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Diseases of wild birds of the orders Passeriformes and Columbiformes - a review of conditions reported from the United Kingdom and an analysis of results from wild bird disease surveillance in Scotland 1994-2013

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References and Appendices

Images of pathological lesions, parasites and parasite eggs from wild birds of the orders Passeriformes and Columbiformes are provided on the CD in the pocket on the inside back cover of the references/appendices volume, and on-line at http://datashare.is.ed.ac.uk/

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Appendix I: Latin names of birds found in Britain and discussed in thesis (including appendices)

The common names and Latin names of the birds discussed in the thesis and appendices follow the recommendations of the British Ornithologists' Union as updated by Harrop et al. (2013) and as used in the Breeding and Wintering Bird Atlas 2007-2011 (Balmer et al., 2013).

Species of bird	**Latin name**
Auk, little	*Alle alle*
Blackbird	*Turdus merula*
Blackcap	*Sylvia atricapilla*
Brambling	*Fringilla montifringilla*
Bullfinch	*Pyrrhula pyrrhula*
Bunting, cirl	*Emberiza cirlus*
Bunting, reed	*Emberiza schoeniclus*
Buzzard	*Buteo buteo*
Chaffinch	*Fringilla coelebs*
Chiffchaff	*Phylloscopus collybita*
Chough	*Pyrrhocorax pyrrhocorax*
Coot	*Fulica atra*
Cormorant	*Phalacrocorax carbo*
Crossbill species	*Loxia species*
Crow, carrion	*Corvus corone*
Crow, hooded	*Corvus cornix*
Dipper	*Cinclus cinclus*
Diver, red-throated	*Gavia stellata*
Dove, collared	*Streptopelia decaocto*
Dove, rock	*Columba livia*
Dove, stock	*Columba oenas*

Appendix I. Latin names of birds.

Species of bird	**Latin name**
Dove, turtle	*Streptopelia turtur*
Duck, tufted	*Aythya fuligula*
Dunlin	*Calidris alpina*
Dunnock	*Prunella modularis*
Eagle, golden	*Aquila chrysaetos*
Eider	*Somateria mollissima*
Fieldfare	*Turdus pilaris*
Fulmar	*Fulmarus glacialis*
Gannet	*Morus bassanus*
Goldcrest	*Regulus regulus*
Goldeneye	*Bucephala clangula*
Goldfinch	*Carduelis carduelis*
Goose, Canada	*Branta canadensis*
Goose, greylag	*Anser anser*
Grebe, great crested	*Podiceps cristatus*
Greenfinch	*Chloris chloris*
Grouse, black	*Tetrao tetrix*
Guillemot	*Uria aalge*
Guillemot, black	*Cepphus grylle*
Gull, black-headed	*Chroicocephalus ridibundus*
Gull, common	*Larus canus*
Gull, great black-backed	*Larus marinus*
Gull, herring	*Larus argentatus*
Gull, ivory	*Pagophila eburnea*
Gull, lesser black-backed	*Larus fuscus*
Harrier, hen	*Circus cyaneus*
Heron, grey	*Ardea cinerea*
Jackdaw	*Corvus monedula*
Jay	*Garrulus glandarius*
Kestrel	*Falco tinnunculus*

Appendix I. Latin names of birds.

Species of bird	**Latin name**
Kingfisher	*Alcedo atthis*
Kite, red	*Milvus milvus*
Kittiwake	*Rissa tridactyla*
Lapwing	*Vanellus vanellus*
Magpie	*Pica pica*
Mallard	*Anas platyrhynchos*
Martin, house	*Delichon urbicum*
Martin, sand	*Riparia riparia*
Merganser, red-breasted	*Mergus serrator*
Merlin	*Falco columbarius*
Moorhen	*Gallinula chloropus*
Nuthatch	*Sitta europaea*
Owl, barn	*Tyto alba*
Owl, eagle (feral)	*Bubo bubo*
Owl, little	*Athene noctua*
Owl, long-eared	*Asio otus*
Owl, short-eared	*Asio flammeus*
Owl, tawny	*Strix aluco*
Oystercatcher	*Haematopus ostralegus*
Peregrine	*Falco peregrinus*
Pigeon, feral	*Columba livia*
Pipit, meadow	*Anthus pratensis*
Pochard	*Aythya ferina*
Puffin	*Fratercula arctica*
Raven	*Corvus corax*
Razorbill	*Alca torda*
Redpoll, lesser	*Carduelis cabaret*
Redshank	*Tringa totanus*
Redwing	*Turdus iliacus*
Robin	*Erithacus rubecula*

Appendix I. Latin names of birds.

