ings at weekly intervals on the serum concentrations of total glycoprotein, seromucoid, and total protein and on the hemoglobin and hematocrit values of blood have been investigated in adult, male guinea pigs and rats. No significant increases occurred in levels of the serum components. Transient decreases were observed in the total serum protein and seromucoid of the rat and the total serum glycoprotein of the guinea pig. Statistically significant decreases occurred in hematocrit and hemoglobin values following the first and ensuing hemorrhages.

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Localization of Specific Cholinesterase About the Eccrine Sweat Glands of Human Volar Skin.* (22398)

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Eccrine sweating of the palms and soles in man occurs almost exclusively in response to non-thermal stimuli, usually emotional or mental(1); the response to heat is minimal and delayed(2). In sharp contrast to this, eccrine sweating of the rest of the skin is due primarily to thermal stimulation(1). Indeed, emotional and thermogenic sweating have been regarded as separate functions controlled by different mechanisms(3). The idea of different control mechanisms is partially supported by published pharmacologic evidence. On the one hand the glands of the general skin are stimulated to secrete sweat by cholinergic drugs and are inhibited by anticholinergic drugs but not by antiadrenergic drugs (4). These results accord with the demonstrated cholinergic innervation of the glands of the general skin(4). On the other hand the glands of the palms and soles have been reported to show little sweating in response to cholinergic drugs(5,6) and a reduction of spontaneous sweating in response to dibenamine, a potent adrenergic blocking agent(7). A possible inference, therefore, is that the volar glands have primarily an adrenergic innervation and the general skin glands have a cholinergic innervation. More recent studies, however, seem to indicate that the volar glands are also specifically stimulated by cholinergic drugs in the same concentrations as are effective for the general skin(8,9). Also, mental sweating of the palms was not inhibited by adrenergic blocking agents but was readily inhibited by the anticholinergic substance atropine(8). Furthermore, systemic administration of epinephrine does not evoke eccrine sweating(7), although local injection into the skin irregularly elicits the appearance of local sweat in both volar and general skin(4). This latter effect may be due to the stimulation of the myoepithelial cells surrounding the sweat gland tubules causing them to contract and eject preformed

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sweat. The ensuing refractory state (1-24 hours) in the presence of generalized sweating is consistent with this interpretation(12). A similar state exists in the apocrine sweat gland where sweating consists of ejection by myoepithelial contraction in response to adrener-

