GLIOMAS IN ANIMALS

A Report of Two Astrocytomas in the Common Fowl

ERWIN JUNGHERR, D.M.V., AND ABNER WOLF, M.D.

(From the Department of Animal Diseases, Storrs Agricultural Experiment Station; the Department of Neuropathology, Columbia University; the Neurological Institute of New York)

In one of the first modern studies of comparative tumor pathology, Bland-Sutton (4) stated that "no tumors are peculiar to man." While this view was supported in general by subsequent observations, the infrequent reports of gliomas and other tumors of the central nervous system in animals other than man seemed to be significant. This low incidence, however, is probably more apparent than real. In a recent dissertation on the subject, Grün (20) points out that post-mortem examination of the brain in animals is performed comparatively infrequently and that possible carriers of tumors of the central nervous system are often disposed of by slaughter without adequate study.

Enhanced interest in the study of brain tumors in man has been reflected in the increased number of reports of cerebral neoplasms in animals, especially during the past decade, but many of these cases have been so inadequately described that even an approximate classification is difficult. There is thus a definite need for wider information on the comparative pathology of tumors of the nervous system. The present communication aims to contribute to the subject by a brief critical review of the literature on gliomas in the lower animals, and by the reports of two additional cases in the common fowl.

LITERATURE

During recent years several efforts have been made to collect the available information on tumors of the nervous system in animals. Slye, Holmes and Wells (44) reviewed the literature on intracranial neoplasms in lower animals up to 1931; Schlotthauer and Kernohan (41) and Courteau (10) extended the summary up to 1935. Apparently the first attempt to harmonize the older nomenclature with the modern histogenetic classification of brain tumors, in this case based upon the modified scheme of Henschen (22), was made by Grün (20), and elaborated in the new edition of Joest’s Handbuch (29).
Table I: Gliomas in Animals, Apparently Authentic Cases

<table>
<thead>
<tr>
<th>Species</th>
<th>Probable Type</th>
<th>Author's Designation</th>
<th>Location</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fish (Limanda Yokohama)</td>
<td>Ganglioneuroma</td>
<td>Neuroma gangliocellulare</td>
<td>Thoracic spinal cord</td>
<td>Takahashi (45)</td>
</tr>
<tr>
<td>Chicken</td>
<td>Astrocytoma</td>
<td>Isomorphic glioblastoma</td>
<td>Cerebellum and midbrain</td>
<td>Belmonte (3)</td>
</tr>
<tr>
<td>Chicken</td>
<td>Astrocytoma</td>
<td>Spangioblastoma multiforme</td>
<td>Cerebrum</td>
<td>Jackson (27)</td>
</tr>
<tr>
<td>Chicken</td>
<td>Astrocytoma</td>
<td>Glioma</td>
<td>Cerebellum</td>
<td>Jackson (27)</td>
</tr>
<tr>
<td>Chicken</td>
<td>Astrocytoma</td>
<td>Glioma</td>
<td>Cerebrum and cerebellum</td>
<td>Jungherr and Wolf</td>
</tr>
<tr>
<td>Parakeet (Melopsittacus undulatus)</td>
<td>Oligodendro-glial or astrocytoma?</td>
<td>Glioma retroocular</td>
<td>Optic nerve</td>
<td>Anders (1)</td>
</tr>
<tr>
<td>Sparrow</td>
<td>Ganglioneuroma</td>
<td>“True nerve cell tumor”</td>
<td>Cerebellum</td>
<td>Seligman (42)</td>
</tr>
<tr>
<td>Mouse</td>
<td>Choroid papilloma</td>
<td>Papillary ependymoma</td>
<td>Lat. ventricle</td>
<td>Slye et al (44)</td>
</tr>
<tr>
<td>Rat</td>
<td>Ganglioneuroma</td>
<td>Gliosepanglioneuroma</td>
<td>Optic nerve</td>
<td>Bullock and Curtis (6)</td>
</tr>
<tr>
<td>Dog (Bull Terrier)</td>
<td>Glioblastoma</td>
<td>Sarcomatous glioma</td>
<td>Ammon's horn</td>
<td>Hjärre (23)</td>
</tr>
<tr>
<td>5 Dogs</td>
<td>*</td>
<td>Glioma</td>
<td>Cerebrum</td>
<td>Hjärre (24)</td>
</tr>
<tr>
<td>1 Dog</td>
<td>*</td>
<td>Glioma</td>
<td>Diencephalon</td>
<td>Hjärre (24)</td>
</tr>
<tr>
<td>2 Dogs</td>
<td>*</td>
<td>Glioma</td>
<td>Cerebellum</td>
<td>Hjärre (24)</td>
</tr>
<tr>
<td>Dog</td>
<td>Glioblastoma multiforme</td>
<td>Glioblastoma multiforme</td>
<td>Thalamus</td>
<td>Schlotthauer and Kernohan (41)</td>
</tr>
<tr>
<td>Dog (Toy Pinscher)</td>
<td>Retinoblastoma</td>
<td>Glioma of retina</td>
<td>Intraocular</td>
<td>Chevki (9)</td>
</tr>
<tr>
<td>Dog</td>
<td>Astrocytoma</td>
<td>Gliosarcoma</td>
<td>Pyriform lobe</td>
<td>Marchand et al (32)</td>
</tr>
<tr>
<td>Dog</td>
<td>Choroid papilloma</td>
<td>Glioma ?</td>
<td>Cerebellum</td>
<td>Dawes (11)</td>
</tr>
<tr>
<td>Dog (Bull)</td>
<td>Glioblastoma</td>
<td>Small-cell gliosarcoma</td>
<td>Pyriform lobe</td>
<td>Dawes (11)</td>
</tr>
<tr>
<td>Dog (Bull Terrier)</td>
<td>Glioblastoma</td>
<td>Round-cell sarcoma</td>
<td>Cerebrum</td>
<td>Slawson (43)</td>
</tr>
<tr>
<td>Dog (Fr. Bull Terrier)</td>
<td>Glioblastoma</td>
<td>Mature glioma</td>
<td>Temporal lobe</td>
<td>Pallaske (36)</td>
</tr>
<tr>
<td>Dog (Boston Terrier)</td>
<td>Oligodendroglioma</td>
<td>Oligodendroglioma</td>
<td>Cerebellum</td>
<td>Milks and Olafson (35)</td>
</tr>
<tr>
<td>Dog (Boston Terrier)</td>
<td>Ganglioneuroma</td>
<td>Ganglioneuroma</td>
<td>Medulla</td>
<td>Milks and Olafson (35)</td>
</tr>
<tr>
<td>Dog (Eng. Setter)</td>
<td>Ganglioneuroma</td>
<td>Ganglioneuroma</td>
<td>Pons and chiasm</td>
<td>Milks and Olafson (35)</td>
</tr>
</tbody>
</table>

