the students tell me things to do to the box (such as shake it) to give them some clues to its contents. Once that is done, we go over the items written on the board and cross out those we feel are not possibilities. A unanimous decision must be made before any item is eliminated.

Next the students are encouraged to ask me about any property of the item in the box (for example, does it float, write, burn?). After many questions, we again look at the board. By this time, the majority of the students are sure that they know what the item is. To them, they have established a "fact." With everyone in agreement about the box's contents, I lay it down and go about other business. But wait—the students want me to open the box to see if their "fact" was correct!

The point is emphasized that scientists often cannot get first-hand information about a phenomenon. Many scientific facts are gotten from hypotheses, observations, and experimentation: such are the workings of science.

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AMITOSIS IN *NITELLA AXILLARIS*

Most biology textbooks and courses give extensive details of mitosis and meiosis but amitosis, a relatively uncommon type of nuclear division, is rarely discussed. Amitosis is a type of vegetative nuclear division that does not involve a typical mitosis. Shen (1967) has indicated that amitosis is probably a means of increasing the DNA content and nuclear surface area. In this study amitosis was observed in the vegetative cells of *Nitella axillaris.*

Nitella plants (which can be obtained from most biological supply companies) were grown in the laboratory under continuous illumination in soil extract medium made from garden soil (Green 1958). Small vegetative cells were removed and permanent slides prepared by a modification of the aceto-orcein squash method suggested by Darlington and La Cour (1970):

1. Remove the vegetative cells and fix for 24 hours in Carnoy's fluid (3 parts absolute alcohol and 1 part glacial acetic acid).

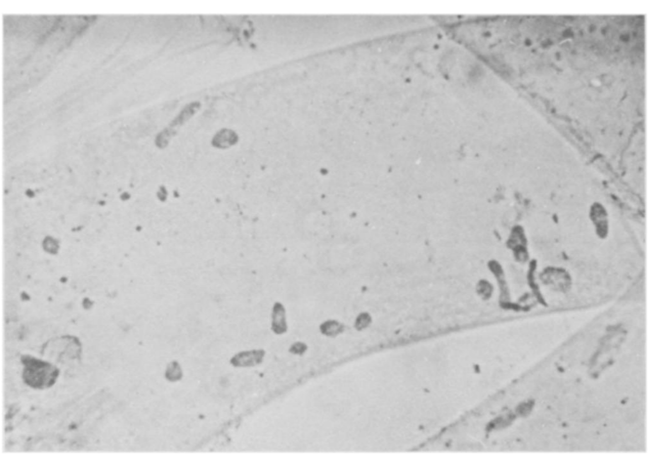

Fig 1. Vegetative cell of *Nitella* with several nuclei in different stages of amitotic nuclear division.

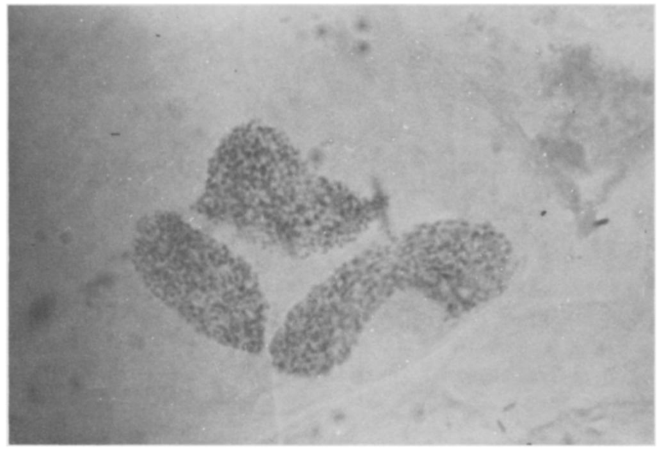

Fig 2. Three nuclei in early stages of amitotic nuclear division.

2. Wash in 40% acetic acid.
3. Transfer to a slide and immerse in 2% aceto-orcein stain (available from Turtox Co., Chicago).
4. Position a coverslip and carefully pass over an alcohol flame.
5. Place between sheets of bibulous paper and squash carefully.
6. Place the slide on the surface of dry ice. The slide and cover slip readily separate on contact with the dry ice for a few minutes.
7. Dehydrate through an alcohol series 50%, 70%, 90% and two rinses in absolute alcohol with the slide and cover slip separated.
8. Clear in xylene.
9. Mount with a drop of Canada balsam.
10. Dry at room temperature for a few days. The slides are now ready for study.

