with a vengeance was permitted to disappear 'in the thick woods,' after adjusting and hardening his clay cast. Could the creature have been captured, we venture to affirm that he would have been eligible to a chair of surgery in one of our leading medical schools, and a phenomenally rapid progress of the science would have been insured.

Mr. Long does not rely entirely on the hazy reminiscences of his boyhood. A brace of reminiscing 'gunners' is introduced and another surgical genius among woodcocks, who, though deeply versed in osteogenesis, must have been singularly ignorant of such comparatively simple mechanisms as firearms or he could hardly have come to such an ignominious end as hanging in a market. This bird, unfortunately, had mud on both legs, though only one of them had been injured. It is surprising that Mr. Long supplies so obvious an explanation of the presence of mud on the sound leg. As he seems to set considerable store by this woodcock anecdote, we suggest that in future editions of his work he discard so commonplace an explanation and adopt one more in harmony with the remainder of his story. Thus he might state that the fracture occurred while the bird was sojourning in a country of unusual geological formation. He was unacquainted with the physical qualities of the mud in that particular region, so that before making the cast for his fracture he made an experimental cast for his sound leg in order to test the cohesive properties of the substance.

The heavy artillery of Mr. Long's proof is the concluding reminiscence of a lawyer 'known all over' the vast state of Connecticut. Again, from a dead bird, which in this instance he has not even seen, he not only infers what the living bird had done, but he indulges in some vaticination as to what the bird 'undoubtedly' would have done had he escaped death or, in other words, evolved from his inner consciousness as clear a knowledge of firearms and explosives as of fractures and casts. Since an ounce of prophylaxis is worth at least a pound of cure, it is rather surprising that the wise woodcocks should spend so much time making casts for their broken limbs instead of keeping out of the reach of gunners.

In last analysis the whole fanciful anecdote is seen to be built on the finding of mud on the legs of a couple of dead woodcocks. In both cases the mud had accumulated at a healed fracture, not at all an unlikely occurrence in mud-frequenting birds. In the whole passage one looks in vain for a particle of authentic proof that the woodcock possesses any chirurgical knowledge or skill whatsoever. Before publishing his article, Mr. Long should have consulted his legal acquaintance on the evidential value of boyhood reminiscences and the tales of sportsmen. He seems really to put implicit confidence in all sorts of hunting and fishing yarns, even when they fall from the lips of lawyers known all over the state of Connecticut. The careful reader of the paper can see between the lines the sly, mirthful twinkle in the eyes of some of these old gunners to whom Mr. Long seems to be continually running for confirmation and amplification of his vagaries.

The passage above quoted is a fair sample of not a little of the literature that is being recommended by teachers and publishers as collateral reading for the pupils of the 'nature study' classes of our schools. Such reading is fondly supposed to afford both instruction and entertainment. That it furnishes instruction can be flatly denied, for it lacks truth, the first requisite of instructive reading. It is bad even as fiction. Amusement it undoubtedly furnishes—more, in fact, than the authors contemplate, since it not only titillates the fancy of the boys and girls, but adds to the gayety of comparative psychologists. Those who are attacking the fads of our educational system will find plenty of work awaiting them as soon as they turn their attention to the excrescences of 'nature study.'

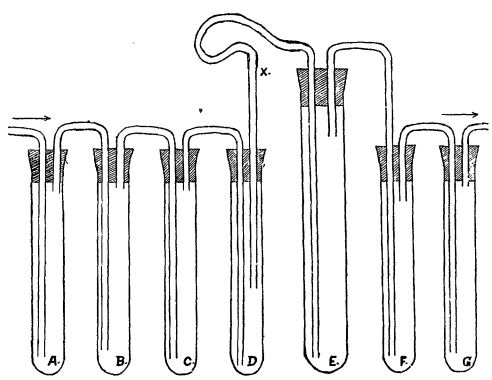
William Morton Wheeler.

SPECIAL ARTICLES.

RHYTHMS OF CO_2 PRODUCTION DURING CLEAVAGE.

The wonderful sequence of morphological changes in indirect cell division is a subject of perennial interest to biologists. The visible changes are generally recognized to be the

expressions of different physiological states. As a means of gaining further insight into the physiological conditions underlying cleavage, I adopted the plan two years ago of testing the susceptibility of the egg at different stages in the first cleavage. Potassium cyanide was used; also lack of oxygen produced by a current of hydrogen. A rhythm of alternate susceptibility and resistance was demonstrated. About ten or fifteen minutes after fertilization the echinoderm egg is very easily poisoned by KCN. The resistance increases from that time to about the time of the first cleavage. A period of susceptibility follows; then another rise of resistance as the second cleavage approaches. Probably this rhythm goes on in each subsequent division. The rhythm to lack of oxygen is similar. This makes it probable that the cell needs oxygen, especially in the period immediately following division, this being the time of nuclear growth and presumably of active synthesis.