* Histologic data not given or insufficient for reclassification.

In the present communication the term "glioma" is used, according to Bailey and Cushing, to indicate tumors arising from tissues which are derivatives of the original neural tube; it includes glial, neural, choroidal, ependymal, and pineal neoplasms. This usage of the term glioma obviously extends its literal meaning, but is simple and has become firmly established. In this sense, it is inclusive of both the gliomas and the paragliomas of the classification of Henschen (22).
TABLE I—Continued

<table>
<thead>
<tr>
<th>Species</th>
<th>Probable Type</th>
<th>Author's Designation</th>
<th>Location</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dog (Eng. Setter)</td>
<td>Medulloblastoma</td>
<td>Medulloblastoma</td>
<td>Cerebellum, pons</td>
<td>Olafson (35)</td>
</tr>
<tr>
<td>Dog (Pointer)</td>
<td>Choroid papilloma</td>
<td>Choroid</td>
<td>Lat. ventricle</td>
<td>Olafson (35)</td>
</tr>
<tr>
<td>Dog</td>
<td>Astrocytoma?</td>
<td>Glioma</td>
<td>Lumbar cord</td>
<td>Milks and Olafson (35)</td>
</tr>
<tr>
<td>Dog</td>
<td>Medulloblastoma ?</td>
<td>Glioma</td>
<td>Medulla and cerebellum</td>
<td>Batten (2)</td>
</tr>
<tr>
<td>Fox (Vulpes fulvus)</td>
<td>Pinealoma</td>
<td>Pinealoma</td>
<td>Cerebrum</td>
<td>Schlothauer and Kernohan (41)</td>
</tr>
<tr>
<td>Cat (Persian)</td>
<td>Astroblastoma</td>
<td>Astroblastoma</td>
<td>Cervical cord</td>
<td>Milks and Olafson (35)</td>
</tr>
<tr>
<td>Cat</td>
<td>Retinoblastoma</td>
<td>Neuroblastoma</td>
<td>Intraocular</td>
<td>Grün (20)</td>
</tr>
<tr>
<td>Goat</td>
<td>Pinealoma</td>
<td>Pinealoma</td>
<td>Brain</td>
<td>Trautmann, cited by Joest (29)</td>
</tr>
<tr>
<td>Ox</td>
<td>*</td>
<td>Gioma</td>
<td>Spinal cord</td>
<td>Joest (28)</td>
</tr>
<tr>
<td>Ox</td>
<td>*</td>
<td>Gioma</td>
<td>Cerebrum</td>
<td>Hjärre (24)</td>
</tr>
<tr>
<td>Ox</td>
<td>Choroid papilloma</td>
<td>Papillomatous</td>
<td>Cerebellum</td>
<td>Hjärre (24)</td>
</tr>
<tr>
<td>Horse</td>
<td>Glioblastoma?</td>
<td>Glioma</td>
<td>Right cerebrum and base of brain</td>
<td>Schlegel (40)</td>
</tr>
<tr>
<td>Horse</td>
<td>Retinoblastoma?</td>
<td>Glioma</td>
<td>Intraocular</td>
<td>Bland-Sutton (4)</td>
</tr>
<tr>
<td>Horse</td>
<td>Ganglioneuroma</td>
<td>Neurona</td>
<td>Olfactory trigone, pons</td>
<td>Gmelin (19)</td>
</tr>
<tr>
<td>Horse</td>
<td>Glioblastoma</td>
<td>Subpial giosarcoma</td>
<td>Cerebrum</td>
<td>Holz (25)</td>
</tr>
<tr>
<td>Horse</td>
<td>Astrocytoma</td>
<td>Sarcomatos glio</td>
<td>Cerebrum</td>
<td>Glamser (18)</td>
</tr>
<tr>
<td>2 Horses</td>
<td>Retinoblastoma</td>
<td>Retinal glioma</td>
<td>Intraocular</td>
<td>Fösger (14), cited by Joest (29)</td>
</tr>
<tr>
<td>Horse</td>
<td>*</td>
<td>Gioma</td>
<td>Diencephalon</td>
<td>Hjärre (24)</td>
</tr>
<tr>
<td>Horse</td>
<td>*</td>
<td>Gioma</td>
<td>Medulla</td>
<td>Marchand and Petit (31), cited by Grün (20)</td>
</tr>
<tr>
<td>Horse</td>
<td>Glioblastoma</td>
<td>Sarcoma</td>
<td>Frontal lobe</td>
<td>Meyer (34)</td>
</tr>
<tr>
<td>Horse</td>
<td>Choroid papilloma</td>
<td>Angioma</td>
<td>Lat. ventricle</td>
<td>Butler (7)</td>
</tr>
<tr>
<td>Horse</td>
<td>Choroid papilloma</td>
<td>Venous papilloma</td>
<td>Medulla and pons</td>
<td>Rutherford (39)</td>
</tr>
<tr>
<td>Horse</td>
<td>Choroid papilloma</td>
<td>Adenocarcinoma</td>
<td>Lat. ventricle</td>
<td>Meyer (34)</td>
</tr>
<tr>
<td>Zebra</td>
<td>Pinealoma</td>
<td>Adenoma or adenosarcoma</td>
<td>Epiphysis</td>
<td>Vermeulen (46)</td>
</tr>
<tr>
<td>Bonnet monkey</td>
<td>Retinoblastoma?</td>
<td>Glioma</td>
<td>Intraocular</td>
<td>Bland-Sutton (4)</td>
</tr>
</tbody>
</table>

* Histologic data not given or insufficient for reclassification.

