

Table 1. Segregation of amphiploids *N. tabacum* × *N. tomentosiformis* for mosaic resistance in testcrosses to susceptible tobacco.

Plant No. of amphiploid	Seeds sown (No.)	Necrotic reaction	Mottled reaction	Died
<i>Amphiploid Holmes Samsoun</i> × <i>N. tomentosiformis</i>				
C 113-4	90	58	0	1
C 113-13	90	33	2	1
C 113-15	180	98	2	1
C 113-23	90	47	0	0
Totals	450	236	4	3
<i>Amphiploid Burley 21</i> × <i>N. tomentosiformis</i>				
B 51-9	270	41	0	2

amphiploids, ratios ranging from 2.3:1 to 4.7:1 were obtained for six loci on five different chromosomes. These results did not suggest any differential affinity, though thus far it could not be satisfactorily explained why the ratios were all smaller than 5:1 and mostly even smaller than 3.7:1 (5). On the other hand, *N. tabacum* × *N. glutinosa* amphiploids gave ratios of about 80:1 for two independent loci (6), which were attributed to the effect of pronounced differential affinity at meiosis.

Thus, the chromosomes of *N. tabacum* and *N. tomentosiformis* appear to be closely homologous while those of *N. glutinosa* differ. The question to be asked is this: will the mosaic resistance factor of Holmes Samsoun give as small a segregation ratio as the other factors in amphiploid *N. tabacum* × *N. tomentosiformis*, or, alternatively, will the *N. glutinosa* chromosomes, in which the resistance factor is located, exhibit a behavior all their own?

To test this problem four amphiploids *N. tabacum* (Holmes Samsoun) × *N. tomentosiformis* were used. They had been produced by the treatment of germinating seedlings for 3 hours with 0.12 percent aqueous colchicine; the seeds came from a single capsule of a cross between Holmes Samsoun tobacco and *N. tomentosiformis*. A fifth amphiploid had been made in the same way with Burley 21 tobacco which carries mosaic resistance in a relatively small *N. glutinosa* segment in a chromosome of *N. tabacum* (4). The amphiploids were testcrossed to nonresistant tobacco. When the progeny plants had reached a diameter of approximately 2 in., their leaves were brushed with tobacco mosaic virus suspension. The inoculation was repeated one to several times at weekly intervals until each plant showed clearly either the localized necrotic lesions caused by the presence of the "resistance" factor from *N. glutinosa* or the mottling symptoms with which nonresistant tobacco responds.

The results are shown in Table 1. Out of a total of 240 scored plants, four did not contain the resistance factor—that is, the ratio was 59:1 in the backcross progenies from the Holmes

Samsoun × *N. tomentosiformis* amphiploid. Unfortunately, the seed from the backcross of the amphiploid Burley 21 × *N. tomentosiformis* germinated poorly, and only 41 plants were obtained from 270 seeds. All of these had the resistance factor.

The data suggest that the low segregation ratios reported previously (5) for amphiploid *N. tabacum* × *N. tomentosiformis* are determined by the individual chromosomes and are not characteristic of the amphiploid per se. The *N. glutinosa* chromosome introduced into the *N. tabacum* complement behaved in a specific manner.

The result obtained from the amphiploid with Burley 21 was perhaps surprising, because here the resistance factor was carried in a chromosome which was in part *N. tabacum*; in a previous paper (4) it was suggested that the *N. glutinosa* sector in this interchange chromosome was less than an arm. Yet this chromosome exhibited pronounced differential affinity through the absence of segregation (Table 1, bottom). Because of the small family which was obtained the result could not be exploited quantitatively.