During the last summer I have been working on the effects of heat and cold on the dividing egg. The experiments show well-marked rhythms of susceptibility and resistance during each cleavage. The details will be published later.

While pursuing this work it occurred to me that the production of CO_2 during cell division might also run in rhythms. The question seemed one of sufficient interest to warrant a careful investigation. Unfortunately apparatus for accurate chemical analysis was not available at Woods Hole. Furthermore, the season had so far advanced that only comparatively small quantities of *Arbacia* eggs were obtainable. It seems best, therefore, to put my results in the form of a preliminary publication, it being understood that the conclusions are tentative and subject to revision on further experimentation.

The apparatus finally adopted is shown in the diagram. Positive pressure forced air in the direction of the arrows. The test-tubes were tightly closed with rubber stoppers. Tubes *A* and *B* contained KOH solution to absorb the CO_2 of the air. Tube *C* contained $Ba(OH)_2$ solution and served as an indicator of the efficient action of *A* and *B*. *D* contained *Arbacia* sperm in sea water. *E* contained the unfertilized eggs of a large number of females, in sea water. These eggs had been carefully freed from body liquids and from immature ova by allowing them several times to sink through sterile, filtered sea water in test-tubes or Naples jars. Tube *E* was kept at a constant temperature, usually 23°. Tubes *F* and *G* contained $Ba(OH)_2$ solution whose degree of turbidity constituted an index of the amount of CO_2 produced by the eggs and sperm.

Before the experiment began the egg tube was nearly filled with sterile sea water and a current of air free from CO_2 passed through for several hours. Tube *D*, which meanwhile had been empty, now received a few cubic centimeters of sea water containing fresh sperm. The eggs, recently washed, were added (with as little water as possible) to the water in *E*. The air was allowed to pass for fifteen or twenty minutes. Then measured amounts of $Ba(OH)_2$ solution were placed in *F* and *G*, the air current being continued. After ten minutes the eggs were fertilized and fresh tubes substituted for *F* and *G*, the first two being securely closed with rubber stoppers and labelled '0.' Every ten minutes fresh tubes were substituted at *F* and *G*, those used during the ten minutes following fertilization being numbered '1,' and so on.

It was found that in ten minutes either before or after fertilization tube *F* became visibly turbid. On standing, a precipitate of $BaCO_3$ formed. Tube *G* showed little or no turbidity or precipitate and, therefore, was usually disregarded. In some experiments

fifteen or twenty-minute periods were used instead of ten-minute periods.

Fertilization of the eggs was accomplished in the following manner: The tube marked *X* was pushed down into the sperm. The latter was, therefore, immediately forced over by the air pressure and mixed with the eggs. Fertilization was usually very perfect and cleavage, so far as I could determine, went on in a normal way, provided sufficient air was forced through. In one experiment the current of air equalled 25 c.c. per minute. One difficulty experienced was the maintenance of a uniform current. This is a possible source of error.

The experiment was continued usually about two hours, or over two or three cleavages. In one case it was continued until swimming blastulæ had formed.

It will be noted that tubes '0' contained the CO_2 produced by both the sperm and unfertilized eggs during ten minutes. A single trial indicated the probability that the larger proportion of CO_2 was due to the sperm, probably because of their motility. Tubes '1,' on the other hand, contained the CO_2 produced in ten minutes by the fertilized eggs and the *unused sperm.*

It is, therefore, plain that no accurate comparisons of the CO_2 production of unfertilized and fertilized eggs, and no measurement of the CO_2 produced by the eggs in either condition, can be made until the CO_2 production of the sperm has been ascertained. This has not yet been done.

The results so far apparent may be briefly stated. It appeared in nearly all the experiments that an increase in CO_2 production occurred in the first ten- or fifteen-minute interval following fertilization. The increase was slight and sometimes could not be detected. Following this came an interval in which the CO_2 production was small, visibly less, indeed, in two or three experiments than that of the unfertilized eggs and sperm. This is the mid-period of cleavage, approximating, perhaps, the time of nuclear growth and the early stages of karyokinesis.

The interval during which the eggs were actively dividing into the first two blastomeres (say 45 to 60 minutes after fertilization) was one of active CO_2 production. In nearly every experiment the barium hydrate tubes for this time became markedly turbid as compared with any others. After this period of greater CO_2 production came an interval of lessened production. In one or two cases a second rise occurred at about the time of the second cleavage. Presumably a regular pendulum swing of increased and decreased CO_2 production occurred in the successive cleavages.

