Letters

Clearer Views for Astronomy

Irwin's views ("The training of an astronomer," 17 June, p. 1597) on the importance of near-lunar observing conditions for training of astronomers will undoubtedly furnish administrators and congressmen much food for thought, differing so sharply, as his opinions do, from the recommendations of the Whitford committee to which he referred.

Instead of the "cloudy" institutions cited by Irwin, a more realistic comparison with the output of the Lick Observatory's 36-inch (91-centimeter) refractor would be the Yerkes 40-inch (102-centimeter) which is situated at a site roughly as cloudy as those named by Irwin. Few, if any, astronomers would not agree that the scientific output of the two instruments in the period 1900 to 1950 or so (before the 40-inch fell into disuse) was entirely comparable. This does not support the thesis that exceptionally good weather is the magical key to astronomical success. The virtues of wilderness life that are cited by Irwin do not seem to square realistically with the fact that the two observatories that have in the past maintained their entire staffs in residence at their excellent observing sites —Lick Observatory and the National Radio Astronomy Observatory—have both recently elected to abandon that system.

What does the author really mean by "cloudy" observing sites? Since he cites my own institution as an example, it is relevant to quote our weather experience. During the fairly typical period 1 June 1965 to 31 May 1966, our 36-inch reflector (situated in the city of East Cleveland) worked on approximately 40 percent of the nights of the year. Of these, 52 nights belonged to the June–August period noted by Irwin as important to be available to students. About 90 nights were clear from dusk to dawn; the telescope was in actual use perhaps 1000 hours. This figure is, of course, poor compared to what could be attained in interplanetary space or even in southern California (Mount Palomar reported about 2400 hours worked in 1964–65). However, if this telescope were moved to California, its available clear sky time would be increased by, at most, a factor of two to three. Whence will come, by moving our telescope, the factor of five to ten, and presumably eventually more, that would be necessary in order that present graduate schools may enlarge to the extent that Irwin envisions? Also, we have no experience in astronomy to justify his conclusion that concentrations of 100 graduate students are preferable to creating more graduate schools with smaller enrollments.

Also, this 36-inch reflector is being used for spectroscopic work, which is, to be sure, relatively undemanding of sky conditions. Yet the spectrograph obtains plates of higher dispersion and resolution than the similar instrument I used at Lick (with a telescope of identical aperture) only five years before ours was put into service, and it typically does this for a given star in less than half the exposure time that I needed at Lick—despite the differences in average sky conditions between the two sites. Vast progress has naturally occurred in the Lick instrumentation in the meantime, but the comparison (not intended to be critical in any way of Lick equipment) suggests that improvement in the design of auxiliary equipment can yield gains equivalent to moving the instrument to a remote superior observing site.

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Irwin advocates establishing new astronomical observatories in favorable climates, equipped with modern telescopes and auxiliary instrumentation, for the exclusive purpose of graduate student training. His case is generally sound, though premature. The major issue raised in the Whitford report is that too few major observatories exist today to permit a significant fraction of astronomers already possessing the Ph.D. to pursue "frontier" research. Unless the primary recommendations of that report are carried out, namely that more and enlarged observing facilities are built for full-time research, a large-scale student training facility construction program would not only be financially wasteful, but generally foolish. Seven new 60- to 200-inch (152- to 508-centimeter) optical telescopes and a modest increase in radio astronomy facilities would certainly lead to more efficient utilization of present scientific manpower, a logical precursor to flooding the profession with new Ph.D.'s.

The morality of a crash program to produce many new Ph.D. astronomers, many of whom will never be able to do astronomy, is itself highly questionable. Abelson's editorial (1 July, p. 11), for example, states: "There is an acute shortage of physical scientists to fill jobs in industry. . . . Most university science graduates must eventually find employment in nonacademic posts." The standard argument that increased production of astronomers is needed to alleviate a "critical shortage" and prevent its worsening in the future is false. The shortage is one of research equipment, hence of good jobs in astronomy. It is illogical to conclude that since only a few astronomers carry on "frontier" observational research (owing to their fortunate access to the necessary instruments), a manpower shortage exists!

