Beckman IR-7 spectrometer), the sample was irradiated at 20°K with the focused light from an AH-4 medium-pressure mercury lamp (without its glass envelope). After photolysis for a period of 3 hours, the infrared spectrum of the sample then showed a relatively sharp (half-width about 3.5 cm^{-1}) absorption at 580 cm^{-1} (optical density 0.19) and a second band at 236 cm^{-1} (optical density 0.04).

Supporting experiments show that these absorptions can be assigned to krypton difluoride. After 8 hours of photolysis of a fluorine-argon sample (without krypton), no absorptions can be detected. Analogous experiments with mixtures of fluorine, xenon, and argon produce xenon difluoride very readily. The spectrum of xenon tetrafluoride is also detectable in the spectrum of the irradiated matrix samples, but in amounts small compared with XeF_2.

The infrared absorptions of KrF_2 can be assigned as the asymmetric stretching and the bending modes of a linear, symmetric molecule. They imply force constants (*4*) $k_r\text{-}k_{rr} = 2.59$ mdy/Å and $k_\delta/l^2 = 0.21$ mdy/Å. These force constants are very close to those of XeF_2. This is a surprising result since it is implied that the bond energies in KrF_2 cannot be greatly different from those of XeF_2.

This work shows that the matrix technique is useful for preparing compounds of inert gases, and it may have unique value for those that are least stable. It is significant, perhaps, that no evidence could be obtained for an argon-fluorine compound by this method (*5*).

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4. The force constant notation is that used by Agron *et al.* in their treatment of XeF_2; see P. A. Agron, G. M. Begun, H. A. Levy, A. A. Mason, C. G. Jones, D. F. Smith, *Science* **139**, 842 (1963).
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14 May 1963

Marsilea vestita: Conversion of the Water Form to the Land Form by Darkness and by Far-Red Light

Abstract. *A period in darkness or in continuous far-red light can cause the ferns of the species* Marsilea vestita *Hook. and Grev. to develop as a land form in a medium which normally allows only the water form to develop. Far-red light is more effective than darkness in causing this conversion. The difference in the quality of light reaching plants growing in water or on land may cause this conversion to occur in nature.*

The fern *Marsilea,* like many other aquatic vascular plants, can exist as a land form or as a water form (Fig. 1*A*). The factors that determine which form will develop in nature have not yet been resolved. According to Allsopp the osmotic pressure of the cells of the plant is an important factor (*1*). Under conditions of low osmotic concentration—for example, in nutrient solutions with low glucose concentrations—the water form predominates; when the osmotic concentration of the solution is raised by addition of glucose, a land form develops. Bauer (*2*) obtained land forms of *Ranunculus aquatilis* under water by darkening terminal buds with black vaseline and then immersing the buds but not the leaves of the plants. If the leaves were also immersed the production of a land form depended on other factors. This variation in his results was most likely due to nutritional differences. If *Marsilea* are grown in exact nutrient media, nutritional differences can be ruled out, and the true effect of light on the form of the plant can be evaluated.

In order to study the effect of light on *Marsilea,* aseptic sporelings of *M. vestita* Hook. and Grev. were obtained by the method of Allsopp (*3*). These sporelings were allowed to develop a first leaf and root under weak fluorescent light. Then they were transferred to tubes containing 20 ml of White's nutrient (*4*) fortified with 5 percent sucrose. Plants kept in this medium under continuous fluorescent lighting (47 days) remained in the water form for the duration of the experiments.

