STEADY POTENTIAL FIELDS AND NEURONE ACTIVITY*

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THE ISOLATED FROG BRAIN continues to manifest essentially stationary rhythmic potential oscillations and, under the influence of drugs such as caffeine, slowly traveling potential waves (Libet and Gerard, 1939; Gerard and Libet, 1939, 1940; Gerard, 1941). Such phenomena demand, respectively, the synchronous or successive electrical discharge of large numbers of neurones. Experiments with tiny bits of olfactory bulb, with changed intercellular ionic milieu, with added drugs, with altered temperature, etc., demonstrated that the mechanisms controlling the beat of the individual neurone and the set timing of many neurones are not restricted to the familiar conduction of impulses along neural paths.

The case is especially clear with the large caffeine waves, which travel at about 6 cm. per sec. mainly from the anterior to the posterior pole of the cerebral hemispheres; for these waves are not abolished by nicotine, which blocks synaptic transmission (Libet and Gerard, 1938; Schweitzer and Wright, 1938), and often not even by a sharp complete transection of the entire cerebrum. Since a traveling wave can cross a cut in its path, nerve conduction cannot be responsible; and since a slight separation of the cut halves, even with a film of Ringer connecting them, does block the wave, a chemical mechanism is probably excluded. There remains the possibility of electric currents, flowing through intercellular fluids, as a basis of neurone interaction.

An hypothesis was developed (Gerard and Libet, 1940) which explains the propagation of electric waves along the brain in a manner analogous to the propagation of an impulse along a nerve fiber. The neurones in the frog's hemisphere are in the main oriented alike, with their dendrites directed toward the pial surface and their axones emerging from the ventricular pole of the cell body; and, further, the cell bodies are gathered into a sheet, a few cells thick, paralleling these gross hemisphere surfaces (Fig. 1a. See also Cajal, 1911, p. 844; and Herrick, 1927, Fig. 6 to 9). Assuming that the soma of each neurone is polarized from dendritic to axonic poles (the somatic potential), a D.C. potential maintained by the cell's active metabolism, the whole cell sheet would behave like the polarized membrane of a nerve fiber. A local depolarization, resulting from the discharge of one cell or a few adjacent ones, would permit neighboring cells to discharge through the "leak" and so initiate a spreading wave of depolarization (see Gerard and Libet, 1940, Fig. 16). The "action current," flowing through conducting fluids—

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