the honest effort in a new field from the work of the venial deluder or psychopathic crank. Thus, on pages 12 and 13 he outlines five excellent criteria which will trip up the crank.

Dudley's sense of fair play is admirable but does not, apparently, include the judicious selectivity required so desperately in our modern society. So often, today, individuals worry so about the rights of others and the problems of the minority that they allow the minority to subvert the ideals and steal the rights of the majority.

One is reminded of the tale of "The bear who let it alone" in James Thurber's *Fables for Our Times*. The moral of the tale is very relevant to conditions today. "You might as well fall flat on your face as lean too far over backwards."

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Starvation with and without Painful Hunger Pangs

Kelman (*1*), Wittenberg (*2*), and Ross (*3*) regarded starvation as too painful to justify its use in studies on animals such as Denenberg and Karas (*4*) made. The gnawing pangs of hunger are commonly considered to be the most disagreeable accompaniment of prolonged starvation, and hunger generally makes even a few days of fasting difficult. However, Kelman, Wittenberg, and Ross apparently did not take into consideration the fact that disagreeable hunger sensations usually decrease or disappear after the first few days in prolonged starvation without any food. Unfortunately, even widely accepted authorities like Cannon and Carlson did not agree about the manifestation of hunger during prolonged starvation, although both regarded the hunger experienced during a few days of starvation as consisting mainly of uncomfortable or gnawing sensations produced by periodic contractions of the fasting stomach (*5*, *6*). Cannon maintained that hunger disappeares after the first few days in prolonged starvation, while Carlson maintained that hunger persists. Cannon's view was based on the reports of others but not on any study made by him or his students. Carlson's view was based on a study made on himself and an assistant while they fasted about 5 days.

Eight years ago before I learned of Carlson's view by reading his monograph on hunger (*6*), I accepted the explanation of hunger or normal appetite advanced by Fletcher (*7*). Fletcher distinguished between a normal appetite and a false appetite but not between hunger and appetite. He considered normal hunger or appetite to be mainly of

mental origin, false appetite to be often a manifestation of stomach craving. My observations largely seemed to support Fletcher's views. In 1913, I fasted 26 days, and my impression was that the reference of hunger to the stomach tended to disappear after about the fifth day. It therefore seemed that Carlson and his assistant simply did not fast long enough to note that the reference of hunger to gastric contractions decreases or disappears in prolonged starvation. Moreover, I believed that Carlson (and Cannon's student, Washburn) had merely found a better explanation of the desire to eat which Fletcher considered to be false appetite. A discussion with Carlson of my experience and findings led to his making a study of hunger on me at the University of Chicago, while I fasted 15 days in the summer of 1917. Actually, observations were made daily before, during, and after this fast and an additional 8-day fast, or during a total of 10 weeks in which I lived in Carlson's laboratory (*8*).

The periodic gastric or hunger contractions were found to be manifested throughout the 15-day fast, and the desire to eat was always increased more or less when the gastric contractions occurred. Carlson therefore felt that his previous view concerning the persistence of hunger during prolonged starvation had been supported. However, the increase in my desire to eat with the occurrence of gastric contractions was less after the sixth day of fasting. Carlson attributed this to a decrease in appetite, not to a decrease in hunger, because the records of the gastric contractions showed no change. He had previously explained in the same way a change in sensations noted after the second or third day of his 5-day fast. Neither Carlson nor Cannon ever made a clear distinction between hunger and appetite, and, as indicated in a letter published as an appendix to Carlson's report (*8*), I remained unconvinced that the sensations produced by the so-called hunger contractions represented the basic element in normal hunger.

Nevertheless, after my fasting in 1917 I seemed to find a closer relation between the need of food, the desire to eat, and the gastric hunger contractions than I had found before or during the fasting, and I realized that Carlson's and Cannon's explanation of hunger would have to be taken into consideration in any attempt to find a better explanation. I therefore gave my epigastric hunger sensations close attention, especially when I made changes in my dietary regimen. Thus, in 1924 I found that the periodic gastric contractions could be felt without any desire to eat whatever, under appropriate nutritional conditions. This was first noted when my stomach became empty early in the evening after I had deliberately eaten a large meal of easily digested and rapidly absorbed food early in the day. Subsequent observations made under less extreme conditions clearly indicated that the basic desire to eat (hunger) is more directly related to a central need of food than to emptiness of the stomach or the hunger contractions (*9*).

