in regard to the real character of Mr. Long's efforts to reveal 'a vast realm of nature outside the realm of science' in 'ideas above and beyond the world of facts'?

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THE METRIC SYSTEM.

TO THE EDITOR OF SCIENCE: It is now years since the metric system has been authorized and permitted in this country and yet very little progress has been made in its practical introduction. We still labor with the old system. We can never tell in statistics or contracts what a ton of coal means (long or short) unless it is explicitly stated. And so in water analyses, they are stated in three or four different ways, so that it is hard to compare them. Even if we know they are in grains per gallon, it remains to be determined whether the gallon is imperial or U. S.

Allow me to suggest a method of introducing the metric system which might meet much less friction and meet all practical purposes.

The proposed legislation would be as follows:

1. On and after January 1, 1906, the U. S. standard ton shall be the metric ton, which shall contain 2,000 U. S. standard pounds, each of which shall contain 16 U. S. standard ounces. No other ounce, pound or ton weights, or weights purporting to be fractions or multiples thereof, shall be used under penalty.

2. The U. S. standard pint shall be the volume of one U. S. standard pound of pure water under certain conditions of temperature and pressure, and shall be equivalent to one-half liter. A quart shall be two such pints, and a gallon four such quarts, and a peck eight such quarts, and a bushel thirty-two such quarts, and no other measure of volume shall be permitted, the distinction between fluid and dry measure being abolished.

3.* The U. S. standard foot shall be the length of the edge of a cube which shall contain 1,000 U. S. standard ounces of water under certain conditions of temperature and pressure, *i. e.*, 62.5 U. S. standard pints. The popular use of the terms would not need be changed *at all*, and the actual change of units would be so slight (ten per cent. or less) that it would not popularly be noticed, as may appear from the following table:

United States Standard.							Metric.
.985	present	ton	=	1	proposed ton	=	1 metric ton.
1.102	"	pounds	=	1	" pound	=	½ Kilo., German 'Pfund.'
1.102	"	ounces	=	1	" ounce	=	1/32 Kilo. = 31¼ grams.
1.05671	"	liquid pints	=	1	" pint	=	½ liter.
.9081	"	dry pint	=	1	" quart	=	1 liter
.9081	"	" bushel	=	1	" bushel	=	32 liters.
1.05671	"	liquid gallons	=	1	" gallon	=	4 "
.984	"	foot	=	1	" foot	=	25 3/2 cm. or 315 cm.

Moreover, the old proverb, 'A pint is a pound the world around,' will be strictly true, and in water analyses a nickel's weight in a pint will be the same as an ounce per cubic foot and, specific gravity apart, the same as parts per thousand.

Especially in ending the long wrangle over various tons, I think the proposed changes would be decided improvements, and the differences between wet and dry measure should be abandoned.

ALFRED C. LANE.

SEX DETERMINATION IN BEES AND ANTS.

IN SCIENCE for December 25, 1903, Professor W. M. Wheeler characterizes as lacking in critical caution and 'apodictic' the statement that 'the egg of the bee, if unfertilized, invariably develops into a male, but if fertilized into a female.' If Wheeler's objection is directed merely against the form of this statement and not against its general content, if he desires merely the eradication of the word

* This is not so essential to the scheme.

invariably and would see it replaced with *so far as observed,* I am quite ready to grant all that he desires. It scarcely requires explicit statement here that *all* conclusions of inductive science must be so qualified.

But if, as seems possible, Wheeler's objection extends farther and he would have us understand that the generalization made is supported by insufficient or uncritical observation, I would join issue with him sharply. Dzierzon's theory did not grow out of idle speculation, as a casual reading of Wheeler's article might lead one to suppose; it was the outgrowth of much careful observation and thought on the part of a keen-eyed bee-keeper. It won its way to general recognition in the face of bitter opposition and has successfully withstood for half a century repeated assaults from various sources, scientific and otherwise. A brief summary of the evidence on which it rests may not be out of place here.

1. Dzierzon showed more than fifty years ago* that mating of the queen-bee (the egg-laying female of the hive) does not take place within the hive, but high up in the air. It takes place, if at all, before the queen has begun to lay eggs, and occurs but once in the lifetime of the queen, viz., in what is called her 'nuptial flight.' For this flight she issues from the hive on a bright still day. Her seminal receptacle then contains only a thin watery fluid, as Dzierzon and his coworker, Berlepsch, found by dissection. When she returns, the seminal receptacle is swollen and opaque, crowded with spermatozoa. This observation we have on the added authority of von Siebold, who made microscopical examination of the seminal receptacle of a queen captured as she returned from the nuptial flight.

