



## The pecten oculi comparison of the different bird species

Jehan Mahmood rajab , Shaima D. Salman  and Yasamin Abdul-amer Kadhum 

Department of Biology, College of Sciences, Mustansiriyah University, Iraq

Received: Oct 2, 2023/ Revised: Nov 3, 2023/Accepted: Nov 7, 2023

(✉) Corresponding Author: Jehan Mahmood rajab

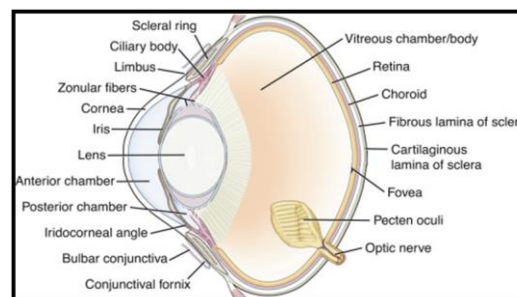
### Abstract

The pecten oculi is a unique and highly specialized structure found in the eyes of birds. It is a thin, folded, fan-like membrane that extends from the optic nerve region into the vitreous fluid of the eyeball. This membrane is primarily composed of pigment cells, an extensive network of blood vessels, and a thick basal lamina. The pecten's main function is to supply nutrients and oxygen to the retina, maintain the internal eye temperature, and support sharp vision, especially during activities such as migration and hunting. The number of folds in the pecten varies between diurnal and nocturnal birds, with diurnal birds generally having larger and more complex pecten structures. The pigmentation of the pecten, especially at the apical and peripheral regions, plays a role in protecting the blood vessels from UV radiation and oxygen radicals. Different bird species exhibit variations in the number, size, and thickness of pecten folds, reflecting their specific visual requirements. For example, species like the emu have a more primitive, pleated pecten, while birds like the seagull and quail have a greater number of folds and capillaries. Additionally, the presence of melanocytes and their interactions with capillaries and blood vessels contribute to the pecten's structural integrity. The study of the pecten oculi's histology reveals that it is essential for the bird's visual health and can be linked to their lifestyle and environmental conditions. The structure and size of the pecten are tailored to the bird's daily activities, with diurnal birds having larger and more complex pecten structures compared to their nocturnal counterparts. This specialized organ's morphology and vascularization are crucial for delivering nutrients to the retina and protecting it from UV radiation. In summary, the pecten oculi is a remarkable anatomical feature in the avian eye, and its structure and function are closely related to the lifestyle and visual requirements of different bird species. This study provides valuable insights into the diverse adaptations of the pecten across bird species and its significance in maintaining avian visual health.

**Keywords:** Pecten Oculi, Avian Eye, Visual Adaptation, Histology, Retinal Nutrition.

### Introduction

The pecten oculi (Fig.1) in a bird's eye is a thin, folded, fan-like membrane. It protrudes from the inner surface of the region of the optic nerve and extends toward the vitreous fluid that fills the cavity of the eyeball (Gultiken et al., 2011; Pourlis, 2013). The pecten oculi consists of highly pigment non-sensory tissue and a dense network of blood vessels covered with a thin membrane, which is an extension of the membrane lining the retina (Al-Hamdany and AL-arajee, 2019; Alan et al., 2020). The pecten oculi supply nutrients and oxygen to the retina to balance acid and base, keep the internal eye temperature constant (Mishra and Meshram, 2019), and contribute to sharp vision during migration and



**Fig. 1** Diagram of the eyeball in birds

hunting, UV absorption from sunlight, as well as preservation of intraocular equilibrium (Korkmaz et al., 2023).

The number of pecten oculi folds varies between nocturnal and diurnal birds. The shape of these folds also differs between different types of birds, as its shape is pleated type, as in raptors and most birds, while its shape is conical in the kiwi and vanned, as in the ostrich (Dayan and Ozaydin, 2013; Mohammed, 2023). These folds increase the surface area of the pecten in the birds (Tucker, 1975). It has been observed that birds that are active during the day have larger pecten with more folds than those that are active at night (Jones et al., 2007). The activity of the bird is also a factor that affects the pecten's variability. Additionally, different species have different levels of pecten pigmentation. The apical and periphery of the pecten are heavily pigmented with melanin. Along the extensive plexus of capillaries, these incomplete sheaths of pleomorphic melanocytes are formed. They give the pecten some structural support and shield the blood arteries from oxygen radicals and UV rays (Bennet and Cuthill, 1994).

