ter cells and form the nebenkern. Telokinetic movements can be followed. The young spermatid cells have short axial filaments. These can be seen to elongate and become the tails of the more mature spermatids. The long tails can be traced from the heads down toward the open end of the follicle. The tails are in groups and are more or less intertwined. The aggregation of the sperm into bundles can be studied, as well as the movement of the bundle to the open end of the follicle.

Preparations of crickets and beetles have been set up, with slight modifications of the technique. It is best to mount a cricket with the back flat on the slide. The follicles are shorter and the cells are smaller, but they may be studied by using the above-described method.

We have been able in a few months to see most of the characteristic structures and to follow many of the activities of the *living* germ cell, in a state that very nearly approaches the normal condition. We anticipate that our continued efforts will bring out other important data. It may not be too optimistic a viewpoint to expect the solution of some knotty problems in chromosome behavior and spermatid transformation by the use of this method. With such a hope we are offering the details of the method to other investigators.

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A RAPID POSITIVE CONTROL METHOD OF HANDLING SMALL QUANTITIES OF LIQUIDS

FOR a certain experiment here there was needed a means of adding small quantities of liquids that would make it possible to secure more positive and satisfactory control than is afforded by any ordinary pipette or burette. The final design of the special tube or pipette for this purpose is shown in Fig. 1. As is at once apparent, the pipette substitutes a mercury plunger or piston for the usual rubber bulb or the rubber tube connected with the mouth. By inclining the pipette at an angle such as indicated and rotating it until the mercury has filled bulb N the air on the N side is crowded out at the tip. If now the tube, still at the same angle, is inserted into the liquid supply and rotated about its own axis until the mercury runs from N into the bulb M the liquid will be drawn up into the pipette to a height depending on both the angle of inclination and the amount of rotation, each of these conditions being subject to definite control individually. Scratches on the tube corresponding to volumes desired for particular work make the tube suitable for quantitative work. To expel any quantity of the liquid from one drop to the entire quantity contained one has but to rotate the pipette in the reverse direction, the mercury flowing back into N and crowding out the liquid to an extent positively controlled by either the inclination or the rotation, or both.

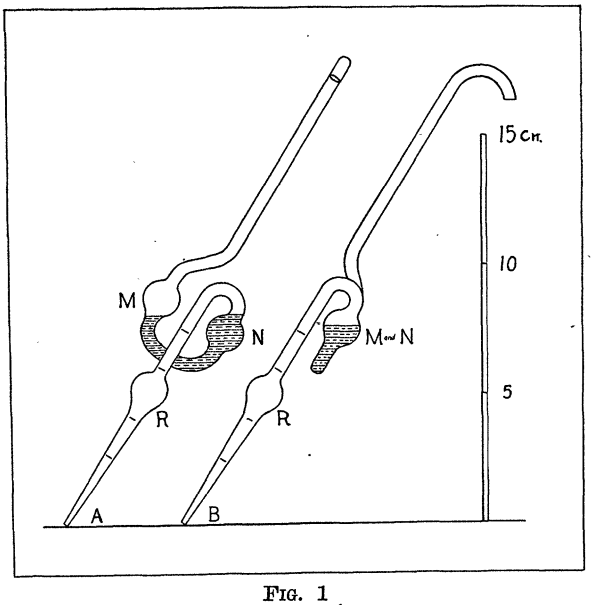

FIG. 1.

Compared to a burette in handling small quantities of liquids it is much more quickly filled and emptied and involves none of the uncertainties of either a stopcock or a pinch-cock. It is superior to any type of pipette operated by suction from the mouth, directly or through a short length of rubber tubing, for it eliminates any chance of fumes or liquids being inadvertently drawn into the mouth, as well as all danger of mouth or breath moisture contaminating the pipette, and relieves the user of the rather unpleasant and often inconvenient, if not unsanitary, use of his mouth.