If this rhythm proves, on further investigation, to be constant, we have in the segmenting egg an interesting demonstration of the principle that oxygen consumption and CO_2 production are not parallel and concomitant processes. Pasteur's yeast experiment shows well that abundant oxygen leads to synthesis and growth, and little CO_2 is excreted. Lack of oxygen, on the other hand, means fermentation and a large production of gas. In my experiments the time of maximum oxygen need was apparently one of only moderate CO_2 production, while the period of maximum CO_2 production was really the period of least demand for oxygen. In other words, the CO_2 produced in cleavage seems to be largely the result of splitting or fermentative processes and not of direct oxidation.

Another fact clearly indicated was the increase in CO_2 production as development progresses. By the time the eggs have reached the blastula stage, even before they begin to swim, they produce much more CO_2 per hour than in earlier stages.

An effort was made to determine the CO_2 production quantitatively. At Dr. Mathew's suggestion the $BaCO_3$ in tube *F* was allowed to settle; measured samples of the supernatant liquid were drawn off and titrated with *m*/20 oxalic acid. Phenophthalein was used as an indicator. Enough was done to indicate the applicability of the method.

As indicated earlier in the paper, I do not consider the results so far obtained conclusive. But by the application of refined methods the problem can be solved. I hope at some future time to work out a modification of Blackman's* or Fletcher's† apparatus which may be appli-

* Blackman, *Philosophical Transactions*, Vol. 186, 1895.

† Fletcher, *Jour. of Physiol.*, Vol. 23, 1898.

cable to the conditions. It will also be necessary to command larger quantities of eggs. In this connection it may be worth mentioning that in one experiment the number of eggs used was estimated at 17,850,000. The method consisted in diluting 1 c.c. of eggs to 100 c.c. and then counting the eggs in ten drops, which equaled .4 c.c. This number seems large and several hundred animals were opened to obtain them; but from a single ripe sea urchin at the height of the season was taken a mass of eggs estimated at 4,600,000. Thus by working at the proper time of the year it will be easily possible to obtain ten times the number of eggs I was able to get for these experiments.

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CURRENT NOTES ON METEOROLOGY.

CLIMATOLOGY OF CALIFORNIA.

CALIFORNIA has the good fortune to have its climate discussed in considerable detail in 'Bulletin L' of the Weather Bureau (Climatology of California, by Professor A. G. McAdie). In fact this is the most complete tabulation hitherto published of the climatic data of any single state in the union. The 'Bulletin' numbers 270 pages, and is illustrated by means of numerous charts, curves and half-tone views. After a consideration of the controlling factors of the climate (pressure, storms, topography, etc.), there follow tabulated data and brief discussions of the climate of individual localities. Much of the report is naturally tabular. In some cases the tabulation is remarkably complete, as in the case of San Francisco, for example, where the daily rainfall is given for the period January 1, 1865, to March 19, 1902. Persons interested in obtaining meteorological data for California will find this report of great service. A good deal of the present 'Bulletin' has appeared in separate instalments in the *Monthly Review of the California Climate and Crop Service,* and it is a great convenience to teachers, and all others interested, to have the matter collected in one volume. Special reports on frost, fog and thunder-storms are found at the end of the 'Bulletin.'

SKY COLORS AND ATMOSPHERIC CIRCULATION.

IN *Nature* for December 24, Mr. A. L. Rotch, of Blue Hill Observatory, calls attention to the fact that the occurrence of Bishop's ring and of abnormal glows after sunset, observed at Blue Hill during the past year, was intermittent, and that the respective phenomena occurred at Blue Hill about twenty days later than they did in Switzerland. Assuming that the conclusions are approximately correct, the drift of the dust clouds from central Europe to the eastern United States was at the rate of about thirty miles an hour, or a good deal less than the velocity of the highest clouds. The importance of such studies in connection with the general circulation of the atmosphere is great, and the suggestion made by Mr. Rotch, that a committee, like the Krakatoa Committee of 1884, undertake an investigation of the recent sky colorations, will have the support of all meteorologists. In *Nature* for January 21, Mr. H. H. Clayton calls attention to the steadily diminishing size of the new Bishop's ring around the sun, as determined by measurements made at Blue Hill Observatory.

WEATHER FOLK-LORE.

UNDER the title 'Weather Folk-Lore and Local Weather Signs,' the Weather Bureau has recently published 'Bulletin No. 33' (8vo, 1903, pp. 153), prepared by Professor E. B. Garriott. The object of the 'Bulletin' is to collect the weather proverbs and sayings that are applicable to the United States, and to combine with these the local prognostics noted by observers of the Weather Bureau at the different stations over the United States. Persons who are interested in weather proverbs will find abundant material in this collection. The proverbs are grouped by subjects, as temperature, clouds, humidity, barometer, etc., often, however, rather haphazardly, as when we find under 'The physiological effects on animal life of changes of pressure' the saying 'smoke falls to the ground preceding rain.' There are several extracts from daily newspapers which, unless the writers of the articles referred to are persons of scientific standing, are out of place in an official publication of