To avoid repetition, and yet to permit the reader a bird’s eye view of the literature on gliomas in animals, apparently authentic cases are summarized in Table I. An attempt is made to interpret the original descriptions or diagnoses of the neoplasms in terms of the current nomenclature.

Two significant series of observations on gliomas in animals, namely those by Milks and Olafson (35) and by Hjärre (24), were not accompanied by histologic descriptions. The former authors made definite histologic diagnoses but these cannot be critically discussed in the absence of details. Hjärre's
(24) series became known indirectly through a statement by Henschen which contained only statistical data as to the number of gliomas observed, their location, and the species affected.

Certain cases listed in Table I deserve further discussion. This is true also of cases reported in the literature under the title of glioma which have not been listed here because the diagnosis seems doubtful.

Heading the list of gliomas presented in Table I is the remarkable report by Takahashi (45) of a ganglioneuroma in a fish, apparently the first recorded instance of a tumor of the nervous system in a cold-blooded animal. The three instances of glioma in the chicken reported by Belmonte (3) and Jackson (27) bear a close resemblance to those observed by the authors and will be reviewed in detail below. Anders (1) observed a retro-ocular glioma in a Wellensittich, a type of budgerigar or parakeet (not a "gull" as stated by Slye et al (44)). He remarked on the fact that although all tumors observed in man are known to occur in vertebrates, including amphibians, reptiles and fish, no tumor of the nervous system had been reported in birds up to his time except that by Podmaniczky (38). Anders was not certain whether his tumor was a glioma or a sarcoma. His histologic description suggests either an oligodendroglioma or a small-cell astrocytoma of the optic nerve. Seligman's (42) case of a cerebellar tumor in a sparrow was quoted widely and has been designated a neurocytoma by Fox (16). From the original author's very meager description it would appear to be an extra-axial tumor. His statement that it contained "true nerve cells" makes it probable that he was dealing with a ganglioneuroma, possibly of a cranial nerve.

The papillary tumor in the lateral ventricle of the mouse described by Slye et al (44), which was diagnosed papillary ependymoma, would appear, from its gross structure and the typical choroid epithelium observed microscopically, to be a choroid papilloma.

Examples of glioma in the dog outnumber by far those reported in any other species of animal. The majority have been observed in bulldogs and related breeds, such as the Boston bull and French terrier. Chevki (9) observed an interesting glioma of the retina in a Rehpinscher (toy Doberman or miniature Pinscher) that showed marked enlargement of the corresponding optic bulb. With the Hortega silver carbonate stain the neoplastic cells appeared stellate, with finely branching polar processes; spindle-shaped elements were also present. It is probable that the former were astrocytes and the latter retinoblasts or possibly spongioblasts. The extreme cellularity of the tumor leads one to think that it may have been malignant and therefore a retinoblastoma equivalent to the cerebellar medulloblastoma. This probability is supported by the author's comment on its resemblance to a round-cell sarcoma. The unusual presence of what would seem to be astrocytes, and possibly spongioblasts, is against this diagnosis, but maturing and, rarely, mature cells have been described in some of the equivalent tumors in man.

Of the tumors presented in the early reports, that described by Marchand, Petit and Pécard (32) in a ten-year-old dog seems to be regarded by most investigators (44, 20, 29) as a true glioma. It was situated in the pyriform

1 The authors believe the latter to be a congenital malformation rather than a neoplasm, as explained below.
lobe of one cerebral hemisphere, was soft and gelatinous in consistency, and
was not sharply demarcated from the surrounding parenchyma. The presence
of definite glial fibers and the uniformity of the cell type make it more likely
that it was an astrocytoma.

Two cases reported by Dawes (11) were not studied histologically, nor
named. The illustration of the gross appearance of one of them is typical of
a choroid papilloma. The two cases of "gliosarcoma" reported by Hjarre
(23) and by Dexler (12) in bulldogs are sufficiently described to permit a prob-
able diagnosis of glioblastoma; and this holds true to a lesser degree for the
"round-cell sarcoma" observed by Slawson (43).

Pallaske (36) made a detailed study of a cerebral glioma in a French bull-
dog. There was involvement of the temporal lobe and the mediodorsal aspect
of the thalamus. The diffusely infiltrating microcystic neoplasm had the
superficial histologic appearance of a vascular sarcoma and showed a tendency
to necrosis, hemorrhage, and perivascular arrangement of some of its neoplastic
elements. Two types of cells were observed, one relatively small with a hyper-
chromatic nucleus and scanty cytoplasm, the other large, round or oval, with
pale, sometimes indented, nucleus and "fringe-like cytoplasm, the branches of
which seemed to connect with neighboring cells." Few glial fibers could be
demonstrated by special stains. The author observed that tumor cells tended
to line up or "form a wall" along necrotic cell bands, a description distinctly
reminiscent of pseudo-palisade formation in glioblastomas. Pallaske felt that
the absence of bizarre nuclear pictures placed the tumor among the mature
gliomas. The rapid clinical course, the tendency to hemorrhage, the degenera-
tion, the capillary hyperplasia, the variability in cell type, and the suggestion
of pseudo-palisade formation lead the present authors to regard this as a glio-
blastoma.

