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Peculiarities of the thyroid gland structure

(With special reference to the presence of ganglion cells)

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Summary. We have performed a study on the comparative structure of the thyroid gland in several species of mammals (rat, cat, dog, lamb, pig, cow, and man). We have described the structural differences among them, paying special attention to the distribution of connective tissue, the intrafollicular and parafollicular cells. In the thyroid gland, we can confirm the existence of nerve cells, either isolated or forming vegetative ganglions in the interfollicular spaces, in some of the species studied, especially in the rat and the dog.

Key words: Thyroid structure, Comparative, Ganglion cells

Introduction

The conventional structure of the thyroid gland has been known for a long time (Peremeschko, 1867; Andersson, 1894; Trautmann, 1920; Popow, 1927, Rossi and Lanti, 1935, Bargmann, 1939). Several species of mammals have been carefully studied one by one; there is, however, a lack of studies regarding the comparative structure of the gland. That is why the main reason of our work has been the structural comparison among the thyroids of several animal species.

We have also paid special attention to the nerve cells in the thyroid parenchyma, which has been described by Nonidez (1931, 1932, 1935) in the dog and not yet confirmed by Taniai (1938) in the same animal, or Bargmann (1939) (dog, cat, rat). These ganglion cells were later observed by Sarrat (1965) in the rat, and our research team has confirmed them in several species of mammals. Thus, we will discuss the meaning of the different types of intrafollicular cells that show, according to the species, a significant variety of forms.

Nowadays there is still great difficulty in distinguishing between parafollicular cells and real neurons. In the studies of Barasch et al. (1987), Hoefler et al. (1987) and Nolan et al. (1985), distinctions are made by inmunocytochemical techniques.

From the point of view of innervation, Mikhail (1971) and Grunditz et al. (1984, 1987, 1988) provide data about the presence in the thyroid gland of adrenergic fibres, VIP and P-containing substance located around the blood vessels and follicles.

In pathological specimen, Zrustova (1974) and Carney et al. (1976) state to have found neurons in medullary thyroid carcinoma.

Materials and methods

We studied 155 serial cuts of mammalian thyroid glands (50 rats, 15 cats, 20 dogs, 10 lambs, 15 pigs, 20 cows and 25 men). After careful washing, the specimens were fixed in Bouin's solution, paraplast embedded, serial cut (7 µm) and stained with Martin's trichrome.

Results

1) General aspects

Although the structure of the thyroid gland in all species studied corresponded to a common morphological pattern, there were occasionally different characteristics.

The rat (a), the cat (b) and man (f), had a thyroid gland with a cubic follicular epithelium and not much interfollicular connective tissue. The dog (c) showed a low follicular epithelium with a tendency to form large follicles, abundant colloid and parafollicular cells. The pig (d) showed, as a distinctive feature, the thickness of the interfollicular walls, formed by an abundance of connective tissue, but with few cells. The cow (e) tended to produce secondary follicles with a prismatic epithelium and scarce colloid. In human thyroid gland (f) desquamous cells and a wide variety of forms of its epithelium were noticed (Figs. 1, 2).

In young animals (progressive phase), abundant mitosis (b, e, arrow) and degeneration of thyrocytes, which have completed their vital cycle (c, f), were seen.

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Also, in the thyroid gland of the lamb, an ultimobranchial follicle was seen, which is very frequent in this species. A strange epithelium forming villi, which were prominent in the follicular lumen of the cow (d), was also observed (Fig. 3).

2) Types of intrafollicular cells

Inside the thyroid follicles, generally occupied by colloid substance, there may be cells which show different forms (Fig. 4). We usually found desquamous