When the slides are studied under the microscope several nuclei at various stages of amitotic nuclear division can be observed (fig. 1). Several particulate structures that are DNA positive can be seen when the stained cells are examined (fig. 2). However there is no evidence of organized chromosomes. Wilson (1928) suggests two types of nuclear division: one where the two parts of the nucleus draw apart, and the other by

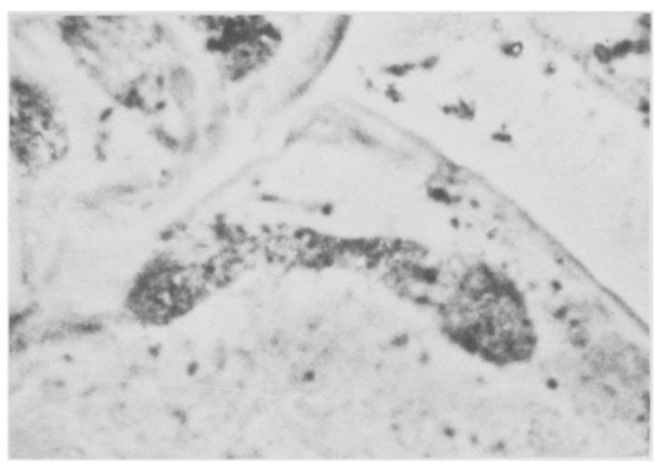

Fig 3. A single nucleus in a late stage of amitotic nuclear division.

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the formation of transverse partitions. In *Nitella axillaris* a central constriction appears, which gradually draws apart forming a neck-like region before splitting in two (fig. 3). Amitosis is never followed by cytokinesis.

The possible role of microtubules in amitotic nuclear division has been suggested (Mole Bajer 1965, Pickett-Heaps 1967); however, the exact mechanism of amitotic nuclear division is not clearly understood. The significance of amitotic nuclear division to a plant or animal has not been explained.

Amitosis represents a relatively uncommon type of nuclear division that remains a little-understood nuclear phenomenon.

Acknowledgement.—This paper is part of a more detailed research study by the author and James C. W. Chen, "Chromosome analysis and amitotic nuclear division in *Nitella axillaris*" which will be appearing in *Cytologia: International Journal of Cytology.*

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SOME ADDITIONAL APPLICATIONS OF THE POPULATION SAMPLING BOARD

The idea of a population sampling board, introduced by Jerry L. Wilhm in 1967 *(ABT* 29 [6]:471), can be used to introduce students to methods of designating sampling plots and applying some statistical tests. Wilhm pointed out how this board can be used to demonstrate the concept of numerical distribution patterns in populations. His original sampling board contained data on a population of benthic macroinvertebrates taken from 100 dredged samples from a coldwater stream. The data board consisted of 100 squares, with data from one sample entered in a corresponding square.

Last summer in the NSF (COSIP-C) program for two-year college biology instructors carried out on our campus, I offered the biometrics part of a combined aquatic biology–biometrics course. We had occasion to employ the sampling board of Wilhm, and we also discovered some additional techniques which may have wide application.

The spatial dispersion of a population describes the distribution of the individuals in the population. Types of dispersion often vary with different species within a population as well as within a given species. In addition, patterns often change with time.

In general, three basic types of patterns occur: (i) random, in which there appears to be no pattern to the dispersion; (ii) regular, a uniform or even distribution of the population in which each sample square contains approximately the same number of pieces of data and the data is equally spaced in each square; and (iii) contagious, a situation in which the population has a tendency to clump in patches scattered throughout the various sample squares (as would happen in the case of the spread of an epidemic).

Three mathematical formulas describe each of these types of dispersion respectively: the Poisson distribution, the positive binomial distribution, and the negative binomial distribution. Elliott (1973) gives a rather extensive discussion of each of these types and also shows with examples how to employ chi-square tests to determine if data gathered from a number of adjacent plots actually "fit" one of these dispersion patterns. All of the tests Elliott uses can be applied to the data on the population sampling board.

In our sampling board we had the following data for our 100 squares:

1 square contained 3 different species
13 squares contained 4 different species each
29 squares contained 5 different species each
31 squares contained 6 different species each
20 squares contained 7 different species each
6 squares contained 8 different species each

To determine if the number of species in our sample data was randomly distributed throughout the 100 squares, we used the Poisson distribution. We checked our data for agreement to a Poisson (random) distribution at the 5% level and rejected the hypothesis that our data were randomly distributed. Thus, we suspected that the number of species per sample was subject to some type of pattern, either a uniform or clumped one. Similar tests are discussed by Elliott (1973) which can be used to determine if data indicate a uniform or clumped population.

An additional test for random distribution has great intuitive appeal to students. In this process, the number of 100 sample plots on the data board that contain 0, 1, 2, 3, 4, and so on, of the desired species are counted. The frequency of occurrence of these different numbers can then be checked against the predicted frequencies of a Poisson distribution via a chi-square test for goodness of fit. An excellent discussion of this method appears in Schefler (1969). We applied this technique to our data, and because our data value, chi square 36.28, is greater than 9.49, we again concluded that our data did not fit a Poisson distribution. Note that both of our methods led to the conclusion that our data were not randomly distributed.

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