Eye examination as part of the equine prepurchase examination

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Summary
Prepurchase examination (PPE) is the most common reason for eye examination in first opinion equine practice. This paper describes a standard protocol for competent eye examination in the PPE, and reviews the interpretation of the more common clinical findings, particularly in relation to their expected influence on functional vision and their progression. The content is based on the limited existing literature, the personal opinions and experience of the author, and from discussions held with colleagues over the past 30 years.

Introduction
“An imperfect apprehension of the sensory world of animals usually prevents our being able to speak confidently of what the ‘vision’ of a given species is like. On the other hand familiarity with the structure and physiological reactions of its eyes, together with an understanding of its behaviour and requirements can, perhaps, enable us to make not too foolish a guess.” Tansley (1965).

At a conservative estimate, >50% of eye examinations carried out in first opinion equine practice are undertaken as part of the prepurchase examination (PPE), and this requires the examining veterinarian to undertake a stochastic decision-making process unique to this species and examination. This involves:

• Identification of, primarily, clinical normality.
• Recognition of ocular anomaly or pathology, and expression of a reasoned opinion on the physiological consequences of that pathology.
• Expression of an opinion on the possible progression of that pathology through the lifetime of the horse.

Given the current position of there being no understanding of higher visual function in the horse and no standardised means of objectively assessing ‘vision’, with the exception, in most cases, of where there is total loss of ocular function in one or both eyes, along with only limited factual information available on the progression of many ocular pathologies, making any decision at all seems reckless. However, using a competent and structured examination and thoughtful interpretation of any observations made, the veterinarian can approach the ophthalmic component of the PPE on the basis of Professor Tansley’s assertion quoted above.

The present author’s preferred term for what is being assessed in the PPE is ‘functional vision’. This describes how the horse is able to interact with its immediate environment primarily using ocular input, but understood to be in conjunction with other sensory inputs. This is necessarily subjective, and the role of the examining veterinarian should be to provide the potential purchaser with a professional and considered opinion to allow an informed decision on the purchase to be made. In most instances it is possible to state that:

• Ocular abnormality is or is not present.
• Abnormality will have either a significant effect or no significant effect on functional vision.
• The abnormality is either unlikely in its normal course to progress, or might progress over time.

Where any anomalous variation from normality or overt pathology is found at examination the veterinarian should accurately and succinctly describe the finding in a written report, along with an opinion on the effect of that finding on functional vision and its anticipated progression or lack of progression in its normal course, and, if possible, obtain a dated photographic record of the eye. This typically demands the confidence that comes with knowledge and, particularly, experience, and in some instances the examining veterinarian would be advised to seek opinion from colleagues. The aim of this article is to outline the requirements of competent ocular examination as part of the PPE, and to discuss some of the more common problems likely to be encountered in the course of the examination.

Does this abnormality significantly affect functional vision?
Equine clinicians have long been familiar with the enigma of ocular disease vs. apparent visual compromise in their patients; i.e. horses with frank ocular disease and consequent physiological disruption very frequently show no behavioural or other changes attributable to impaired ocular function. Whether the horse is capable of maintaining some degree of useful visual function in the face of significant loss of some of its integral anatomy, possibly by using alternative sensory cues, or whether we are simply unable to determine visual loss objectively in this species is an unanswered question (Miller and Murphy 2010). In these circumstances, when making a professional judgement on the effects of ocular disease on vision in a particular horse, and by implication the suitability and safety of that horse for a particular use, some general rules may be followed:

• Horses with congenital or long standing lesions, where the eye is only partly compromised, are likely to have adapted to any loss or disruption of visual input.
• Dense and extensive opacities of the transparent ocular media within the visual axis may disrupt light passage onto the macular areas of the retina and interfere with
binocular and high acuity vision, or will create a frank blind spot (Miller and Murphy 2010).

- Acquired inclusions in the fluid media of the eye, mainly in the vitreal body, which move precipitately with ocular movement (saccades), can be associated with head shaking or estiloering behaviour (Miller and Murphy 2010), although only in a very small number of affected horses.

- Retinal pathology encompassing the macular area is likely to have significant effects on visual acuity and colour perception in the affected eye. The equine macular area conforms to the oblate pupil and lies approximately 1–3 disc diameters superior to the optic disc.

- Peripapillary chorioretinal pathology where there is overt attenuation of the retinal blood vessels is likely to be associated with some disruption of contiguous ganglion cell neural traffic, creating a peripheral visual field deficit associated with the areas of origin of these ganglion cells (Matthews 2004a).

- Multiple focal chorioretinitis lesions (‘bullet hole’ lesions) distributed in a horizontal linear pattern in the peripapillary fundus can, for unknown reasons, be associated with significant visual disability (Fig 92) (Matthews 2004a).

- Horses with extensive pigmentary retinopathy (Fig 94), including older horses with age-related senile retinopathy, will have significantly impaired neuroretinal function in the geographic areas involved (Matthews 2004a).

The veterinarian must appreciate the very general context of the above rules, and be aware that, amongst individual horses, relatively minor ocular abnormalities can apparently precipitate significant behavioural problems. An example of this is iris cysts (Fig 28), where the large majority of affected horses exhibit no behavioural abnormality, yet a small number of affected horses appear to do so and will return to normality following ablation of the cyst(s).

It is neither appropriate nor defensible for the examining veterinarian to make quantitative statements about visual impairment (e.g. ‘this horse has 50% vision’), nor to make subjective judgements, such as stating that a horse with an ocular abnormality is suitable to be ridden only by a skilled rider/in an outdoor or well lit environment.

Is this abnormality heritable?
Where the horse is intended for breeding, difficulties arise in that very little is known about the heritability of equine ocular pathologies. Heritability, where known, is discussed below in relation to individual conditions.