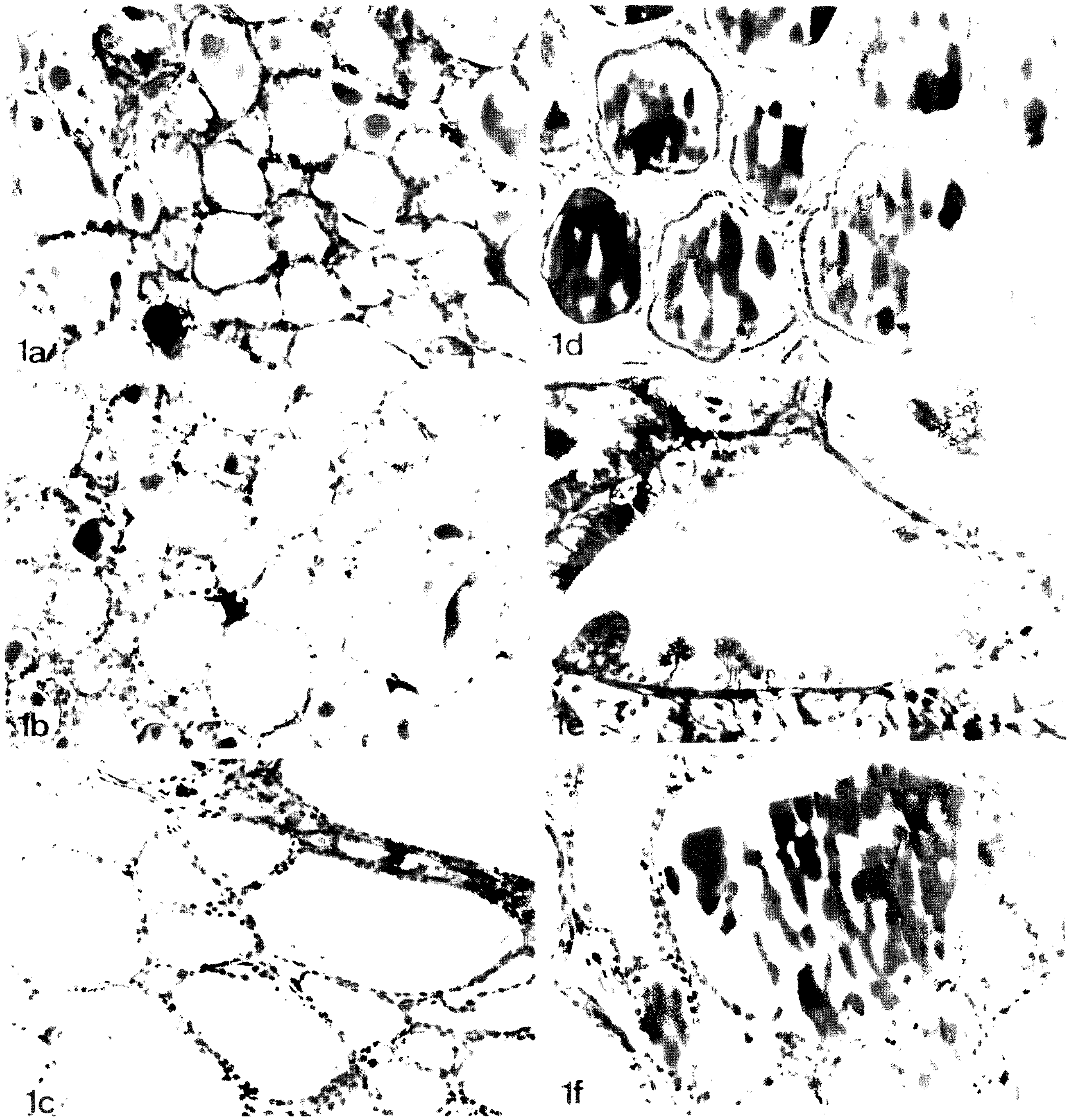

Fig. 1. View of the thyroid gland in several species of mammals showing the aspect of follicles, and the interfollicular connective tissue. **a)** rat, **b)** cat, **c)** dog, **d)** pig, **e)** cow, **f)** man. Martin's trichrome. x 240

cells (a) with picnotic nucleus and small cytoplasm. Occasionally there may be blood cells (haemorrhagic follicles) (b) that almost completely covered the follicular lumen; but intrafollicular cells were very often large (c, d, e, f) with a significant nucleus and abundant cytoplasm full of basophil granulations. They formed groups that covered all the follicular lumen most of the time, and in some exceptional cases, mitosis were