Piana (37), cited by Casper (8), described a spinal glioma at the level of
the second and third lumbar vertebrae, which measured 10 × 6 mm. in size
and was said to be "subdural" and disc-like. Microscopically, it was reported
to contain tissues resembling both the white and the gray matter of the cord.
There are points in the author's description favoring a diagnosis of either
astrocytoma or ganglioneuroma.

Batten (2) described a unilateral "sarcoma" in a mongrel terrier involving
the medulla, right cerebellar hemisphere, and right acoustic nerve. He be-
lieved it to have originated from the sheaths of the pial blood vessels, a point
which caused Grün (20) to place this tumor among the perithelial sarcomas.
The original author described the tumor cells as small, round and deeply
stained, or large, oval, and light-staining. The cells of each type were uniform
in size and were often arranged about blood vessels. This neoplasm may well
have been a medulloblastoma originating in the cerebellum.

Grün (20) reported a tumor of the eye in a cat, which he diagnosed as a
neuroblastoma of the retina. The histologic description and illustrations con-
firm this diagnosis. It would seem preferable to use the at present more gen-
erally accepted term, retinoblastoma, to designate this neoplasm. This is true
also of the tumors which Joest (29) has listed as neuroblastomas of the retina,
in the horse (4, 14) and bonnet monkey (4).

Schlegel (40) observed a large papillary tumor in the right lateral ventricle
of the cerebrum of an ox. He described cuboidal and cylindrical cells which lined vascular papillae. Although he diagnosed this tumor as a papillary carcinoma, it appears to be a benign choroid papilloma.

Reports of brain tumors in horses are second in frequency to those in dogs. M'Fadyean (33) reported a large tumor of the right cerebral hemisphere of a horse, which extended ventrally to present on the inferior surface of the brain. The neoplasm had indefinite margins and a variety of cell forms. The author classed it as a glioma. The short duration of the symptoms, a month and a half, and the varied cell types suggest glioblastoma, but the histologic description is too incomplete to permit a definite diagnosis. Gmelin (19) observed a ganglioneuroma in a twelve-year-old mare. A firm, white, fibrous tumor, measuring 5.0 × 1.5 × 0.8 cm., apparently arose from the ventral aspect of the pons and extended by way of the left cerebral peduncle to the olfactory trigone. Microscopically, the tumor consisted of myelinated and unmyelinated nerve fibers, subdivided into bundles by connective tissue. Between the meshes of the nerve bundles were numerous nests of ganglion cells.

A "subpial glial sarcoma poor in fibers" was observed by Holz (25) in the cerebral hemisphere of a nineteen-year-old black gelding. The short clinical duration of the symptoms and the author's impression of great cellularity and lack of fibers in the tumor would lead one to suspect that the tumor belongs to the glioblastoma group. A neoplasm somewhat different morphologically was described by Glamser (18) in a discussion of the differential diagnosis of Borna disease. The growth measured 5.0 × 4.0 × 1.5 cm., and was described as being situated in the parenchyma of the cerebrum and as lacking definite margins. The majority of the cells were stellate and had cytoplasmic processes. They were arranged in lobules or clusters, often surrounded by connective-tissue bands. There were a few multinucleated giant cells present. Although this tumor appeared quite cellular, it was fairly uniform in character. The preponderance of stellate cells with protoplasmic processes makes it seem probable that the tumor is either a protoplasmic astrocytoma or an astroblastoma.

A tumor infiltrating the central white matter of the right frontal lobe in a horse was described by Marchand and Petit (31). They diagnosed it as sarcoma, but from the gross and histologic description of the neoplasm, it seems probable that they were dealing with a glioblastoma.

Grün (20) has pointed out that the tumors described in horses by Butler and Rutherford (7, 39), Meyer (34), and Harger (21) should be classed as papillomas of the choroid plexus. In the horse described by Butler and Rutherford there were multiple small masses attached to the choroid plexus in each lateral ventricle and on the lateral aspects of the cerebellum (the latter were probably attached to the choroid plexus of the fourth ventricle presenting through the foramina of Luschka). These tumors were referred to as angiomas, but the authors' description of vascular papillae lined by cuboidal or flattened cells makes it probable that they were dealing with multiple choroid papillomas. In Meyer's case the tumor lay external to the medulla and pons, enveloping them, but projected dorsally beneath the cerebellum through the posterior medullary velum, where it became continuous with the choroid plexus of the fourth ventricle. In spite of the unusual location, the gross description
of the tumor as deep red, papillary, and attached to the choroid plexus of the fourth ventricle, and the histologic description of vascular papillae covered by cuboidal cells, render it extremely probable that this was a choroid papilloma, and not a venous papilloma, as designated by the author. Harger's instance of an "adenocarcinoma" in the left lateral ventricle of a horse would also seem, from the gross and histologic description, to be a choroid papilloma.

An interesting primary tumor of the pineal gland in a zebra was reported by Vermeulen (46), who recognized it as being composed of pineal tissue, and diagnosed it as an adenoma or an adenosarcoma. This neoplasm might better be classified as a pinealoma.

**Doubtful Gliomas:** Podmaniczky's (38) "neuroglioma" of the spinal cord in a seven-day-old chick embryo was associated with a spina bifida and seems to have been a congenital malformation of the cord rather than a neoplasm. The "glioma of the brain" found in an undulated male grass parakeet (*Melopsittacus undulatus*) described by Fox (15) was probably not a glioma, though it was listed by Slye et al (44) as one of two instances of true gliomatous neoplasms in animals. The growth consisted of irregular masses of large cells with vesicular nuclei and homogeneous cytoplasm. Scattered between these elements were irregular bands of hyperchromatic spindle-shaped cells. The supporting tissue was faintly eosinophilic and scant. The cytologic description of this cerebral lesion is too incomplete to permit of a diagnosis. An atypical metastasis was found in the liver. The author's diagnosis of glioma is doubtful, inasmuch as no known glioma metastasizes outside the cranial cavity or spinal canal. Although there is a possibility that two independent neoplasms were present, secondary tumor in the brain seems more likely, a point of view taken by Joest (29). Two other cases described by Fox seem to fall into the same doubtful category: a softened area, $3 \times 2 \times 1$ cm., found in the central gray matter of the cerebrum of a green monkey (*Cercopithecus callithrix*), and designated as "glioma or gliosis" (16); a cystic area found in the cerebrum of a sooty mangabey (*Cercocebus fuliginosus*) (17), and thought perhaps to represent a remnant of a glioma. These seem to be instances of encephalomalacia with gliosis.