The examination: requirements

The instrumentation required for competent ophthalmic PPE is relatively simple, and comprises:

- A focused white light source, such as a penlight or head torch, or Finhoff transilluminator.

- A functioning direct ophthalmoscope.

- Magnification may be helpful, e.g. ‘hobby’ type head loupe e.g. Optivisor.

The use of any other examination instrumentation or techniques, e.g. indirect ophthalmoscopy, biomicroscopy, is entirely at the discretion of the individual examiner.

The examination: procedure

Competent ocular examination as part of the PPE takes the form of a standardised clinical examination, and is essentially an examination for normality. The examination has five parts:

- Assessment of ocular and adnexal symmetry.

- Assessment of the gross adnexal and external ocular appearance.

- Assessment of the pupillary light reflexes and dazzle reflexes in both eyes.

- Distant direct ophthalmoscopy.

- Close direct ophthalmoscopy.

In addition, the examining veterinarian should be vigilant throughout the PPE for behavioural or other signs suggesting any visual impairment. However, objective assessment of vision on the basis of behaviour alone, i.e. where there is no discernible ocular abnormality, is not possible; other than in the very rare event of the animal being bilaterally centra blind.

With experience, this examination can be carried out competently in a matter of a few minutes. The first two parts are carried out in bright or daylight conditions. Assessing ocular reflexes and direct ophthalmoscopy must be carried out in a darkened area. The order in which the examination is performed is the preference of the examiner. Direct ophthalmoscopy should be carried out through at least a mid-dilated pupil. This can be achieved in most horses after a short period of dark adaptation (a suitable time to begin completion of paperwork, check passport etc.). The bright light of the ophthalmoscope, however, will induce pupil constriction, allowing only relatively brief time windows for the examination, and multiple periods of dark adaptation may be required. Ophthalmoscopy through a mid-dilated pupil is unlikely to permit assessment of more than 50% of the ocular fundus, necessarily restricting access to the more peripheral areas of the fundus, and very rarely lesions in the peripheral fundus may be missed. Common experience indicates most significant fundic pathologies occur in the circumpapillary fundus, usually within 2–3 disc diameters from the margins of the optic disc, and can be fairly assessed through a mid-dilated pupil. Similarly, abnormalities in the peripheral lens, e.g. equatorial cataracts (Fig 51), are typically visible at the medial or lateral margins of the mid-dilated pupil. The decision to pharmacologically dilate the pupil routinely during PPE is the prerogative of the examining veterinarian. The current recommendation in the UK (BEVA/RCVS Guidelines 2012), and supported by this author, is that pharmacological dilation of the pupil is neither appropriate nor necessary to carry out ophthalmic examination as part of the PPE. Exceptions are where dilation is specifically requested by the purchaser or where the examiner, suspecting abnormality, wishes to carry out a more detailed examination of the eye. This should be carried out at the end of the PPE and only with the explicit permission of the vendor.

Assessing ocular and adnexal symmetry

The examiner stands in front of the horse to assess overall facial, adnexal and orbital symmetry. In particular, the relative angulation of the upper eyelashes should be assessed; lowering of the angle is a subtle indicator of ocular...
discomfort in the absence of overt blepharospasm or lacrimation.

**Assessment of gross adnexal and external ocular appearance**
The examiner should note the presence of ocular discharge, abnormality in adnexal and eyelid contour or alignment, globe position and direction of gaze, the presence of conjunctival injection or congestion, corneal opacity or pigmentation, and pupil shape and symmetry.

**Assessing ocular reflexes**
Direct and consensual pupillary light reflexes should be assessed. In the horse, the constrictor response is relatively slow compared to other species. Absence of a direct pupillary light reflex is significant and most likely to indicate interruption of afferent traffic within the optic nerve or optic tract. Absence of a consensual reflex may indicate afferent input loss in ipsilateral eye or loss of efferent function (occulomotor nerve) in the contralateral eye. It should be noted that the consensual reflex can result in bilateral pupil symmetry where there is complete loss of optic nerve input and blindness in one eye (e.g. optic atrophy [Fig 9]).

The ‘dazzle reflex’, where a bright and focused light is slowly brought up to and directed into the eye, eliciting a blinking response, is a subcortical reflex indicative of a functioning optic nerve, neurosensory retina and lower optic pathway. Absence of a dazzle response, in the presence of normal facial nerve function (i.e. ptosis not present), indicates severe visual impairment.

The ‘menace response’, where the eye is ‘threatened’ by sudden movement of the examiner’s hand, sometimes from behind a Perspex plate, is in the opinion of this author of very little value, if any, in assessing vision in the PPE. However, its use and interpretation is the prerogative of the individual veterinarian.

**Distant direct ophthalmoscopy**
Using this technique, the ‘0’ lens on the direct ophthalmoscope is selected and the eye examined from a distance of 20–50 cm. Any opacity in the transparent media (cornea, anterior chamber, lens and vitreous) appears dark or in silhouette against light reflected from the tapetum (retroillumination; Fig 1). This is a basic scanning technique used to identify opacities within the visual axis.

Using distant direct ophthalmoscopy, parallax can be employed to locate the position a cataract within the central axis of the lens (Fig 2). The observer’s axis of vision pivots on the posterior lens nucleus, and any opacity near this location remains fixed within this axis of vision as the observer changes the angle of view. In the case of opacities in the anterior lens, the opacity ‘moves’ in relative terms opposite to the change in direction of the observer angle of view. The reverse is the case in posterior lens opacities. With practice this becomes instinctive.

