RELATIONSHIP BETWEEN THE THYROTROPHIC FUNCTION OF THE HYPOPHYSIS AND THE NEUROSECRETION IN THE PIGEON

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The causative connection between the rhythm of illumination and sexual activity effected through the hypothalamo-hypophyseal system is demonstrated with particular clarity in experiments on birds. Light is also a factor concerned in the thyrotrophic function of the hypophysis and thyroid gland [2, 4]. However, attempts to explain the role of the hypothalamic neurosecretion in the thyrotrophic function of the hypophysis during the application of light have been unable to differentiate between this effect and gonad-stimulating activity. We therefore reverted to the technique of early experiments in which thyroid function was influenced by activation of growth of the plumage [1, 3].

With the object of obtaining proof of the participation of the neurosecretory substance in activation of the basophils responsible for thyrotrophic hormone production, we carried out experiments on pigeons, in which growth of a new generation of feathers was evoked by plucking the original plumage.

EXPERIMENTAL METHOD

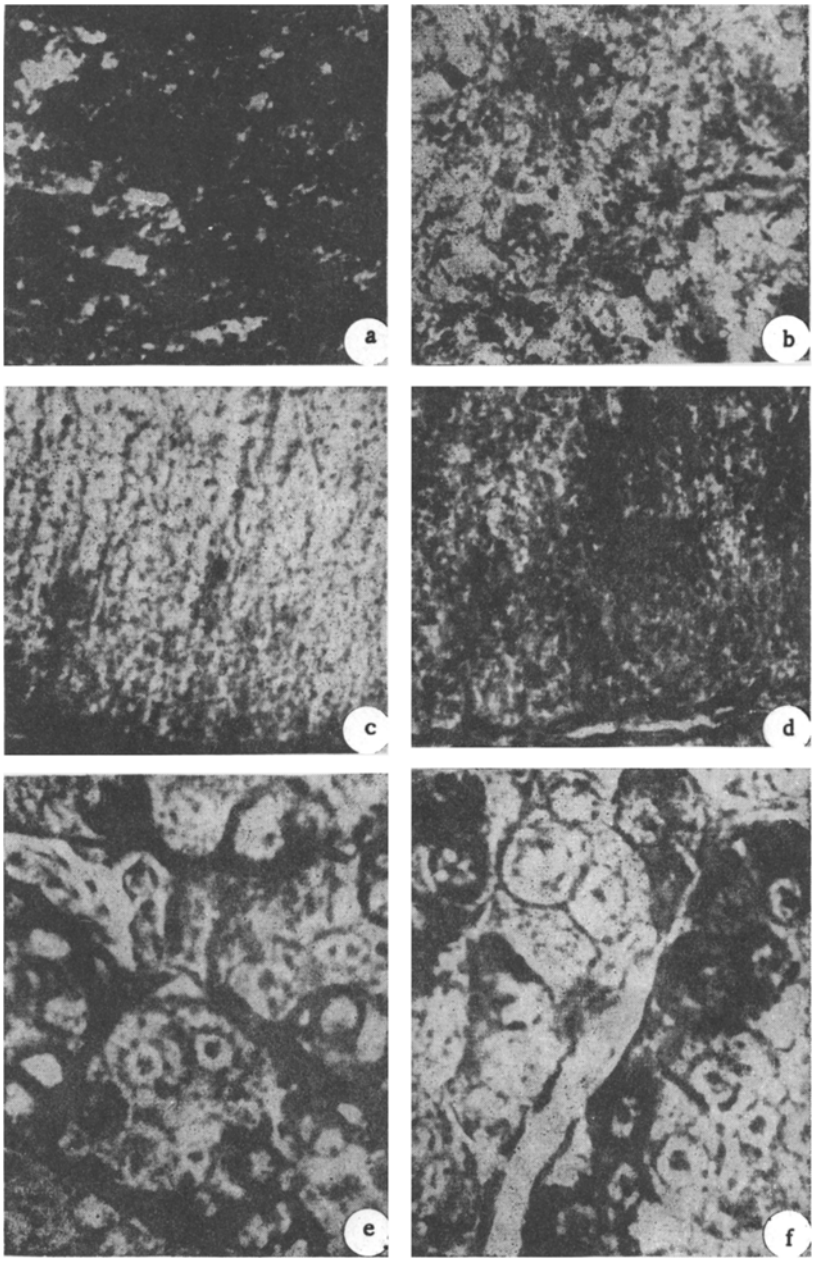
Experiments were carried out on male pigeons of a decorative race (July). The birds were kept in isolation in separate cages for 6 months before the experiments. Control birds were not plucked. Growth of young feathers began in the experimental birds on the 5th day, and by the 10th day the young feathers possessed a small, partly spreading vane. Birds were sacrificed in batches of four periodically, 3 and 10 days after plucking. The endocrine organs and hypophysis, together with the hypothalamic region, were fixed in Bouin's fluid. Sections were stained with Heidenhain's azan, aldehyde-fuchsin, the periodate-Schiff reagent, and by Halmi's method.

EXPERIMENTAL RESULTS

After 7 and, in particular, after 10 days of proliferation of the new plumage the structure of the thyroid tissue of the control and experimental birds showed evidence of the intensive supplying of hormones to the blood stream: colloid was absent, the epithelium was greatly increased in height, and the follicular structure was disorganized. Marked depression of the gonads was observed in all the experimental birds.