Species of bird	**Latin name**
Rook	*Corvus frugilegus*
Scaup	*Aythya marila*
Scoter, common	*Melanitta nigra*
Skylark	*Alauda arvensis*
Shag	*Phalacrocorax aristotelis*
Shearwater, Manx	*Puffinus puffinus*
Shelduck	*Tadorna tadorna*
Siskin	*Carduelis spinus*
Snipe	*Gallinago gallinago*
Snipe, Jack	*Lymnocryptes minimus*
Sparrow, house	*Passer domesticus*
Sparrow, tree	*Passer montanus*
Sparrowhawk	*Accipiter nisus*
Starling	*Sturnus vulgaris*
Swallow	*Hirundo rustica*
Swan, mute	*Cygnus olor*
Swan, whooper	*Cygnus cygnus*
Swift	*Apus apus*
Thrush, song	*Turdus philomelos*
Tit, blue	*Cyanistes caeruleus*
Tit, coal	*Periparus ater*
Tit, great	*Parus major*
Tit, long-tailed	*Aegithalos caudatus*
Treecreeper	*Certhia familiaris*
Turnstone	*Arenaria interpres*
Warbler, reed	*Acrocephalus scirpaceus*
Warbler, sedge	*Acrocephalus schoenobaenus*
Warbler, willow	*Phylloscopus trochilus*
Wagtail, grey	*Motacilla cinerea*
Wagtail, pied	*Motacilla alba*

Appendix I. Latin names of birds.

Species of bird	**Latin name**
Waxwing	*Bombycilla garrulus*
Whitethroat	*Sylvia communis*
Whitethroat, lesser	*Sylvia curruca*
Woodcock	*Scolopax rusticola*
Woodpecker, great spotted	*Dendrocopus major*
Woodpigeon	*Columba palumbus*
Wren	*Troglodytes troglodytes*
Yellowhammer	*Emberiza citrinella*

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Appendix II: Diagnostic criteria used for carcases of the Orders Passeriformes and Columbiformes

Diagnosis	Diagnostic criteria
Adverse environmental conditions	Supporting history e.g. found during heavy snow, ice or rain, found trapped in building, nest destroyed. No other primary cause of death detected.
Arthritis, cellulitis, myositis, pododermatitis	Gross swelling of one or more joints, inflammatory debris beneath skin or within foot web, or evidence of muscle damage e.g. caseous tracks. Often in combination. Excludes cellulitis as an extension of trichomonosis or salmonellosis. May be sterile, may be associated with a range of organisms including *Staphylococcus aureus*, *Escherichia coli*, *Pasteurella multocida*, *Candida albicans*, *Salmonella* Typhimurium, *Yersinia pseudotuberculosis*.
Avian tuberculosis	Gross lesions, usually granulomatous, plus demonstration of acid-alcohol-fast bacilli typical of *Mycobacterium species*. Presumed to be *Mycobacterium avium avium.*
Beak deformity	Gross deformity of beak.
Candidiasis	Isolation of *Candida albicans* in association with an accumulation of white inflammatory debris on the mucosa of the oropharynx, oesophagus, crop, sinus, proventriculus etc.
Chlamydiosis/chlamydiasis	Demonstration of *Chlamydia psittaci* by PCR or immunohistochemistry. Pathological significance may be unclear, hence the term chlamydiosis / chlamydiasis.
Circovirus infection	Histological demonstration of botryoid inclusions in bursa of Fabricius.
Cnemidocoptic mange	Gross lesions (scab formation on feet, shanks or hocks), plus demonstration of cnemidocoptic mites on microscopy.
CNS condition NOS (not otherwise specified)	Histopathological evidence of mycotic or bacterial encephalitis, hydrocephalus etc. Excludes Fledgling CNS of starlings and house sparrows, PPMV-1 in pigeons, and CNS abnormalities associated with eye problems in young choughs.
Coccidiosis	Pathology of the intestine (e.g. haemorrhage, thickening, necrosis, abnormal contents) associated with large numbers of coccidial oocysts. Includes isosporoid coccidia and *Eimeria* spp.

Appendix II. Diagnostic criteria.