There is a membrane covering that hangs over the pecten oculi. The inner side limiting membrane of the retina is assumed to be continuous with this membrane (Bacha and Bacha, 2000). The optic disc and the nearby portion of the retinal nerve fiber layer are superimposed at the location of the pecten oculi (Seaman and Storm, 1963; Pollard, 2009). The nutrition of the vitreous body and the avascular avian retina is greatly aided by the pecten (Dieterich et al., 1973; Rodriguez-Peralta, 1968). In order to safeguard eye visual effectiveness and sustain pecten erectile function, the structural integrity of the pectineal blood vessels must be strengthened (Arey, 1974). Melanosomes develop a dense investment over the anastomosing network of vessels of blood on the free half of the apical pectineal surface, giving the latter a bloated look. The ensheathed blood arteries at this location of the pecten appear to be shielded from incident UV radiation by the melanosomes there. Chicks, pigeons, and vultures have all been noted to have a high pigmentation of the pectineal bridges (Raviola and Raviola, 1967; Bawa and Yash Roy, 1974).

The pecten oculi of the bird that engages in daily activities are quite large, very complex, and have numerous folds. Many avian species have oculi of the pleated type that resemble these structures. The number of pleats, the size, and the thickness of the capillary basal lamina of pecten oculi, however, differ between species (Dayan and Ozaydin, 2013). In the emu (*Dromaius novaehollandiae*), the pecten is modest compared to the globe size and with a primitive pleated form. The pecten is held in a fan-like shape, widest at the base, by just three or four loose folds linked at the apex by a tissue that acts as a bridge (Braekevelt, 1998). The night hawk (*Chordeiles minor*), for example, has a pecten that is pleated and has a highly vascular, pigmented structure. It is positioned over the head of the optic nerve

and extends into the vitreous. Four or five folds are common for accordions (Braekevelt, 1984). A species of the Spotted Eagle Owl (*Bubo bubo africanus*), exhibits five to six folds (Kiama et al., 2001), and the Great horned owl (*Bubo virginianus*) and Common barn owl (*Tyto alba*) both have seven to eight folds. However, the Barred owl (*Strix varia*) has eight to ten folds (Yilmaz et al., 2017; Braekevelt, 1993; Smith et al., 1996). These nocturnally active birds have a little, straightforward pecten oculus. The seagull (*Larus canus*) has 18 to 21 folds, and the quail (*Coturnix coturnix japonica*) has 18 to 22 folds (Onuk et al., 2017; Orhan et al., 2011). The Australian galah (*Eolophus roseicapillus*) has a pecten oculi that is made up of twenty to twenty-two accordion folds that are connected at the tip by a tissue bridge, with the tissue acting as a support for the pecten, which is held in a shape like a fan at the base. Each fold contains many capillaries and melanocytes, as well as larger supply and drainage vessels within it (Braekevelt, 1996). The American crow's (*Corvus brachyrhynchos*) pecten oculi are quite big and pleated in style. Twenty-two to twenty-five accordion folds make up the pecten, which is held in a fan-like form at the base by a tissue that serves as a bridge connecting the folds at the apex. Each fold contains a significant number of capillaries, greater supply and drainage arteries, and a large number of melanocytes (Braekevelt, 1995). The Japanese jungle crow (*Corvus macrorhynchos*), a bird that is active during the day, has large pecten oculi that are made up of twenty-four to twenty-five highly vascularized pleats that project freely into the vitreous body in the ventral part of the eye cup (Rahman et al., 2010). These pleats are held together apically by heavily pigmented bridges. These active birds have pecten oculi that are huge, complex, and numerous folds. The structures of the pecten oculi pleated type are identical in all avian species. The number, size, and thickness of the pleats, however, can be used to distinguish between species (Dayan and Ozaydin, 2013). Even yet, the functional shape of the pecten oculi is correlated with the lifestyle of birds (Kiama et al., 2001) (Table 1).

