OCULAR DISORDERS REPORT

AUSTRALIAN SHEPHERD

	DISORDER	INHERITANCE	REFERENCE	BREEDING ADVICE
A.	Microphthalmia with multiple ocular defects	Presumed autosomal recessive with incomplete penetrance	1-6	NO
B.	Distichiasis	Not defined	1, 7	Breeder option
C.	Corneal dystrophy - epithelial/stromal	Not defined	8	Breeder option
D.	Iris coloboma	Not defined	1	NO
E.	Iris hypoplasia	Not defined	9	Breeder option
F.	Persistent pupillary membranes - iris to iris - all other forms	 Not defined Not defined	 1 1, 8	 Breeder option NO
G.	Cataract * a DNA test is available	Autosomal co-dominant	1, 10, 11	NO
H.	Vitreous degeneration	Not defined	21	Breeder option
I.	Persistent hyaloid artery	Not defined		Breeder option
J.	Retinal atrophy - generalized (*prcd*) * a DNA test is available	Autosomal recessive	1, 9, 12, 13	NO
K.	Cone degeneration - day blindness * a DNA test is available	Autosomal recessive	14	NO

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	DISORDER	INHERITANCE	REFERENCE	BREEDING ADVICE
L.	Multifocal retinopathy - cmr1 * a DNA test is available	Autosomal recessive	15	Breeder option
M.	Retinal dysplasia - folds	Not defined	8	Breeder option
N.	Choroidal hypoplasia (Collie Eye Anomaly) - optic nerve coloboma - retinal detachment - retinal hemorrhage - staphyloma/coloboma * a DNA test is available	Autosomal recessive	1, 7, 16-19	NO
O.	Coloboma/staphyloma without microphthalmia	Not defined	1	NO
P.	Micropapilla	Not defined	20	Breeder option

It is recommended that this breed be examined prior to pharmacological dilation to best facilitate identification of iris coloboma.

Description and Comments

A. Microphthalmia with multiple ocular defects

Microphthalmia is a congenital defect characterized by a small eye with associated defects of the cornea, iris (coloboma), anterior chamber, lens (cataract) and/or retina (dysplasia). In the Australian Shepherd, microphthalmia has long been suspected to be associated with merle coat coloration but a definitive genetic relationship has not been established. The eyes of affected homozygous merle (usually white) dogs have extreme forms of this entity and are usually blind at birth. Affected heterozygous merle-coated dogs demonstrate less severe manifestations.

B. Distichiasis

Eyelashes abnormally located on the eyelid margin which may cause ocular irritation. Distichiasis may occur at any time in the life of a dog. It is difficult to make a strong recommendation with regard to breeding dogs with this entity. The hereditary basis has not been established although it seems probable due to the high incidence in some breeds. Reducing the incidence is a logical goal. When diagnosed, distichiasis should be recorded; breeding discretion is advised.

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C. Corneal Dystrophy - epithelial/stromal

A non-inflammatory corneal opacity (white to gray) present in one or more of the corneal layers; usually inherited and bilateral.

D. Iris coloboma

A congenital abnormality in iris development usually characterized by a full-thickness defect in iris tissue, commonly (though not exclusively) located at the 6 o'clock position associated with failure of closure of the optic fissure. A partial-thickness defect in iris tissue should be recorded as iris hypoplasia on the OFA form.

E. Iris hypoplasia

A congenital abnormality in iris development usually characterized by a reduced quantity of tissue identified as a partial-thickness defect in iris tissue. Full-thickness iris hypoplasia is rare and should be recorded as an iris coloboma on the OFA form.

F. Persistent pupillary membranes (PPMs)

Persistent blood vessel remnants in the anterior chamber of the eye which fail to regress normally by 3 months of age. These strands may bridge from iris to iris, iris to cornea, iris to lens, or form sheets of tissue in the anterior chamber. The last three forms pose the greatest threat to vision and when severe, vision impairment or blindness may occur.

G. Cataract

A partial or complete opacity of the lens and/or its capsule. In cases where cataracts are complete and affect both eyes, blindness results. The prudent approach is to assume cataracts to be hereditary except in cases known to be associated with trauma, other causes of ocular inflammation, specific metabolic diseases, persistent pupillary membrane, persistent hyaloid, or nutritional deficiencies. Cataracts may involve the lens completely (diffuse) or in a localized region.

