make it available to any one interested. It is hoped that a large amount of duplication of effort can be avoided in this way.

UNIVERSITY AND EDUCATIONAL NOTES

THE will of the late John McMullen, of Norwalk, Conn., and New York, was upheld by a jury in the Superior Court on February 7. A compromise was reached, but no details were given out. Under the will the bulk of the $2,000,000 estate goes to Cornell University.

MR. DAN RADCLIFFE, the shipowner, of Cardiff, has promised to give £50,000 in 3½ per cents. for the benefit of the University of Wales in honor of the Prince of Wales.

DR. THOMAS STOCKHAM BAKER, formerly professor of German in the Johns Hopkins University and director of the Jacob Tome Institute, has been elected president of the Carnegie Institute of Technology, where he has been since 1919 secretary of the institute and acting president since the resignation a year ago of Dr. A. A. Hamerschlag.

DR. OTTO M. SMITH, formerly in charge of research for the Roseville Chemical Company, Roseville, Indiana, has been appointed assistant professor in quantitative chemistry at Iowa State College.

PROFESSOR F. TRENDELENBURG, of Tübingen, has refused a call to the University of Berlin to serve as the successor of Rubner for the chair of physiology. A call has been sent to Dr. Franz Hofmann, of Bonn.

PROFESSOR H. POLL, of the University of Berlin, has been appointed professor of general biology and the theory of heredity.

DR. POTTEVAN, senator, has been elected professor of general hygiene in its relations to industry in the Paris Conservatoire National des Arts et Métiers.

DISCUSSION AND CORRESPONDENCE

REACTION TIME AND FATIGUE

THE personal equation in star transits is due to the coordination of eye, hand and brain of the observer. Its absolute amount is difficult to determine, as artificial transits must always lack some features of the usual observing conditions. Fortunately it does not affect most of our right ascension results, since they are derived from the differences of transits, in which the effect is eliminated, if it is constant. In longitude campaigns, also, the difference of personal equations can be eliminated by exchanging stations.

We can not determine absolute clock corrections, nor absolute clock rates without taking account of personal equation and its constancy. For the mean daily rate of a clock, derived from successive observations of the same stars, the equation eliminates, if it is constant. For hourly rates, derived from successive clock corrections during a night, the question of variability of personal equation needs consideration. Variation might be produced by fatigue or other physical conditions.

There are traditional stories in astronomical practice of observers who indulged in the excessive use of strong stimulants, such as coffee, in excessive smoking and, possibly, taking into account the origin of these stories, in *Pilsener* for the contrary reflex, and then proceeded to determine the effects upon observations. Large accidental variations would be anticipated, rather than systematic changes, with such abnormal deviations from the habits of rational observing.

In the series of observations recently completed here for the purpose of testing a possible diurnal periodic term in clock performance, the test of change in personal equation emerges as a by-product. The test is a delicate one, and it is only by assembling a relatively large mass of material that a reliable conclusion can be reached.

Six hours of continuous observing have been included on each of twenty-four nights during a complete year, nearly two thousand transits in all. For the usual night of about four hours' interval no sensible amount of physical or mental fatigue is commonly experienced. Perhaps it is the consequence of more than forty years of observing that renders an observer sensitive to real fatigue at the close of six hours of work. Ordinarily it would not be considered wise to continue work when the precision of the results might be affected by physical conditions, but the requirements of this special problem made it advisable to use these long periods.

In the closing error of a cycle of observed clock rates, where each pair of successive hours of right ascension has been employed, with invariably the same stars in each hour, there are four conditions to consider, as influencing the results.

The errors of the adopted right ascensions enter every computed hourly rate, but these errors are completely eliminated in summing up the cycle.

Progressive change in instrumental corrections would produce progressive changes in computed clock rates, if undetected, and the performance of the meridian instrument has consequently received careful and rigorous treatment in this special series.

The difference between clock corrections observed at sunset and sunrise may be due to special conditions affecting the observed results at these two epochs of the day, or to a diurnal variation in the clock rate.

Progressive change in personal equation during the night would produce a computed change of observed clock rates.

The closing error of this series will be assumed to be due to either one or both of the last two conditions enumerated.

The summation of the observed clock rates gives the following means for successive pairs of hours from 9 P. M. to 3 A. M. The means are the excesses of observed hourly rates over the average daily rates of the clock at the corresponding epochs.

	s.
First two hours, excess	−0.002
Second two hours, excess	−0.003
Third two hours, excess	+0.005
Fourth two hours, excess	+0.005
Fifth two hours, excess	−0.000
Mean	+0.001
Average	±0.003

The probable error of observation for a rate from two successive hours, as summed up, is $\pm 0.^{s}002$. The deviations from the mean of all are evidently fortuitous and there is no real progressive change such as would be due to the effect of fatigue or to periodic variation of the clock rate, unless these two effects balance each other.

The constancy of the reaction time, assuming uniform performance of the clock, should interest psychologists and physiologists, and the measure of its variations within errors of less than one one-hundredth of a second can be confirmed by other observers.

R. H. TUCKER

LICK OBSERVATORY

PHYSIOLOGY OF STOMATA OF RUMEX PATIENTIA

THE behavior of the stomata of *Rumex patientia* has been studied for the past two years and, although the work has not been completed, the data at hand are sufficient to warrant the following conclusions:

1. The stomata close completely at night and check water loss from the intercellular spaces of the leaf.

2. When open the stomata modify the rate of water loss from the intercellular spaces of the leaf in proportion to changes in their perimeters, not to changes in their areas.

3. Light is the most important environmental factor, while acidity and the amount of water in the guard cells are the two internal conditions directly concerned with stomatal movements.

4. The guard cells contain green plastids which are structurally, physiologically and genetically different from the chloroplasts of the mesophyll.

5. The starch-sugar change in the guard cells is an equilibrium reaction and the point of equilibrium is shifted by changes in acidity. The guard cells change in acidity more readily than the mesophyll cells because their buffer content is low.

6. The series of changes which result in the opening of the stomata is as follows:

(*a*) In the morning the light changes the acidity of the guard cells.

(*b*) This change in acidity makes conditions more favorable for the hydrolytic action of diastase.

(*c*) The diastase in the guard cells changes the starch to sugar.

(*d*) The formation of sugar results in an increase in the osmotic pressure of the guard cells.

(*e*) Water enters the guard cells from the epidermal cells which do not change in pressure and causes them to swell.

(*f*) The swelling of the guard cells causes them to open because the thickened cell wall