**Close direct ophthalmoscopy**
The eye is examined from a distance of 2–3 cm. For most examiners the optic nerve and peripapillary fundus can be brought into focus with the ‘0’ lens selected. As the dioptre strength of the lenses rotated into the viewing aperture is increased (typically black +1→+10) the focal distance is decreased and the focal point is brought closer to the viewer’s eye. The lens strength permitting various parts of the eye to come into focus will vary to some degree with the refraction of the horse’s and viewer’s eye and with the examination distance. In the emmetropic (‘normal’ refraction) horse eye,
the present author expects to view the vitreous at +2 to +6, the lens at +7 to +8 and the cornea at +10.

In regard to the fundus, close direct ophthalmoscopy gives a magnified and upright view, but a single field of view covers only some 2-3% of the fundus. It then becomes necessary to rotate the angle of view in multiple directions to observe as much of the fundus as possible.

Common ocular findings and their interpretation

The veterinarian can expect to come across a very wide spectrum of ophthalmic anomalies and pathologies in the course of PPEs, and these can present challenges in their interpretation for even experienced clinicians and ophthalmologists. What follows is a descriptive series of more commonly encountered findings, derived from the experience of the author in both first and second opinion scenarios, along with the author’s view on their interpretation. The conditions described are principally those likely to be encountered in both young and mature horses. It does not include age related pathologies in older horses, which are only very rarely presented for PPE.

Some findings should be considered grounds for advising against purchase in all circumstances. These are:

- All neoplastic, or potentially neoplastic, lesions of the adnexa, eyelids, conjunctivæ and cornea. These include squamous cell carcinoma (SCC; Fig 3), melanoma (Fig 4) and sarcoid.
- The presence of ocular pain, redness and discharge.
- Any abnormality of globe size or position.
- Any evidence of active inflammatory disease in the absence of overt ocular pain, in particular suspected ‘immune mediated keratitis’ (Fig 5) or subacute uveitis (Fig 6).
- Any pathology causing extensive obstruction of the visual axis precluding any ophthalmoscopic visualisation of the fundus, or otherwise severely compromising ocular function.

However, some findings will relate to treatable pathologies. In these circumstances the vendor can be advised to seek

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independent diagnosis and treatment, and the horse may subsequently be represented for examination. In these cases the diagnosis and prognosis should be made clear to any potential purchaser, including any likelihood of recurrence, particularly in the case of immune mediated keratitis or uveitis. Some of these conditions are included in the series that follows.

One-eyed horses

Horses overtly presenting with one functional eye, the contralateral eye being phthisical or having been enucleated, are generally suitable for purchase with reservation. Potential owners should be made aware of two things primarily: loss of an eye and, by default, significant impairment of binocular vision and depth perception may result in consequent impairment of jumping ability, and, in the case of a phthisical eye, the possible presence of chronic local pain impacting on the horse’s behaviour.

Adnexa and orbit

Eyelids

Minor discontinuities in the eyelid margins where there is no trichiasis (eyelid hair in contact with cornea) or injury of the contiguous cornea can be considered suitable for purchase. These include eyelid coloboma (Fig 7) and irregularity following laceration repair. Cicatricial entropion (Fig 8) or extensive acquired anatomic disruptions of the lid are likely to result in trichiasis (Fig 9), and should not be considered suitable for purchase, even where there is no present corneal compromise. However, in some instances these may be represented for PPE after surgical repair.

Signs of solar blepharitis or blepharodermatitis in horses with nonpigmented eyelids (Fig 10), in particular in white faced horses or breeds such as Appaloosas or Paints, represent a significant risk of consequent development of SCC of the eyelid. Similarly, erosive or small nodular lesions of the lid margin, particularly in nonpigmented eyelids, are likely to be early stages of SCC (Fig 11). In these instances potential purchasers must be advised accordingly.

Third eyelid

Absence of the third eyelid itself does not appear to compromise ocular function, but should be recorded at PPE. However, most instances are a consequence of tarsal resection for the management of SCC, and potential purchasers must be made aware of this and advised that, although unlikely in most cases, local recurrence is possible. The contralateral third eyelid should be examined in detail in these cases. This is particularly relevant in breeds known to be susceptible to third eyelid SCC, such as Haflingers, draught horses and light coloured horses in general.

Deformity of the third eyelid is rare (Fig 12) and in most cases is of no significance and horses are suitable for purchase.

Fig 7: Coloboma of the upper eyelid.

Fig 8: Cicatricial entropion and trichiasis.

Fig 9: Failure to repair a lateral upper lid laceration resulting in trichiasis.

Fig 10: Solar blepharodermatitis in a white faced pony. A dorsal iris hernia is an incidental finding in this eye. (Courtesy of Ann Dwyer).
purchase. However, ectopic cilia may be present or desiccation of the exposed conjunctiva may be a problem, and affected horses are not suitable for purchase. However, in most instances a vendor will have the option of excision of the eyelid.

Prolapse of the extraorbital fat pad
This is a benign condition presenting as a smooth, conjunctiva covered, nodular mass located between the margin of the third eyelid and cornea (Matthews 1994). Clinical appearance alone is definitively diagnostic in the overwhelming majority of cases. Other than for cosmetic reasons, affected animals are suitable for purchase (Fig 13).

Conjunctiva

Follicular conjunctivitis
Presentation varies from small individual, often conspicuously nonpigmented, follicles near the limbus or on the external
surface of the third eyelid (Fig 14a), to fleshy, confluent and reactive nodules (Fig 14b). The former presentation is common and can be considered normal, the latter; however, is likely to reflect chronic local imuno responsiveness and affected horses are liable to exhibit recurring acute conjunctivitis.

**Conjunctival vesicles**

Isolated limbal vesicles, typically more obvious dorsally, are a relatively common and benign finding of unknown origin, and are of no consequence in relation to PPE (Fig 15).