The neurons of the supraoptic nucleus were not significantly different from those in the controls, but in the neurohypophysis the difference was considerable. On the 10th day of the experiment the posterior lobe of the hypophysis was enlarged and hyperemic; the number of granules of neurosecretion was appreciably reduced (see figure, a, b). The difference in the fine organization of the proximal portion of the neurohypophysis and in the number of granules of secretion was particularly pronounced (see figure, c, d).

The median eminence of the neurohypophysis in birds differs essentially in structure from the analogous formation in mammals [6, 7]. For instance, the proximal portion of the neurohypophysis in birds is characterized by the powerful development of the zone of neurosecretory terminals before coming in contact with the primary capillary plexus, which is confined to the area of the lamina of the tuberal portion of the adenohypophysis. Differences are present in the fine structure of the two divisions of the median eminence, separated by the bundle of portal vessels into two parts – anterior and posterior. Our comparisons are mainly concerned with the anterior portion, where the organization into layers is very clearly distinguishable. Beneath the ependyma a fibrous layer is prominently displayed by aldehyde-fuchsin, containing large glial cells, processes of ependymal cells, and granules or clumps of



Endocrine organs of control (a, c, e) and experimental (b, d, f) pigeons (10th day of experiment). a, b) posterior lobe of hypophysis; staining with aldehyde-fuchsin, × 1200; c, d) median eminence of neurohypophysis – palisade layer; aldehyde-fuchsin, × 1200; e, f) anterior lobe of hypophysis: degranulation and partial vacuolation of cytoplasm of basophils (e); thyrotrophic basophils (f) on endothelium of blood vessel. Halmi, × 1200.

neurosecretion of different sizes; it is slightly hyperemic. Conversely, few granules of neurosecretion are present in the region of the median eminence. It could be assumed that a little neurosecretion passed through the apparatus of the median eminence into the primary capillary plexus.

In the palisade layer of the median eminence of the experimental birds numerous neurosecretory granules appeared and were arranged radially along the terminals of the nerve fibers (see figure, c, d). It may be concluded from this pattern that when the trophic functions of the hypophysis are switched over during a period of increased utilization of thyroid hormone, when hyperplasia of the thyroid gland develops, the proximal portion of the

neurohypophysis undergoes considerable activation. Meanwhile, in the posterior lobe of the hypophysis, the previously deposited secretion is mobilized fairly intensively into the blood stream, which can hardly be attributed to a change in the thyrotrophic function of the adenohypophysis. In our experimental conditions other mechanisms may also have been involved – thermoregulation, water and mineral metabolism, and so on – so that the state of the posterior lobe of the hypophysis did not remain indifferent.

The increased mobilization of the neurosecretion into the primary capillary plexus in the region of the median eminence was accompanied by hyperemia of the vessels both in the region of the vascular stalk joining the anterior lobe to the pars tuberalis, enveloping the median eminence externally, and in the parenchyma itself of the adenohypophysis. An important consequence of these processes was the reaction of the basophilic cells. Their number, especially the number of cells lying in contact with the endothelium of the capillaries, was considerable increased (see figure, e, f). Whereas in the control birds during the summer period the basophils were often irregular in shape and contained cytoplasm which had largely lost its specific granulation, in the experimental birds the same cells differed significantly in both shape and size from those in the controls. According to Benoit's classification of the basophilic cells of the hypophysis [5], in their staining properties they had come to resemble typical thyrotrophic cells.

These results complete the chain of connection between the experimentally induced changes in the utilization of thyroid hormone, which involved a compensatory response reaction of the thyroid tissue and which was brought about, in turn, by activation of the neurosecretory hypophyseal system. The results demonstrate the close relationship between the thyrotrophic function of the anterior lobe of the hypophysis and the neurosecretion of the hypothalamus. Further confirmation of the principle, previously suggested by us, has been obtained, namely, that the relationships between the functions of a peripheral gland of internal secretion and the concentration of its hormone in the organism are reciprocal in character [3]. The results described in this paper show that the neurosecretion of the hypothalamic nuclei and the thyroid-stimulating hormone of the hypophysis play a part in this interaction.

SUMMARY

Gonad function is depressed and thryoid function activated in male pigeons under conditions of intensive growth of feathers. At the same time the discharge of neurosecretion into the blood from the posterior lobe of the hypophysis becomes stimulated and the entrance of a new secretion into the area of the median eminence of the neurohypophysis is intensified.

Increased vascularization and hyperemia are seen in the anterior lobe of the hypophysis; in such conditions the formation of new typical basophils is enhanced. A reciprocal relationship between the thyroid gland function and the concentration of its hormone in the organism is realized through the activation of the neurosecretory and thyrotropic functions.

LITERATURE CITED

1. A. A. Voitkevich, Transactions of the Research Institute of Experimental Morphogenesis [in Russian], Vol. 6, p. 426, Moscow (1938).
2. A. A. Voitkevich, Izv. Akad. Nauk SSSR, Seriya biol., 4, 385 (1945).
3. A. A. Voitkevich, Zh. obshchei biol. 9, 1, 13 (1948).
4. B. Novikov and L. Favorova, Doklady Akad. Nauk SSSR 58, 4, 701 (1947).
5. J. Benoit, Gen. comp. Endocr., Suppl. 1, p. 254 (1962).
6. D. S. Farner, A. Oksche, and L. Lorenzen, in book: Neurosecretion. London. p. 187 (1962).
7. A. Oksche, in book: Neurosecretion. London. p. 199.