It may be argued that the possibility of genic control of differential affinity has not been disproved. One may propose that the particular *N. glutinosa* chromosome used could have contained a factor with such an effect. Simultaneous segregation for mosaic resistance and some independent factor could be used to test this point. Unfortunately, in the progenies of Holmes Samsoun × *N. tomentosiformis* amphiploids no other segregations could be scored. However, the Burley 21 × *N. tomentosiformis* amphiploid segregated also for the burley (white stem) character as reported elsewhere (5) and gave in a testcross 36 green and 16 burley plants. This result was in striking contrast with the 41:0 segregation ratio for mosaic resistance obtained from the same amphiploid but similar to other segregation ratios from *N. tabacum* × *N. tomentosiformis* amphiploids (5). Therefore, an association of a gene controlling differential affinity with the resistance factor is unlikely.

Recently a genetic system has been described in hexaploid wheat which effectively suppresses pairing between homeologous chromosomes (7). Thus there exists in wheat what amounts to genetically controlled preferential pairing which insures meiotic regularity. Since the subgenomes of *Triticum aestivum* share considerable homologies, such genic control was presumably favored early during the evolution of the species (8). In the evolutionary history of *Nicotiana tabacum* such mechanism was not required since amphiploids between species of the ancestral types already exhibit fairly regular bivalent pairing (9). The present study did not reveal the existence of genic influences upon preferential pairing; but only genes which reduce its amount could have been discovered in the present experiment—with the exception of the *N. glutinosa* segment in Burley 21 in which genes with the opposite effect could have made their influence felt (10).

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References and Notes

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2. Differential affinity [C. D. Darlington, *J. Genet.* 29, 213 (1928)] describes the tendency in allopolyploids for completely homologous chromosomes derived from the same species to pair with each other more often than with partial homologs from the other parent. Preferential pairing is the physical consequence.
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10. This is paper No. 1233 of the journal series of the North Carolina Agricultural Experiment Station. The work was supported in part by National Science Foundation grant No. G-4851.

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On Antimatter and Cosmology

Abstract. A cosmological model based on a gravitational plasma of matter and antimatter is discussed. The antigravitational interaction of matter and antimatter leads to segregation and an expansion of the plasma universe. The expansion time scale is controlled by the aggregation time scale.

There have been speculations recently about the possible large-scale existence of antimatter in the universe and the relation between such postulated existence and physical theory (1-8).

The present position seems to be as follows: (i) Elementary particle theory indicates a complete symmetry in the production of particles and antiparticles. (ii) It is generally argued that we live in a universe of matter alone because great annihilation energy would be observed if appreciable antimatter existed and there were no segregation mechanism. (iii) "Antigravity" segregation would not be consistent with the general theory of relativity.

General approaches to the question of the coexistence of matter and antimatter on a large scale in the universe have been two. First, the general theory of relativity is given preference over the symmetry of production of matter and antimatter (6), and (ii) is accepted. A second approach has been to assume that the production of matter and antimatter is—and was at every epoch—symmetric, but that annihilation is prevented by a segregation mechanism. A statistical fluctuation segregation mechanism has been considered by Goldhaber (1) but a further analysis does not support it (7). A second segregation mechanism considered by Goldhaber is that of an initial segregation through decay of a self-conjugate universon into a cosmon and an anticosmon which were the precursors of our universe and an unobservable anti-universe (1).

Still another proposed segregation mechanism is that of "antigravity," whereby it is supposed that there is mutual repulsion between matter and antimatter and mutual attraction between all bodies of the same type matter (3, 4, 8). Morrison (4) considers a mixture of the two types of matter interacting in this way and calls such a mixture a gravitational plasma.

The purpose here is to discuss an evolving cosmological model based on matter-antimatter symmetry and anti-gravitational segregation. While general relativity may be supposed valid in any region occupied by one type matter alone (3), it would not apply to the gravitational plasma as a whole; therefore, a Newtonian system will be considered (9). The basis of this model is a "neutral" gravitational plasma in which the bodies all have the same inertial mass at any epoch; it is assumed that the bodies may grow by aggregation or agglomeration.

In the first place, it has been noted that a gravitational plasma has properties which are significantly different from those of an electric plasma (4). Besides these we consider that each charged body in a neutral electric plasma has a positive binding energy because the dominant interaction is with its nearest neighbors, to which it is attracted. On the other hand, in a "neutral" gravitational plasma each

body is repelled by its nearest neighbors and possesses a negative binding energy. Thus, besides being unstable to segregation and aggregation, a neutral gravitational plasma is unbound.