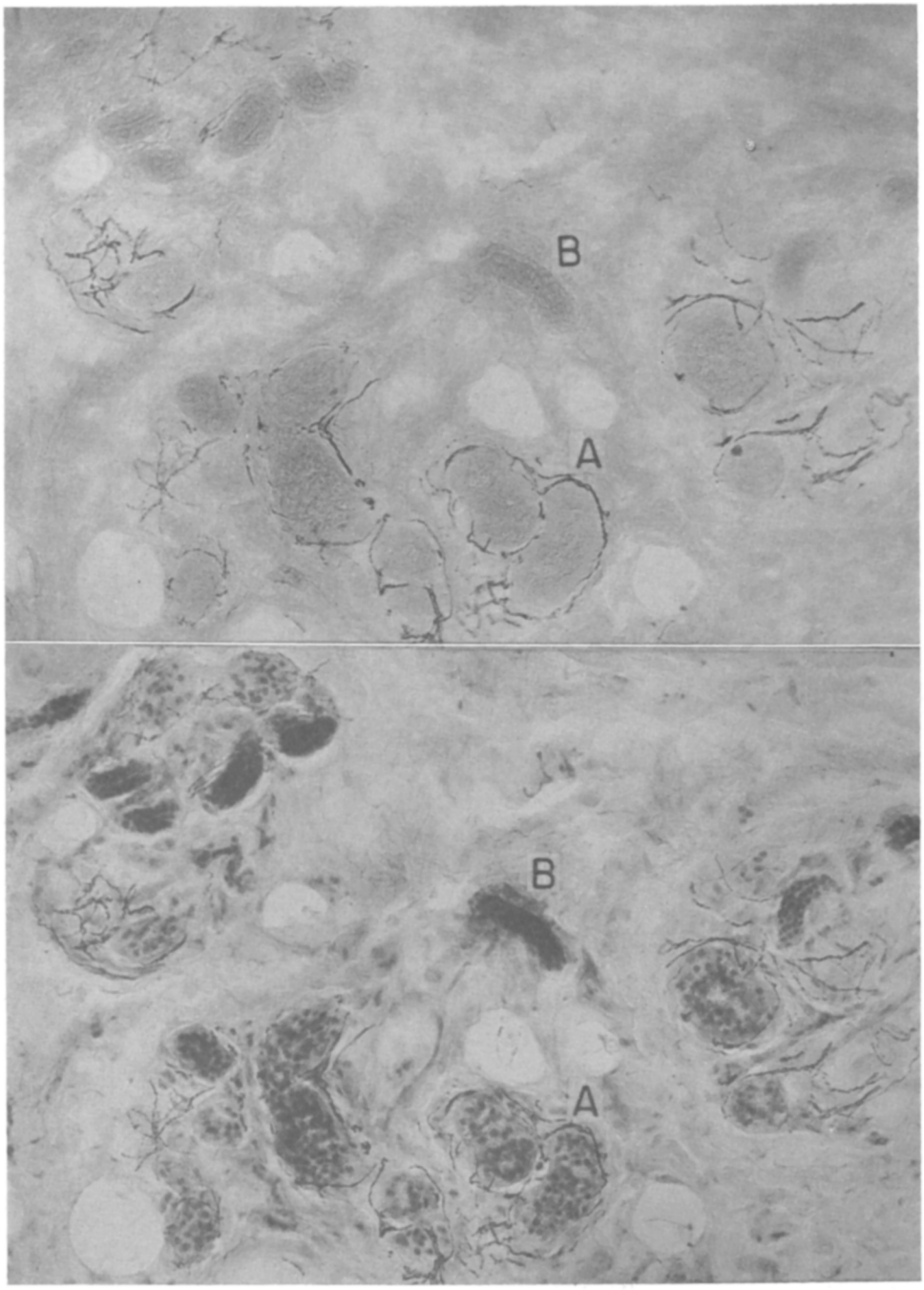

FIG. 1. Photomicrographs showing a specific cholinesterase in nerve fibers to secretory tubules of volar eccrine sweat glands (A), and absence of such fibers about eccrine ducts (B). Upper photograph—section counterstained lightly with eosin; lower—adjacent serial section counterstained with hematoxylin and eosin. Mag. × 100.