In the Australian Shepherd, a mutation in *HSF4* (heat shock transcription factor 4), the HSF4-2 mutation, has been shown to increase the likelihood of cataract formation. The mutation is inherited in a co-dominant manner. Dogs with one copy of the mutation develop bilateral posterior cataracts and homozygotes develop a nuclear cataract that typically progresses to a mature cataract. A DNA test is available for this mutation. Other genetic factors can contribute to cataract formation in this breed and will not be detected by this test.

H. Vitreous degeneration

A liquefaction of the vitreous gel which may predispose to retinal detachment.

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I. Persistent hyaloid artery (PHA)

Congenital defect resulting from abnormalities in the development and regression of the hyaloid artery. The blood vessel remnant can be present in the vitreous as a small patent vascular strand (PHA) or as a non-vascular strand that appears gray-white (persistent hyaloid remnant).

J. Retinal atrophy - generalized (*prcd*)

A degenerative disease of the retinal visual cells which progresses to blindness. This abnormality, also known as progressive retinal atrophy or PRA, may be detected by electroretinogram (not part of a routine eye screening examination) before it is apparent clinically. With limited exceptions, most PRAs are recessively inherited.

Studies have shown that the principal form of PRA in the Australian Shepherd is *prcd* which is a late-onset form of PRA inherited as autosomal recessive. The mutation is allelic to that present in Miniature Poodles, Labrador Retrievers, English and American Cocker Spaniels, and others. The locus is termed the progressive rod-cone degeneration (*prcd*) gene and at least 30+ breeds are affected. In most affected dogs to date, the disease is recognized clinically in dogs 3-6 years of age or older. This photoreceptor degeneration is characterized by slow death of visual cells following their normal development. The disease begins clinically with signs of night blindness followed by day blindness. A DNA test is available.

K. Cone degeneration - day blindness or hemeralopia

Autosomal recessively inherited early degeneration of the cone photoreceptors. Affected puppies develop day-blindness, color blindness, and photophobia between 8 and 12 weeks of age. Affected dogs remain ophthalmoscopically normal their entire life. Electroretinography is required to definitively diagnose the disorder. Genetically, the condition results from a mutation in the *CNGB3* gene. A DNA test is available.

L. Multifocal retinopathy

Canine Multi-focal Retinopathy type 1 (cmr1) is characterized by numerous distinct (i.e. multi-focal), roughly circular patches of elevated retina (multifocal bullous retinal detachments). There may be a serous subretinal fluid, or accumulation of subretinal material that produces gray-tan-pink colored lesions. These lesions, looking somewhat like blisters, vary in location and size, although typically they are present in both eyes of the affected dog.

The disease generally develops in young dogs between 11-20 weeks of age and there is minimal progression after 1 year of age. The lesions may flatten, leaving areas of retinal thinning and RPE hypertrophy, hyperplasia, and pigmentation. Discrete areas of tapetal hyper-reflectivity may be seen in areas of previous retinal and RPE detachments. Most dogs exhibit no noticeable problem with vision or electroretinographic abnormalities despite their abnormal appearing retinas.

Canine Multi-focal Retinopathy type 1 is caused by a mutation in the Bestrophin 1 gene (*BEST1*) and is described to be recessively inherited in the Great Pyrenees, Dogue de Bordeaux, Bullmastiff, and Mastiff.

M. Retinal dysplasia - folds

Linear, triangular, curved or curvilinear foci of retinal folding that may be single or multiple. When seen in puppies, this condition may partially or completely resolve with maturity. Its significance to vision is unknown. There are two other forms of retinal dysplasia (geographic, detached) which are known to be inherited in other breeds and, in their most severe form, cause blindness. The genetic relationship between folds and more severe forms of retinal dysplasia is undetermined.

N. Choroidal hypoplasia (Collie Eye Anomaly)
- staphyloma/coloboma
- retinal detachment
- retinal hemorrhage
- optic nerve coloboma

A spectrum of malformations present at birth and ranging from inadequate development of the choroid (choroidal hypoplasia) to defects of the choroid, sclera, and/or optic nerve (coloboma/staphyloma) to complete retinal detachment (with or without hemorrhage). Mildly affected animals will have no detectable vision deficit.