**Pseudotumour and Habromema spp. granuloma**

These are chronic inflammatory masses that mimic squamous cell carcinomas. Affected horses should not be considered suitable for purchase until a definitive diagnosis and successful treatment has been implemented (Guiliano 2010) (Figs 16 and 17).

**Dermoids**

These are choristomas, i.e. normal, although often anatomically disrupted, tissue at an abnormal site. They are unilateral or, more commonly, bilateral and are found at the superior limbus, extending onto the cornea. Small, hairless dermoids are innocuous, benign and do not progress (Fig 18). Large or hairy dermoids are potentially troublesome and affected horses should not be recommended for purchase unless first treated.
Cornea

Corneal opacities

Congenital corneal opacities (leukoma) are relatively rare and nonprogressive. They may occur in isolation (Fig 19) or be associated with anterior segment dysgeneses (see below; Fig 35). Since the affected animal’s central visual mechanisms will be expected to have adapted to the presence of the opacity, peripheral or small central (axial) opacities it is unlikely that functional vision is significantly compromised, and potential purchasers can be advised accordingly. Extensive axial opacities should be considered to have the potential to significantly affect functional vision.

Acquired corneal scarring or fibrosis is common, permanent and nonprogressive, and can be assessed in

Fig 20: Corneal fibrosis. Functional vision unlikely to be significantly compromised.

Fig 21: Corneal fibrosis. Extensive central opacity will compromise functional vision.

Fig 22: Minor, mainly perilimbal, corneal fibrosis, on its own of no significance in relation to prepurchase examination.

Fig 23: Same eye as Fig 22, showing extensive chorioretinal degeneration (pigment dispersal and retinal vascular attenuation). This is a major finding of abnormalities likely to compromise vision seriously.

Fig 24: Linear keratopathy. Shown bridging the (a) horizontal meridian and (b) parasagittal vertical meridian of the cornea. Incidental iris cysts are present in (b), and is a minor finding.
much the same way as congenital opacities (Figs 20–22). However, it is imperative that any affected eye is thoroughly examined for any associated injury, in particular chorioretinopathy (Fig 23), which would significantly and adversely influence PPE opinion.

Linear keratopathy [“single stria”] (Brooks and Matthews 2007) is a common and benign incidental finding. Here a deep, linear refractile and nonoedematous opacity bridges the cornea, typically near the horizontal meridian or parasagittal vertical meridian (Fig 24). Critically the eye is otherwise normal. The opacity represents a discontinuity in Descemet’s membrane. The cause is unknown but a single and isolated episode of elevated intraocular pressure is probable. Similar refractile opacities occur following blunt trauma to the globe and in glaucoma; however, in these instances the opacities are typically multiple and branching (Fig 25), and more general and serious signs of ocular injury are present. Where the linear opacity is single and nonbranching, and is the only abnormality, the lesion should not impact on the PPE.

Corneal oedema in the absence of any epithelial discontinuity reflects endothelial dysfunction, and this is potentially permanent. In all cases of extensive or generalised oedema the affected horse should not be considered suitable for purchase. Local oedema will arise in two broad circumstances: where an intraocular mass directly impinges on the endothelium (Fig 26), and where intraocular inflammatory or other detritus adheres to the endothelium (Fig 27). In both cases the horse should not be considered suitable for purchase at the time of PPE. In some instances of low-grade inflammatory pathology (Fig 27b), the horse may be reassessed after treatment. However, the potential purchaser must be explicitly advised that recurrence of the problem cannot be predicted or excluded in any one case.
Iris cysts arise from the posterior pigmented epithelium of the iris, and ‘hang’ over the pupil margin into the anterior chamber (Fig 28a). They are common and may be solitary or multiple (Figs 24b and 28b). In the majority of cases, the cyst does not enlarge beyond the size noted at first examination. However, very rarely, the cyst may detach and float free within the anterior chamber, and in that location would be expected to interfere significantly with functional vision. Also very rarely, the cyst may enlarge to partially block the pupil or impinge on the axial corneal endothelium causing persistent local oedema and superficial ulceration (Fig 26b). It is not possible to predict which cysts are likely to enlarge. There are anecdotal reports of aspiration or laser deflation of cysts resolving straying problems in a small number of horses. However, in the majority of horses iris cysts should be considered a benign finding of little or no significance. Purchasers however should be advised of the small possibility of progression.
Cysts and hyperplasia of the granulae iridica (corpora nigrans)

Cystic or hyperplastic granulae iridica are an occasional finding at PPE (Figs 29 and 30) and, in most instances, can be considered of no significance. However, rarely cysts may subsequently enlarge and obstruct the miotic pupil in bright ambient lighting conditions. The advice given above in relation to iris cysts applies.

Iris hypoplasia and heterochromia

Iris thinning and pigment loss in the otherwise normal eye are seen typically in conjunction, and are a normal anatomic variant (Fig 31) that produces ‘blue’ or ‘wall’ eyes. Colour dilute breeds such as Paints or Appaloosas commonly exhibit this characteristic, but it is also seen in black colour coat horses and Welsh ponies.

Dorsal herniation of the iris

This is primarily seen in the pigment dilute, hypoplastic iris in Welsh or Welsh cross ponies. However, other breeds and horses with normally pigmented irises can also be affected, although typically to a less obvious degree. The condition presents as an anterior, cyst like, bulging of the dorsal iris, most evident in the miotic pupil (Figs 10 and 32). Very rarely, it may affect the ventral iris. The cause is local herniation of the structurally weakened iris under the hydrostatic pressure of posterior chamber aqueous. Very rarely, the hernia may be ventral. Diagnosis is based on clinical presentation, transillumination where the iris is sufficiently thinned (Fig 32b) and ‘collapse’ of the hernia following the induction of mydriasis. It is of no significance in relation to the PPE.
Iris colobomas

Full or partial thickness discontinuities in the iris are relatively common (Figs 33 and 61). The latter appear as a layer of posterior pigmented epithelium bridging the stromal defect (Fig 33b). The colobomas may be single or multiple, are usually associated with heterochromia, and are more commonly located on the ventral iris. They are of no significance in relation to PPE.

