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.

Haldane² has applied the principle of chromatid segregation to polyploids. This principle was first demonstrated in polyploid *Drosophila* and agrees with the simplified chiasmotype 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 (<i>AAaa</i> × <i>AAaa</i>)		
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 (<i>AAaa</i> × <i>aaaa</i>)		
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 collaborators³ 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 genetically⁴ 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 chiasmotype hypothesis of crossing-over.

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London, S.W.19, April 28.

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 communication¹ 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 ($\nu 108,771$ 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 arsenic² have become available, and a consideration of these has confirmed the above explanation.

The reaction may be represented by the equation:

where $\text{As}^{+'}$ 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, $\text{As}^{+'} \rightarrow \text{As}$) 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 $\lambda 2537$; 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 evidence⁴ 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 $A + B' \rightarrow A^{+'} + B$. 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.

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¹ *NATURE*, 128, 585, Oct. 3, 1931.

² A. S. Rao, *Proc. Phys. Soc.* (in the course of publication), As II ($4p\ ^2P_0 - ^2P_2 = 2540$; $4p\ ^1S_0 - ^1D_2 = 12,504$; $4p\ ^1D_2 - ^1P_2 = 7555$); (unpublished results) As I $4p\ ^4S_2 = 85,000$.

³ Beutler and Josephy, *Naturwiss.*, 15, 540; 1927.

⁴ Duffendack and Smith, *Phys. 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 $\lambda = 2550 \pm 20$ Å. and extending far towards the ultra-