Diagnosis	Diagnostic criteria
Corvid respiratory syndrome	One or more of the following pathological features in corvids:- airsacculitis; tracheitis; pneumonia/pleurisy; sinusitis. Excludes a diagnosis of avian tuberculosis, mycotic pneumonia/airsacculitis or significant *Syngamus* burdens. May be concurrent chlamydiosis / chlamydiasis, mycoplasmosis or pasteurellosis. Lesions associated with large clusters of Gram-negative bacilli or coccobacilli on histopathology.
Cutaneous papilloma	Rough irregular mass on the toes and lower legs, sometimes completely enclosing the toes, of chaffinches or bramblings. Gross appearance sufficient, histopathology not required but KOH preparations may be examined to exclude concurrent mites.
Digestive tract condition NOS (not otherwise specified)	Gross or histological lesions in the digestive tract and liver, excluding specific conditions such as necrotic enteritis, parasites of the digestive tract etc. Includes the result of inappropriate food, e.g. impaction by peas, peanuts, bones, fibre.
E. albertii bacteraemia.	Recovery from finches of heavy growths (from both liver and intestine) of non-lactose fermenting *E. albertii* with the API profile of 4144102 or 5144102, in the absence of evidence of other causes of death such as trauma and trichomonosis. If similar organisms recovered from non-finch species, further confirmation required by serotyping at SAC VS Inverness.
E. albertii (incidental)	Recovery from finches of heavy growths of non-lactose fermenting *E. albertii* with the API profile of 4144102 or 5144102, but only from one organ or if there is evidence of other causes of death such as trauma and trichomonosis. If similar organisms recovered from non-finch species, further confirmation required by serotyping at SAC VS Inverness.
E. albertii incident	A new "incident" of *E. albertii* mortality was recorded if there had been at least three months since any reports of sick or dead finches at that site, or if noted, the cause of death was not *E. albertii* bacteraemia.
E. coli septicaemia	Isolation of heavy pure or nearly pure growths of *E. coli* (not *E. albertii*) from at least one organ other than intestine, in the absence of other primary causes of death such as trichomonosis and trauma. Must be other gross lesions e.g. pericarditis, serositis, splenomegaly, perihepatitis. Often secondary to another, sometimes unidentified, condition.

Appendix II. Diagnostic criteria.

Diagnosis	Diagnostic criteria
Eye problems	Includes corneal opacity and associated problems in young choughs, developmental abnormalities in other species, and hypopyon.
Feather/skin abnormality NOS (not otherwise specified)	Abnormalities of the feathers or skin, including foot lesions but excluding abnormalities caused by trauma, oiling, pox or external parasites.
Fledgling CNS	History of central nervous signs such as circling and torticollis in fledgling starlings and house sparrows. If histopathology carried out, a non-suppurative encephalitis is present. Aetiology uncertain.
Foreign body	Presence of a foreign body in the digestive tract that is causing a significant problem, excluding inappropriate food.
Inclusion body hepatitis	Histological demonstration of basophilic or eosinophilic intranuclear inclusion bodies in hepatocytes.
Kidney disorder	Pale kidneys and/or urate deposits on heart, liver, peritoneum, subcutaneous tissues or joints.
Malnourished nestling / fledgling corvids	Immature corvids in poor body condition, often with poor feathering and soft bones/leg deformities. May be concurrent internal or external parasites, terminal trauma etc. Usually because corvids hatch in an asynchronous fashion, and the last bird to hatch may receive less food, especially in years of limited food supply.
Megabacteriosis	Demonstration of avian gastric yeasts *Macrorhabdus ornithogaster* ("megabacteria") in wet preparations or histopathology sections from the proventriculus. Pathological significance often unclear.
Metabolic bone disease	Immature birds. Bones of legs soft and pliable. Sometimes also bones of skull, ribs etc. Excludes malnourished nestling/fledgling corvids.
Mycotic pneumonia / airsacculitis	Gross lesions (e.g. granulomata in lungs, plaques on airsacs), and culture of pathogenic fungi or demonstration of fungal elements on histopathology.
Necrotic enteritis	Focal or diffuse diphtheritic necrosis of the small intestine associated with *Clostridium perfringens*.
Neoplasia	Gross lesions and histopathology.

Appendix II. Diagnostic criteria.