Anterior segment dysgeneses

The creation of the relative void of the anterior chamber of the eye from the mesoderm of the optic stalk during fetogenesis is a complex and dynamic biological event, and is subject to disruptions resulting in anterior segment dysgeneses (ASDs). In the adult eye these range from persistent pupillary membranes through to relatively large and irregular masses of disorganised pigmented tissue present in the central anterior chamber. Persistent pupillary membranes are stands of pigmented tissue which most commonly bridge the anterior face of the iris, or extend from the anterior face of the iris to the posterior cornea (Fig 34a) or, less frequently, the anterior lens capsule (Fig 34b) where local geographic opacities are inevitably present. Anterior chamber pigmented masses will vary in presentation and may be associated with corneal opacities, or local cataract or other abnormalities (Fig 35). These ASDs are typically unilateral, and can frequently be very difficult to differentiate from post uveitic injury, although affected eyes are spared the diffuse and reactive post inflammatory sequelae of uveitis (Figs 37–39). However, where there is doubt concerning the differential diagnosis of these ASDs, veterinarians should advise that a potential purchaser seek specialist opinion. As congenital anomalies, these ASDs do not progress, and unless very extensive are not likely to be associated with significant disruption of functional vision, the animal’s higher visual centres presumably having adapted to the obstruction within the visual axis.
More extensive and rare ASDs are usually bilateral and
can be associated with major ocular fetopathies such as
microphthalmia, corneal opacity and microphakia (Fig 36).

Affected horses are often apparently visual, but are rarely
presented for PPE and not suitable for purchase.

Uveitis
In all cases, horses with evidence of previous uveitis; posterior
synechiae, loss of granulae iridica, cataracts, pupillary
distortion, iris depigmentation or pigment dispersal and iris
neovascularisation (Figs 37–39), should be considered
unsuitable for purchase. An exception is where there is
convincing evidence of a traumatic aetiogenesis (e.g.
tearing of the granulae iridica; Figs 40 and 60), where
recurrence is unlikely and where intraocular disruption is
minor. This may not be a straightforward differentiation, and
the examining veterinarian should apply the precautionary
principal when reporting examination findings (Brooks and
Matthews 2007).

Iris naevi
Small and well defined hyperpigmented areas on the central
anterior iris (naevi) are commonly seen in grey horses, and
occasionally in horses of other coat colours. They are in these
instances a minor and inconsequential observation (Fig 41).
However, more extensive, peripheral and irregular naevi can
signify the presence of ciliary melanoma (Fig 42), and
affected eyes should be examined in detail, including using
ultrasonography, before any decision is made with regard to the purchase.

Iridociliary melanomas

Iridociliary melanomas occur relatively commonly and almost exclusively in grey horses. In most instances the melanomas either do not progress from the time of initial diagnosis or grow slowly to a finite point without distant metastasis. In some cases the tumour enlarges to make corneal contact or exfoliates cells into the dependent drainage angle, causing corneal opacity, or obstructs the pupil (Figs 26a and 43). In most instances, iridociliary melanomas found incidentally at PPE represent a benign finding at the time of examination. However, affected eyes carry an unpredictable lifetime risk of glaucoma of 10-20% (Matthews, personal observation), and, rarely, tumour growth can result in perforation of the globe. Potential purchasers must be advised of these risks, and, in general affected horses should not be considered suitable for purchase.

Peripheral retinal (ciliary) cysts

Multiple, tremulous and translucent posterior ciliary epithelial cysts (Fig 44), typically located temporally, are an occasional and not unexpected finding in horses or ponies with a silver dapple coat colour. This represents heterozygous expression of the PMEL17 gene mutation responsible for multiple congenital ocular abnormality syndrome (Matthews 2013). The cysts are nonprogressive and have no effect on functional vision, but affected animals should not be used for breeding.

Lens

Lens abnormalities, in particular opacities of the lens and its capsule (developmental or acquired cataracts) or retrolental opacities associated with fetal tissue remnant attachments, are very common, and are a frequent cause of concern in relation to PPE. Most affected horses, including those with extensive and bilateral cataracts, are likely to show no deficit in functional vision. However, extensive or complete cataracts, unilaterally or bilaterally, should significantly compromise
functional vision and affected horses should not be considered suitable for purchase. Such clear cut cases make up only a very small minority of lens opacities encountered at PPE, however. The remaining majority of cases where horses present with lens abnormalities can present a major challenge to the examining veterinarian (Matthews 2004b).

All retrolental tissue attachment opacities and the majority of cataracts encountered at PPE do not progress. Progression, however, is possible in the case of acquired cataracts secondary to ocular disease, in particular uveitis, or injury, or to presumptive ‘metabolic or toxic’ insult.

Potential purchasers electing to proceed with purchase in these cases should be made aware of the uncertainty surrounding progression and that sequential examinations at a time interval of 12-24 months is necessary to determine progression or otherwise.

Retrolental opacities
These typically appear as dark vermiform or Y configured densities, or as a faint fibrillar meshwork, adherent to the axial posterior lens capsule (Figs 45-47). These presumptively represent remnants of the vasculature of the fetal tunica vasculosa lentis, and have only minor, if any, effect on functional vision, and alone should not impact adversely on a PPE decision.