2. If for any reason the queen is unable to take the nuptial flight, as because she has crippled or defective wings, or because her wings have been artificially removed, she is not prevented thereby from laying eggs capable of development, but from such (unfertilized) eggs develop only bees of the male sex (drones). This conclusion, the outcome of repeated observations made by Dzierzon, Berlepsch and Bessels, is further supported by an experiment made by Berlepsch. He induced a hive of his bees to rear queens late in the season (near the end of September), after the drones had disappeared. One of these queens, which was wintered over, produced in the following spring some 1,500 cells of drone brood in worker cells. A dissection of this queen made by Leuckart showed that she really was, as expected, unimpregnated.

3. Worker bees, which are only imperfectly developed females, sometimes lay eggs capable of development. This frequently occurs after a hive has lost its queen. From such 'worker' eggs develop only male offspring. Dissections of egg-laying workers, which were made by Leuckart, revealed no seminal receptacle, hence the eggs of such animals can not have been fertilized.

4. Old queens, which possibly have exhausted or lost control of the supply of spermatozoa received at the nuptial flight, sometimes produce only drone offspring (in worker as well as in drone cells). An old but fruitful queen, which had been producing offspring of both sexes, was accidentally crushed toward the tip of the abdomen by Berlepsch, so seriously that he thought her dead, but she revived after about an hour and was replaced in the hive. All the eggs which she subsequently produced (and they numbered thousands) developed into drones. This case is, with a good show of reason, explained on the hypothesis that the genital organs of the queen were so injured by the accident that thereafter none of her eggs could be fertilized.

5. Queens which have mated in normal fashion subsequently lay eggs some of which are fertilized, others unfertilized. The fertilized eggs are deposited ordinarily only in the small worker cells or the very large queen cells, and they develop into females. The unfertilized eggs are deposited ordinarily only in the drone cells, and they develop into males.

* The original papers of Dzierzon were published in a bee journal now not generally accessible, *Die Bienenzeitung,* but extensive quotations from them are contained in the classical paper of von Siebold, 'Wahre Parthenogenesis bei Schmetterlingen und Bienen,' Engelmann, Leipzig, 1856. Other important papers on this subject are those of Bessels (1868), and Petrunkewitsch (1901, 1903).

That the eggs laid in such cases in worker cells are in reality fertilized, and those laid in drone cells unfertilized, has been established by direct observation. Von Siebold examined under the microscope 40 fresh laid eggs taken from worker cells; in 30 of these he was able to identify one or more spermatozoa; in three cases the spermatozoa were still moving. In 24 eggs taken from drone cells and carefully examined, no spermatozoa were seen. Von Siebold's observations are fully confirmed by results obtained by the more perfect methods of microscopical study now available. Petrunkewitsch (1901), who has recently made a careful study of the bee's egg by means of sections, found 61 ripe eggs taken from worker cells to have been fertilized, while in only one such egg he found no evidence of fertilization; on the other hand, 273 eggs taken from drone cells were all, with one exception, *unfertilized*. In this one egg the presence of a spermatozoon was indicated. That egg, however, can hardly rank as an undoubted exception to the perfectly obvious general rule. It may well have come from one of the cells of intermediate size on the border between the drone comb and the worker comb, from which either workers or drones may develop, or it may even have been introduced accidentally from worker comb into the lot of eggs in which it was found.

In favor of the view resurrected by Wheeler, that female bees may develop from unfertilized eggs, not a bit of trustworthy evidence has ever been presented, so far as I know. Certainly Wheeler presents none. The strongest support ever given to such an idea came from the experiments of Landois (1867). He transferred eggs from drone to worker cells and *vice versa*, and concluded that the sex of the bee produced depends upon the nature of the cell in which it develops, or more directly upon the character and amount of the food supplied to it. But Bessels (1868), who repeated the experiments of Landois, found that the workers regularly destroy eggs transferred from one cell to another, and the queen then lays new eggs in their stead. Berlepsch, however, as quoted by Bessels, by first removing the queen from the hive, and then by transferring a segment of the cell with the egg attached, succeeded in getting the workers to rear in worker cells a few eggs laid in drone cells. From these developed only drones!

But in the case of ants, Wheeler thinks it even a 'probability' that female ants develop from unfertilized eggs, and the title of his article would lead one to suppose this already a demonstrated fact. His conclusion certainly receives no support from the case of the honey-bee. We may accordingly reasonably ask for pretty clear evidence in its favor from some other source before accepting it as even *probable*. What evidence has Wheeler to present? Three different cases recorded by competent observers, in which worker ants have produced female offspring. But does it follow that the eggs from which these offspring developed were *unfertilized*? Clearly not. Because worker bees do not mate with drones, it does not follow that worker ants never mate with male ants. Indeed, Wheeler quotes Reichenbach, whom he characterizes as 'a very conscientious worker,' to the effect that in at least one species of ant, *Anergates atratulus*, 'fertilization always occurs normally within the nest.' If fertilization may occur within the nest, why may not the wingless worker mate with a male, as does the winged queen? At any rate, this possibility must first be excluded before we shall be justified in drawing the conclusion that all eggs laid by workers are necessarily *unfertilized* eggs. It is a possibility which two of the authorities cited by Wheeler, viz. Tanner and Reichenbach, distinctly recognize. They both emphasize the fact that the workers which under their observation produced female offspring 'had been living in community with males.'

