This pattern notation was secured by photographing the sequence on the strobophotograph.[3] It automatically plots a pitch graph on a vertical measure of 1 cm for each half-step of the tempered musical scale, and a horizontal measure of 50 cm for each second. The phonograph record is played at 15 r.p.m. Fig. 1 is a transposition from the strobophotographic record to a more condensed type of pattern notation.

In this writing it is possible only to mention a few of the effects now photographed:

(1) The predominance of bird notes between 2,500 dv. and 4,000 dv. suggests the frequent use of the vowels in *seat* and *sit* in syllabifications of bird music. Resonance regions of these vowels are generally found between these pitches. There are no vowels in bird song, but the vowel-like character of pure tones at the pitches of the resonance regions has been known to psychologists from the early work of Köhler.

(2) The rapid chirps of the canary often are timed so as to produce a decreasing curve of rate resembling that of muscular fatigue. In a typical case, the chirps begin at a rate of 27 times per second. Each chirp is a discrete unit, a starting and stopping of the note. The chirps come in rhythmical groups of two on approximately the same pitch, the first of each pair being more intense and slightly longer in time. They drop off in rate to three per second during the seventh second. In the sixth second the chirps become trill-like, and in the seventh they change to tones with a falling inflection of about a half-step. Other variations of the pitch patterns of the canary chirps have been isolated. There is the slurred chirp on two notes a little more than three half-steps apart, and the single rapid chirp with a falling inflection of but a half-step. Most of the chirps at the beginning average .025 sec., with the pause between chirps as short as .01 sec. Such performances are impossible by human voices or whistles.

(3) Likewise the rapidity of the trills and warbles are beyond human duplication. The typical warble of the garden warbler has a rate of 50 per second and a rise and fall extent of more than a whole-step. Other warbles of the same bird reveal a rate of 70 per second and extent averaging a half-step. Especially interesting is the double-note of the garden warbler, in one instance with two separate and simultaneous pitches sounded 260 dv. apart, and producing fluctuations at that rate. Another case reveals beats 30 times per second. These would be heard as warbles, but the warble is a rise and fall of successive pitches on the scale, rather than two simultaneous pitches.

A typical trill of the nightingale has a rate of 60 cycles per second and about .5 step in extent; that of the European mocking-bird a rate of 30 per second and an extent of between 1 and 1.5 steps. The human trill is about 7 times per second, with an extent averaging 1.25 step. Some tremolos reach a rate as high as 14 per second, which is likewise the warble rate limit of bird imitators. One of the warbles of the European mocking-bird has an average extent of 1.8 steps and an average rate of 5.5 per second. Such a slow rate is a rarity.

(4) The interplay of noises with tones is an important charactersitic of the birds thus far studied. The general pitch level of the noises is ordinarily between 500 dv. and 1,500 dv.

(5) The "burring" of tones is frequently noticeable. ("Burring" resembles human humming and whistling at the same time.) It is different from the beating effect of the garden warbler in that the "burring" involves notes in the low and high registers, often 2,000 dv. apart.

MILTON METFESSEL
PSYCHOLOGY LABORATORY
UNIVERSITY OF SOUTHERN CALIFORNIA

[3] *Cf.* two articles by the writer: (1) "A Photographic Method of Measuring Pitch," SCIENCE, 68: 430–432, 1928; (2) "The Strobophotograph," *Jour. Gen. Psychol.*, 2: 135–139, 1929.

THE PURE CULTURE OF PARAMECIUM

THE need for a uniformly multiplying culture of animal cells in the absence of bacteria and other kinds of life has long been felt. The efforts to obtain *Paramecium* in pure culture have been particularly numerous, but the first reported success, by Glaser and Coria,[1] has only recently appeared. Since this work, describing the pure culture of *Paramecium caudatum,* has not been confirmed, their experiments were repeated in an attempt to verify the results.

Glaser and Coria developed an enormously complex medium consisting of liver extract, yeast cells and fresh rabbit kidney. The liver extract (0.5 per cent. Eli Lilly Company's No. 343) was passed through a bacteriological filter. To this filtrate, yeast which had been killed at 75° C. and pieces of kidney from a freshly killed rabbit were added, using aseptic precautions. The paramecia were washed through tubes of sterile medium in order to remove bacteria. From inocula of as many as 870 of these ciliates per 10 cc of the medium, luxuriant growth was obtained. Tests with the usual bacteriological media indicated sterility. Microscopic examination revealed small rods with a superficial resemblance to bacteria, but which, in the opinion of these authors, were "cilia torn from the Paramecia."