Histologic analysis of diverse bird species revealed that the pecten oculi is primarily made up of pigment cells, massive blood arteries, and a large number of capillaries. The huge conglomeration of pectineal blood vessels of various diameters is ordered and well-supported by an extensive contingent of melanosomes. The capillaries are covered by a thick basal membrane (Braekevelt, 1998). The researchers have suggested that the pecten's pigmented intervascular tissue serves as support (Raviola and Raviola, 1967). The delicate endothelial cells have multiple microfolds and extremely thin cell bodies. The thicker basal laminae may act as a support for these cells (Braekevelt, 1996). Each fold in the emu (*Dromaius novaehollandiae*) has a large number of melanocytes and pectineal capillaries are only found at the folds' edges. These capillaries, which are thought to be structurally significant, are surrounded by thick fibrillar basal laminae. These capillaries' basal lamina frequently contains pericytes. It is also believed that the numerous melanocytes in the periphery, which roughly encircle the

capillaries, are crucial for the pecten's structural stability (Braekevelt, 1998). The night hawk (*Chordeiles minor*) has a fine basal lamina that encloses the pecten on its whole. Numerous capillaries, as well as melanocytes, can be found within each fold. The capillaries are encircled by a basal

lamina that is very thick which is made up of several fibrillar layers. On the luminal and abluminal borders of these capillaries, there are remarkably high microfolds. The capillaries and other blood vessels are encircled by an imperfect sheath made of melanocytes (Braekevelt, 1984).

**Table 1. The numbers of pecten oculi pleats in different avian species**

Bird Species	Pleats number	Activity time	References
Emu ( <i>Dromaius novaehollandiae</i> )	(3-4)folds	Nocturnal bird	(Braekevelt, 1998)
Night hawk ( <i>Chordeiles minor</i> )	(4-5)folds	nocturnal bird	(Braekevelt, 1984)
Spotted eagle owl ( <i>Bubo bubo africanus</i> )	(5-6)folds	nocturnal bird	(Kiama et al., 2001)
Common barn owl ( <i>Tyto alba</i> )	(7-8)folds	nocturnal bird	(Yilmas et al., 2017)
Great horned owl ( <i>Bubo virginianus</i> )	(7-8)folds	nocturnal bird	(Braekevelt, 1993)
Barred owl ( <i>Strix varia</i> )	(8-10) folds	nocturnal bird	(Smith et al., 1996)
Budgerigar ( <i>Melopsittacus undulates</i> )	(10-12) folds	diurnal bird	(Micali et al., 2012)
Sparrow hawk ( <i>Accipiter nisus</i> )	(11-12) folds	diurnal bird	(Rajab, 2012)
Duck	(12) folds	diurnal bird	(Dayan and Ozaydin, 2013)
Black kite ( <i>Milvus migrans</i> )	(12) folds	diurnal bird	(Kiama et al., 1994)
Mallard duck ( <i>Anas platyrhynchos</i> )	(12-14) folds	diurnal bird	(Braekevelt, 2011)
Baladi ducks ( <i>Anas boschas domesticus</i> )	(14-15) folds	diurnal bird	(Moselhy and El-Hady, 2019)
Pigeon ( <i>Columba livia</i> )	(15-17) folds	diurnal bird	(Braekevelt, 1988)
Stork ( <i>Ciconia ciconia</i> )	(15-17) folds	diurnal bird	(Onuk et al., 2013)
Ostrich ( <i>Struthio camelus australis</i> )	(16-19) folds	diurnal bird	(Kiama, 2006)
Domestic fowl ( <i>Gallus gallus</i> )	(16-18) folds	diurnal bird	(Kiama et al., 2001)
Starling	(17) folds	diurnal bird	(Dayan and Ozaydin, 2013)
Red-tailed hawk ( <i>Buteo jamaicensis</i> )	(17-18) folds	diurnal bird	(Braekevelt, 1991)
Buzzard ( <i>Buteo buteo</i> )	(17-18) folds	diurnal bird	(Gultiken et al., 2012)
Chick	(18) folds	diurnal bird	(Fischlschweiger and O'rahilly, 1968)
Seagull ( <i>Larus canus</i> )	(18-21) folds	diurnal bird	(Onuk et al., 2017)
Quail ( <i>Coturnix coturnix japonica</i> )	(18-22) folds	diurnal bird	(Orhan et al., 2011)
Australian galah ( <i>Eolophus roseicapillus</i> )	(20-25) folds	diurnal bird	(Braekevelt, 1996)
Turkey	(21-22) folds	diurnal bird	(Dayan and Ozaydin, 2013)
American crow ( <i>Corvus brachyrhynchos</i> )	(22-25) folds	diurnal bird	(Braekevelt, 1995)
Jungle crow ( <i>Corvus macrorhynchos</i> ).	(24-25) folds	diurnal bird	(Rahman, 2010)

