Chromatid Segregation in Tetraploid *Rubus*

IN *Rubus rusticanus* an unprickled variety *inermis* occurs. The character behaves as a recessive in reciprocal crosses with the normal type. In 1927,[1] we showed how this character was inherited in tetraploid forms. A tetraploid seedling 'RT4' was raised from the cross *R. rusticanus inermis* ♀ ($n=7$) by the tetraploid prickled species *R. thyrsiger* ♂ ($n=14$); the female parent had given an unreduced egg with 14 chromosomes, which was fertilised by normal pollen of *R. thyrsiger*, also with 14 chromosomes. The constitution of RT4 in regard to the *inermis* character was, therefore, *AAaa*. With random segregation amongst four chromosomes (considered by Muller in 1915) it should have given a 35 : 1 ratio of prickled to unprickled. With regular segregation of *A* from *a* (allosyndesis) it should have given a 15 : 1 ratio. The proportion found was intermediate (471 : 19) and we considered therefore that randomness was modified in the direction of allosyndesis—an improbable but, as it then seemed, an inevitable explanation.

Haldane[2] has applied the principle of chromatid segregation to polyploids. This principle was first demonstrated in polyploid *Drosophila* and agrees with the simplified chiasmatype hypothesis of crossing-over. The ratios expected with random *chromatid* segregation in a tetraploid of the constitution *AAaa* are 20·78 : 1 (187 : 9) instead of 35 : 1, and in the backcross to *aaaa* 3·67 : 1 (11 : 3) instead of 5 : 1. The following table shows the comparison of new results obtained in the last five years with the two alternative expectations of random segregation of chromosomes and chromatids. (The possibility of allosyndesis need not now be considered.) The results agree closely with the chromatid expectation and differ significantly from the simple chromosome expectation.

	Prickles.	No Prickles.
Selfed (*AAaa* × *AAaa*)		
Observed (872 plants)	835	37
Chromatid expectation	832·0±6·2*	40±6·2
Chromosome expectation	847·8±4·9	24·2±4·9
Back-crossed (*AAaa* × *aaaa*)		
Observed (43 plants)	33	10
Chromatid expectation	33·8±2·7	9·2±2·7
Chromosome expectation	35·8±2·4	7·2±2·4

* Standard error, $\sigma=\sqrt{p(1-p)n}$.

Blakeslee and his collaborators[3] have found recessives in the progeny of *AAAa* plants of tetraploid *Datura*, and *AAaa* plants also show ratios that may be accounted for by chromatid segregation. These are the only sharp deviations from the simple chromosome segregation yet observed in autotetraploids. The explanation is clear. Chromatids from the same parental chromosome have been shown to segregate together at the spindle attachment, both where chromatid segregation has been shown genetically[4] and where crossing-over has been proved cytologically.[5] Random chromatid segregation will therefore only be expected with factors having 50 per cent of observed crossing-over between them and the spindle attachment, a value which under most conditions is only approached asymptotically.

Observations of inheritance in tetraploids therefore confirm expectation based on general cytological and genetical observation, and particularly agree with the chiasmatype hypothesis of crossing-over.

M. B. CRANE.
C. D. DARLINGTON.

John Innes Horticultural Institution,
London, S.W.19, April 28.

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[1] *Genetica*, **9**.
[2] *J. Genet.*, **22**; 1931.
[3] *Bot. Gaz.*, **76**; 1923.
[4] E. G. Anderson, *Genetics*, **10**; 1925.
[5] Darlington, *Proc. Roy. Soc.*, B, **107**; 1930. *J. Genet.*, **24**; 1931.

Resonance Spectrum of Hydrogen

IT was reported in a previous communication[1] that, in the course of experiments by Dr. J. S. Badami and me on the spectrum of arsenic by the Paschen hollow cathode discharge in helium, the Lyman series of hydrogen was obtained with remarkable strength, the important feature of the series being the curious intensity anomaly exhibited by the members. Instead of the intensity gradually falling off, a sudden enhancement was observed in that of the 10th and the 11th members (ν108,771 and 108,916). Experiments under varying conditions indicated definitely that this intensity anomaly occurs only in the presence of arsenic. The suggestion was made that the energy of excitation of this resonance spectrum is to be sought for in a transfer, by collisions of the second kind, from the excited arsenic atoms. Since sending this report, values of the characteristic energy levels of the neutral and ionised atom of arsenic[2] have become available, and a consideration of these has confirmed the above explanation.