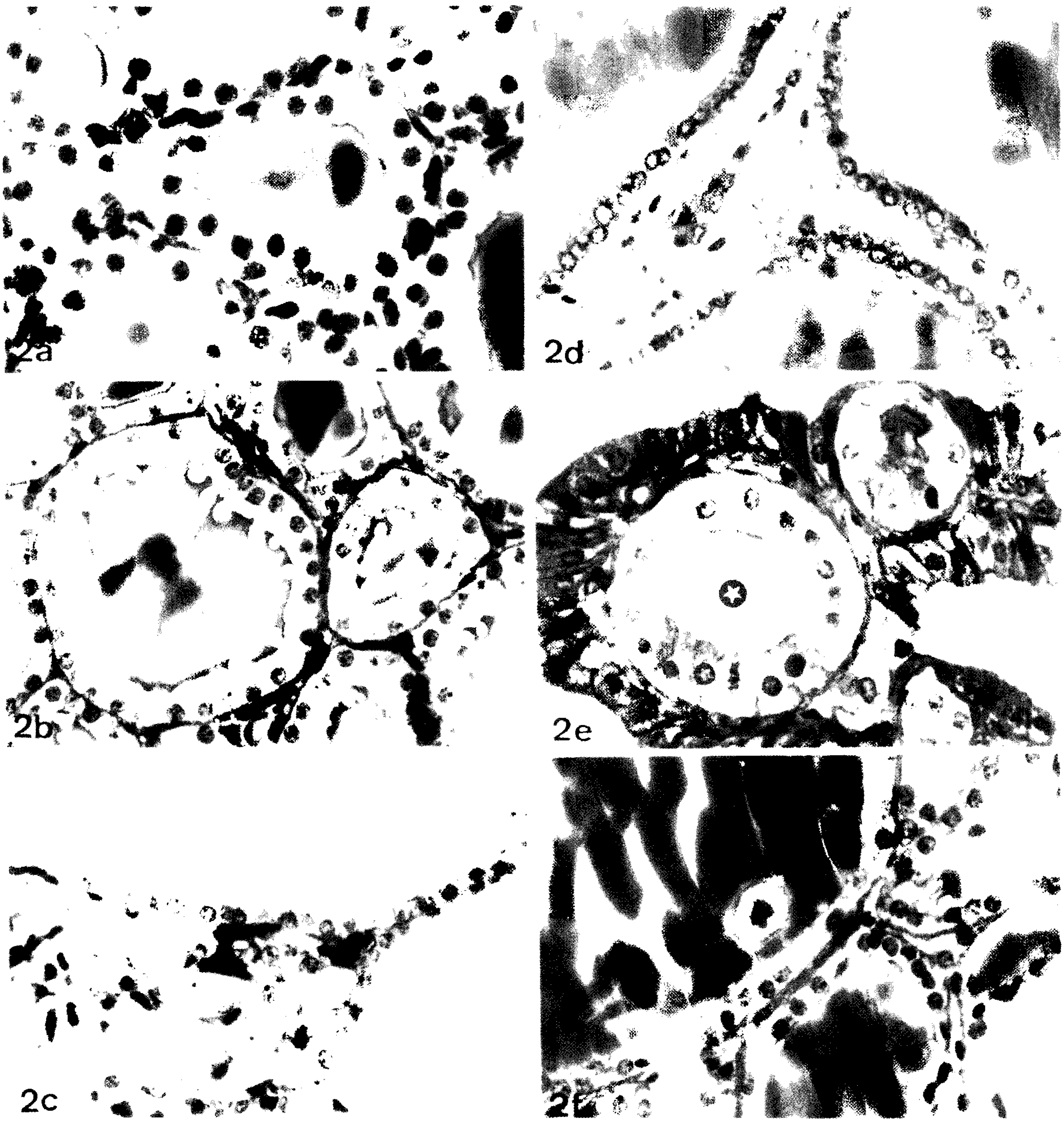

Fig. 2. Detail of the structure of the thyroid gland, showing the differences according to species. **a)** rat, **b)** cat, **c)** dog, **d)** pig, **e)** cow, **f)** man. Notice the structural uniformity of the rat (a) and the cat (b), the abundance of parafollicular cells in the dog (c), the thickness of the interfollicular space in the pig (d), and the aparition of secondary follicles in the cow (e *). Martin's trichrome. x 480