The pecten oculi of the great horned owl (*Bubo virginianus*) contain a lot of pleomorphic melanocytes, many capillaries, and larger supply and drainage arteries. Although some capillaries only have a few micro folds visible on their luminal and abluminal surfaces, the majority of them do because they are highly specialized vessels. The majority of the organelles are located in the very thin endothelial cell bodies, near the nucleus. It is believed that the thick fibrillar basal lamina that envelops all capillaries is physically significant. These pericytes are commonly present in these thicker basal laminae. The many melanocytes are expected to generate an imperfect covering surrounding the capillaries and also have a structural role. When compared to pectens in species that are more visually oriented and have fewer micro folds within the capillaries, the great horned owl pecten is smaller and shows fewer characteristics, even though its morphology clearly indicates a heavy involvement in transport (Braekevelt, 1993). The pecten oculi folds of the barred owl (*Strix varia*) have numerous capillaries, larger supply and drainage vessels, and an abundance of pleomorphic melanocytes. Numerous microfolds can be found on both the luminal and abluminal surfaces of the majority of these capillaries, which are highly specialized vessels. However, some capillaries only have a few microfolds. The extremely thick fibrillar basal lamina covers every capillary, and it is considered that this lamina gives capillaries their structural support. These thicker basal laminae frequently include pericytes. There are also several melanocytes with processes that surround the capillaries in an imperfect sheath. The capillaries are also thought to receive structural support from these activities (Smith et al., 1996). In contrast to other birds, the budgerigar's bridge possessed a considerable number of capillaries, which meant that in addition to the choriocapillaris, this portion of the organ could serve as a trophic support for the retina (Micali et al., 2012). Light absorption and the resulting rise in pectineal temperature cause this intraocular structure to function more physiologically in the delivery of nutrients to the retina (Dayan and Ozaydin, 2013). Light microscopic analysis of the stork (*Ciconia ciconia*) found two different types of blood arteries. Afferent-efferent vessels were more numerous and larger in diameter, whereas capillary vessels were more numerous and smaller in diameter. The apical portion of the pleats had granules with melanin pigment included in quantity. There were fewer of these granules, which were dispersed irregularly on the base of the pleats. As a result, it was discovered that the pecten oculi of the stork, a bird that migrates, are comparable to those of other diurnal birds (Onuk et al., 2013).

In quail (*Coturnix coturnix japonica*), Pecten oculi were being separated from the vitreous body by a thin membrane that was covering them. This building was made out of two distinct laminae. Each blood artery was

enclosed by the basal lamina. It had a lot of fine reticular microfibrils and was linked to the outside of the blood vessels. The top layer resembled an amorphous material. A rich vascular network with branching and anastomosing veins was visible on the surface of the pleats. Extravascular spheroidal entities inside this network were seen and recognized as pigmented cells. The hyalocytes were discovered on the pectineal surface, particularly on the pleats, where amoeboid phagocyte-like cells were present. The hyalocytes differed in size and shape (Orhan et al., 2011). In Galah (*Eolophus roseicapillus*) from Australia, numerous capillaries, numerous melanocytes, and larger supply and drainage vessels can all be found within each fold. The capillaries have large microfolds on both their luminal (inner) and abluminal (outer) edges and are highly specialized for transport tasks. The endothelial cell bodies are incredibly thin, with the exception of the nuclear area, which also houses the majority of the organelles. Thick fibrillar basal laminae, which are thought to be structurally significant, surround these capillaries. Pericytes are a typical component of the capillary basal lamina. It is also believed that the numerous pleomorphic melanocytes that roughly round the capillaries play a crucial role in the structural support of the pecten (Braekevelt, 1996).