The reaction may be represented by the equation:

$$\mathrm{As}^{+\prime}+\mathrm{H}\longrightarrow\mathrm{As}+\mathrm{H}^{\prime},$$

where $\mathrm{As}^{+\prime}$ represents an arsenic ion in an excited metastable state. The existence of such states, formed by collisions of the second kind with excited rare gas atoms or ions, in the source employed, can be easily supposed from the experiments of various investigators on this method of discharge. The excitation energy of the enhanced 11th member of the hydrogen series is 13·44 volts, and the energy corresponding to a transition of the excited arsenic ion in the metastable state $4p\ {}^1S_0$ to the normal state $4p\ {}^4S_2$ of the neutral atom (that is, $\mathrm{As}^{+\prime}\longrightarrow\mathrm{As}$) is found equal to the above value within the limits of error involved in the estimate of the first ionisation potential of arsenic.

The phenomenon appears to be analogous to the observations made by Beutler and Josephy,[3] where a mixture of the vapours of sodium and mercury and a foreign gas was excited by mercury radiation λ2537; and the lines $2P-5S$ and $2P-7S$ of sodium appeared with great intensity, the excitation energy of these lines corresponding closely to the energy of the excited states $2\ {}^3P_1$ and $2\ {}^3P_0$ of mercury. It is to be noticed that a close 'resonance' between the two colliding partners is of importance for this transfer of energy.

If the above interpretation of the phenomenon is accepted, we meet here with a type of collision which, so far as I am aware, has not hitherto been observed. We have evidence[4] of a simultaneous ionisation and excitation by collisions of the second kind with excited atoms, in which the reaction can be represented by the equation $A+B^{\prime}\longrightarrow A^{+\prime}+B$. The present phenomenon represents then a type of impact in which, clearly, the reverse process is involved.

A full report of the experiments will be published shortly.

K. R. RAO.

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Kodaikanal, S. India, April 8.

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[1] NATURE, **128**, 585, Oct. 3, 1931.
[2] A. S. Rao, *Proc. Phy. Soc.* (in the course of publication), As II ($4p\ {}^3P_0-{}^3P_2=2540$; $4p\ {}^1S_0-{}^1D_2=12{,}504$; $4p\ {}^1D_2-{}^3P_2=7555$); (unpublished results) As I $4p\ {}^4S_2=85{,}000$).
[3] Beutler and Josephy, *Naturwiss.*, **15**, 540; 1927.
[4] Duffendack and Smith, *Phy. Rev.*, **34**, 68; 1929.

Photochemical Dissociation of Carbonyl Sulphide

WE have recently determined the ultra-violet absorption spectrum of carefully purified carbonyl sulphide, using a quartz spectrograph and a hydrogen discharge tube as a source of light. The spectrum shows a continuous absorption starting from a sharp limit at λ = 2550 ± 20 A. and extending far towards the ultra-violet. This spectrum is interpreted as corresponding to the dissociation of the COS molecule, which was also indicated by the deposit of sulphur on the walls of the absorption tube. The products of dissociation may be CO and S, or CS and O. The energies of these processes as calculated from thermochemical data are:

$$COS \rightarrow CO + S - 76 \text{ kcal.} \quad . \quad . \quad (1)$$
$$COS \rightarrow CS + O - 148 \text{ kcal.} \quad . \quad . \quad (2)$$

The determined photochemical dissociation energy is 4·84 volts or 111 ± 1 kcal. and hence the dissociation must proceed according to (1). The difference between the observed and calculated dissociation energy is 35 kcal. and corresponds to the excitation energy of the sulphur atom, since the first excitation potential of the carbon monoxide molecule, as obtained from band spectra analysis, is 5·9 volts above the ground-level. The energy of 1·5 volts (35 kcal.) corresponds to the difference in energy between the ^{3}p ground-level and the ^{1}d metastable state, as the lowest possible excitation energy of the sulphur atom. The position of the latter term has not yet been established directly. Christy and Naudé [1] have recently suggested 1·6 volts from a study of the predissociation spectrum of the sulphur molecule. This is in excellent agreement with the above value.

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[1] Christy and Naudé, *Phys. Rev.*, **37**, 907; 1931.