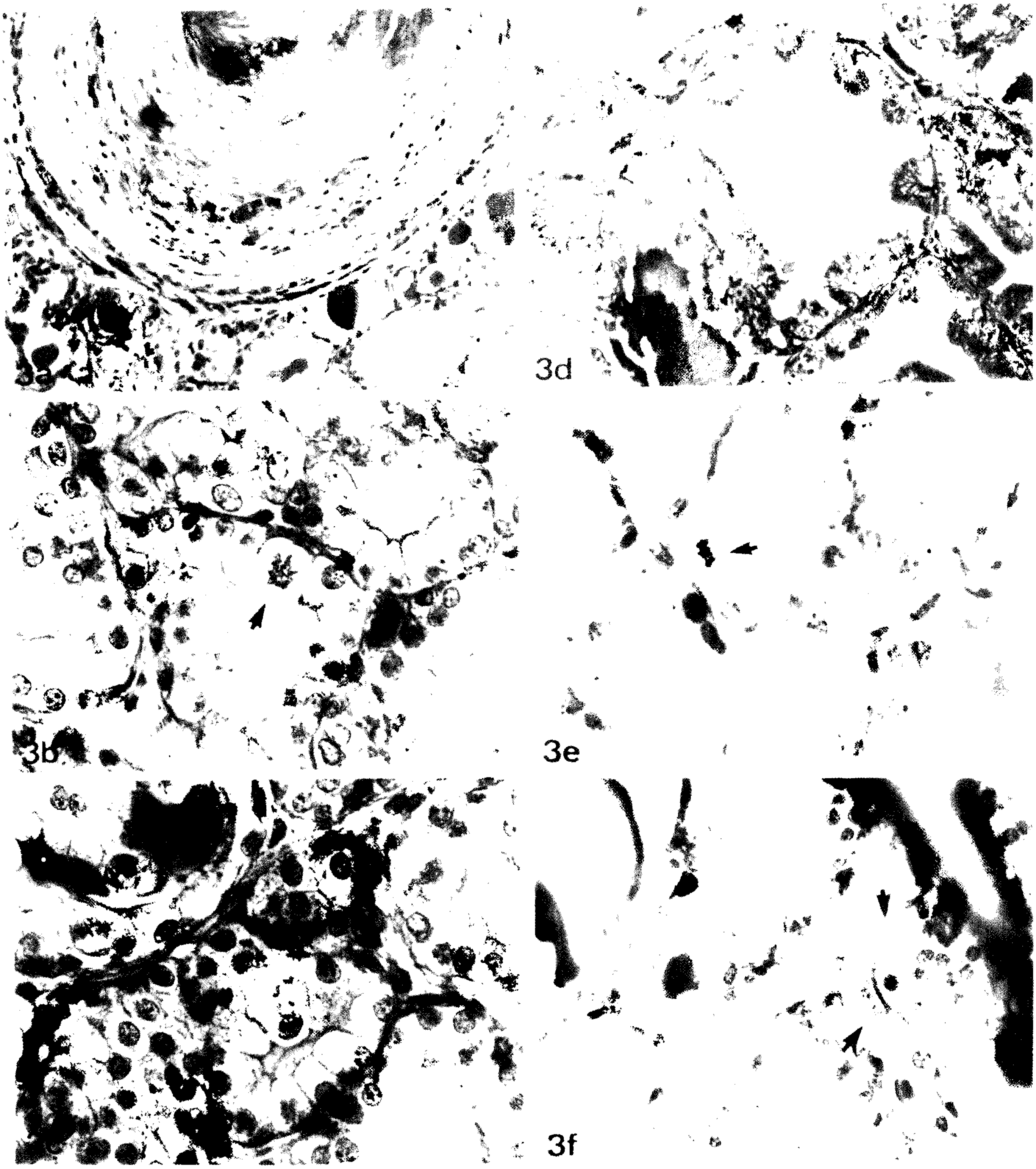

Fig. 3. Features of the thyroid gland in several species. Notice the abundance of ultimobranchial follicles in the lamb **(a)**, the folds of the follicular epithelium (secondary follicles) in the cow **(d)**, the numerous mitosis in follicular cells **(b, e)** in the rat and the phenomenon of degeneration caused by the aging of the thyrocytes (arrow) in the rat **(c, f)**. Martin's trichrome. (a, d) x 240; (b, c, e) x 1.200; (f) x 480