Bland-Sutton (4) studied a specimen of an intraocular tumor in a sheep, and Joest (28) one in a calf. Both of these tumors were pigmented and seem to be more closely related to melanosarcoma of the choroid than to retinoblastoma. Hutyra (26) described what he considered to be a vascular papilloma of the ventral surface of the spinal cord in a horse. Grün (20) listed this tumor under probable choroid papillomas. The position of the tumor precludes such a possibility, while the histologic description of the lesion would suggest an hemangioblastoma. Among the "gliomas" cited by Casper (8), the case of Gratia is interesting, because it corresponds in essential features to perineurial fibroblastomas or schwannomas of the eighth nerve. Another widely quoted case of "gliosarcoma" of the spinal cord of a cow, reported by Dörrwächter (13), seems to have been essentially an extramedullary spindle-cell sarcoma which had extended into the vertebral canal along the last cervical and first thoracic nerve roots.

Yamane (47) observed that "atresia coli," a fatal anomaly of newborn foals of certain Percheron breeding lines, is frequently associated with anom-
lies of the brain, such as "gliomatous thickenings" at the base of the brain, pachygyria, agyria, and hydrocephalus. Although the title and summary of his report refer to "cerebral gliomas," there is nothing in the text to indicate that a true neoplasm was present. The report of a "brain tumor" in an ant by Brun (5), although interesting and amusing, has not much to support the title, since the lesion consisted primarily of a hiatus in which the author suspected the former presence of a glioma or an abscess.

---

**FIG. 1. CASE I: ASTROCYTOMA IN CEREBRUM; NODULE IN LATERAL VENTRICLE; LOBULATION AND SHARP DEMARCATION. HEMATOXYLIN-EOSIN. X 8**

**REPORT OF CASES**

CASE I: **Clinical Data:** Four single-comb white Leghorn chickens, one to two years old, were submitted for examination out of a flock of 460, because the owner had experienced a 50 per cent drop in egg production. Three of the chickens were found to be affected with non-specific diseases of the genito-urinary tract; the fourth (No. 14655) showed a peculiar twist of the head and neck, and at autopsy was found to have a large brain tumor. The other organs of this bird showed no significant changes.

**Gross Pathology:** On gross examination, the meninges and the external configuration of the brain showed no definite abnormalities, except that the dorsal surface of the left cerebral hemisphere appeared somewhat more translucent than usual. A section in the median plane revealed a deeply placed, roughly oval, rather firm, grayish, well demarcated mass, 5 × 7 mm. in extent, surrounded by a band of whitish tissue 0.5 mm. in width. There were several small cysts on the cut surface of this tumor which contained gray gelatinous material.

Examination of total sagittal histologic sections of the brain revealed that the main body
of the tumor lay in the posterior portion of the augmented paleostriatum and diencephalon, where the dorsal and ventral thalamic areas and the epithalamic centers were chiefly involved (Fig. 1). A small nodule projected into the dilated lateral ventricle where the body of the ventricle joined the ventral horn. A seemingly separate neoplastic mass lay farther dorsally and cephalad in the central portion of the body of the lateral ventricle, apparently occluding its lumen. In this area the tumor involved both the ventral hyperstriatum and caudal neostriatum, and the accessory hyperstriatum on the dorsal side of the ventricle. In sagittal sections taken further laterally through the left cerebral hemisphere, the largest mass ap-

![Image](https://via.placeholder.com/150)

**Fig. 2.** Case I: Large Fibrillar Astrocytes in Cerebral Tumor. Phosphotungstic Acid-Hematoxylin. X 400

peared to lie in the augmented and primitive paleostriatum and dorsal thalamus; small separate islands were seen in the intermediate neostriatum, dorsal medullary lamina, and archistriatum, which may have represented cross-sections of slender finger-like projections. The lateral ventricles were considerably dilated; the major dilatation had occurred in the posterior two-thirds of the body of the left lateral ventricle; its anterior segment was only moderately enlarged since it had become completely separated from the rest of the ventricular cavity and was devoid of choroid plexus. The dilatation of the lateral ventricle had caused a close approximation of the posterior cortical surface of the left cerebral hemisphere to the anterior aspect of the optic lobe.

Tumor like that in the cerebrum was also found diffusely invading the roof of the fourth ventricle. The ependymal lining had disappeared in this area and tumor occupied the central cerebellar white matter and a cerebellar folium. It also projected markedly into the lumen of the fourth ventricle, reducing it considerably in size and blocking it. It reached and became attached to, but did not invade, the floor of the ventricle at a number of points. There was no visible connection between this tumor nodule and that in the cerebrum; it may have been a secondary implantation by way of the cerebrospinal fluid in the wall of the fourth ventricle.

