Light and Electron Microscopic Evidence of Hypothalamic Afferences Originating from the Hippocampus in the Pigeon

N. Bons, C. Bouillé, J. D. Baylé and I. Assenmacher[1]

Laboratoire de Physiologie Animale et Générale, Université de Montpellier II, Place Eugène Bataillon, F–34060 Montpellier Cedex (France), 19 May 1976.

Summary. Degenerating nervous fibres and synaptic boutons were demonstrated in the nuclei posterior medialis hypothalami after hippocampal lesions in the pigeon (light and electron microscopy).

It was shown that the region containing the nuclei posterior medialis hypothalami (PMH: Karten and Hodos[2]) is basically involved in the control of pituitary-adrenocortical function in the pigeon[3]. On the other hand, placement of bilateral electrolytic lesions in the hippocampus resulted in a high steady level of plasma corticosterone[4] and partial anterolateral deafferentation of the hypothalamus led to a quite similar situation[5]. It was therefore interesting to investigate histologically whether direct nervous fibres afferent to the hypothalamus, emerging from the hippocampus, could be demonstrated.

10 adult pigeons (red Carneau) were used for this experiment. Uni- or bilateral electrolytic lesions were placed stereotaxically[2] in the hippocampus by passing a 500 μA direct current for 40 sec (20 mc) through a platinum electrode insulated with INSLE 33 X varnish (Product Corp.) except at its tip (60 μm). The animals were sacrificed 1, 2, 4, 5 or 7 days later. For light microscopic observations, the head was perfused via carotid arteries with 0.9% saline and 10% formol saline, and prepared according to the Johnstone and Bowsher technique[6]. For electron microscopic studies, the head was perfused with 0.9% saline, 4% paraformaldehyde and post-fixed in 2% osmic acid solution.

5 or 7 days after an unilateral lesion was placed in the hippocampus, the brain's preparations impregnated according to the Johnstone-Bowsher method contained fine myelinated degenerating fibres in the medial hypothalamic area (PMH). These hypothalamic fibres appeared to be thinner than the numerous degenerated

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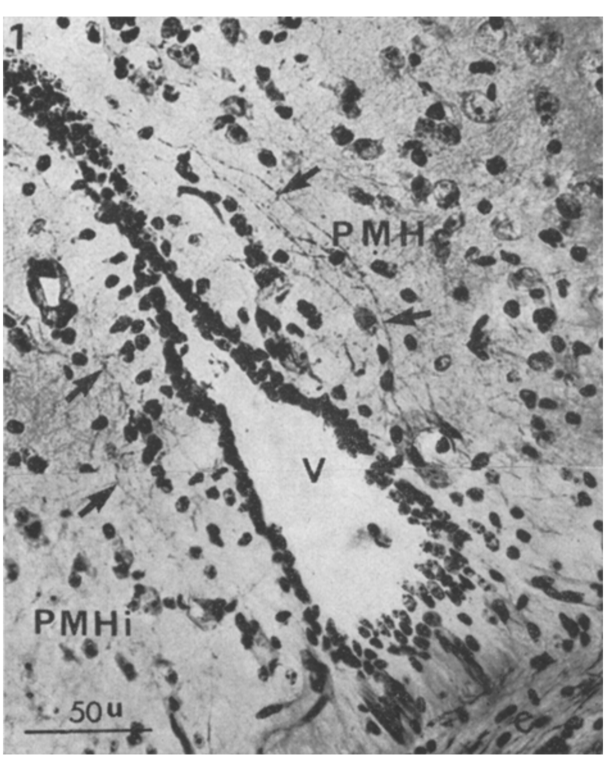

Fig. 1. Johnstone-Bowsher impregnations in the corticotropic area of the pigeon's hypothalamus, 7 days after placement of unilateral lesion in the hippocampus. Commissura supraoptica (c), nucleus posterior medialis hypothalami contralateral (PMHc) and ipsilateral (PMHi), 3rd ventricle (V). Arrows indicate degenerated fibres.