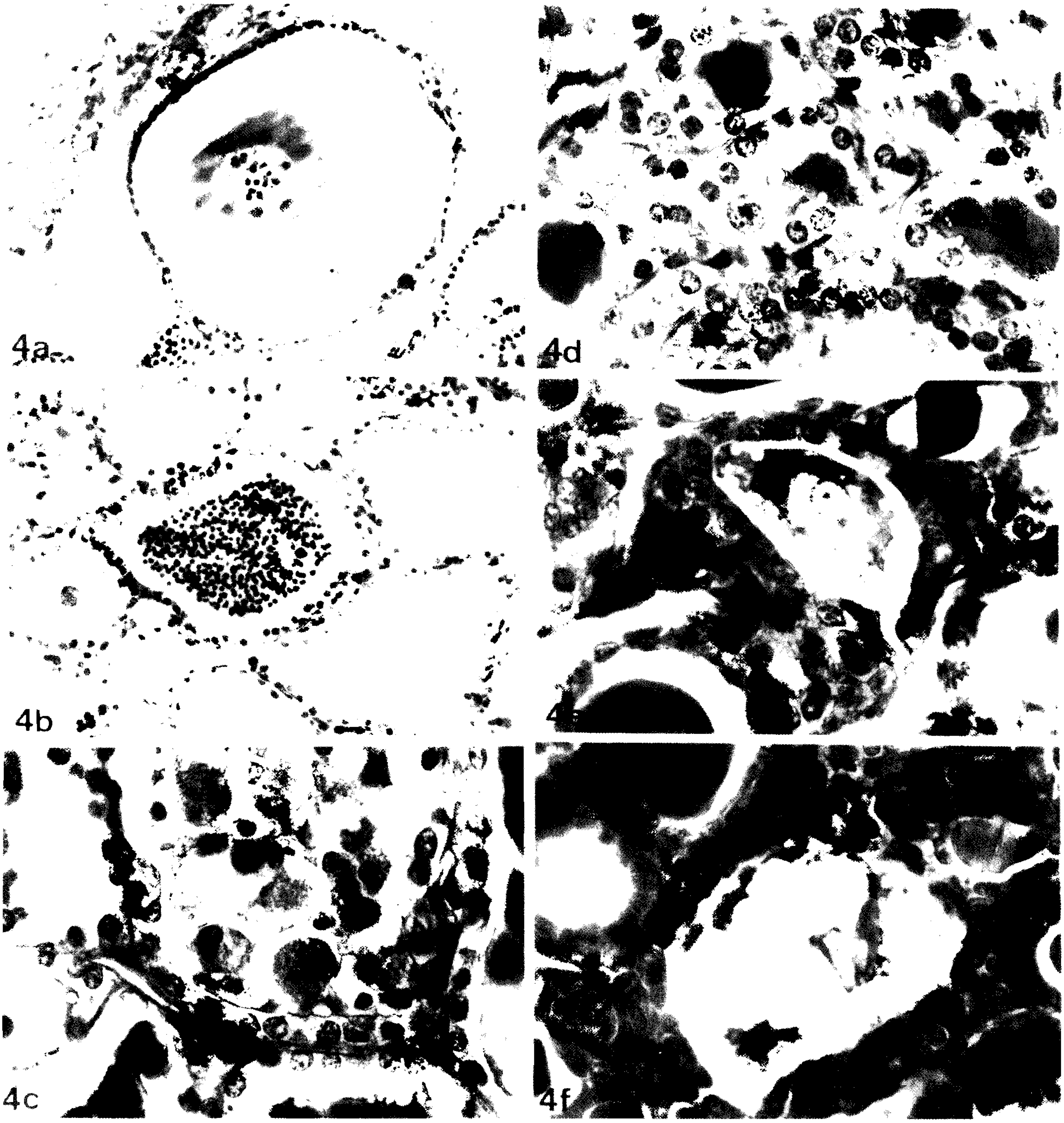

Fig. 4. The intrafollicular cells: their aspect and significance. **a)** Desquamous cell group (rat), **b)** haemorrhagic follicle (rat), **c)** large cells with eccentric nucleus filling a (human) follicle, **d)** polymorphic nuclei in the human thyrocytes, **e)** and **f)** intrafollicular cell types in the cat thyroid. Martin's trichrome.(a, b) x 240; (c, d, e, f) x 1,200

