lieutenant, about $2,300, for a first lieutenant about $2,800, for a captain about $3,400. These are all low grades in the army.

What teacher receives anything approaching this on graduation from a college or even on receiving a doctor's degree after six more arduous years of hard study?

The salary on graduation of a Massachusetts Institute of Technology man as assistant is $500, with an increase to $600 the next year. It may in some institutions reach as high as $1,000, but that is exceptional.

A common soldier may reasonably look forward to retirement at the age of 45 or 50 years, with a life-long income of $2,040, and the opportunities to devote himself to a congenial pursuit.

One feels a certain amount of chagrin in meeting casually on a train an enlisted naval petty officer younger than himself who has $12,000 saved in the bank.

Why must the teaching profession be forever in such an unfortunate financial position in comparison with other callings? Have we not, as a class, enough common interest, enough moral courage to wage a campaign together for what is justly due us, for our labors? That is, a reasonable salary sufficient for our needs, sufficient for our family, sufficient to maintain the responsible and honorable position we now hold and which would in the event of a just increase become of much more influence in public life.

J. G. Coffin

FAIR PLAY AND TOLERATION IN SCIENCE

To the Editor of Science: I have read with surprise, if not indignation, Professor Blackwelder's discussion of Lowell's "Mars as the Abode of Life" in your issue of April 23, 1909; and feel that it is only just to enter a protest, in the interest of fair play and that degree of toleration which has always been characteristic of the better men of science. Professor Blackwelder speaks as if some great injury had been done to the public by the appearance of a popular book, written in a narrative style adapted to the lay demand. Of course this is wholly untrue, and mere idle vaporing. Lowell's popular works are all better than Proctor's and Flammarion's, and both of these latter writers have done valuable service in diffusing the results of scientific research among the multitude. It may sound very plausible to the scientific recluse to say that nothing but mathematical formulæ and tables are of value, but every well-informed man knows better. It is by the popularization of science that new interest is awakened in the public mind and increased opportunities provided for the extension of scientific research.

To take a specific example, it was the reading of a popular work by Huyghens, entitled "Comotheoros," which led Dr. Plume to establish the Plumian professorship of astronomy at Cambridge, which has been held by such distinguished mathematicians as Sir George Darwin, who has greatly extended our knowledge of mathematical astronomy, yet is not so narrow as to deny the value of popular science, but on the contrary has contributed to it by popular articles in magazines and a standard work on the tides.

If we compare the present state of astronomy in the United States with that in other countries, we shall be compelled to admit that American preeminence is due very largely to popular interest, and a general appreciation of results. Without popular diffusion of the results of scientific research, who among our business men and captains of industry could possibly have any interest in scientific work? In this day of specialization even scientific workers find it difficult to understand the labors of others, and the public is at vastly greater disadvantage. I make great use of logarithms, trigonometry and calculus, but I have yet to see the laymen who enthuse over columns of figures or complicated mathematical analysis.

When Proctor was living he was assailed by the self-appointed critics in much the same way as Lowell is now; but they always forget that there are others to be considered besides the mere priesthood of science. It sometimes seems to me that some of the latter are almost as intolerant as those divinely inspired persons who took it upon themselves to conduct

the inquisition during the middle ages. For one, I am not at all prepared to admit the justice of contemporary criticism, though in the long run a moderate and just opinion will prevail. This has been true in all ages and professions, and therefore is not confined to our own time or to any particular science.

Now as to some of the points cited by Professor Blackwelder as objectionable:

1. He finds fault with Lowell for adhering to Laplace's cosmogony; but let me point out that this same cosmogony very slightly modified, to take account of tidal friction, has been held by the most eminent mathematicians abroad.[1] If such views have been held by those who have spent many years on the subject, at such mathematical centers as Cambridge, England, surely Lowell may be excused for not accepting the inconsistent and purely destructive criticisms recently put forth at Chicago by Chamberlin and Moulton. It is only fair to say that no constructive results of consistent character had been reached on this subject till my own investigation was completed last year, of which an account is given in *Astronomische Nachrichten,* No. 4308 (February, 1909), but which appeared too late to be used in Lowell's book. As I have worked on this subject uninterruptedly for twenty-five years, I am prepared to speak with some degree of authority. If Professor Blackwelder will study my last paper carefully, and the work now in press, when it appears, he will find that most of the recent speculations on cosmogony are not worth the paper they are written on; and yet some of them have been published by the *Astrophysical Journal* and the Carnegie Institution, just as other erroneous and misleading papers have often been published by the Royal Society, the Paris Academy of Sciences and other learned societies of standing. Every experienced investigator recognizes the great amount of error that creeps into scientific literature even of the best type. How much more latitude, therefore, is to be expected in popular literature, which in the nature of the case must be entertaining rather than strictly exact and ultra-conservative!