Before the foregoing finding was published, Carlson enabled me to begin a study with the use of facilities at his laboratory to determine whether a relation existed between the secretory activity of the fasting stomach and epigastric hunger sensations. Some of the gastric sensations seemed explainable by simple or spastic contractions of the muscles of the stomach, but others seemed to involve irritation or burning by acid. Observations on the secretory activity of the fasting stomach were usually made before and after observations were made on the motor activity with the aid of an inflated balloon in the stomach, in 1917. Variations in the gastric acidity were then noted, but no definite relation to the desire to eat or to the hunger contractions was noted. In 1925 I found that by making gastric aspirations every half hour, data were obtainable on both the secretory and the motor activity of the fasting stomach, and an interrelationship between the two functions was revealed (*10*). By alternately using the aspiration method and the balloon method of study, it became obvious that the gastric hunger contractions were simply the final gastric emptying contractions and that the number of contractions that could be felt was greatly increased by the presence of an inflated balloon in the stomach. There was no evidence that the fasting gastric functioning was significantly altered by the use of an aspiration tube—a conclusion reached after about 500 aspirations; over 3500 additional aspirations were then made. In a study made with Kleitman it was also found that a nonnutritive substitute for food tended to promote the development of hunger contractions instead of serving to prevent them while basal metabolism tests were being made (*11*).

At the same time that I began making observations on the secretory activity of the fasting stomach, in 1925, I began making variations in my protein intake in the hope of discovering, by chance, how protein is craved. My attempts to live on low protein or vegetarian diets between 1908 and 1918 always led to the development of a practically irresistible craving for meat. Raw beef was greatly appreciated under such circumstances and fully satisfied the craving, or more than sat-

isfied it in a few days. This craving seemed to be an instinctive call for more or better protein, but no explanation of the manner in which the craving was manifested and dispelled suggested itself. However, it soon became evident in 1925 that the gastric acidity of fasting increased with protein restriction and decreased with restoration of protein (*12*), and when protein restriction was carried to an extreme, the easily recognized protein craving or protein hunger manifested itself and soon became excruciating epigastric hunger pangs (*13*). These were not directly related to the gastric hunger contractions but took my breath away and were first objectively recorded by disturbing my breathing when a basal metabolism test was being made. The painful sensations seemed to be produced by irritation of the duodenum or parapyloric region by highly acid gastric contents when they were being discharged from the stomach. The duodenum or parapyloric region probably was also made hypersensitive by the protein restriction or protein starvation. At the same time the gastric secretion was evidently kept at a high level through consumption of plenty of low-protein food.

As an alternative to simple protein restriction, I also tried fasting in 1925 to produce protein starvation. My original intention was to fast only 1 or 2 days intermittently, but I took advantage of an opportunity to serve as a subject in a study of the effect and after-effect of prolonged fasting on mental performance (*14*) and thus undertook my longest fasts, of 33 and 41 days, respectively. Prolonged fasting involves more or less dehydration, partly because of carbohydrate starvation, and the gastric secretion was found to be depressed more or less after the first few days. No epigastric protein hunger pangs were experienced during the prolonged fasts, but displays of fat meat seemed almost irresistible toward the end of the fasts. After the fasts, the gastric acidity became higher than before fasting, and I experienced more or less protein hunger. It also was difficult to restrict the food intake again until after I had become fatter than before fasting. During these long fasts, tests were made to determine the effect of drinking more water than I needed (500 ml). The result was that the gastric acidity became increased after the water left the stomach, and the gastric hunger sensations were also increased (*15*).

I never tried fasting without drinking water, but Cannon (*16*) cited the experience of Viterbi, a political prisoner, who kept a diary while he abstained from drinking as well as eating until he died on the 18th day. Apparently, hunger disappeared sooner and more completely after the first two days than would have

been the case had he drunk water, because of the dehydration involved, and death was hastened.

In any case, it seems of interest that the lack of an adequate amount of an essential food like protein is likely to be accompanied by more pain than starvation without any food or water.

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Training of College Teachers

I note in your editorial "Real professionalism" [*Science* **132**, 439 (19 Aug. 1960)] that the National Education Association is now attempting to impose state licensure and a requirement "to study the theory and practice of education in the course of their professional education" on college and postgraduate educators.

I have long been disenchanted with the training too many of the school educators receive at the "teachers colleges," whose curriculum is so heavily laced with courses on how to teach but seems so weak in the subjects to be taught. Are we now to inflict the same "uniformity" (or is it mediocrity) on the collegiate instructors?

Perhaps I am too naive in my belief that the two essential characteristics of a good teacher are (i) enthusiasm and (ii) thorough knowledge of and interest in his subject.

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Brain Dysfunction

A report by Wells and Wolff [*Science* **131**, 1671 (1960)] offers a slim but adequate excuse for me to make some remarks which I have been saving up for some time.

The authors cite a fascinating experi-