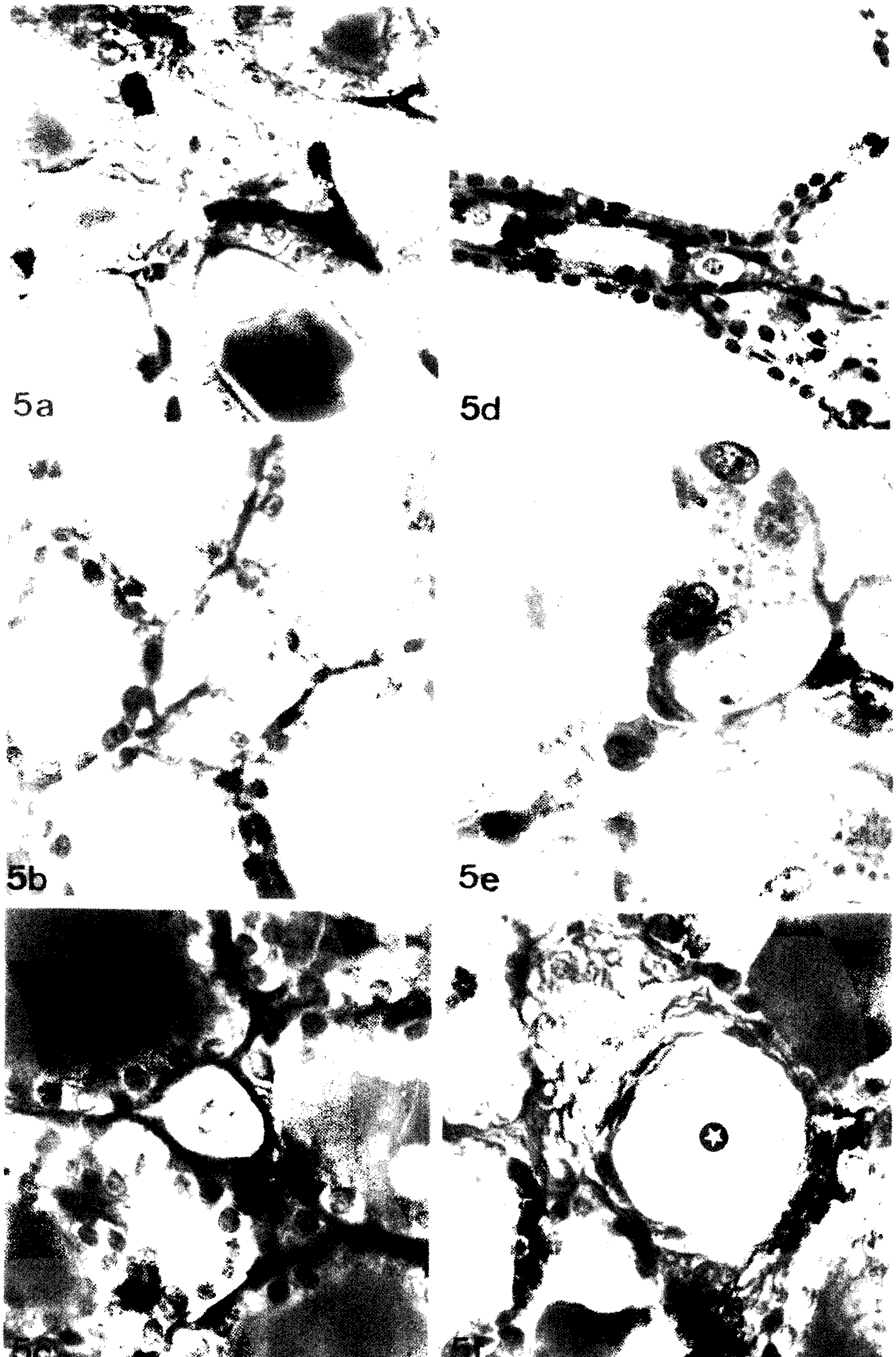

Fig. 5. Parafollicular cells. Autonomic neurons and ganglions. Normal aspect of the parafollicular cells. isolated **(a, d, e)** or forming groups **(b)**. Vegetative elements are frequent in the thyroid structure **(c, f, *)**. Martin's trichrome. (a, b, c, e, f) x 1,200; (d) x 480

observed (Fig. 2 f).

3) Parafollicular and ganglion cells

During development, the thyroid gland received a transfer from the neural crest in the form of parafollicular cells, «clear cells» or «C cells», producing calcitonine (a, b, d, e). But there are other cell types (c, f) which were real vegetative nerve cells, appearing isolated or forming groups (small ganglions) (Fig. 5).

The presence of ganglion cells in the thyroid gland is a reality (Figs. 6, 7). In fact, within the thyroid parenchyma, we found very large nerve cells (25-30 μm) whose morphology was oval, pyramidal or polyedric, showing an enormous, spherical eccentric nucleus with a clear nuclear membrane, lax chromatin and a prominent nucleolus. Its cytoplasm was surrounded by a well defined plasmatic membrane, containing abundant Nissl granulations. We found isolated neurons, or groups forming small ganglions in the interfollicular spaces.