Diagnosis	Diagnostic criteria
No diagnosis	• May be advanced autolysis. • Sometimes a possible diagnosis has been made but the diagnostic criteria were not fulfilled. • May be no lesions detected, or no explanation for the lesions found. • Often thin birds that have not been feeding, and an underlying undetected injury may be present. • Or birds dying suddenly in good condition, and an underlying undetected trauma or poisoning is suspected. • Includes young birds found "orphaned" by the general public, which then die, with no other diagnosis made. • Includes pigeons in which PPMV-1 is suspected but not confirmed. • Includes other birds with CNS signs, for which no cause was established.
Pasteurella multocida infection	Isolation of heavy growths of *Pasteurella multocida* from viscera including joints. May also be gross lesions e.g. punctures, cellulitis. May also be history of cat predation.
Poisoning	Demonstration of significant residues of toxic substances (not lead, not oil) in tissues, e.g. carbamates, alphachloralose, strychnine.
Pox (presumed or confirmed)	Typical gross lesions e.g. nodules on feet, around eyes, on skin. May be confirmed by histopathology or demonstration of virus by EM.
PPMV-1 (Pigeon paramyxovirus-1) infection	Significant titres to PPMV-1 (haemagglutination inhibition test titres of 2^4 and above) or isolation of PPMV-1 virus.
Reproductive tract disorder	Adult female birds with lesions including salpingitis, impacted oviduct, smearing of abdomen with yolk material, prolapsed cloaca.
Respiratory tract condition NOS (not otherwise specified)	Gross or histological lesions in the respiratory tract, excluding conditions such as mycotic pneumonia, avian tuberculosis, corvid respiratory syndrome, respiratory tract parasites.
Salmonellosis	Isolation of *Salmonella* species from at least one organ/tissue on direct culture.
Salmonellosis (incident)	A new "incident" of salmonellosis was recorded if there had been at least three months since any reports of sick or dead finches at that site, or if noted, the cause of death was not salmonellosis.

Appendix II. Diagnostic criteria.

Diagnosis	Diagnostic criteria
Salmonellosis (presumed)	If there was an ongoing confirmed incident of salmonellosis, with multiple recent isolations of *Salmonella* from other carcases from this site, and typical gross lesions were present, a presumptive diagnosis of salmonellosis was occasionally made without bacteriology. Only used prior to the emergence of finch trichomonosis.
Significant ectoparasites	Large numbers of mites or lice. Excludes cnemidocoptic mites (scaly leg).
Significant helminthosis	Burdens of internal parasites (single or mixed species) considered sufficiently high to have adversely affected the health of the bird. Based on gross pathology or histopathology, including detection of the helminths or their eggs. May be other concurrent diagnoses, e.g. adverse environmental conditions, coccidiosis, significant ectoparasites, trauma.
Skeletal abnormality NOS (not otherwise specified)	Scoliosis, twisted limbs etc. Excludes metabolic bone disease and malnourished nestlings/fledglings.
Spironucleosis	Demonstration of motile protozoa with the morphology of *Spironucleus* sp. in wet preparations from intestine.
Staphylococcus aureus infection	Presence of lesions associated with *Staphylococcus aureus*.
Suttonella ornithocola infection	Isolation of the organism, with or without lesions.
Trauma	Gross evidence of trauma, e.g. internal haemorrhage, fractures, punctures. Diagnosis also accepted if firm history of trauma (e.g. window collision observed), even if no gross lesions detected.
Trichomonosis (presumed or confirmed)	Thickening and necrosis of oropharynx, oesophagus or crop of columbiforms. Thickening of oesophagus or crop of garden birds (finches, sparrows, blackbirds, tits), often with necrosis, sometimes with additional oropharyngeal lesions. Confirmatory evidence (e.g. histopathology, demonstration of motile protozoa, PCR) not required. In garden birds, *Salmonella* spp. not isolated on direct culture.
Trichomonosis (incident)	A new "incident" of trichomonosis was recorded if there had been at least three months since any reports of sick or dead finches at that site, or if noted, the cause of death was not trichomonosis.
Yersinia pseudotuberculosis infection	Isolation of organism from viscera (excluding intestine). Usually focal lesions in one or more organs.

Appendix III: Presumptive identification of internal parasites from wild birds of the Orders Passeriformes and Columbiformes

Some of the internal parasites and/or their eggs that were encountered during this study are described in this appendix. Where appropriate, presumptive identification of the parasites is given. However, this is not a detailed description of the parasites, but rather a basic introductory guide to help non-parasitologists identify the commonest internal parasites to group or genus level. Measurements below are expressed as mean ± 2 standard deviations. Images, where indicated, are in Appendix X. It is hoped that the descriptions in this appendix can be expanded in future years.

Descriptive terms used

Spherical – all dimensions equal or nearly equal.

Sub-spherical – nearly spherical.

Ellipsoid – like a stretched-out circle.

Elongate ellipsoid – ellipsoid where length is more than three times the width.

Ovoid – blunt end and sharp end readily recognised.

Pyriform – pear-shaped, with blunt end considerably larger than sharp end.