Developmental cataracts
These represent interruptions or disruption of the growth and accretion of the normally transparent and annucleate lens fibres, initially in utero and subsequently post natally. Some of these will be present at birth (congenital) with others becoming evident in the interval up to early adulthood.
These cataracts typically are confined to a defined geographic or anatomic area or areas within the lens. Nuclear cataracts (Fig 48) can involve the central primary or embryonic lens nucleus, the fetal nucleus or the adult nucleus. Perinuclear or lamellar cataract (Fig 49) where the zone of opacity surrounds the adult nucleus is typically bilateral and symmetrical. Crystalline or coralliform cataracts (Fig 50) are unilateral and are located in the posterior axial nucleus. Equatorial cataracts (Fig 51) are typically bilateral and involve the peripheral or equatorial lens. Anterior polar (Fig 52) and capsular cataracts (Fig 53) are the most commonly found opacity. The latter appear as small focal capsular opacities, usually on the anterior capsule. None of these developmental cataracts are progressive. However, those causing extensive and bilateral obstruction of the visual axis or of the peripheral visual fields (Figs 49 and 51) should be considered significant in relation to PPE.

Bilateral and symmetric developmental cataracts should be viewed as having a heritable component, and affected horses should not be used for breeding.
Acquired cataracts
These arise secondary to intraocular disease or injury, most commonly uveitis (Figs 54–57). Typically affected eyes show obvious evidence of inflammatory injury; however, some postuveitic cataracts, in particular vacuolar cataracts (Fig 57) can be present in the absence of overt iridociliary injury, and care is required in their interpretation. ‘Toxic or metabolic’ cataracts is a ‘dustbin’ term for irregular opacities where no specific aetiology can be determined (Figs 58 and 59), although in many instances there may be an inflammatory aetiology. All acquired cataracts are potentially progressive through recurrence or the progressive consequences of the causal insult, and potential purchasers should be advised against purchase. The exception is in the case of some traumatic cataracts (Figs 54 and 55). However, in these instances there is typically extralenticular ocular injury likely to compromise the eye, and nonprogression can only be established by sequential examination over several years.

A specific and relatively common acquired cataract is an axial triradiate (Y) configured posterior capsular opacity (Fig 60). This cataract is a consequence of whiplash injury to the globe, the pressure wave transmitted through the fluid media presumptively causing dehiscence of the capsulohyaloid membrane around the posterior lens pole. This is a nonprogressive cataract caused by a single isolated event, and is frequently accompanied by minor peripapillary chorioretinal scarring (Fig 83a). Unless there is evidence of extensive and disruptive extralenticular injury, this cataract alone is likely to result in only minor, if any, compromise of functional vision, and has only minor significance in relation to PPE.

In no circumstances should horses be advised as being suitable for purchase subject to surgical lensectomy. While technical procedures for cataract surgery have evolved and improved in the last decade, the results remain relatively poor, with only 25% of horses remaining visual 2 years after surgery (Brooks et al. 2014).

Concentric cortical lamination
This term describes the refractive ‘onion ring’ layering present in some lens cortices when viewed by distant direct ophthalmoscopy (Fig 61). This appears to be a physiological adaptation by the large horse lens to limit the defocusing effect of chromatic aberration (Krüger et al. 1999), and is a normal finding.

Lens luxation or subluxation
Posterior lens luxation or subluxation is an occasional finding in the eyes of horses presented for PPE (Fig 62). In these cases, luxation is usually a consequence of trauma or uveitis (particularly in Appaloosas), and while the luxation alone does not appear to be associated with overtly impaired functional vision in most cases, potential purchasers should be advised that affected horses cannot be considered suitable for purchase.

Fig 55: Nonprogressive perinuclear cataract resulting from blunt trauma.

Fig 56: Extensive anterior capsular and cortical cataract following endogenous uveitis.

Acquired cataracts

Fig 57: Vacuolar cataract associated with posterior uveitis.

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The equine vitreous is a dilute and uniformly dense collagen-GAG hydrogel, partly compartmentalised by a series of concentric membranes formed by condensation of the collagen matrix. The central vitreous is variably liquefied in horses of all ages, and membranous or particulate ‘inclusions’ within the central vitreous are typically highly motile. Changes in vitreal rheology, principally increasing liquifaction, occur with age (Matthews 2004c).

Motile vitreal ‘inclusions’ are a frequent finding on distant direct ophthalmoscopy at PPE, and can be grouped pragmatically into developmental and acquired inclusions. Developmental inclusions are the more common, and are typically unilateral and likely to derive from several sources (Table 1). The vast majority of horses with developmental inclusions within the central vitreous show no impairment of functional vision, even in those cases of extensive motile opacities within the visual axis. However, the literature records

### Table 1: Developmental vitreal inclusions

<table>
<thead>
<tr>
<th>Inclusion Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Congenital persistence of the fetal primary vitreous (PPV; Figs 63–65)</td>
<td>These appear as solitary refractile densities extending a variable distance into the central vitreous from the periphery of the optic disc or posterior pole of the lens. A probable and rare variant of PPV presents as an extensive and consolidated, tangled mesh-like structure occupying much of the central vitreous (Fig 65)</td>
</tr>
<tr>
<td>Vermiform vascular remnants (Fig 66)</td>
<td>These appear as fine tangled tubular structures, presumably derived from mesodermal hyaloid vascular elements within the developing fetal vitreous</td>
</tr>
<tr>
<td>Membranous or fibrillar condensations (Figs 67 and 68)</td>
<td>These are probably anomalous condensations of the normal collagenous anatomy of the vitreous, typically within the central vitreous or in the periciliary vitreous</td>
</tr>
<tr>
<td>‘Floaters’ (Figs 69 and 70)</td>
<td>These motile inclusions are probably analogous to vitreal ‘floaters’ in the human eye, and derive from redundant glial material shed into the vitreal body from the peripheral vitreoretina</td>
</tr>
</tbody>
</table>

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isolated instances of aberrant ridden behaviour attributed to vitreal ‘floaters’ (Miller and Murphy 2010), and potential purchasers should be made aware of the uncertainty of the effect of vitreal inclusions on behaviour, albeit with a very low probability of significant effect in any one case. Horses with extensive inclusions obstructing the visual axis and blocking visualisation of the fundus should not be considered suitable for purchase.