From these considerations, a gravitational plasma universe, of itself, flies apart. It is tempting to associate this unbinding with a cosmic repulsion (10) leading to recession of the galaxies. Consider a Newtonian gravitational plasma spherically symmetric about an origin of coordinates (9). For all epochs, the concentrations of matter and antimatter will be supposed equal in the large. For simplicity we do not consider the detailed internal dynamics of the plasma but, as usual, assume the interior of the sphere to be uniformly filled with the plasma. The kinetic pressure is also assumed to be zero. If we follow these assumptions, and neglect velocity dispersion at the boundary (11), the evolution of the plasma is described by the radial motion of the boundary bodies. The bodies on the boundary experience a net radial force and a radial acceleration. If, for ease of computation, the bodies are assumed to be distributed regularly on a three-dimensional cubic lattice, the radial acceleration of a boundary body is (12)

$$\ddot{R} = C \frac{m}{a^2} = C \left(\frac{3M}{4\pi m} \right)^{\frac{2}{3}} \frac{m}{R^2} = C \left(\frac{3M}{4\pi} \right)^{\frac{2}{3}} \frac{m^{\frac{1}{3}}}{R^2} \quad (1)$$

where C is a constant, m is the body inertial mass, R is the plasma radius, and M is the total inertial mass. This assumes that R is much larger than the body separation or "lattice parameter," a .

On this basis one might visualize the evolution of this model as follows. At the beginning of the expansion the finite radius gravitational plasma universe is at rest relative to the coordinate origin and is in a state of relatively high density and low aggregation (small R , small m). Because of the small body mass, m , the plasma expands very slowly—resembling a slow expansion from a static Einstein universe—the rate of aggregation effectively controlling the expansion. Aided by instability against segregation and aggregation (4), stars and antistars are formed while over-all neutrality is maintained by the randomness of aggregation sites.

As aggregation proceeds, m and R increase, and acceleration of the expansion proceeds as a competition between aggregation and expansion dilution. The expansion is always accelerated, however, and after a sufficiently long time the gravitational plasma universe is flying apart at a high rate and all bodies are receding from any body well inside the plasma (9).

For such a model universe, departure from a smoothed-out universe forms an essential part of its dynamics; an ideally smoothed-out universe of this type would expand only through annihilation radiation or an initial radial velocity. Another important feature is that the expansion time scale is not independent of the aggregation time scale.

An interpretation which might be made is that the present epoch in our universe is to be identified with the epoch in this model universe at which clustering of galaxies and of anti-galaxies has taken place, but at which there is yet no appreciable clustering of clusters and of anticlusters (13).

This is admittedly very hypothetical, but on the other hand there are observations interpreted by some (14) to indicate an apparent noninteraction of clusters which might be understood on the basis of such a model.

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10. This cosmic repulsion is of a different nature from the usual cosmic repulsion in that it does not vary directly with radius and in that it depends on boundary effects.
11. The boundary would actually be unstable against velocity dispersion to some degree.
12. Equation 1 can be obtained from a calculation at the boundary similar to a Madelung constant calculation or by considering the negative binding energy to result in a pressure which accelerates the boundary matter. From the latter, the constant $C = G a / 3$, where G is the gravitational constant and a is the Madelung constant.
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Observations on the Sexual Stage of *Colletotrichum orbiculare*

Abstract. An isolate of the fungus *Colletotrichum orbiculare* (syn. *C. lagenarium*) race 1 that forms perithecia in culture was isolated from edible gourd in North Carolina. This isolate has been identified as a species of *Glomerella*. The isolate produces very few ascospores when selfed; however, ascospores are produced in abundance when mated with certain other isolates of *C. orbiculare*.

An isolate of the cucurbit anthracnose fungus *Colletotrichum orbiculare* (syn. *C. lagenarium*), originally cul-