The light energy at the level of the plants was 11,200 $\text{erg/cm}^2\ \text{sec}$ (*5*), and the tubes were slanted to expose the plants to the light. Plants placed in darkness or under far-red light became etiolated (*6*). These etiolated plants had certain characteristics of the land form—a large number of stomatal initials appeared on both sides of the leaf lamina and the petioles were thin and elongated, but they differed from both the land and the water form in that the leaf lamina did not expand and the rhizome was ageotropic. Unless

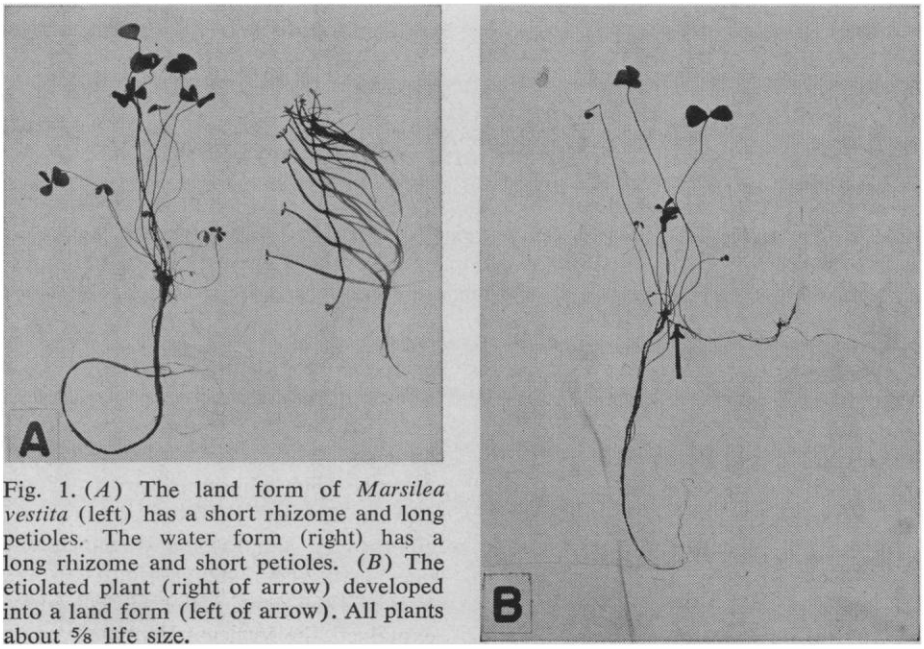

Fig. 1. (*A*) The land form of *Marsilea vestita* (left) has a short rhizome and long petioles. The water form (right) has a long rhizome and short petioles. (*B*) The etiolated plant (right of arrow) developed into a land form (left of arrow). All plants about ⅝ life size.

Table 1. Effect of darkness or far-red light in converting *Marsilea* sporelings to either water or land forms. After treatment with continuous far-red light or darkness, the sporelings were transferred to continuous fluorescent light. The results for dark-treated sporelings are averages of two experiments.

Time (days)	Cultures (No.)	Percentage: Water forms	Percentage: Land forms
Sporelings treated with darkness			
1	15	100	0
4	16	89	11
7	14	71	29
9	20	40	60
11	16	11	89
25	18	0	100
Sporelings treated with far-red light			
1	10	60	40
4	10	20	80
7	10	0	100
9	10	0	100
11	10	0	100
25	10	0	100

the plant was given red light (as supplied by the fluorescent lighting) it never developed into either the land or the water form.

Plants were placed in continuous darkness or under a continuous far-red light (4600 erg/cm^2 sec) for a varying number of days and then were placed under continuous fluorescent lighting for the remainder of the 47-day period. As the length of time in darkness or under far-red light increased, more of the etiolated plants developed as the land form upon return to red light (see Fig. 1*B*). Apparently etiolation results in some change such that the plants are converted from the water form to the land form.

Table 1 shows that far-red light is more effective in accomplishing this conversion than darkness. If 1 percent sucrose or ⅕ the normal concentration of minerals are used in the medium, much more darkness or far-red light is required to convert the plants. In the case of 1 percent sucrose darkness is not effective at all, and the plants remain in the water form.

According to James and Birge (*7*), light energy above 7000 Å may be rapidly absorbed by lake water. Thus lake water could act as a barrier to far-red radiation, and water forms of aquatic plants would then be growing in the absence of far-red light. Aquatic plants growing in shallow water or on land would be exposed to far-red radiation and would develop as land forms. Other environmental factors have some effect on this conversion (*8*).