Without the new telescopes and supporting equipment recommended in the Whitford report, most graduate students aiming at a career in observational research will encounter their most serious dilemma not while in school—well equipped with training telescopes or not —but after receiving the Ph.D. Competition for the few good positions in the profession will stiffen by an order of magnitude, and many of the losers will be unable to apply their newly acquired knowledge or skills in the posts they must occupy. They will be sorry that they did not learn business management, economics, or systems engineering rather than astronomical observation techniques.

Beginning graduate students will sense the discouraging situation as more and more astronomers are forced into administrative or product development work in government or industrial laboratories, or into teaching jobs in small university or college departments lacking even minimal observing facilities, at the same time that they are denied access to the large telescopes as visiting investigators. The sensible students among those who sincerely desire a career in phenomena-oriented research will pursue theoretical, not observational courses of study. Yet in most areas of modern astronomy there is already too much effort invested in theoretical research, considering the lack of observational data to test the theories. (Exception: planetary physics.) The authors of the Whitford report have indeed emphasized that astronomy today is data limited. It is dangerous for any field of science to be overladen with theories, which in the absence of checks can freely degenerate into wild speculation and eventually breed dogmas. Only 2 years ago, for instance, the remoteness of quasi-stellar galaxies was accepted dogmatically by most astronomers, and a host of theories were advanced to explain their (apparent) enormous luminosity. Acceptable cosmological theories were identified on the basis of a few spectrum wavelength shift measurements interpreted as Doppler shifts. The remoteness of the quasars is at this time seriously in doubt, so many of the well publicized theories concerning these objects may well be irrelevant.

As Irwin has pointed out, the nation's various programs in space astronomy will be less effective and more costly than necessary unless a large number of experienced observational astronomers are available to plan these programs. I agree that NASA should eventually fund the training observatory construction program, but only after the major expansion of ground-based research facilities is effected and more efficient use is made of current astronomical manpower. Irwin's training observatories will not likely begin to produce observing geniuses until 10 years from now at the earliest, yet strategic planning of space astronomical research is needed now and throughout the intervening years.

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How To Police Pollution

As a former chemist for what is now the Federal Water Pollution Control Administration, I would like to comment on certain aspects of the ninth conference on Great Lakes research (24 June, p. 1773).

How can the FWPCA expect to conduct a fair and equitable enforcement program largely based on "informal discussions"? Such a practice could easily lead to flexible enforcement. Although federal water pollution control machinery has been established for over 3 years, there are, as yet, no formal procedures for conducting hearings. I have attended such informal pollution control conferences in the past in which the government has presented an overwhelming amount of "scientific" data by "experts" who gave proof-positive conclusions about the cause, amount and source of pollution. There was no provision for cross-examination, and industry, unprepared to refute such "evidence," was reluctant to argue its side for fear of being cast in the role of an active supporter of pollution.

Finally, I disagree that it is "hazardous to swim, fish [in], or even get water spray in the face" from lake water bearing *Salmonella* bacteria. This is a half-truth, at best. Certainly no one would advocate swimming in grossly polluted water or would support the willful insult to the human body by unnecessary exposure to any harmful agent. *Salmonella* are ubiquitous microorganisms, as we know from the reported difficulty controlling them in hospitals. The alleged hazard to a fisherman or boating enthusiast by the presence of *Salmonella* in surface waters can only be labeled conjectural.

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Simplifying the Formula

The discussion (Letters, 1 April and 8 July) of N. O. Calloway's proposal (Letters, 31 Dec.) for distributing the ages of experimental animals has been made unnecessarily complicated. If A is the age of the youngest animal to be used, and B is the age of the oldest animal to be used, and $n + 1$ is the number of animals to be used, the problem is simply that of inserting $n - 1$ geometric means between A and B. This requires merely determining R such that

$$B = AR^n$$

Then

$$\log R = \frac{\log B - \log A}{n}$$

and the $n + 1$ ages are

$$A, AR, AR^2, \ldots AR^n.$$

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