Chapter 3 – finches, sparrows, buntings, dunnocks and tits

Syngamid worms from trachea of house sparrows

- White or reddish worms, circular in cross-section, large female and small male joined together to form a Y-shape. 1 mm in diameter, around 6-8 mm long.
- Fresh adult females may have a "barber-pole" appearance caused by the red digestive tract and white undulating reproductive tract.
- Presumptive identification as *Syngamus* sp., most likely *Syngamus trachea* (see 3.2.10 in thesis).
- Eggs ellipsoid, clear/colourless with a dark morula of 8-16 blastomeres and a thick smooth shell. Operculum at both poles. Images 15a-16b.
- 35 eggs from two house sparrows:
  - length 91 µm ± 7 µm
  - width 45 µm ± 3 µm

Hairworms from digestive tract of dunnocks

- Long thin worms barely visible to the naked eye, usually seen on microscopy of smears from oesophagus or intestine.
- Typical hairworm eggs (see below) seen in adult female worms.
- Presumptive identification of worms in the upper digestive tract as *Eucoleus* sp., and worms in lower digestive tract as *Capillaria / Baruscapillaria* sp., but some debate about nomenclature and described generically in thesis as "hairworms".
- Eggs brown or golden in colour, ellipsoid, with distinctive bipolar plugs that sometimes protrude. Images 38a-38c.
- 20 hairworm eggs from two dunnocks measured:
  - length 60 µm ± 10 µm
  - width 26 µm ± 3 µm

Schistosome-like eggs from intestinal contents of dunnocks and house sparrow

- Unidentified eggs, described in the thesis as schistosome-like eggs, were detected in the intestinal mucosa and/or contents of dunnocks, and the intestinal contents of a house sparrow. Also detected in intestinal contents of blackbirds.
- Their identity is discussed more fully in sections 3.3.9, 8.3.9 and 8.4.3 of the thesis.
- Eggs spherical, sub-spherical or ellipsoid, with thin smooth outer membrane. Dark granular contents that may fill the egg, or may be retracted to produce a spherical or ellipsoid mass with a clear space between the contents and the outer membrane. Images 23-32 (dunnocks) and images 33-36 (house sparrow).
- May be found within the mucosa of the intestine, sometimes in large numbers. Image 22.
- Variable in size. The figures below are expressed as mean and range, rather than mean ± 2 standard deviations, because the dimensions did not form a normal distribution. Instead, there appeared to be two sub-populations. For the purposes of the images in Appendix X, those 75 µm and above are described as "larger form", and those less than 75 µm are described as "smaller form".
    - Mean length 75 µm (range 54-105) and width 68 µm (range 53-97) (110 eggs from three dunnocks).
    - Mean length 75 µm (range 61-110) and width 68 µm (range 52-99) (38 eggs from one house sparrow).

Coccidial oocysts from intestine of finches and sparrows

- Unsporulated oocysts are spherical/sub-spherical, thick walled, sometimes containing a contracted spherical sporont. Images 17-19.
    - 20 oocysts from one house sparrow: spherical/sub-spherical oocyst, length 26 µm ± 3 µm and width 24 µm ± 3 µm.
    - 27 oocysts (smaller form) from two chaffinches: spherical/sub-spherical oocyst, length 23 µm ± 3 µm and width 21 µm ± 4 µm. Images 17a-17c.

  - 33 oocysts (larger form) from two chaffinches: spherical/sub-spherical oocyst, length 27 µm ± 2 µm and width 25 µm ± 3 µm. Images 18a-18c.
- On the few occasions that sporulation was carried out, two sporocysts were present. Image 20.
- Described as isosporoid coccidia (see 3.2.9 in thesis). Probably several different species, possibly even within the same host.

Trichomonas sp. in upper digestive tract of finches

- Motile protozoa that are difficult to detect microscopically unless they are actively moving. The greater the time interval between the death or euthanasia of the bird and microscopic examination of the material, the greater the likelihood that the organisms will stop moving and not be detected.
- Round, pyriform or crescent-shaped. Measure approximately 5-20 µm by 2-10 µm (about the same size as an avian red blood cell).
- Have a prominent undulating membrane, protruding axostyle, but no ventral sucker, and have several anterior flagella.
- Move in a relatively slow, rotational fashion.
- Presumptive identification as *Trichomonas gallinae* (see 6.2 in thesis).

Chapter 8 – blackbirds, thrushes, robins and starlings

Large roundworms from intestine of blackbirds/thrushes and starlings

- Large whitish worms, circular in cross-section, pointed ends. 1-2 mm in diameter. Mostly 15-45 mm long. Images 142, 143, 162.
- Presumptive identification as *Porrocaecum* sp., most likely *Porrocaecum ensicaudatum* (see 8.2.11 in thesis).
- Eggs ellipsoid, thick scalloped shell, opercula sometimes visible at one or both poles. Dark contents, often retracted into circular or ellipsoid solid mass with space between shell and contents.
- 45 eggs from three blackbirds (images 144-148):
  - length 103 µm ± 15 µm
  - width 75 µm ± 12 µm
- 24 eggs from one starling (images 149-152):
  - length 97 µm ± 7 µm
  - width 67 µm ± 5 µm

