primarily due to this very fact, that its spawning grounds lie farther west than the latter, rarer species, so that its larvæ would have more chance of being carried passively by the Gulf Stream and the Atlantic Current over to the European side ?

I have to thank Mr. Å. V. Tåning for undertaking the difficult task of photographing the specimens shown, and also for valuable assistance in other ways.

JOHS. SCHMIDT.

Carlsberg Laboratory,
December 2.

The Energy Levels of the Nitrogen Molecule.

IN a paper before the American Physical Society (*Phys. Rev.*, 23, 294, Feb. 1924) and in a letter to NATURE (Nov. 1, 1924, vol. 114, p. 642), I gave a set of electronic energy levels for the neutral nitrogen molecule, based on an analysis of its band spectra. These levels were designated X, A, B, C, and D, where X denotes the stable state of the molecule. The interval X to A was suggested as $65{,}000\nu$ (=8·0 volts), the band system corresponding to this transition being as yet unknown. Dr. Sponer (*Zeitsch. f. Phys.*, 34, 622, 1925), by measuring the excitation potentials of various groups of nitrogen bands, has now obtained results in exact agreement with this diagram. The X to A interval comes out as 7·9 volts.

Duncan (*Astrophysical Jour.*, 62, 145, 1925) also has measured excitation potentials in molecular nitrogen. In discussing the theory he has stated that the 0-0 band of the second group (λ3371) should be excited at a potential higher than the 0-0 band of the first group (λ9108) by 2·3 volts. This, however, is incorrect. The difference should be 3·66 volts, corresponding to the frequency of the 0-0 band of the second group. However, the bands of the first group which he *actually observed* should be excited at about 2·0 volts less potential than the 0-0 band of the second group, in agreement with his actual results (10 and 12 volts respectively). With this correction, and with the assumption that all of his measured potentials are about 1·3 volts too low, there is agreement between his results and those of Dr. Sponer, as well as with my theoretical diagram. The only measurement by Duncan in error by more than his stated probable error is that for the weak fourth positive group.

As a result of my analysis of the nitrogen levels, I further stated that the carrier of the characteristic afterglow bands of active nitrogen was a neutral nitrogen molecule with 11·5 volts of energy (9·3 volts electronic and 2·2 volts vibrational) in excess of the stable state. The afterglow phenomenon was noticed by E. P. Lewis and the chemical activity associated with the afterglow was discovered some ten years later by Lord Rayleigh, who gave the name "active nitrogen" (see NATURE, Nov. 15, 1924, vol. 114, p. 717). As has been customary, I identified the carriers of the afterglow bands with the entity responsible for this chemical activity, and hence was forced to postulate that this molecule with 11·5 volts excess energy was in a metastable condition. Because this condition corresponded to the high vibrational quantum number eleven, there are grave theoretical objections to such an assumption, and Dr. Sponer now assumes that "active nitrogen" is atomic nitrogen. The recent work of R. W. Wood, Bonhoeffer, and others, on atomic hydrogen, and of Franck and his co-workers on "collisions of the second class," now make such an assumption not only possible, but plausible, even though the afterglow (a secondary effect of the *association* of atomic nitrogen) has been obtained with a duration of more than fifteen minutes (R. Rudy, *American Physical Society*, Nov. 1925). The full argument is given in her paper, to which reference has just been made, and leads directly to the conclusion that the 11·5 volts of excess energy of the carriers of the afterglow bands measures accurately the heat of dissociation of nitrogen.

After the emission of the afterglow bands, the excited nitrogen molecule is in state A and has 9·4 to 8·9 volts of energy. The bands corresponding to the transition A to X should lie in a spectral region where Prof. Hopfield and I later found a system of bands (NATURE, July 4, 1925, vol. 116, p. 15), but this system gave progressions which, on the basis of the data then available, agreed with no other known progressions of nitrogen or of any other molecule. Using data which have recently become available, Dr. Sponer has now been able to classify this system, and her results are given in the accompanying letter.

RAYMOND T. BIRGE.

University of California,
December 5.

The Energy Levels of the Nitric Oxide Molecule.

IN a recent letter to NATURE (July 4, 1925, vol. 116, p. 15) R. T. Birge and J. J. Hopfield record the observation of a system of emission bands in nitrogen in the region of λ1854-λ1250. They found a formula for these bands that did not fit into the known level-scheme of nitrogen. This was a peculiar fact because the bands arising from the normal state of the N_2 molecule are to be expected in this region. The apparent discrepancy can now be explained by the discovery that these bands do not belong to the N_2 but to the NO molecule. This is quite possible, as the nitrogen used was not completely free from oxygen.

I am much indebted to Prof. J. J. Hopfield for giving me the opportunity to see the manuscript of an investigation by S. W. Leifson, on absorption spectra of different gases and vapours in the Schumann region (*Astrophysical Journal*, in press). By comparing the frequency differences of the NO bands of Leifson with those in the above-mentioned band system of Birge and Hopfield, I find that both systems have a common state. The final state of the absorption NO bands of Leifson is also the final state of the emission bands of Birge and Hopfield. Moreover, with the aid of new wave-length measurements of certain bands of the third positive group of nitrogen, kindly made for me by Prof. Hopfield from his plates, I find that the absorption bands of Leifson are merely the 0-0, 0-1, 0-2, etc., bands of the third positive group. Leifson's plates contain also the Birge and Hopfield bands.

Hence we have conclusive evidence that the third positive group belongs to NO, as has usually been assumed, and that its initial state in absorption is the normal state of the NO molecule, as Mulliken (NATURE, Sept. 6, 1924, vol. 114, p. 349) and Birge (*ibid.*, Nov. 1, 1924, vol. 114, p. 642) had suggested. The excitation potentials of the levels of the NO molecule can be given from these considerations as 5·44 and 5·44 + 8·52 = 13·96 volts; that is, 5·44 volts for the excitation of the 0-0 band (λ2269) of the third positive group, and 13·96 volts for the excitation of the 0-0 band (λ1450) of the Birge and Hopfield bands. From this it follows that the ionisation potential of the NO molecule must be greater than 14 volts.

I am glad to have had the opportunity to discuss these matters with Prof. R. T. Birge, and wish to thank him for his friendly co-operation.

HERTHA SPONER.

University of California,
December 5.

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