**Histologic Findings:** The neoplasm was sharply demarcated and lobulated, the margin having a scalloped appearance. Separating the tumor lobules were fine septa of edematous
glial tissue, which were fairly vascular. Many of the blood vessels in these trabeculae and in the adjacent outer margin of the tumor lobules showed mural and perivascular infiltration by lymphocytes. The neoplasm was quite cellular and densely fibrillar. In some places it was loose-meshed. The tumor cells varied somewhat in size and shape, but for the most part were irregularly polygonal or stellate, and had numerous processes (Fig. 2). The latter were fine and fibrillar. In the majority of the neoplastic elements the cytoplasm of the cells was homogeneous and abundant, but there were also appreciable numbers of much smaller neoplastic cells with scanty cytoplasm. In places both the large and small cells appeared as elongated forms and lay in parallel rows. Here too, they could be seen to have numerous processes which, however, were polar. The nuclei of the cells were eccentric and varied in shape. They were oval, spherical, or somewhat elongated. The majority contained only a small amount of finely granular chromatin and one or more small nucleoli. Blood vessels were comparatively few in number in the central portion of the lobules. In the interlobular glial trabeculae, it appeared clear that the parenchyma had degenerated and become extremely edematous. Normal neural elements had largely disappeared, and there remained only a loose-meshed, astrocytic, fibrillar tissue. In addition to the perivascular and mural lymphocytic infiltration of the blood vessels in the septa, many of the capillaries and arterioles showed mild edema of their walls, associated with endothelial hyperplasia and, at times, with considerable fibrosis as well.

Where the tumor approached the ventricular surface, a narrow band of subependymal tissue showed marked edema and was invaded by small clusters of tumor cells which had advanced beyond the bounds of the adjacent, sharply marginated neoplasm. These cells were in all respects like those described in the main body of the tumor except that, being less compressed, they appeared somewhat larger: The surface of the ventricular wall was denuded of ependyma and often the ependymal cells, where present, were flattened. In one large area the tumor had apparently penetrated through the ependymal lining and was projecting into the ventricle, but in most of the zones in which it invaginated into the ventricle it was covered by a layer of flattened ependymal cells.

The cerebral tissue at the margins of the neoplasm showed a varying reaction. In some places there was considerable proliferation of capillaries, some of which exhibited a mild perivascular infiltration of lymphocytes and a marginal gliosis. In other areas there was less vascular reaction, and more of an astrocytosis, associated with edema, moderate degeneration of the neural and neuroglial elements, and lipoid-laden cells.

In Foot-Bielschowsky preparations the tumor appeared moderately vascular and some of its vessels showed marked thickening of their walls due to fibrosis. A diffuse meshwork of reticulin and collagen fibers, obviously arising from the vessel walls, was found throughout the tumor. The reticulin fibers had no intimate relationship to the individual tumor cells. Toward the sharp borders of the neoplasm the reticulin network became denser and its bands were thicker. In this region the vessels were more abundant and the surrounding parenchyma also showed an increased number of hyperplastic vessels.

In phosphotungstic acid-hematoxylin preparations the processes of the tumor cells stained deep blue. These fibers were quite abundant throughout the neoplasm; occasionally they were seen to be attached to blood vessels. The parenchyma of the tumor showed a varying degree of fibrillary astrocytosis corresponding to the white border about the neoplasm, described grossly. The lack of specific fixation made it impossible to use any of the metallic impregnation methods for glia in this study, but the stains referred to above proved adequate for determining the tumor cell type.

**Diagnosis:** Astrocytoma (multiple) of cerebrum and cerebellum.

**Case II: Clinical Data:** The owner of this bird was an experienced breeder of various fancy breeds. In one of his strains of Golden Penciled Hamburg bantams he had experienced the loss of one member of mated pairs, usually the male, during three previous generations. According to him, the losses occurred usually between the eighth and tenth months of life and were accompanied by identical symptoms, namely loss of appetite and paralysis, both of short duration. On advice, he submitted a bird in the initial stages of the disease for examination. The specimen (No. 18152) was a Golden bantam female, eight months of age, which appeared somewhat somnolent. It was put on a diet rich in vacuum-
dried liver meal but did not improve. A serologic examination for pullorum disease was negative. During the next four days the bird became progressively weaker, stood with eyes closed and head lowered, and at times showed coarse tremors of the legs. It was then sacrificed.

Gross Pathology: On gross examination the bird was found to be in good flesh and without significant changes in the visceral organs. As seen through the dura, after removal of the calvarium, the left cerebral hemisphere seemed grayish and fluctuant. The brain was removed in toto for further study.

Total histologic sections taken through several sagittal and parasagittal planes showed a sharply demarcated lobulated tumor occupying a large area of the left cerebral hemisphere, without involving the right hemisphere. It lay ventral and caudal to the body of the left lateral ventricle and extended ventrally and cephalad into the anterior portion of the ventral

Fig. 3. Case II: Astrocytoma in Cerebrum; Sharp Demarcation; Lobulation and Projection into Lateral Ventricle. × 8

horn of the lateral ventricle, almost reaching the ventral surface of the cerebrum (Fig. 3). As seen in a parasagittal section, the tumor measured 9 × 4 mm.

In addition to being finely lobulated, the tumor showed three major divisions or lobes. The ventral and dorsal lobes were small, whereas the central lobe or body of the tumor was large. The dorsal lobe occupied approximately the archistriatum and caudal neostriatum and projected dorsally into the dilated body of the left lateral ventricle to a considerable extent. The surface of this portion of the tumor lying bare to the ventricle was relatively smooth, whereas that portion which infiltrated the underlying parenchyma was scalloped, due to lobulation. The body of the tumor, which was roughly ovoid in shape, occupied most of the neostriatum and part of the augmented and primitive paleostriatum. It lay caudal to the middle portion of the ventral horn of the lateral ventricle. This lobe of the tumor was subdivided into coarse lobules, but its surface was relatively smooth, since there was only a minor degree of finer lobulation. The antero-ventral lobe of the neoplasm projected into the
dilated anterior aspect of the ventral horn of the lateral ventricle. It showed coarse lobulation and invaded the wall of the ventricle at three points in the region of the accessory hyperstriatum.

There was considerable dilatation of the body and the ventral horn of the left lateral ventricle. The former had led to marked thinning of the dorsal wall of the ventricle.