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4. Iron supplied as NaFeEDTA as suggested by D. Sheat, B. Fletcher, H. Street, *New Phytologist* **58**, 128 (1959).
5. Light energy was measured with a large-area bolometer (Kurlbaum type) calibrated against a standard tungsten lamp (U.S. National Bureau of Standards). The far-red source consisted of two 25-watt incandescent bulbs whose radiation was filtered through 7 cm of water and six layers each of red and blue cellophane.
6. The etiolation of *Marsilea* under far-red light or in darkness and its reversal by red light were first described by W. Laetsch and W. Briggs, *Plant Physiol.* **37**, 142 (1962).
7. H. James and E. Birge, *Trans. Wisc. Acad. Sci.* **31**, 1 (1938).
8. I am grateful for the guidance and advice of R. Cleland and A. S. Foster. Photographs were made by the Scientific Photographic Laboratory, University of California, Berkeley.

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Mammalian X-Chromosome Action: Inactivation Limited in Spread and in Region of Origin

Abstract. *In its simplest form the hypothesis of the single-active-X chromosome does not explain variegated-type position effects in the mouse. Inactivity appears not to involve one entire X chromosome; furthermore, even those parts of the chromosome that can change to an inactive state spread inactivation not to the entire attached piece of autosome, but along a gradient to limited distances.*

Variegated-type (V-type) position effects from X-autosome translocations in the mouse have played a major role in development of the hypothesis of the single-active-X chromosome. Recent results from seven such translocations will be presented to show that this hypothesis is not valid in its simplest form (*1*).

V-type position effects were first reported by us in 1959 (*2*). Now, eight stocks of independent origin exist—seven of these (some radiation-induced, some spontaneous) at our laboratory (*1–5*) and one (induced with tri-ethylene melamine) in Edinburgh (*6*). All eight carry X-autosome translocations, one involving linkage-group (L.G.) VIII and the remainder L.G. I. We have explained the variegated phenotype by concluding that when an autosomal gene is transferred to the vicinity of portions of the X chromosome its action is suppressed in some cells of the body, thus allowing, in these cells, expression of a recessive allele present on the intact autosome. Evidence for this conclusion has been presented (*4*), particularly the proof that variegation is not due to any permanent change in the autosomal gene and the demonstration that the translocation does indeed involve the X chromosome. Cytological studies at mitotic metaphase indicate that all of the translocations are unequal. Meiotic metaphase studies are not possible since degeneration of spermatogenic elements occurs in pachytene (*4*).

More than one X chromosome has to be present for the expression of variegation (*3*). Thus, translocation heterozygotes without an additional X chromosome (XY males or XO females) are nonvariegated (*2–5*); conversely XXY males with the translocation are variegated (*6, 7*). This evidence, considered in conjunction with various cytological results in other mammals—namely, the single nature of the sex chromatin, the "n-1" rule for sex chromatin, and the difference between the two X's both in morphology at late prophase and in time of DNA synthesis—led us to suggest (*8*) that genic balance required the action of one X, leaving additional X chromosomes (or X-chromosome regions) to assume a heteropycnotic state; and that, in this state, they were able to exert a position effect on transposed autosomal genes. This idea of alternate states of X chromosomes is in keeping with Cooper's postulate that "heterochromatin" and "euchromatin" do not reflect underlying structural peculiarities, but portray temporal states of behavior related to the functioning of genes (*9*). Lyon later suggested that one or the other X, at random, becomes entirely inactive early in embryonic development, and she explained the position effects by assuming that the translocated autosome behaves completely like the X to which it is attached (*10*), as shown in Fig. 1*A*.

According to Lyon's explanation of the position effects, all of the recessives on the standard autosome should (on the average) be expressed in half the cells of the body. Thus for any given autosomal locus, variegation characteristics should be independent of the position of the X and autosomal break-