Syngamid worms from trachea of blackbirds/thrushes and starlings

- White or reddish worms, circular in cross-section, large female and small male joined together to form a Y-shape. 1 mm in diameter, around 8-12 mm long.
- Fresh adult females may have a “barber-pole” appearance caused by the red digestive tract and white undulating reproductive tract.
- Presumptive identification as *Syngamus* sp., most likely *Syngamus trachea* (see 8.2.11 in thesis).
- Eggs ellipsoid, clear/colourless, with a dark morula of 8-16 blastomeres and a thick smooth shell. Operculum at both poles. Images 156-161.

- 7 eggs from one blackbird:
  - length 91 µm ± 6 µm
  - width 49 µm ± 8 µm
- 19 eggs from one starling:
  - length 85 µm ± 7 µm
  - width 50 µm ± 7 µm

Hairworms from digestive tract of blackbirds/thrushes, robins and starlings

- Long thin worms barely visible to the naked eye, usually seen on microscopy of smears from oesophagus or intestine.
- Typical hairworm eggs (see below) seen in adult female worms.
- Presumptive identification of worms in the upper digestive tract as *Eucoleus* sp., and worms in lower digestive tract as *Capillaria / Baruscapillaria* sp., but some debate about nomenclature and described generically in thesis as "hairworms".
- Eggs brown or golden in colour, barrel-shaped, with distinctive bipolar plugs that sometimes protrude. Images 139-141.
- Thick-shelled, with granular contents that fill the egg.
- 17 hairworm eggs from one blackbird measured:
  - length 61 µm ± 10 µm
  - width 29 µm ± 5 µm

Tapeworms and eggs from intestine of blackbirds/thrushes, robins and starlings

- Usually found as fragments up to 4mm in width, cream coloured. Flattened. Fragments often tapered in size to one extremity. Image 162.
- Identification not attempted in thesis. The commonest tapeworms found in blackbirds/thrushes and starlings are *Hymenolepis* spp. and *Dilepis* spp. (see 8.2.11 in thesis).

Appendix III. Presumptive identification of internal parasites.

- Eggs recovered from intestinal contents of blackbirds/thrushes vary in appearance, with a hexacanth larva with six hooks enclosed in one or more envelopes.
- Type 1. Six-hooked hexacanth larva enclosed in two well-defined envelopes. Images 171-174.
    - Spherical/subspherical hexacanth, length 48 µm ± 4 µm and width 46 µm ± 4 µm (10 eggs from one blackbird).
    - Inner envelope spherical/subspherical, length 57 µm ± 4 µm and width 54 µm ± 3 µm (10 eggs from one blackbird).
    - Outer envelope ellipsoid, length 99 µm ± 15 µm and width 75 µm ± 13 µm (10 eggs from one blackbird).
- Type 2. Small six-hooked hexacanth larva enclosed in one well-defined envelope and a thin outer envelope. Images 175-178.
    - Spherical hexacanth, length 23 µm ± 2 µm and width 23 µm ± 2 µm (7 eggs from one redwing).
    - Inner envelope spherical, length 28 µm ± 4 µm and width 28 µm ± 4 µm (7 eggs from one redwing).
    - Outer envelope thin, ellipsoid, sometimes distorted, length 62 µm ± 12 µm and width 54 µm ± 14 µm (7 eggs from one redwing).
- Type 3. Six-hooked hexacanth larva enclosed in a single well-defined envelope. Dimensions variable. Example 1 (no images):
    - Spherical/subspherical hexacanth, length 52 µm ± 8 µm and width 50 µm ± 7 µm (14 eggs from two blackbirds).
    - Spherical/subspherical envelope, length 69 µm ± 9 µm and width 66 µm ± 7 µm (14 eggs from two blackbirds).
- Type 3. Six-hooked hexacanth larva enclosed in a single well-defined envelope. Dimensions variable. Example 2. Images 165-168:
    - Spherical/subspherical hexacanth, length 39 µm ± 6 µm and width 36 µm ± 5 µm (18 eggs from one blackbird and one redwing).
    - Spherical/subspherical envelope, length 60 µm ± 11 µm and width 50 µm ± 8 µm (18 eggs from one blackbird and one redwing).

- Type 3. Six-hooked hexacanth larva enclosed in a single well-defined envelope. Dimensions variable. Example 3. Images 163-164:
  - Spherical/subspherical hexacanth, length 43 µm ± 4 µm and width 40 µm ± 4 µm (5 eggs from one blackbird).
  - Spherical/subspherical envelope, length 87 µm ± 8 µm and width 83 µm ± 7 µm (5 eggs from one blackbird).