2. Great fault is found with Lowell's claim that in general the terrestrial continents have been formed from the interior outwards, though he justly cites Dana, one of the greatest geologists of any age, in support of this view. Now I venture to say that Professor Blackwelder has not read carefully the four memoirs recently published in the *Proceedings of the American Philosophical Society* at Philadelphia, in which I have examined this question and the related topics with great care; otherwise he would see that, however deficient our knowledge may be as to details, in general his contentions are absolutely without foundation. In the opinion of many eminent men of science, including some of the foremost geologists and physicists, who have done me the honor to read these papers, I have proved that mountains are formed by the sea, and not at all by the shrinkage of the globe; and as the younger mountains are generally nearest the oceans it follows that the oceans are gradually drying up and the land increasing, as Lowell maintains. Therefore Lowell is right, and Blackwelder wrong; and that too in a subject which he represents as his own. Dana and Le Conte clearly understood that the mountains are related to and have in some way risen from the sea, but on the old contraction theory, now happily abandoned, they could form no correct conception of the cause of mountain formation. If Professor Blackwelder is prepared to contest my results, let him answer my argument on mountain formation in the case of the Aleutian Islands, where I have proved that they are a submarine mountain range now being pushed up by matter expelled from beneath the trench dug out in the sea bottom to the south of these islands; and that the whole movement is due to the secular leakage of the ocean and the resulting expulsion of lava beneath the crust, and nothing else. On this point other geologists have discreetly kept silent, but perhaps Professor Blackwelder "will rush in where angels fear to tread."

[1] Cf. paper by Mr. F. J. M. Stratton, on "Planetary Inversion," in the *Monthly Notices* of the Royal Astronomical Society, April, 1906.

3. Now in regard to life on Mars, it is sufficient to say that Professor Newcomb has justly remarked that the physical conditions on that planet are very similar to those prevailing in the Himalayas of Central Asia. But even the tableland of Tibet is inhabited, and maintains a respectable civilization. As Lowell has proved that there are water and clouds on Mars, and the polar snows melt and disappear with the advance of the summer seasons on that planet, why may there not be life there as well as here? Of course there is life on Mars; there is no doubt about it. But I am not prepared to say how far advanced the creatures on Mars may be; neither am I narrow enough to deny the possibility of their high development.

Perhaps it will interest Professor Blackwelder and others to know that I have just sent to the *Astronomische Nachrichten* and to the American Philosophical Society extracts from a letter of Euler, written in 1749, and published in the *Philosophical Transactions* of the Royal Society, before the cosmogonic theories of Kant (1755) and Laplace (1796) were put forward, in which the great Swiss mathematician, then residing at Berlin, even went so far as to say that the planets had gradually neared the sun from a great distance—thus implying that the earliest life originated on these bodies in the depths of space, before they came anything like so near the sun as they now are. Arrhenius holds a similar view to-day, and even thinks that life is carried by germs from one world to another.[2] In the work now in press, it is shown, on new grounds, that all the fixed stars are attended by systems of planets. Is Professor Blackwelder prepared to claim that all these billions of worlds are uninhabited? If not, why is he so unreasonable about the habitability of Mars? Lowell's view that there is life in the other worlds is sure to triumph, and we had as well come to it one time as another.

4. Professor Blackwelder is sure that Lowell is working for "a certain notoriety and a brief but undeserved credence for his pet theories." Let us, in common fairness, have no assignment of motives. These are seldom known in any man, either by himself or by others. If Professor Blackwelder is as candid as he wishes others to be, he will now come forward and say that there is much yet to be learned in every branch of science, including geology, and about contemporary scientific investigators as well, and that according to the best ethics, every tree must be judged by its fruit.

Lowell has maintained for fifteen years a magnificent observatory, which has carried on valuable work on Mars, and the other planets and satellites; on double stars, both visual and spectroscopic; on the spectra of the outer planets; on comets and meteoric phenomena; on meteorology as related to the best sites for observatories; and on many other topics. He has given many young astronomers a chance to do good independent work, and the results obtained are highly valued throughout the world. What has Professor Blackwelder done in comparison? And is he the one to say that censure can not be too severe upon one who has deserved so well of American men of science as Professor Lowell has done? Let the still voice of conscience answer! Emerson says that alone all men are conscientious. If so, we shall have a little more toleration, and fair dealing, and less of this clique and faction business, by which a man who is not in the ring never can get justice or fair consideration. Of all the evils which afflict American science to-day the wide-spread tendency to partizanship and factionism and the resulting total disregard of the ultimate interests of truth, is undeniably the worst. As the truth is difficult to discover, and in the end will be found only among the errors of the wise, it is clear that every cause must be heard, and we must preserve a tolerant and open-minded attitude towards all contemporary work. Recent revolutions in all branches of science have been so great that no man knows, and no honest man will attempt to predict, what a day may bring forth.

T. J. J. See

U. S. Naval Observatory,
Mare Island, California,
April 30, 1909

[2] Cf. "Worlds in the Making," *Harper's*, 1908.