Nor does the third authority, as cited by Wheeler, Mrs. A. B. Comstock, even suggest that the eggs laid by worker ants in the colony kept by her were *unfertilized* eggs. The credit for that idea belongs solely to Wheeler. What she records is that worker ants taken from out of doors laid in captivity eggs which developed into females. Is there any reason for supposing that the ants captured had not previously been with males? If not, then where-

in does this case differ from the other two?

May we not reasonably exercise some 'critical caution' before with Wheeler we conclude it probable 'that worker ants can really produce other workers or even queens parthenogenetically'? But suppose they can; wherein lies the 'ominous import' which such a possibility has for 'current views on sex determination'? For myself, I do not see that the case of the ant would then present any new problems not found either in the case of *Nematus,* or in the silk-moth, or in *Daphnia,* to any theory of sex determination ever conceived or conceivable. Should it be shown that the unfertilized eggs of the ant may develop either into males or into females (at present we have no evidence whatever that such is the case), then it would be in order to inquire whether all such eggs undergo two maturation divisions, as do the eggs of the bee, or whether, as in the Rotifera and Crustacea, male parthenogenetic eggs undergo *two* maturation divisions, whereas female parthenogenetic eggs undergo only one.

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January 25, 1904.

SPECIAL ARTICLES.

AMITOSIS IN THE EGG FOLLICLE CELLS OF INSECTS.

Professor Conklin's interesting account of the amitotically dividing egg follicle cells of the common crickets (*Gryllus pennsylvanicus, abbreviatus* and *domesticus*) in the *American Naturalist* for October, 1903, recalls attention to a condition and phenomenon in animal cytology all too little known. Despite the rarity of amitotic cell division elsewhere among animals, and the interest and significance of the phenomenon, the opportunity offered for its study in the egg follicle cells of insects has been taken little advantage of. We know simply that amitotic division occurs in some of these cells in certain insects. How consistently through the insect class; whether identical or varying in character among the different insect species in which it occurs; and finally and most importantly, how far back in the lineage (ancestry) of the cells themselves the phenomenon persists; in other words, at what time the amitotic division appears in the history of cells which must be derived from cells with mitosis; all these interesting questions remain to be answered. Professor Conklin finds that only in the follicle of the lowest egg-chamber of each ovarial tube of *Gryllus* are all the cells ami-

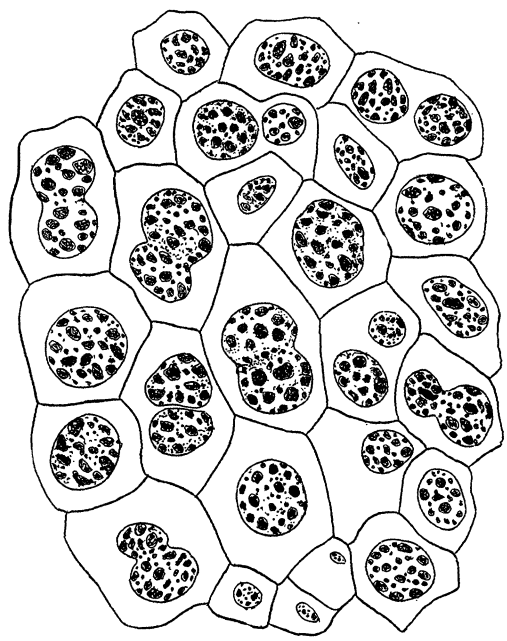

Fig. 1. Egg follicle cells of *Hydrophilus* sp.; showing amitotic division.

totically dividing. In the upper chambers or sections of the tubes the division of the cells is always (as far as observed) mitotic; in the lowest chamber, on the contrary, always amitotic.

The obvious conclusion, in the light of our knowledge of the fate of the follicular cells of the lowest chamber—they secrete here the chorion of the egg and then give up the ghost—that the amitosis is a concomitant with senescence and decay, is probably indisputable. But it is a fact that in not all of the few insects in which this amitosis has been studied is it limited to the follicle cells of the last egg chamber.

Certain differences exist in the character of the amitosis of the egg follicle cells of *Gryllus* (as described by Professor Conklin)