Flukes and fluke eggs from digestive tract of blackbirds/thrushes, robins and starlings

- Flukes usually not seen grossly, but flukes or fluke eggs seen on microscopy of wet preparations from the intestine. Fluke eggs found in intestine may originate from flukes elsewhere in the body.
- Identification not attempted in thesis. See 8.2.11 in thesis for possible species.
- Eggs ovoid or ellipsoid, brown in colour, with contents filling the shell. May be asymmetric, with one side wall longer than the other side. Operculum may be visible at one pole. Images 191-198.
- 13 eggs from one redwing:
  - length 32 µm ± 4 µm
  - width 19 µm ± 2 µm
- 15 eggs from one robin:
  - length 34 µm ± 5 µm
  - width 23 µm ± 2 µm

Thorny-headed worms from digestive tract of blackbirds/thrushes and starlings

- White, brown or grey when *in situ* in intestine. Attached to mucosa.
- Approximately 3-10 mm long, 1 mm wide. After storage in alcohol or formol saline, look white and less wrinkled. Images 179-181.
- May be smooth and turgid and circular on cross-section, or corrugated and flaccid. Thin proboscis may be apparent grossly, protruding from one end.

- Cylindrical proboscis with many hooks visible on microscopy. Images 182-183. Presumptive identification as *Plagiorhynchus* sp., most likely *Plagiorhynchus (Prosthorhynchus) cylindraceus* (see 8.2.11 in thesis). Specimens from one starling confirmed as *Plagiorhynchus (Prosthorhynchus) cylindraceus* by Mrs Eileen Harris at the Natural History Museum, London.
- Alternatively, the proboscis may have a spherical tip with large spines, and small spines on the posterior proboscis – possibly *Sphaerirostris* sp. Image 184.
- Eggs seldom seen in intestinal smears, but when obtained from worms a variety of forms may be seen:
    - Granular embryo within a thick-shelled membrane. Most likely *Plagiorhynchus* sp. Images 185-186.
        - The embryo forms an extended ellipse, length 35 µm ± 7 µm and width 11 µm ± 2 µm (16 eggs from two blackbirds).
        - The thick outer membrane is ellipsoid, length 46 µm ± 4 µm and width 18 µm ± 2 µm (23 eggs from two blackbirds).
    - Larger form with three or more different layers. Possibly *Sphaerirostris* sp. Images 187-190.
        - Outer layer is ellipsoid, length 73 µm ± 12 µm and width 33 µm ± 6 µm (24 eggs from two blackbirds).

Coccidial oocysts from intestine of blackbirds/thrushes, robins and starlings

- Unsporulated oocysts are spherical/subspherical, thick walled, sometimes containing a contracted spherical sporont. Images 111-118.
    - Spherical sporont, length 20 µm ± 1 µm and width 19 µm ± 2 µm. Contained within spherical/subspherical oocyst wall, length 26 µm ± 2 µm and width 24 µm ± 2 µm (11 oocysts from one blackbird).
    - Spherical/subspherical oocyst wall, length 22 µm ± 4 µm and width 21 µm ± 4 µm (15 unsporulated oocysts from one starling).

  - Spherical/subspherical oocyst wall, length 23 µm ± 4 µm and width 22 µm ± 3 µm (20 sporulated oocysts from one starling).
- On the few occasions that sporulation was carried out, two sporocysts were present (two blackbirds, one starling). Images 119-122.
  - Spherical/subspherical oocyst length 23 µm ± 3 µm and width 22 µm ± 3 µm, containing two sporocysts of length 15 µm ± 5 µm and width 10 µm ± 2 µm (9 sporulated oocysts from one blackbird).
- Described as isosporoid coccidia (see 8.2.10 in thesis). Probably several different species.

Schistosome-like eggs from intestinal contents of blackbirds and a redwing

- Unidentified eggs, described in the thesis as schistosome-like eggs, were detected in the intestinal contents of blackbirds and a redwing. Also detected in dunnocks and a house sparrow.
- Their identity is discussed more fully in sections 3.3.9, 8.3.9 and 8.4.3 of the thesis.
- Eggs spherical or sub-spherical, with a thin smooth outer membrane. Dark granular contents that may fill the egg, or may be retracted to produce a spherical or ellipsoid mass with a clear space between the contents and the outer membrane. Images 200-209 (blackbirds) and 215-216 (redwing).
- Variable in size. The figures below are expressed as mean and range, rather than mean ± 2 standard deviations, because the dimensions did not form a normal distribution. Instead, there appeared to be two sub-populations. For the purposes of the images in Appendix X, those 75 µm and above are described as “larger form”, and those less than 75 µm are described as “smaller form”.
  - Mean length 74 µm (range 47-109) and width 72 µm (range 59-109) (37 eggs from two blackbirds).
  - Mean length 72 µm (range 53-101) and width 61 µm (range 44-96) (16 eggs from one redwing).