This disorder is collectively referred to as "Collie Eye Anomaly." The choroidal hypoplasia component is caused by a 7799 base pair deletion with the gene *NHEJ1*. The mutation is a recessive trait. A DNA test is available and is diagnostic only for the choroidal hypoplasia component of CEA. For colobomas to develop, an additional mutation in a second gene has to be present; that gene is still unknown.

O. Coloboma/staphyloma (unassociated with microphthalmia)

A coloboma is a congenital defect which may affect the iris, choroid or optic disc. Iris colobomas are seen as notches in the pupillary margin. Scleral ectasia is defined as a congenital thinning and secondary distention of the sclera; when lined by uveal tissue it is called a staphyloma. These may be anteriorly located, apparent as a bulge beneath the upper eyelid or posteriorly located, requiring visualization with an ophthalmoscope. These conditions may or may not be genetically related to the same anomalies seen associated with microphthalmia (entity "A" above).

P. Micropapilla

Micropapilla refers to a small optic disc which is not associated with vision impairment.

Optic nerve hypoplasia refers to a congenital defect of the optic nerve which causes blindness and abnormal pupil response in the affected eye. It may be difficult to differentiate between micropapilla and optic nerve hypoplasia on a routine (dilated) screening ophthalmoscopic exam.

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Diagnostic Name	TOTAL DOGS EXAMINED	1991-1999 26846 #	%	2000-2009 44675 #	%	2010-2016 29626 #	%
GLOBE							
0.110	microphthalmia	42	0.2%	36	0.1%	15	0.1%
10.000	glaucoma	6	0.0%	2	0.0%	0	
EYELIDS							
20.110	eyelid dermoid	1	0.0%	0		0	
20.140	ectopic cilia	1	0.0%	4	0.0%	0	
20.160	macropalpebral fissure	0		3	0.0%	1	0.0%
21.000	entropion, unspecified	2	0.0%	6	0.0%	8	0.0%
22.000	ectropion, unspecified	2	0.0%	3	0.0%	1	0.0%
25.110	distichiasis	410	1.5%	726	1.6%	501	1.7%
NASOLACRIMAL							
32.110	imperforate lower nasolacrimal punctum	2	0.0%	0		4	0.0%
40.910	keratoconjunctivitis sicca	0		0		1	0.0%
NICTITANS							
51.100	third eyelid cartilage anomaly	2	0.0%	1	0.0%	1	0.0%
52.110	prolapsed gland of the third eyelid	0		1	0.0%	1	0.0%
CORNEA							
70.210	corneal pannus	5	0.0%	1	0.0%	3	0.0%
70.220	pigmentary keratitis	0		1	0.0%	0	
70.700	corneal dystrophy	123	0.5%	156	0.3%	214	0.7%
70.730	corneal endothelial degeneration	6	0.0%	6	0.0%	2	0.0%
UVEA							
93.110	iris hypoplasia	0		63	0.1%	177	0.6%
93.140	corneal endothelial pigment without PPM	0		1	0.0%	0	
93.150	iris coloboma	402	1.5%	697	1.6%	375	1.3%
93.710	persistent pupillary membranes, iris to iris	679	2.5%	2164	4.8%	2123	7.2%
93.720	persistent pupillary membranes, iris to lens	27	0.1%	36	0.1%	27	0.1%
93.730	persistent pupillary membranes, iris to cornea	17	0.1%	20	0.0%	6	0.0%
93.740	persistent pupillary membranes, iris sheets	50	0.2%	42	0.1%	0	
93.750	persistent pupillary membranes, lens pigment foci/no strands	0		2	0.0%	26	0.1%
93.760	persistent pupillary membranes, endothelial opacity/no strands	0		5	0.0%	17	0.1%
93.810	uveal melanoma	0		2	0.0%	6	0.0%
93.999	uveal cysts	9	0.0%	19	0.0%	14	0.0%
97.150	chorioretinal coloboma, congenital	0		0		20	0.1%
LENS							
100.200	cataract, unspecified	169	0.6%	0		0	
100.210	cataract, suspect not inherited	495	1.8%	1249	2.8%	639	2.2%
100.301	punctate cataract, anterior cortex	66	0.2%	95	0.2%	67	0.2%
100.302	punctate cataract, posterior cortex	111	0.4%	158	0.4%	61	0.2%
100.303	punctate cataract, equatorial cortex	34	0.1%	38	0.1%	12	0.0%
100.304	punctate cataract, anterior sutures	4	0.0%	19	0.0%	8	0.0%
100.305	punctate cataract, posterior sutures	55	0.2%	98	0.2%	64	0.2%
100.306	punctate cataract, nucleus	35	0.1%	73	0.2%	53	0.2%
100.307	punctate cataract, capsular	5	0.0%	58	0.1%	30	0.1%