**Histologic Findings:** The neoplasm was fairly cellular, quite fibrillar, and only moderately vascular. In some places fine connective-tissue septa were present between the tumor lobules. These were obviously vascular in origin. The neoplastic cells were irregularly stellate, polygonal, or somewhat elongated, and had numerous heavy or fine processes (Fig. 4). The heavier processes stained tan with the phosphotungstic acid stain, while the finer processes stained blue; occasionally fine blue fibrils could be seen within the thick tan-staining processes. In some areas there was a predominance of cells with protoplasmic processes, and in others the fibrillary type was the commoner. The cells were at times found radiating from, and attached to, blood vessels by a prominent process ending in a broad tip. The capillaries which formed the foci for such neoplastic cell orientation showed mild thickening of their walls, due to fibrosis. Some of the processes traversed the tissue for a considerable distance. Others were very short, so that the cell bodies lay close to the vessel wall. The nuclei of the tumor cells were round or oval and eccentric. They had a small amount of finely granular chromatin and some contained one or more small nucleoli. The intervascular elements showed no special arrangement, except for some of the elongated cells which lay in parallel rows. (The latter were evidently piloid astrocytes.)

With the Foot-Bielschowsky stain the connective-tissue septa in most of the tumor were found to contain moderate numbers of blood vessels, while the parenchyma of the neoplasm contained only a few. A few separate marginal nodules of tumor tissue contained moderate numbers of blood vessels in the parenchyma, and a fine network of reticulin, less closely meshed than in Case I. These fibers seemed to have no relationship to the individual tumor cells.
Where interventricular tumor came into contact with the wall of the ventricle, the ependyma had disappeared and some tumor cells were found invading the parenchyma for a short distance. Adjacent to the cerebral parenchyma the margin of the tumor was fairly sharp and marked by a mild marginal astrocytosis. Here focal collections of perivascular lymphocytes were quite frequent. In a few places, finger-like processes of tumor penetrated beyond the margin of the tumor proper. There were some ependymal granulations in the walls of the lateral ventricles at a distance from the tumor, and there was marked atrophy of the parenchyma, with gliosis over the convexity of the left cerebral hemisphere secondary to the internal hydrocephalus.

In this instance, as in Case I, there was no suitably fixed material for metallic impregnation. It was clear, however, from the stains available that the elements comprising the neoplasm were both protoplasmic and fibrillary astrocytes, including the piloid type.

**Diagnosis:** Astrocytoma (multiple) of cerebrum.

**Literature on Gliomas in the Common Fowl**

Three gliomas in chickens have been reported, one by Belmonte and two by Jackson. These show an interesting resemblance to the two instances reported here, and will be reviewed for the purpose of comparison.

**Belmonte's (3) Case:**

### Clinical Data:
A Leghorn hen which was observed for a number of days showed marked disturbances in equilibration. The head was held low and turned sharply toward the right. There was deviation toward the right on walking. The general condition of the bird grew worse rapidly; the animal refused food and lost weight.

### Gross Pathology:
The cerebral hemispheres were considerably enlarged. The marked dilatation of the lateral ventricles rendered the normally thin dorsal portion of the cortex even more transparent than usual, and fluctuant as well. On medial sagittal section of the cerebrum, a grayish-white, fairly firm neoplasm was found filling the lumen of the fourth ventricle.

### Histologic Findings:
The tumor was quite cellular and deeply infiltrated the medulla and the white matter of the cerebellum. There were many small secondary masses in the molecular and granular layers of the cerebellar folia and in the optic lobes. The tumor cells were arranged in columns or rounded lobules separated by fibrillary connective tissue containing blood vessels. Some of the blood vessels showed thickening of their walls, due to fibrosis and hyalinization. The neoplastic elements were closely approximated and polygonal, "comet-shaped," "spindle-formed," or triangular in shape. They had pale eccentric nuclei and a varying number of processes, one of which was occasionally seen to be attached to a blood vessel. In most places there was only slight angiotropism. With the neuroglia stains many glial fibers were found to be present. In addition, numerous "pre-collagen" and collagen fibers were seen among the tumor cells. The center of some tumor nodules appeared edematous and the adjacent parenchyma showed a marked reactive gliosis.

**Diagnosis:** Isomorphic glioblastoma in the fourth ventricle; tendency toward development into an astroblastoma.

### Comment:
The author interpreted some of the variable cell forms as astroblasts and "unipolar and bipolar glioblasts." The designation "glioblast" is evidently used in the sense of the commonly accepted term spongioblast, and may have led to the diagnosis of glioblastoma. The variation in cell form, which is described, is within the limits of variability of astrocytes in a neoplasm. It is not unusual to find differences in the form of such cells when they are closely packed and distorted.

The abundance of glial fibers, the fact that the majority of the tumor cells are described as having numerous processes, and the pale eccentric oval or spherical nuclei, lead us to believe that this tumor was a fibrillary astrocytoma. The lack of focal or diffuse areas of degeneration, of hemorrhage, and of endo-
thelial hyperplasia of the blood vessels are against the diagnosis of glioblastoma. This neoplasm was very much like both of those reported by the present authors. It was composed of cerebellar and mesencephalic nodules which were sharply demarcated and lobulated. The lobules were separated by vascular connective-tissue septa, as in the authors' Case II, and connective-tissue fibers were often found between the tumor cells. Although these features are uncommon in astrocytomas in man, the tumor cells are undoubtedly astrocytes in the authors' two tumors, and probably in Belmonte's tumor as well, so that these points of resemblance become of significance.

Jackson's (27) Case 1: Clinical Data: A light Sussex hen about a year old veered to the left on walking and often fell on its left side. Terminally, it was unable to stand, lay on its left side, and appeared stupefied.

Gross Pathology: No gross description is given.

Histologic Findings: The tumor was divided into lobules of round outline and irregular size. A stroma consisting chiefly of blood vessels was accompanied by small amounts of connective tissue, in which there was mild perivascular infiltration. The tumor cells were closely approximated, or loosely packed, were distinctly stellate in form, had pale, oval, vesicular nuclei, and were provided with many "fibril-like" prolongations. These "cytoplasmic" processes formed an intricate intercellular meshwork. In Mallory's phosphotungstic acid-hematoxylin stain, the cell processes stained blue, and the author pointed out that this indicated that they were glial fibers.