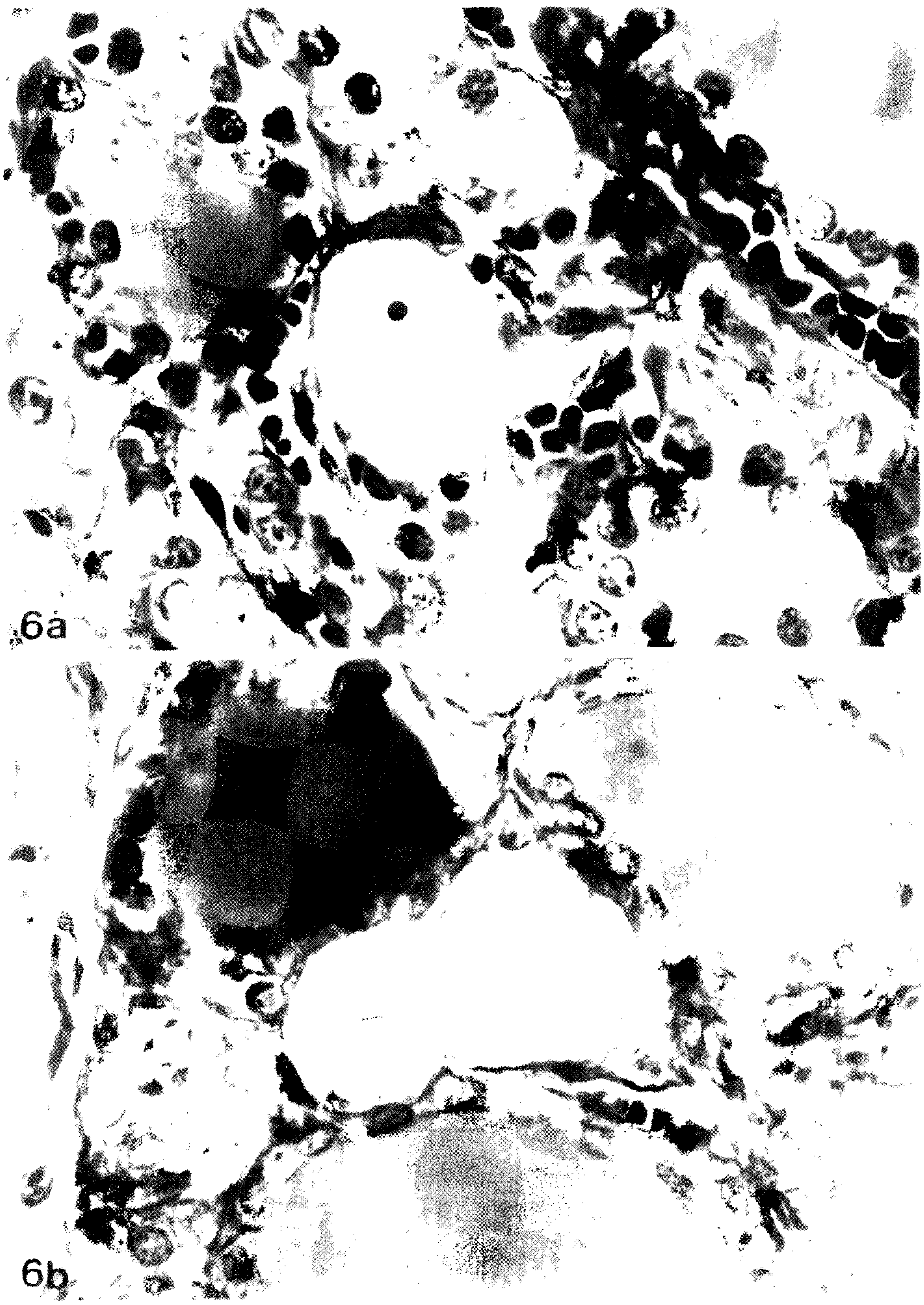

Fig. 6. Ganglion cells in the thyroid structure (rat). **a)** Isolated nerve cell in the interfollicular space, deeply vascularized. **b)** small vegetative ganglion occupying the space among small follicles. Notice the large size of these neurons, with enormous nuclei and significant nucleolus. Satellite cells can also be seen. Martin's trichrome. x 1,200