Acquired vitreal inclusions are typically a consequence of posterior uveitis, and include: fibrin (Fig 71); inflammatory cellular detritus, frequently noted adherent to thickened vitreal membranes (Fig 72); haemorrhage; and vitreoretinal detachment (Fig 73). These pathologies can occur in the absence of any abnormality in the anterior ocular segment. Friesian horses are known to be susceptible to an endogenous form of posterior uveitis, and veterinarians undertaking PPEs in this breed should be aware of this. In all cases there must a major and permanent adverse impact on functional vision, and affected horses should not be considered suitable for purchase.

The fundus

The equine ocular fundus is subject to a wide range of normal anatomic variation, primarily involving pigment...
density and dispersal and the colour, relative thickness or geographic distribution of the tapetum (Figs 74–77). For a comprehensive discussion of these normal variants see Matthews et al. (1990) It is important that the clinician is familiar with these variants, and is confident with their recognition. One normal variant commonly confused with retinal ‘haemorrhage’ is the presence of the vascular reflex of the four large vortex veins, draining the posterior uvea, observed tracking across the tapetal fundus to exit the globe at the dorsal scleral foramen located dorsolaterally to the optic disc (Fig 77) (Matthews 2004a; Nell and Walde 2010).
In addition to anatomic variants, several anatomic anomalous variants are frequently evident on direct ophthalmoscopy. These variants are not likely to be

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**Fig 75:** The normal equine fundus (variant): pigment dilution and tapetal thinning.

**Fig 76:** The normal equine fundus (variant): nonpigmented with marked tapetal hypoplasia. The choroidal circulation is startlingly visible.

**Fig 77:** The normal equine fundus (variant): the vortex veins are visible in the tapetal fundus. The red vascular reflexes can be mistaken for retinal haemorrhages.

**Fig 78:** ‘Coloboma’ of the retinal pigment epithelium: the crescent shaped depigmented area adjacent to the optic nerve probably lacks melanin in the retinal pigment epithelial layer. Tapetum is present in the area of the ‘coloboma’.

**Fig 79:** ‘Coloboma’ of the retinal pigment epithelium: confluent and well defined areas of depigmentation in the nontapetal fundus.

**Fig 80:** Ectopic myelination of the peripapillary ganglion cell axons.
associated with any significant impairment of functional vision and are not progressive, and potential purchasers should be advised accordingly. These variants include ‘colobomas’ of the retinal pigment epithelium (Figs 78 and 79), ectopic myelination of the ganglion cells axons as they approach the optic disc (Fig 80), and small, often multiple, naevi in the tapetal fundus of the otherwise normal eye (Fig 81).

For practical purposes, pathological variants of the fundus are recognised by the presence of specific ophthalmoscopic indicators of disease. These are listed in Table 2.

Since pathological events in the fundus are likely to be largely inflammatory in origin, most appear to be focused within and limited to the peripapillary vascularised fundus. However, the presence of peripapillary pathology should prompt a more extended examination of the peripheral fundus after induction of mydriasis. Most fundic lesions observed at PPE appear to be localised to a specific, and typically limited, area or areas of fundus, and as such are likely to be associated with a blind spot(s) defined by the area of pathology. These, in general, will have no significant effect of functional vision. However, local or generalised attenuation of peripapillary blood vessels, because of their intimate anatomic association with the retinal nerve fibre layer, is likely to indicate the presence of interrupted ganglion cell axonal traffic from photoreceptors within the retinal area roughly defined by the arc of the attenuated or absent vessels. The current working hypothesis is that this will result in a visual field deficit or loss. This is likely to cause significant impairment of functional vision in the affected eye, and potential purchasers should be informed of this.

Most fundic pathologies noted at PPE represent the subsequent healing of a single disruptive insult, and, where the eye is otherwise clinically normal, recurrence or progression of that pathology is highly unlikely in the normal course of events.

**Table 2: Ophthalmoscopic indicators of fundic disease**

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Reference(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loss or attenuation of the peripapillary retinal blood vessels</td>
<td>(Figs 85, 86 and 96)</td>
</tr>
<tr>
<td>Areas of pigment dispersal or loss, commonly but not invariably associated with focal, linear or reticular hyperpigmentation</td>
<td>(Figs 23 and 94)</td>
</tr>
<tr>
<td>White areas of scleral reflex (Figs 86 and 87)</td>
<td></td>
</tr>
<tr>
<td>Attenuation of choroidal blood vessels (Fig 87)</td>
<td></td>
</tr>
<tr>
<td>Linear or reticular pigmentation present in the tapetal fundus (Figs 94 and 95)</td>
<td></td>
</tr>
<tr>
<td>Retinal detachment (Fig 82)</td>
<td></td>
</tr>
<tr>
<td>Optic nerve atrophy (Fig 76)</td>
<td></td>
</tr>
</tbody>
</table>

Fig 81: Multiple small naevi in the tapetal fundus.

Fig 82: Retinal detachment. The detached, and in this case torn, retina hangs in the vitreal chamber and is attached at the optic disc, causing it to drape over the dorsal border of the optic disc.