Diagnosis: Glioma (multiple) of the cerebrum, of the type spongioblastoma multiforme.

Comment: Jackson's description of this tumor makes it clear that he is dealing with a fibrillary astrocytoma. This is borne out by the accompanying illustration. The lobulation and fine connective-tissue septa, as well as the lymphocytic infiltration, are strikingly like the corresponding features in the authors' two cases. The presence of separate nodules of tumor is also like that observed in the authors' material. The problem as to whether the separate tumor masses were connected by cellular neoplastic bridges remains unsolved here as well, since serial sections were not available.

Jackson's Case 2: Only the histologic findings were given for this case. The cerebellum was invaded by a tumor like that described in Case 1. This neoplasm was also lobulated, solid masses of cells being separated by septa of delicate connective tissue containing small blood vessels and showing perivascular lymphocytic infiltration. The cytoplasm of the tumor cells was abundant and was prolonged into prominent processes. The nuclei were oval, vesicular, and occasionally multiple.

Diagnosis: Glioma of the cerebellum.

Comment: The lack of neuroglial stains prevented the author from determining whether the cell processes were glial in type. It is clear, however, from the large size and from the shape of the cells, the type of their nuclei and their prominent processes, as well as the resemblance of the general structure of the neoplasm to that of his Case 1, that we are again dealing with an astrocytoma. The similarity of this tumor to those of the authors and that of Belmonte is obvious.

Discussion

The available data in the literature are as yet too scanty to permit a statistical estimation of the frequency of gliomas in various species of lower animals. As a basis for the experimental study of brain tumors, however, it is valuable to
GLIOMAS IN ANIMALS

attempt to determine which species are now known to harbor these neoplasms. They have been most frequently reported in dogs and horses, and are now seen to be far from rare in birds.

In the series of gliomas collected from the literature and reviewed as to diagnosis (Table I), it would appear that glioblastoma, astrocytoma, ganglioneuroma, and choroid papilloma are the most frequent. They appear with about equal frequency and are found in a variety of species. In respect to glioblastoma and astrocytoma, this finding corresponds to that in man, while ganglioneuroma and choroid papilloma occur much less frequently in human beings. This latter difference is probably accidental, due to the small number of animal gliomas reported.

A few cases of medulloblastoma, oligodendroglioma, and pinealoma have been described in a variety of species and correspond in their lesser frequency to that in man.

The two brain tumors in chickens reported here show many interesting resemblances to each other. Both are multiple. This multiplicity is probably due to the growth of the primary neoplasm into the wall of a ventricle with dissemination of tumor cells by way of the ventricular fluid and the formation of secondary tumor masses. The large secondary masses in and about the fourth ventricle in Case I are evidence of this. Similar dissemination by way of the cerebrospinal fluid has been described frequently in malignant gliomas in man, but only rarely for the more benign neoplasms. It is possible, of course, that many primary foci of growth gave rise to these multiple neoplastic masses, and this explanation has been frequently advanced for this phenomenon in man. Multiple gliomas in man have been compared with and related to the multiple foci of abnormal glial development and growth in tuberosclerosis. That there may have been slender cellular bridges between adjacent tumor masses is not ruled out, since serial sections were not made.

Both neoplasms are distinctly lobulated, unlike the astrocytomas in man. In one instance the lobules were separated by slender septa of degenerated brain which had undergone intense gliosis. In these septa the hyperplastic blood vessels showed intense fibrosis of their walls. In the other astrocytoma, the septa were of connective-tissue type. They were obviously of vascular origin, and probably represented further development of the vascular hyperplasia noted in the first instance. Apparently, both neural and glial elements had disappeared between the lobules, and only the connective-tissue elements persisted. In some places this connective-tissue reaction had invaded tumor at the margins, and also pervaded islands of tumor. Somewhat similar lobulation, with abundant connective-tissue septa and interstitial connective-tissue fibers, has been described in ganglioneuromas of the central nervous system in man, but not in astrocytomas.

Perivascular lymphocytic reaction in the outer portions of the neoplasm and at the margin was noted in each instance, and was similar to the inflammatory reaction which has been described about tumors experimentally implanted in the brain. Such an inflammatory reaction may take place in and about glioblastomas and occasionally in other gliomas in man, evidently as a reaction to degeneration. It is not ordinarily seen in relation to the more benign gliomas, such as astrocytoma.
There is a possibility that there may have been a familial occurrence of brain tumors in the inbred line of fowl from which the authors’ Case I was derived. The owner had noted the same symptoms in single members of three previous generations, all the birds having died at about the same age. Unfortunately this line was allowed to die out.

In reviewing the other three gliomas reported in chickens, one by Belmonte (3) and two by Jackson (27), it becomes apparent that the architectural characteristics noted in the authors’ two cases are strikingly repeated. These neoplasms were lobulated, and the lobules were separated by connective tissue. Two of the tumors were multiple. Although they were variously interpreted and diagnosed, it is clear from consideration of their reported histologic features that they were similar in their constituent elements, and that their component cell was the astrocyte; they too were astrocytomas.

We have, then, interestingly enough, five astrocytomas as the first five gliomas reported in the chicken. They differ in some features from the same type of tumor in man, but are all alike in these differences. The dissimilarities are of minor significance and may depend upon differences in the host reaction.

**SUMMARY**

1. Gliomas in animals reported to date are reviewed with respect to their frequency, type, and species of animal affected.
2. An attempt is made to reclassify them in accordance with recent brain tumor nomenclature.
3. Two astrocytomas in chickens are reported.

**Note:** We wish to thank Dr. Elizabeth Crosby of the Department of Anatomy, University of Michigan, for her kind assistance in localizing and naming the various structures affected by the tumors.

**References**