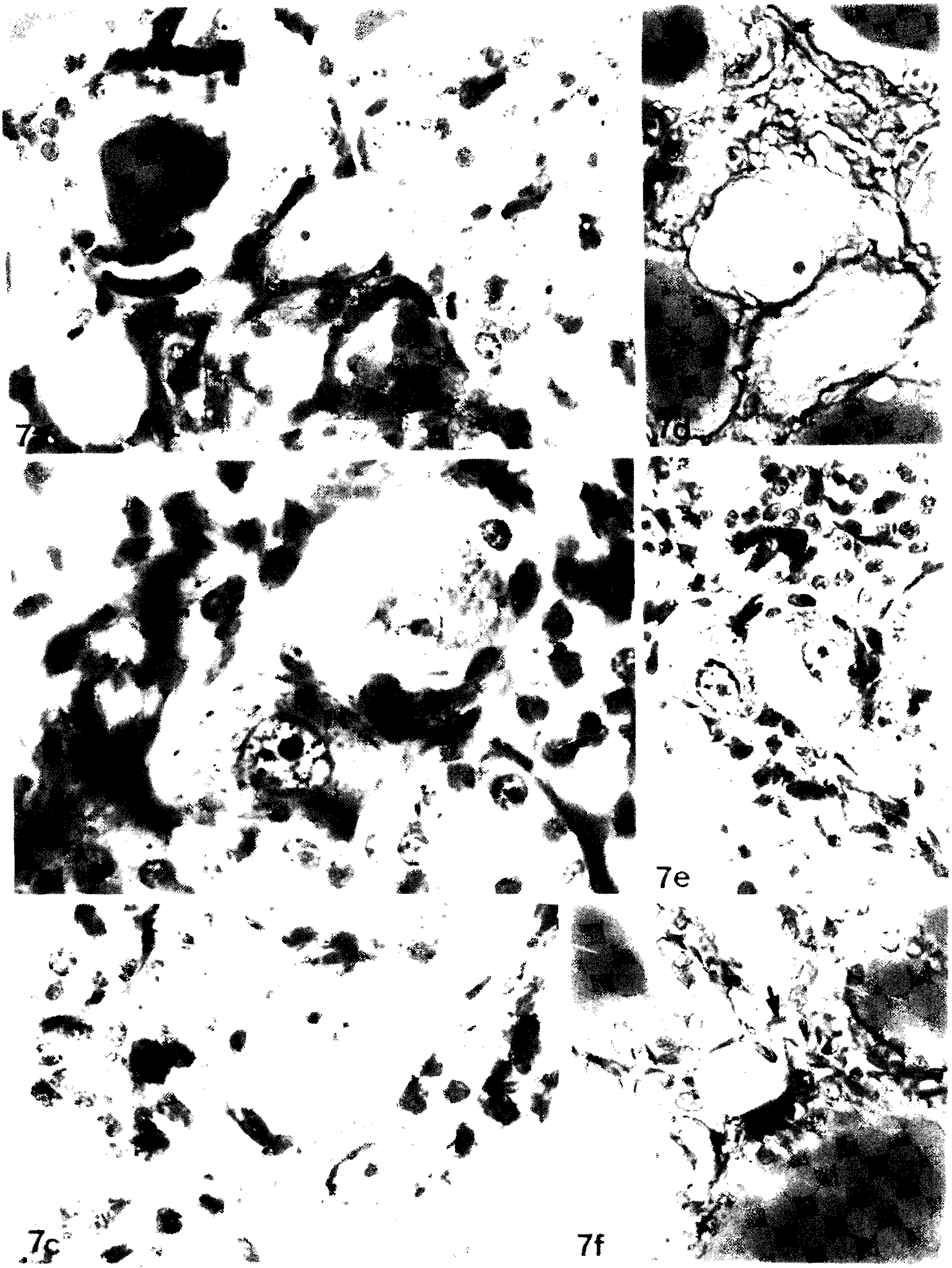

Fig. 7. Several aspects of the presence, in the thyroid gland of the rat and the dog, of vegetative neurons, either isolated or forming small ganglions. Some of them (f) show a branch-like extension (arrow). Martin's trichrome. x 1,200

surrounded by a capsule of connective tissue, with satellite cells of fusiform aspect and numerous blood vessels. Close contact of the ganglion cells with the blood capillaries was also observed.

The neurons adopted an irregular distribution within the thyroid parenchyma, their location in most of the animals being in deep, central zones of the gland. Only on a few occasions were they located peripherically, near the capsule. The number of these cells in each thyroid was extremely variable. In the case of the rat, we found, in one sample, up to 38 ganglion cells throughout the entire cut series, while in others we did not observe any single cell of this type. In the case of dogs, the largest number of nerve elements found was 9.

Discussion

The comparative study of the structure of the thyroid, allows us to establish some different features. The difference in the distribution and abundance of connective tissue is significant according to species.

In relation to intrafollicular cells, we would like to point out that not only all the cells inside the follicle are degenerative cells in process of lysis, but there are also cells in active functional status. As for ganglion cells, in the introduction we have already discussed the controversy raised regarding the existence or not of ganglion cells in the thyroid parenchyma. In our opinion, the only description which categorically affirms their existence is that of Nonidez (1931, 1932, 1935) in dogs. Unfortunately, Taniai (1938) did not confirm these discoveries.

Bargmann (1939), in his book on the thyroid gland, carried out an extensive review of thyroid cut series on different animals, without being able to discover a single ganglion element. Due to his important scientific reputation, the subject remained closed. Thirty years passed before Sarrat (1965) looked back on the subject, describing them in rats.

We believe that thyroid ganglion cells are a normal component in the structure. What happens is that their presence is not regular and is quite variable. In order to reach definitive conclusions, it is necessary to study sequential material. In reference to their origin, we think that they are undoubtedly migrations, from the neural crest in development, of autonomic neurons which form ganglions or penetrate into the same structure of the organ, as happens in other areas (intestine, adrenals, etc.)

We are convinced that these neurons play an important role in the neural regulation of the thyroid, independently of their topography. It is also true that their close and regular contact with blood vessels might suggest that they are, in fact, sensors of the plasmatic concentration of certain hormones and their stimulation might influence the neighbouring thyrocyte.

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