

Invertebrate Oncology

Diseases, Diagnostics, and Treatment



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KEYWORDS

- Invertebrate • Neoplasia • Oncology • Surgery • Histopathology • Diagnosis • Treatment

KEY POINTS

- Neoplasia is a documented occurrence across invertebrate taxa, but challenges remain with regard to tumor diagnosis, identification, and treatment.
- Literature reports of neoplasia are frequent in mollusks and insects, infrequent in Cnidaria and crustaceans, and are yet to be documented in Porifera and Echinodermata.
- The use of traditional methods of diagnosis in veterinary medicine is encouraged, but the unique anatomy and tissue biology of each invertebrate taxon needs to be taken into account.
- Most neoplasms described in the invertebrate literature have been benign, and many external lesions may be amenable to surgical resection.

INTRODUCTION

At the beginning of the twentieth century, it was argued that invertebrates were incapable of developing neoplasia.^{1,2} This argument was based on anatomic differences in the nervous and vascular systems of invertebrates and the embryonal theory of tumor growth, which was popular at the time, believing that invertebrate cells were already in an embryonic state and therefore could not revert to a more undifferentiated state that would produce tumors.³ After decades of study and based on the current understanding of its causes, neoplasia is a well-documented occurrence across invertebrate taxa.⁴ Neoplasia is defined as the proliferation of genetically altered cells that fail to respond to the normal regulatory controls of cell growth.^{5,6} The genetic alterations can be spontaneous, hereditary, or acquired as a result of exposure to mechanical (radiation), chemical (carcinogens), or infectious (oncoviruses) agents.⁶ All 3 causes

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have been recognized in invertebrates.⁷ Importantly, the study of invertebrate neoplasms has revealed that many genes and pathways involved in neoplastic transformation and metastasis are evolutionarily conserved and invertebrate models of neoplasia, particularly in *Drosophila* spp and *Caenorhabditis elegans*, are contributing significantly to the understanding of tumorigenesis.⁶

There have been, and remain, many challenges to documenting neoplasms in invertebrates. The images and descriptions of gross and microscopic findings in the older literature, which would allow comparison or peer evaluation of the identification, are inadequate.³ Pathologists can be inexperienced with the identification of invertebrate tissues, normal tissue reaction, inflammation, and wound repair. Invertebrate biologists are often not familiar with tumor biology, identification, and classification. Both have led to confusing diagnoses in the invertebrate neoplasia literature.^{3,4,7} The classifications that exist for mammalian tumors are also difficult to apply to invertebrate neoplasms, in some cases may not be appropriate, and the tools relied on for cell identification (immunohistochemistry) are generally unavailable. The characteristics used to define neoplasms in vertebrates, particularly mammals, include (1) self-sufficiency in growth signals, (2) insensitivity to antigrowth signals, (3) evasion of apoptosis, (4) unlimited replicative potential, (5) sustained angiogenesis, and (6) tissue invasion and metastasis.⁸ These characteristics may be challenging to fulfill across invertebrate taxa because the organs, organ systems, cell types, and metabolic reactions are different from their vertebrate counterparts and the anatomy of most invertebrate circulatory systems (partially open or lacking organization) makes documenting angiogenesis extremely difficult.⁴ The establishment of the Registry of Tumors in Lower Animals (RTLTA), a cooperative project between the National Institutes of Health (NIH) National Cancer Institute (NCI) and the Smithsonian Institution's National Museum of Natural History in 1965 greatly advanced the understanding of the occurrence, gross and microscopic pathology, and cause of invertebrate neoplasms. However, this valuable resource closed in 2007 because of a lack of funding, although the archives still exist. It is notable that, out of the 1550 invertebrate submissions made to the RTLTA database and evaluated by the RTLTA pathologists between 1965 and its closure in 2007, only 30% were ultimately designated to be neoplasms.⁴

This article assists veterinarians in evaluating and treating invertebrates with suspected neoplasia by (1) summarizing the major types of neoplasms that have been documented across invertebrate taxa, (2) describing the diagnostic tools available to clinicians and pathologists to identify and confirm neoplastic processes, and (3) recommending possible treatment options for invertebrates with neoplasia.

NEOPLASMS REPORTED IN INVERTEBRATES

All tumors consist of 2 major components: the parenchyma, composed of the transformed neoplastic cells; and the stroma, composed of nonneoplastic host-derived connective tissue, blood vessels, and inflammatory cells. The parenchyma largely determines a tumor's biological behavior and classification. The stroma is critical to the growth of the neoplasm by providing structure and necessary blood supply to support the growth of the parenchymal cells.⁵ The fundamental characteristics used to differentiate benign from malignant neoplasms include (1) degree of cellular differentiation and anaplasia, (2) rate of growth, (3) local invasion, and (4) evidence of metastasis.⁵ These features should be applied with caution because invertebrate neoplasms have rarely been studied over time, mitotic figures can be transient, cell division may be under heavy hormonal control, and evidence of local invasion and metastasis can be difficult to assess in species with open circulatory systems.⁴

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