Each fold of the American crow (*Corvus brachyrhynchos*) contains numerous capillaries, bigger supply and drainage arteries, and a significant number of melanocytes. The capillaries exhibit large micro folds on both their luminal and abluminal edges and are highly specialized for transport tasks. The endothelial cell bodies are incredibly thin, with the exception of the nuclear area, which houses the majority of the organelles. Thick fibrillar basal laminae that are thought to be structurally significant surround these capillaries. The capillaries in these tissues frequently have pericytes. It is also believed that the numerous pleomorphic melanocytes scattered across the capillaries play a crucial role in the structural support of the pecten. The pecten is compared to the conus papillaris of reptiles, the supracretinal vessels of amphibians and teleosts, the intraretinal vessels of mammals, and the falciform process of some teleosts, which are all thought to be alternative methods of bringing nutrients to the inner retina (Braekevelt, 1995). The vascular structure of the pecten of the Japanese jungle crow (*Corvus macrorhynchos*) was mostly made up of ascending and descending blood arteries of various calibers, as well as a dense network of capillaries. On the pecten, melanosomes were distributed in a specific pattern, with the concentration being highest at the apical end, moderate at the crest of the pleats, and lowest at the basal and lateral margins. Blood arteries and melanocytes appeared to be closely related both above and inside the vascular network. It is hypothesized that this relationship may have developed to strengthen this nutritive organ's structural framework and keep it firmly anchored inside the vitreous gel. Such erectility

might be a necessary condition for both its best performance and its overt use as a shield against ultraviolet light, which otherwise might cause damage to the pectineal vessels (Rahman et al., 2010). The functional morphology of the pecten coincides with the lifestyle of the bird and its functional needs. The size of the pecten depends on the particular bird species' visual requirements; for example, a bird that is active during the day would have a very large, intricately folded pecten oculi, whereas a bird that is active at night will have a relatively small pecten oculi.

### Conflict of Interest

The author hereby declares no conflict of interest.

### Consent for publication

The author declares that the work has consent for publication.

### Funding support

The author declares that they have no funding support for this study.