Fig 83: Peripapillary chorioretinopathy ('butterfly' lesion).
In all instances of generalised fundic disease (Figs 23, 87, 91 and 94) or where retinal detachment (Fig 82) or optic nerve atrophy (Fig 96) is present, potential purchasers should be advised of significant visual impairment and the horse should not be recommended for purchase. Otherwise the fundic lesion(s) should be assessed on the basis of the above guidelines, and the potential purchaser advised accordingly.

Some of the more common fundic lesions encountered and their interpretation in relation to the PPE are:

**Peripapillary chorioretinopathy**

These are post inflammatory lesions, located typically in the medial and lateral circumpapillary fundus (‘Butterfly’ lesions; Fig 83). In some instances these lesions may be consequence of blunt trauma to the globe. Rarely there may be more extensive or confluent chorioretinal injury involving the entire peripapillary fundus (Figs 84 and 85), and choroidal or retinal vascular injury and attenuation may be evident (Figs 85–87). Where the lesion is geographically extensive, or where there is retinal or choroidal vascular attenuation (Figs 85–87), there is likely to be significant impairment of functional vision. Otherwise, potential purchasers should be informed of the presence of the lesion and that any functional impairment, if present at all, is likely to be minimal. Where the eye is
Focal chorioretinopathy

These are the small focal ‘bullet hole’ lesions found in some 80% of mature horses (Fig 88). They represent the result of historic generic chorioretinal insult, possibly in many cases a consequence of equine herpesvirus viraemia. Unusually the lesions are confluent or individually relatively large (Fig 89).

Figs 89: Focal chorioretinopathy showing (a) a single large isolated lesion and (b) locally confluent lesions.

Fig 89: Focal chorioretinopathy showing (a) a single large isolated lesion and (b) locally confluent lesions.

Fig 90: Focal chorioretinopathy showing an extensive confluent lesion.

Fig 90: Focal chorioretinopathy showing an extensive confluent lesion.

Fig 91: Focal chorioretinopathy. The lesions are widely and densely distributed across the non-tapetal fundus. Vision impairment is likely.

Fig 91: Focal chorioretinopathy. The lesions are widely and densely distributed across the non-tapetal fundus. Vision impairment is likely.

otherwise normal, these lesions are not an indicator of equine recurrent uveitis.

Focal chorioretinopathy

Figs 92: Focal chorioretinopathy. This linear and horizontal distribution in the circumpapillary or ventral peripapillary fundus is associated with behaviour problems suggestive of serious visual impairment in some affected horses.

Fig 92: Focal chorioretinopathy. This linear and horizontal distribution in the circumpapillary or ventral peripapillary fundus is associated with behaviour problems suggestive of serious visual impairment in some affected horses.

Fig 93: Pigmentary retinopathy in a 5-year-old pony.

Fig 93: Pigmentary retinopathy in a 5-year-old pony.
The lesions can be considered to be of no functional consequence, with two exceptions: where they are locally extensive (Fig 90) or densely and widely distributed across the entire pigmented fundus (Fig 91); or where they are distributed in a linear pattern across the circumpapillary or ventral peripapillary fundus (Fig 92). In the latter instance, and for unknown reasons, this particular distribution appears associated with behavioural issues suggestive of serious visual impairment in some affected horses.

**Pigmentary retinopathy**

Here there is a bilateral and generalised dispersal or dilution of fundic pigment along with irregular focal hyperpigmentation, including, critically, the appearance of pigment in the tapetal fundus.
fundus (Figs 93–95). Pigmentary retinopathy is observed in equine motor neurone disease, but is also found in otherwise normal horses, and the cause is unknown. There is some similarity to the appearance of senile retinopathy seen in all older horses. While affected horses typically show no behavioural signs indicative of visual impairment, it can be anticipated that retinal function must be significantly disrupted and affected horses should not be considered suitable for purchase.

Optic nerve atrophy
Unilateral optic nerve atrophy, with the typically pale, granular and nonvascularised optic disc, is seen occasionally in horses presented for PPE (Fig 96). Although blind in the affected eye these horses typically show no behavioural evidence of visual impairment. A common cause of optic nerve atrophy is a space occupying lesion in the area of the optic chiasm. In these cases, with expansion of the lesion there is the potential for the other eye to become blind. Horses with unilateral optic atrophy should not be considered suitable for purchase.

Proliferative optic neuropathy
These present as focal lobular, occasionally vascularised, lesions extending into the vitreal chamber from the periphery of the optic disc (Fig 97). These may represent a benign neoplastic process (oligodendrocytoma), or glial repair, and while presumed to be potentially progressive the majority do not enlarge from the point of initial diagnosis. The fundus is typically otherwise normal in affected eyes, and the lesions are not likely to be a cause of significant visual impairment.

Astrocytoma
This presents as a small, pale focal protrusion from the optic disc or vascular peripapillary fundus (Fig 98). This is a benign and incidental lesion and does not appear to progress from the point of initial diagnosis in the majority of cases.

Discussion
In all cases where ophthalmic anomaly or abnormality is encountered at PPE, the finding should be recorded precisely, using drawings or photographs in addition to a written description, in the contemporaneous notes of the examination. All subsequent reporting to the prospective purchaser should reflect the content of these notes. In addition to the information and advice given to the potential purchaser on the immediate issue of cause and effect of the ocular findings, a potential purchaser should be advised of two further implications of the findings. These are:

Insurance
The presence of any abnormality may have implications in regard to the insurability of the horse, and a potential purchaser should be advised to discuss the situation with a competent underwriter or agent.

Resale
Most abnormalities encountered, while not likely to progress, will be present throughout the lifetime of the horse, and potential purchasers should be advised that the abnormality will be identified on any subsequent competent PPE, and may affect resale.

Author’s declaration of interests
No conflicts of interest have been declared.

Ethical animal research
All images were taken with permission from the owners.

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