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LENS CONTINUED		1991-1999		2000-2009		2010-2016	
100.311	incipient cataract, anterior cortex	92	0.3%	142	0.3%	79	0.3%
100.312	incipient cataract, posterior cortex	211	0.8%	380	0.9%	164	0.6%
100.313	incipient cataract, equatorial cortex	60	0.2%	90	0.2%	44	0.1%
100.314	incipient cataract, anterior sutures	3	0.0%	17	0.0%	4	0.0%
100.315	incipient cataract, posterior sutures	54	0.2%	76	0.2%	27	0.1%
100.316	incipient cataract, nucleus	49	0.2%	120	0.3%	36	0.1%
100.317	incipient cataract, capsular	7	0.0%	73	0.2%	30	0.1%
100.321	incomplete cataract, anterior cortex	0		0		8	0.0%
100.322	incomplete cataract, posterior cortex	0		0		22	0.1%
100.323	incomplete cataract, equatorial cortex	0		0		5	0.0%
100.325	incomplete cataract, posterior sutures	0		0		2	0.0%
100.326	incomplete cataract, nucleus	0		0		7	0.0%
100.327	incomplete cataract, capsular	0		0		1	0.0%
100.330	generalized/complete cataract	94	0.4%	110	0.2%	29	0.1%
100.340	resorbing/hypermature cataract	0		0		1	0.0%
100.375	subluxation/luxation, unspecified	2	0.0%	12	0.0%	4	0.0%
100.999	*significant cataracts (summary)*	*1049*	*3.9%*	*1547*	*3.5%*	*754*	*2.5%*
VITREOUS							
110.120	persistent hyaloid artery/remnant	213	0.8%	195	0.4%	114	0.4%
110.135	PHPV/PTVL	24	0.1%	45	0.1%	41	0.1%
110.320	vitreal degeneration	50	0.2%	132	0.3%	82	0.3%
FUNDUS							
97.110	choroidal hypoplasia	46	0.2%	50	0.1%	64	0.2%
97.120	coloboma	44	0.2%	44	0.1%	8	0.0%
RETINA							
120.170	retinal dysplasia, folds	191	0.7%	421	0.9%	371	1.3%
120.180	retinal dysplasia, geographic	18	0.1%	16	0.0%	11	0.0%
120.190	retinal dysplasia, detached	3	0.0%	1	0.0%	5	0.0%
120.310	generalized progressive retinal atrophy (PRA)	47	0.2%	73	0.2%	14	0.0%
120.400	retinal hemorrhage	10	0.0%	3	0.0%	0	
120.910	retinal detachment without dialysis	31	0.1%	24	0.1%	6	0.0%
120.920	retinal detachment with dialysis	0		0		12	0.0%
120.960	retinopathy	0		0		9	0.0%
OPTIC NERVE							
130.110	micropapilla	8	0.0%	90	0.2%	125	0.4%
130.120	optic nerve hypoplasia	71	0.3%	32	0.1%	18	0.1%
130.150	optic disc coloboma	64	0.2%	49	0.1%	46	0.2%
OTHER							
900.000	other, unspecified	0		148	0.3%	397	1.3%
900.100	other, not inherited	70	0.3%	1173	2.6%	401	1.4%
900.110	other, suspected as inherited	153	0.6%	96	0.2%	30	0.1%
NORMAL							
0.000	normal globe	23562	87.8%	39799	89.1%	24957	84.2%