Rotation of Molecules in Crystals

AN investigation on the relation between the crystal structure and optical properties of organic crystals has revealed further cases of 'rotating' and 'fixed' molecule forms in aliphatic compounds. A hexagonal rotating form has been observed between 16° and 24° C. in dodecyl alcohol $C_{12}H_{25}OH$. The distance between chains is 4·76 A., corresponding to the 4·85 A. found by A. Müller [1] for paraffins. The low temperature form, however, differs by being monoclinic with inclined chains corresponding to the high temperature form of the monobasic acids. The transitions between these forms could be followed for single crystals in the polarising microscope.

A non-rotating form of alkyl-ammoniohalide has been found for $C_{18}H_{37}NH_3Cl$. It is orthorhombic with a base 5·2 A. × 5·15 A. as against 5·0^2 A. for the tetragonal 'rotating' lower members studied by S. P. Hendricks and others,[2] but with the hitherto unobserved feature of four layers per cell in alternate pairs inclined approximately 48° to the *c* plane. This leads to a negative birefringence unlike that of all other long chain compounds.

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[1] NATURE, **129**, 436, March 19, 1932.
[2] *Ibid.*, **128**, 410; 1931.

Heat of Dissociation of Nitrogen

THE value of the heat of dissociation of nitrogen has formed a lively subject of controversy in the past few years. All values from 19 to 7 volts have been given by various workers for the dissociation potential. I have recently determined this value by examining the absorption spectrum of N_2O in a manner which has already been explained in my note on the spectrum of SO_3.[1] The value comes out to be 8·8 volts or 203 kcal.

The absorption spectrum of N_2O is perfectly continuous, with no trace of bands, as in most saturated compounds. From microphotometrical study of the absorption spectra taken at different pressures, I found that the absorption begins at $\lambda 2740$, corresponding to 104·4 kcal. Assuming that this corresponds to a photochemical breaking up of N_2O into NO and N (this assumption is supported by other arguments), and utilising other thermochemical data, the heat of dissociation comes out as 203 kcal. This value is in good agreement with the most recent results of Turner and Samson,[2] and Tate and Lozier,[3] obtained by other methods, and is certainly the most accurate value of the heat of dissociation of N_2 obtained so far.

ARUN K. DATTA.

Department of Physics,
Allahabad University,
March 31.

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[1] Datta, NATURE, **129**, 317, Feb. 27, 1932.
[2] Turner and Samson, *Phys. Rev.*, **34**, 747; 1929.
[3] Tate and Lozier, *Phys. Rev.*, **39**, 254; 1932.

Decomposition of Hydrogen Peroxide by Catalase

IN his recent statistical calculations on the decomposition of hydrogen peroxide by catalase, Prof. J. B. S. Haldane estimated [1] that the mean life of an active catalase-hydrogen peroxide molecule is about 10^{-7} second, and the velocity constant for the union of catalase and hydrogen peroxide exceeds 7×10^6.

Work at present in progress, consisting of a comparison of the *photochemical* decomposition with the enzyme reaction, indicates that the latter may have to be regarded as a *chain reaction*, in which the active centres of the enzyme function only by starting the chains, which then continue in the bulk of the solution, or on other surfaces.

This view becomes more credible in the light of recent work by Allmand and Style, who conclude that even in dilute aqueous solutions of hydrogen peroxide "the photochemical, and hence presumably the thermal reaction, is a chain reaction", and "the reaction chains must be exceedingly long—of the order of 10^4 to 10^7 links".

According to this view, the inhibition of enzyme reactions may be due in some cases to the breaking of the reaction chains by the inhibitors, as in numerous photochemical reactions.

Zeile and Hellström have shown that iron-porphyrin compounds form the active centres in catalase, and, in 1931, I observed that the action of iron compounds in certain inorganic systems analogous to enzyme systems can best be explained by the chain-reaction hypothesis,[3] a view which was put forward independently by Prof. Haber a few weeks later.[4]

I conclude that in view of these facts a modification may have to be introduced into Prof. Haldane's interesting calculations on catalase.

DEREK RICHTER.

Dyson-Perrins Laboratory,
Oxford, May 12.

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[1] *Proc. Roy. Soc.*, B, **108**, 559; 1931.
[2] *J.C.S.*, 621; 1930.
[3] *Ber.*, **64**, 1240; 1931.
[4] *Naturwiss.*, **22**, 450.

Electrochemical Periodicities

THE interesting observation of periodicity at a platinum anode in a solution of dilute sulphuric acid containing dissolved hydrogen, recently reported by Butler and Armstrong,[1] recalls an unpublished experiment which I made in 1927 during the course of a series of investigations of this subject.