### References

- Abramis, D. J. (1990). Play in Work. *American Behavioral Scientist*, 33(3), 353–373.  
<https://doi.org/10.1177/0002764290033003010>
- Alan, A., Onuk, B., Alan, E., & Kabak, M. (2020). Light and electron microscopic studies on the pecten oculi showing blood–retina barrier properties in Turkey's native Gerze chicken. *Anatomia, Histologia, Embryologia*, 49(4), 478–485.  
<https://doi.org/10.1111/ah.e.12551>
- Al-Hamdany, A., & AL-arajee, H. (2019). Comparative Anatomical and Histological Study of the pecten oculi in three species of birds that differ in their nutrition. *Journal of education and science*, 28(3), 166–175.  
<https://doi.org/10.33899/edusj.2019.162972>
- Bawa, S., & YashRoy, R. C. (1974). Structure and function of vulture pecten. *Cells Tissues Organs*, 89(3), 473–480.  
<https://doi.org/10.1159/000144308>
- Bennett, A., & Cuthill, I. (1994). Ultraviolet vision in birds: What is its function? *Vision Research*, 34(11), 1471–1478.  
[https://doi.org/10.1016/0042-6989\(94\)90149-x](https://doi.org/10.1016/0042-6989(94)90149-x)
- Braekevelt, C. (1984). Electron Microscopic Observations on the Pecten of the Nighthawk (*Chordeiles minor*). *Ophthalmologica*, 189(4), 211–220.  
<https://doi.org/10.1159/000309412>
- Braekevelt, C. (1988). Fine Structure of the Pecten of the Pigeon (*Columba livia*). *Ophthalmologica*, 196(3), 151–159.  
<https://doi.org/10.1159/000309892>
- Braekevelt, C. (1998). Fine structure of the pecten oculi of the emu (*Dromaius novaehollandiae*). *Tissue and Cell*, 30(2), 157–165.  
[https://doi.org/10.1016/s0040-8166\(98\)80064-5](https://doi.org/10.1016/s0040-8166(98)80064-5)
- Braekevelt, C. R. (1990). Fine structure of the pecten oculi of the mallard (*Anas platyrhynchos*). *Canadian Journal of Zoology*, 68(3), 427–432.  
<https://doi.org/10.1139/z90-063>
- Braekevelt, C. R. (1991). Fine Structure of the Pecten Oculi of the Red-Tailed Hawk (*Buteo jamaicensis*). *Anatomia, Histologia, Embryologia*, 20(4), 354–362.  
<https://doi.org/10.1111/j.1439-0264.1991.tb00310.x>
- Braekevelt, C. R. (1994). Fine Structure of the Pecten Oculi in the American Crow (*Corvus brachyrhynchos*). *Anatomia, Histologia, Embryologia*, 23(4), 357–366.  
<https://doi.org/10.1111/j.1439-0264.1994.tb00486.x>
- Dayan, M. O., & Ozaydin, T. (2013). A Comparative Morphometrical Study of the Pecten Oculi in Different Avian Species. *The Scientific World Journal*, 2013, 1–5.  
<https://doi.org/10.1155/2013/968652>
- Dieterich, C. E., Dieterich, H. J., Spycher, M. A., & Pfautsch, M. (1973). Fine structural observations of the pecten oculi capillaries of the chicken. *Zeitschrift Für Zellforschung Und Mikroskopische Anatomie*, 146(4), 473–489.  
<https://doi.org/10.1007/bf02347177>
- Gültiken, M. E., Yıldız, D., Onuk, B., & Karayığit, M. (2011). The morphology of the pecten oculi in the common buzzard (*Buteo buteo*). *Veterinary Ophthalmology*, 15(s2), 72–76.  
<https://doi.org/10.1111/j.1463-5224.2011.00965.x>
- Hamid, H. H., & Taha, A. M. (2021). Anatomical and histological structure of the cornea in Sparrow hawk *Accipiter nisus*. *Iraqi Journal of Veterinary Sciences*, 35(3), 437–442.  
<https://doi.org/10.33899/ijvs.2020.126976.1424>
- Ince, N. G., Onuk, B., Kabak, Y. B., Alan, A., & Kabak, M. (2017). Macroanatomic, light, and electron microscopic examination of pecten oculi in the seagull (*Larus canus*). *Microscopy Research and Technique*, 80(7), 787–792.  
<https://doi.org/10.1002/jemt.22865>
- Jones, M. P., Pierce, K. E., & Ward, D. (2007). Avian Vision: A Review of Form and Function with Special Consideration to Birds of Prey. *Journal of Exotic Pet Medicine*, 16(2), 69–87.  
<https://doi.org/10.1053/j.jepm.2007.03.012>
- Kiama, S. G., Maina, J. N., Bhattacharjee, J., & Weyrauch, K. D. (2001). Functional morphology of the pecten oculi in the nocturnal spotted eagle owl (*Bubo bubo africanus*), and the diurnal black kite (*Milvus migrans*) and domestic fowl (*Gallus gallus var. domesticus*): a comparative study. *Journal of Zoology*, 254(4), 521–528.  
<https://doi.org/10.1017/s0952836901001029>
- Kiama, S., Maina, J., Bhattacharjee, J., Mwangi, D., Macharia, R., & Weyrauch, K. (2006). The morphology of the pecten oculi of the ostrich, *Struthio camelus*. *Annals of Anatomy - Anatomischer Anzeiger*, 188(6), 519–528.  
<https://doi.org/10.1016/j.aanat.2006.06.004>
- Kiama, S., Maina, J., Bhattacharjee, J., Weyrauch, K., & Gehr, P. (1998). A scanning electron microscope study of the luminal surface specializations in the blood vessels of the pecten oculi in a diurnal bird, the black kite (*Milvus migrans*). *Annals of Anatomy - Anatomischer Anzeiger*, 180(5), 455–460.  
[https://doi.org/10.1016/s0940-9602\(98\)80108-8](https://doi.org/10.1016/s0940-9602(98)80108-8)
- Korkmaz, D., Demircioglu, I., Harem, I. S., & Yilmaz, B. (2023). Macroscopic and microscopic comparison of pecten oculi in different avian species. *Anatomia, Histologia, Embryologia*, 52(5), 696–708.  
<https://doi.org/10.1111/ah.e.12927>
- Meshram, B. (2019). Gross, Histomorphological, Histochemical And Ultrastructural Studies Of Pecten Oculi In Guinea Fowl (*Numida meleagris*). *Archives of Zoological Studies*, 2(1), 1–12.  
<https://doi.org/10.24966/azs-7779/1000059>
- Micali, A., Pisani, A., Ventrici, C., Puzzolo, D., Roszkowska, A. M., Spinella, R., & Aragona, P. (2012). Morphological and Morphometric Study of the Pecten Oculi in the Budgerigar (*Melopsittacus undulatus*). *The Anatomical Record*, 295(3), 540–550.  
<https://doi.org/10.1002/ar.22421>
- Moselhy, A., & Hady, E. (2019). Gross, histochemical and electron microscopical characterization of the Pecten oculi of Baladi ducks (*Anas boschas domesticus*). *Journal of Advanced Veterinary and Animal Research*, 6(4), 456.  
<https://doi.org/10.5455/javar.2019.f368>
- Onuk, B., Tutuncu, S., Alan, A., Kabak, M., & Ince, N. G. (2013). Macroanatomic, light and scanning electron microscopic studies of the pecten oculi in the stork (*Ciconia ciconia*). *Microscopy Research and Technique*, 76(9), 963–967.  
<https://doi.org/10.1002/jemt.22255>
- Pourlis, A. F. (2013). Scanning Electron Microscopic Studies of the Pecten Oculi in the Quail (*Coturnix coturnix japonica*). *Anatomy Research International*, 2013, 1–6.  
<https://doi.org/10.1155/2013/650601>
- Rahman, M. L., Lee, E., Aoyama, M., & Sugita, S. (2010). Light and electron microscopy study of the pecten oculi of the Jungle Crow (*Corvus*

