one leading to decomposition as

$$4N_2O = 3N_2 + O_2 + 2NO$$

is very possible thermodynamically.

With Dr. Macdonald's permission to publish the contents of his letter, it may be said that other mechanisms proposed therein are pure speculations, as he himself realises. The best of them admits of differences between oxygen atoms in their effects on N_2O. Furthermore, he proposes to add H_2 to the decomposing N_2O. In the event that O atoms are formed he expects water would result from

$$H_2 + O = H_2O.$$

It is doubtful whether this reaction would go in spite of its exothermic nature to the extent of about 140,000 calories, since H_2 can be considered a pseudo-atom with a helium-like structure. Furthermore, unless radiation is emitted and the water molecule occupies a definite quantised state, the principle of conservation of energy and momentum is violated, except in the almost zero probability case, in which the relative kinetic energy of the colliding systems plus the energy of combination corresponds exactly to a quantised state of the water molecule. Therefore a third body would have to intervene in order to remove the energy. Such triple collisions would be rare in view of the atomic pressure. If the life period of the activated N_2O is of the same order of magnitude as that of other systems involving roughly similar electron jumps, then it is possible to distinguish between the *clustering* theory and Macdonald's idea of a binary collision as the first step, by working at low pressures, using a method employed by the writer in his work on hydrogen iodide (*Proc. Nat. Acad. Sci.*, **13**, 720; 1927; *J. Phys. Chem.*, **32**, 270; 1928).

One hesitates to put forward any definite and general theory regarding clustering in photochemical reactions. The examples in which agreement is found between the photochemical and α-ray yields are exceedingly few (see Lind, "Chemical Effects of Alpha Particles," second edition, p. 144, 1928). In one of these at least (photochemical decomposition of hydrogen iodide or bromide), the experimental work of the writer (*loc. cit.*) indicates that clustering is out of the question. The others involve either reaction between two different systems or else yields of less than unity. Even in the decomposition of N_2O, it is difficult to understand the survival of two impacting molecules having more than sufficient energy to decompose, since it has been shown that two N_2O molecules undergo thermal decomposition when the energy increment is only 58,000 calories (Hinshelwood, "Kinetics of Chemical Change in Gaseous Systems"). Such survival would imply electronic stability of the excited molecule until sufficient 'clustering' impacts had been undergone.

Still, cases involving survival of an excited molecule after collision are not lacking. On the other hand, much can be said for the idea of photochemical clustering in reactions involving association or polymerisation. It is important that examples of association be found for comparing the photochemical and α-ray yields; Lind ("Chemical Effects of Alpha Particles," p. 145) has studied the ionic clustering of certain unsaturated hydrocarbons. For acetylene he finds a value for $M/N = 20$. Interest is therefore attached to the yield in the photochemical polymerisation which is reported to take place (Berthelot and Gaudechon, *Compt. rend.*, **150**, 1169; 1910; Bates and Taylor, *J. Am. Chem. Soc.*, **49**, 2444; 1927).

Bernard Lewis
(National Research Fellow).

University of Minnesota,
Minneapolis, U.S.A.