On many grounds it is to be preferred to a pipette using a rubber bulb, particularly where definite quantities are required. When using a rubber bulb one is never sure just how much it should be squeezed in order to get the precise quantity needed—if too little, one has to begin over; if too much, one has to remove it from the liquid before it is fully distended and then allow air to bubble through the liquid, spraying the same into the bulb, or else must maintain the pressure on the bulb just so until the liquid is ejected. Rubber bulbs become contaminated and the contamination is invisible. They are flabby, often leaky, and offer uncertain control of the position of the tip of the pipette, in contrast with the rigidity of the new type. In using ordinary pipettes the heat of the hand is likely in the case of volatile liquids to cause a vapor

pressure so high as to expel the liquid from the pipette prematurely. In the new pipette the heat of the hand can have no effect whatever as the upper end is open. It is obvious, also, that a pipette of the new type may be easily cleaned. It should be stated that the bend at the upper end, though neither necessary nor given originally, was later added to make it possible either to hang it up or lay it on the table without involving any contamination of either its tip or of the table, for the bent portion is just long enough to make the tip incline downward, but not long enough to cause it to touch the table.

Inasmuch as pipettes of this new type have already found a place in three departments here it is thought to be of sufficient general use to justify passing the idea on to others.

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SPECIAL ARTICLES

EXCESSIVE TAX ON SOIL FERTILITY BY CROP PRODUCTION ON POOR LAND

"UNTO him that hath shall be given—from him that hath not shall be taken away even that which he hath." The above verse of Scripture finds further verification in the larger amounts of certain essential nutrients exacted from the soil by some plants, among them such important cereals as wheat and barley, per unit weight of mature crop grown on poor land than if grown on rich soil. That a soil markedly deficient in available phosphorus or nitrogen must supply more of these elements for the production of a unit weight of wheat or barley grain than is required from a soil fairly rich but not oversupplied with these elements lies in the relationship which the supply and absorption of given quantities of essential elements at various growth periods of the plant have to yield.

It appears from the standpoint of plant nutrition that the conditions which determine crop production can be reduced to three general considerations or factors. They are: (1) the minimum requirement (quantity) of each essential element needed to produce a unit quantity (weight) of mature plant and of its differentiated products, for example, in cereals —grain, straw and roots; (2) the time required for the soil (or other growth medium) to supply given amounts of each essential element and for it to be absorbed by the plant at given growth stages; (3) the length of time required for a given quantity of each essential element after it is absorbed to function to completion in the processes for which it is required and to attain the minimum percentage in the mature plant product of which it becomes a part.

The values of each of these three factors are different with the elements concerned. For example, the amount of phosphorus required to produce a given quantity of wheat grain is different (smaller) than that of nitrogen. The time required for a soil to provide a given unit quantity of available phosphorus to wheat plants is much longer (except in rare cases) than that required for nitrogen. The time required for a unit quantity of phosphorus, after it is absorbed by the wheat plants, to function to completion, that is, for the plant to increase in weight until the quantity becomes the limiting factor to growth, is much longer than that for nitrogen. The values of each of the above three factors are different among plant species; they also vary among varieties of any given species.

The time required for a poor soil to supply plants, for instance, wheat, with a given quantity of a given plant food—phosphorus, for instance—is different (longer) than it is in the case of a soil that is fertile as to this element. This difference projects the time when equal quantities are absorbed by plants grown on such different soils much later in the growth development of the plants grown on the poor soil than in the case of those grown on a rich soil. But as the total growth period of many plants is largely fixed by their genetic constitution—although the actual growth period varies more or less with soils and climatic conditions—it follows that the developmental stage obtained when equal quantities of an element are absorbed by plants grown on such different soils would be much nearer to the period of maturation for those grown on poor soils than those grown on the rich soils. As a specified yield requires a quantity of each essential element, which can not be less than that indicated by the product of the weight of the mature plant times the minimum percentage of such element in the product, it follows that the time required for a plant to absorb that quantity when grown on a poor soil would much more restrict the time remaining for utilization of that material than would be the case if the plant was grown on a rich soil.

The maximum utilization, or growth, or increase in weight—whatever term is desired to express the phenomenon of the additions to the weight of a plant by the absorption of elements subsequently to the time a specified quantity of a given element was contained in the plant—is obtained when the given specified quantity enters the rôle of a limiting factor. The element attains its minimum percentage when the maximum amount of other elements have been combined with it,