The author repeated this work, following the method of Glaser and Coria as closely as possible,

[1] *Jour. Parasit.*, 20: 33, 1933.

except that the paramecia were taken from a culture containing a single strain of bacteria, *Achromobacter pinnatum,* and were washed according to the method of Parpart. This bacterium is extremely easy to remove, so it was possible to sterilize large numbers of the ciliates. The following results were obtained. The sterile 0.5 per cent. liver extract killed *P. caudatum* in about one hour. After the yeast suspension and kidney were added, a marked reduction in toxicity was evident. If only a few paramecia were inoculated, survival continued for about three hours. If a large number, *i.e.,* 100, was inoculated, a few lived six to eight hours. If a similar number was added with a few bacteria, some of the paramecia survived and started to increase.

These results were checked, using other ciliates, some of which the author had previously obtained in pure culture. The small and resistant *Glaucoma piriformis,* when taken from a pure culture and added to the liver extract, largely subsides in six hours, but a few swim about for twelve hours. *Colpidium campylum* is slightly less resistant. *Colpidium colpoda,* on the other hand, behaves like *Paramecium,* for it is killed even in the complete medium in a few hours. Since these relatively resistant ciliates are killed by the medium, it is improbable that it is well suited to *Paramecium.*

The most difficult bacteria to remove when washing ciliates are certain slow-growing, adherent forms of very deceiving nature. Peters found that what he first interpreted as "patches of cilia" in his cultures on ammonium glycerophosphate were bacteria and that the growth of *Colpidium* was due to these bacteria. Hetherington[2] repeated these experiments and obtained the same results.

It is instructive to note the characteristics of these bacteria: (1) They are killed at 37° C.; (2) they grow very slowly—colonies on nutrient agar plates are easily overlooked on the third day of incubation at 25° C. and are still very small on the fourth; (3) they do not cloud liquid media even after considerable periods; (4) they are remarkably adherent, usually appearing affixed to the slide or cover-slip in somewhat uniform rows.

These facts suggest that Glaser and Coria probably did not have sterile paramecia.

ALFORD HETHERINGTON
THE JOHNS HOPKINS UNIVERSITY

A HOLDER FOR SMALL ANIMALS

THE following animal holder is being offered as a result of our effort to secure a holder that is not only practical but also simple and inexpensive. Because of its ease of adjustment it is suitable for all small animals, including cats and small dogs. Notwithstanding its simplicity, it permits the arrangement of the animal in the position most satisfactory for any procedure. In general, its design follows that of the holder for chickens developed by Seifried, Cain and Wulf.[1]

The board consists essentially of a metal plate (A) 28 inches long and 5½ inches wide mounted on six-inch legs (B) (Fig. 2) to form a table. The upper

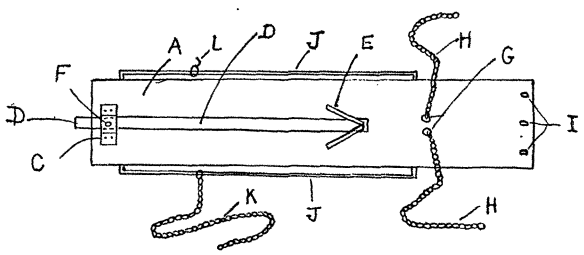

FIG. 1.

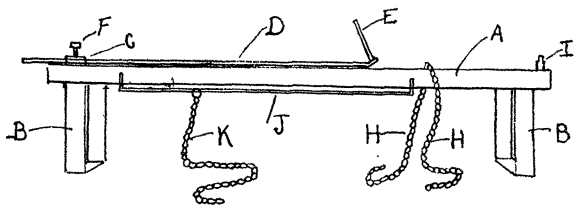

FIG. 2.

surface of the plate is slightly depressed longitudinally down the center to fit the spine of an animal in a dorsal position. At one end and on top of the plate is a bracket (C) carrying a sliding bar (D), to which is attached a forked head holder (E). After adjustment to the length of the animal, the bar, together with the head holder, is locked into position by the set screw (F). The forked head holder is set at an angle of approximately 30 degrees from the vertical as an added safeguard against the animal lifting its head. Coming through two small holes (G) in the plate seven inches from the opposite end from that carrying the bracket are two lengths of light chain (H), permanently fastened to the under side of the plate, for crossing diagonally over the hind legs and then being attached to the pins (I) at the end of the board. On each side of the board are welded two rods (J), extending slightly down and out from it and running from the position of the bracket down about three quarters of the length. Attached to one of these rods is another length of chain (K) and to the other a hook (L). Both the chain and hook are so attached to the rods that they may slide along them. The purpose of this chain is

[1] Oskar Seifried, C. B. Cain and Harro Wulf, SCIENCE, 75: 1942, March 18, 1932.

[2] *Arch. Protistenk.,* Bd. 80: 255, 1933.