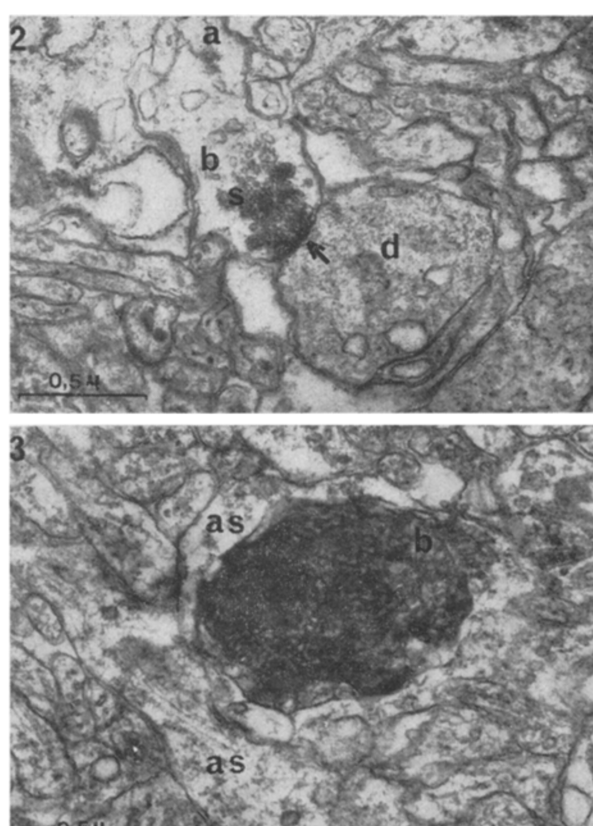

Fig. 2 and 3. Electron microphotographs of the PMH region, 24 h (Figure 2) and 5 days (Figure 3) after surgery. Axons (a); degenerated boutons (b); dendrites (d); synaptic vesicles (s). Arrows show synaptic contacts.

fibres which could be traced within various parts of the brain (e.g., commissura anterior, tractus septo-mesencephalicus) after unilateral lesion of the hippocampus. Fine degenerated fibres were located in both ipsi- and contralateral PMH nuclei (Figure 1).

After bilateral lesions of the hippocampus, the systematic exploration of the ultrathin sections of the PMH area revealed several groups of boutons showing a degenerated aspect (Figure 4). However, the distribution of such degenerated endings in the nucleus was not homogeneous. Groups of 6 to 11 degenerated boutons were found in the anterior and posterior parts of the PMH. Only rare smaller groups of degenerated profiles could be observed in the intermediate region of the nucleus. Early observations were made 24 h after surgery. The degenerated boutons showed an increase (Figure 2) in electron