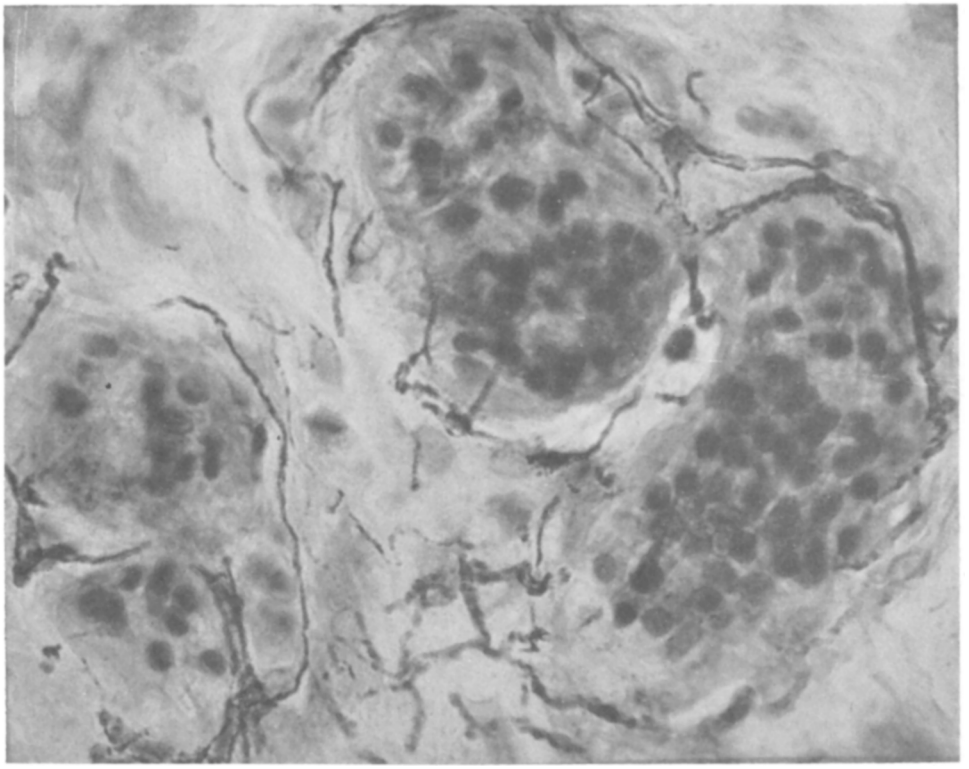

FIG. 2. View of eccrine sweat gland tubules under higher magnification. Observe nerve fibers containing specific cholinesterase. Section counterstained with hematoxylin and eosin. Mag. × 360.

gic stimulation; this is followed by a refractory period of 24-48 hours(13).

It is apparent that the possible existence of 2 different control mechanisms, an adrenergic for the volar glands and a cholinergic for the general skin glands, cannot be established on the basis of the conflicting pharmacologic evidence. It is first necessary to ascertain the nature of the innervation of the volar glands. There is no stain specific for adrenergic fibers. Cholinergic nerve fibers, however, can apparently be identified by means of Koelle's histochemical technic which discloses the localization of the enzyme, specific (true, aceto-, acetyl-) cholinesterase (ChE) in the membrane of the cholinergic fibers(10). This method was here employed to ascertain whether or not the volar sweat glands have a cholinergic innervation.

Materials and methods. Biopsies were obtained from the volar skin of the great toes of 6 healthy white male volunteers (22-26 years of age) after block anesthesia of the digits with 1% procaine. Immediately after excision the skin specimens were placed on dry ice. Frozen sections were cut at 10 μ thickness and placed on glass slides. They were then carried through the histochemical method of Koelle according to the latest modifications described for the localization of specific and non-specific cholinesterase activity(10). Acetylthiocholine and butyrylthiocholine were used as substrates and 10^{-10} M diisopropylfluorophosphate was employed to inhibit selectively the non-specific ChE of the appropriate sections.

Results. Specific cholinesterase was noted in many nerve fibers about the secretory tubules of the eccrine sweat glands (Fig. 1 and 2) and about the digital arteriovenous anastomoses(11). The enzyme was absent about the ductal portions of the eccrine sweat glands (Fig. 1B) and about all other cutaneous vessels. The control sections for non-enzy-

matic staining and other esterases were negative.

The cholinergic fibers appeared to terminate, if not on, then in close proximity to the secretory cells. It was not possible on the basis of these sections, however, to exclude the myoepithelial cells of the gland tubule as a possible site for the termination of the fibers.

Discussion. The above evidence demonstrates that the volar eccrine sweat glands have the same cholinergic innervation as the eccrine glands of the general skin. This information is in accord with the latest pharmacologic evidence that both volar and general skin glands respond similarly to cholinergic and other drugs(8,9). Hence it is necessary to account for the differential specificity of stimuli, non-thermal for the volar glands and thermal for the general skin glands, by a mechanism other than differential innervation. The differentiation as to effective stimulus must be traced back to the location in the central nervous system of the neurons which initiate the discharge of impulses which ultimately effect the secretion of sweat. These loci may be the cortex for impulses to the glands of the palms and soles, and the hypothalamus for impulses to the glands of the general skin surface.

Summary. By means of Koelle's histochemical technic for cholinesterase, the same cholinergic innervation was found for the eccrine sweat glands in the volar skin of the human toe as occurs for the glands in the general skin of the body. This evidence, coupled with recent pharmacologic results in the literature, was taken to indicate that non-thermal sweating in the palms and soles was due, not to a hypothetical adrenergic innervation of volar glands, but to a primary control center in the central nervous system (possibly the cortex) other than the control center (the hypothalamus) for thermal sweating.

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