- macrorhynchos). *Okajimas Folia Anatomica Japonica*, 87(3), 75–83. <https://doi.org/10.2535/ofaj.87.75>
- Raviola, E., & Raviola, G. (1967). A light and electron microscopic study of the pecten of the pigeon eye. *American Journal of Anatomy*, 120(3), 427–461. <https://doi.org/10.1002/aja.1001200304>
- Rodriguez-Peralta, L. A. (1968). Hematic and fluid barriers of the retina and vitreous body. *The Journal of Comparative Neurology*, 132(1), 109–123. <https://doi.org/10.1002/cne.901320106>
- Seaman, A. R., & Storm, H. (1963). A correlated light and electron microscope study on the pecten oculi of the domestic fowl (*Gallus domesticus*). *Experimental Eye Research*, 2(2), 163–IN26. [https://doi.org/10.1016/s0014-4835\(63\)80009-3](https://doi.org/10.1016/s0014-4835(63)80009-3)
- Tucker, R. (1975). The surface of the pecten oculi in the pigeon. *Cell and Tissue Research*, 157(4). <https://doi.org/10.1007/bf00222599>
- Yılmaz, B. (2021). Aseel Tavuklarda (*Gallus domesticus*) Pecten Oculi'nin Işık ve Elektron Mikroskopik Özellikleri. *Journal of Research in Veterinary Medicine*, 40(2), 136–140. <https://doi.org/10.30782/jrv.1029702>
- Yılmaz, B., Korkmaz, D., Alan, A., Demircioğlu, S., Akbulut, Y., & Oto, A. (2017). Peçeli Baykuşlarda (*Tyto alba*) Pecten Oculi'nin Işık ve Elektron Mikroskopik Yapısı. *Kafkas Üniversitesi Veteriner Fakültesi Dergisi*. <https://doi.org/10.9775/kvfd.2017.18070>

#### How to cite this article

Mahmood rajab, J., Salman, S. D. and Kadhum, Y. A. (2023). The pecten oculi comparison of the different bird species. *Science Archives*, Vol. 4(4), 270-275 <https://doi.org/10.47587/SA.2023.4405>

This work is licensed under a [Creative Commons Attribution 4.0 International License](https://creativecommons.org/licenses/by/4.0/)



**Publisher's Note:** Journal stays neutral about jurisdictional claims in published maps and institutional affiliations.