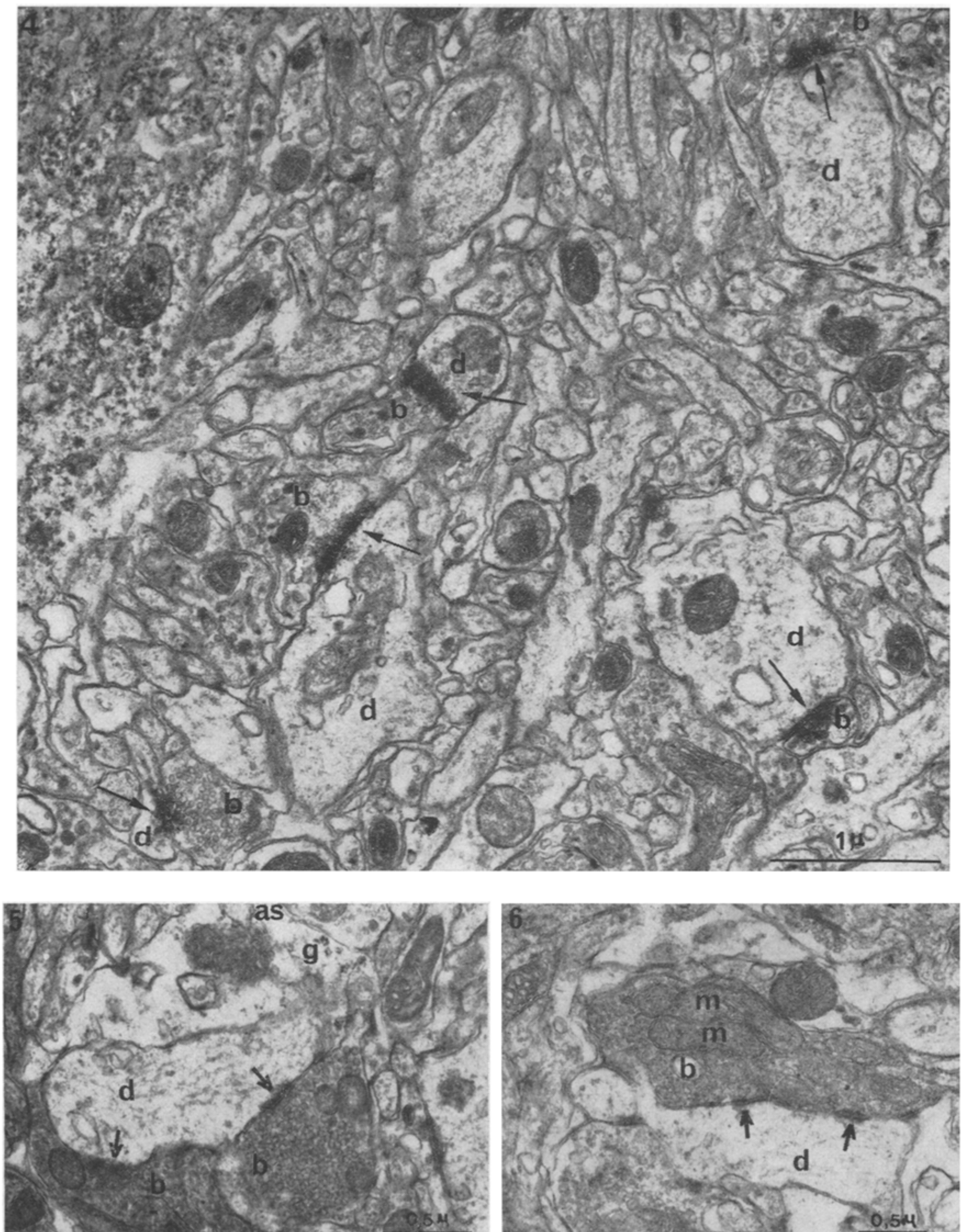

Fig. 4–6. Degenerated endings in the region of the PMH nucleus, 24 h (Figure 4) and 5 days (Figures 5 and 6) after lesioning of the hippocampus. Astrocytes (as); degenerated boutons (b); dendrites or dendritic spines (d); glycogen particles (g); mitochondria (m). Arrows: synaptic contacts.

density of the axoplasm, near the synaptic vesicles which were usually clumped together. An increased electron density could be seen occasionally at the level of the postsynaptic membrane thickening. These alterations became widespread in the degenerated boutons of the PMH nucleus 2 and 5 days after hippocampal lesion were placed. At this time the synaptic boutons were filled in with numerous spheroidal and flattened vesicles (Figures 5 and 6), while the mitochronchia were darkened and their inner structure even disorganized. It was sometimes possible to observe degenerated profiles which exhibited more pronounced changes with a structure becoming hardly recognizable due to their extreme darkness (Figure 3). All degenerating terminals were found to be in contact with dendritic spines and sometimes with smooth dendrites.

During the same time interval (1 to 5 days after lesioning the hippocampus), the neuroglia exhibited an important activity in the PMH nuclei. For example, the perikarya of the astrocytes were increased with hyperplasia of the glial filaments and an accumulation of glycogen particles in the distal part of their large and numerous processes. On the other hand, in phagocytic glial cells the cisternae of the rough endoplasmic reticulum became elongated and very numerous. In controls, groups of degenerated boutons were never found except for some very rare isolated profiles of unknown origin.

Degenerated fibres were undoubtly characterized in both right and left regions corresponding to the n. posterior medialis hypothalami, 5 to 7 days after electrolytic lesions were placed in the hippocampus (light microscopy). Hippocampal lesions resulted also in clearly characterized degenerating synaptic profiles located in the same area (electron microscopy). This 2-fold characterization of degenerating fibres and boutons in the region of the PMH nucleus favours the hypothesis of a direct link between hippocampal and hypothalamic structures in the pigeon. Numerous studies suggest that the hippocampus participates in the regulation of neuroendocrine hypothalamic activities in mammals[7,8]. In birds, it was shown that the hippocampus plays a quite important role in decreasing adrenocortical function[4] and it was suggested that such an inhibiting influence from the hippocampus develops by modulating the activity of the corticotropic neuronal populations lying in the hypothalamus[9]. Present anatomical findings agree with this statement.

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Der Seidenschwanz *Bombycilla garrulus* als frugivorer Ernährungsspezialist[1]

The Waxwing *Bombycilla garrulus* as a Frugivorous Feeding Specialist

P. Berthold

Max-Planck-Institut für Verhaltensphysiologie, Vogelwarte Radolfzell, D-7760 Schloss Möggingen (Bundesrepublik Deutschland), 29. April 1976.

Summary. Eight waxwings, *Bombycilla garrulus*, were fed exclusively with vegetable food for periods of 10–18 days. In contrast to other song birds, they maintained or increased body weight during that time, or reduced it only moderately. Thus the waxwing is a feeding specialist which can subsist at least temporarily on a totally vegetable diet.

Omnivore Singvogelarten, wie Grasmücken (*Sylvia*), Amsel (*Turdus merula*) und Rotkehlchen (*Erithacus rubecula*), sind nach neuesten Untersuchungen lebensnotwendig auf regelmässige Aufnahme von animalischer Nahrung angewiesen. Bei rein vegetabilischer Ernährung durch Beeren und andere fleischige Früchte fällt ihr Körpergewicht rasch und kontinuierlich ab; die Tiere sind nach wenigen Tagen krank und gehen bereits nach etwa einer Woche entkräftet ein. Die Ursache dafür ist höchstwahrscheinlich Proteinmangel[2].

Unter den omnivoren Singvögeln ist der Seidenschwanz, als nordischer Invasionsvogel, bekannt für vielseitige und starke Aufnahme von Beeren und anderen fleischigen Früchten. Auch von anderen Vogelarten wenig beachtete Früchte wie die Beeren des Schneeballs (*Viburnum opulus*), werden von ihm im Winterhalbjahr in grossen Mengen verzehrt. Ferner ist bekannt, dass er einen relativ langen Darm besitzt[3]. Diese Beobachtungen am Seidenschwanz und die festgestellte Unfähigkeit anderer omnivorer Singvogelarten, sich rein vegetarisch zu ernähren, führte zu der Frage, ob sich Seidenschwänze rein frugivor ernähren können. Diese Frage wird zurzeit in unserem Institut an 8 im Januar 1976 in S-Deutschland gefangenen Vögeln untersucht. Die Untersuchungen ergaben bisher folgendes: Die Seidenschwänze wurden im simulierten Naturtag 18 Tage lang bei einer Umgebungstemperatur von 20 °C, 11 Tage lang bei 10 °C und 10 Tage lang bei 0 °C nur mit Vegetabilien (Apfel, Eberesche, Hagebutte, Schneeball) gefüttert. In allen drei Versuchen machten die Vögel einen normalen und gesunden Eindruck, wenngleich auch ihr Körpergewicht teilweise mehr oder weniger abfiel. Es erreichte in der Versuchszeit jedoch keine abnorm niedrigen Werte. Zum Teil stieg das Körpergewicht der Versuchsvögel bei ausschliesslicher Fütterung von Vegetabilien (Apfel, Eberesche) sogar um einige Gramm an.

Der Seidenschwanz ist somit im Gegensatz zu anderen omnivoren Singvogelarten in der Lage, sich zumindest zeitweilig rein frugivor ausreichend zu ernähren. Ihm reicht folglich offenbar auch der geringe Proteingehalt von Äpfeln von weniger als 1%[2] zur Deckung seines Proteinbedarfes. *Bombycilla* ist demnach unter den einheimischen Singvögeln ein ausgeprägter Ernährungsspezialist, und zwar für frugivore Ernährung. Diese Eigenschaft dürfte es ihm ermöglichen, noch relativ spät im Winter in gemässigte Breiten einzuwandern und dort zu bleiben, wenn andere, mehr auf animalische Nahrung angewiesene omnivore Arten wegziehen müssen. Die Untersuchungen werden fortgesetzt.

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