Schistosome-like eggs in H&E sections of liver and intestine from blackbird

- Type 1. Well defined thin outer membrane, often distorted. Below the thin membrane, often separated by a clear space but sometimes contiguous, is a thicker layer, sometimes additionally thickened in places. Then another clear space partially or completely surrounding a multicellular central body, sometimes with spaces between the cells. Images 234-235, 246-249.
    - Outer membrane – mean length 86 µm and width 80 µm. Range 73-92 by 69-86. (8 eggs from histopath of intestine of one blackbird).
    - Outer membrane – mean length 74 µm and width 67 µm. Range 63-91 by 55-74. (15 eggs from histopath of liver of one blackbird).
- Type 2. Thin outer layer contiguous or nearly so with thicker inner layer. Small or no space and then central multicellular body with few/no spaces. Images 240-241, 250.
    - Outer membrane – mean length 63 µm and width 58 µm. Range 54-70 by 49-68. (7 eggs from histopath of intestine of one blackbird).
    - Outer membrane – mean length 62 µm and width 55 µm. Range 48-73 by 44-65. (24 eggs from histopath of liver of one blackbird).

Chapter 9 – corvids

Large roundworms from intestine of corvids

- Large whitish worms, circular in cross-section, pointed ends. 1-2 mm in diameter. Mostly up to 5 cm long. Image 339.
- Presumptive identification as *Porrocaecum* sp., most likely *Porrocaecum ensicaudatum* (see 9.2.4 in thesis).
- Eggs ellipsoid, thick scalloped shell, opercula sometimes visible at both poles. Dark contents filling egg. Images 340-343.
- 16 eggs from one carrion crow:
  - length 101 µm ± 8 µm
  - width 75 µm ± 9 µm

Syngamid worms from trachea of corvids

- White or reddish worms, circular in cross-section, large female and small male joined together to form a Y-shape. 1 mm in diameter, around 8-15 mm long. Images 308, 309, 312.
- Fresh adult females may have a "barber-pole" appearance caused by the red digestive tract and white undulating reproductive tract.
- Presumptive identification as *Syngamus* sp., most likely *Syngamus trachea* (see 9.2.4 in thesis).
- Eggs ellipsoid, clear/colourless, with a dark morula of 8-16 blastomeres and a thick smooth shell. Operculum at both poles. Images 313-318, 384-387.
- 86 eggs from seven corvids (3 rooks, 3 carrion crows, 1 chough):
  - length 90 µm ± 7 µm
  - width 46 µm ± 4 µm
- Adult worms sometimes found in oropharynx and nasal passages/sinuses, usually as spill-over from trachea. Image 309.

Syngamid worms from oropharynx of corvids

- Red and white worms, circular in cross-section. Females 1-1.5 mm in diameter, around 10-20 mm long. Males smaller.
- Males and females separate, not joined in copulation. Images 310-312.
- Fresh adult females may have a "barber-pole" appearance caused by the red digestive tract and white undulating reproductive tract.
- Presumptive identification as *Cyathostoma* sp., most likely *C. lari* (see 9.2.4 in thesis).
- Eggs ellipsoid, clear/colourless, with a dark morula of 8-16 blastomeres and a thick smooth shell. Operculum at both poles.
- 24 eggs from one rook:
  - length 81 µm ± 4 µm
  - width 46 µm ± 3 µm

Hairworms from oral cavity, oesophagus and intestine of corvids

- Long thin worms barely visible to the naked eye, usually seen on microscopy of smears. Image 328.
- Typical hairworm eggs (see below) seen in adult female worms. Images 328, 329.
- Presumptive identification of worms in upper digestive tract as *Eucoleus* sp. (see 9.2.4 in thesis).
- Presumptive identification of worms in lower digestive tract as *Capillaria* / *Baruscapillaria* sp. (see 9.2.4 in thesis).
- Eggs brown or golden in colour, barrel-shaped, with distinctive bipolar plugs that sometimes protrude. Images 329-338, 381-383.
- Eggs thick-shelled, with granular contents that fill the egg.
- 41 hairworm eggs from three corvids (2 rooks, 1 chough) measured:
  - length 63 µm ± 7 µm
  - width 32 µm ± 7 µm

Spirurid worms from gizzard of choughs

- White worms up to 16 mm long and 1 mm wide, embedded in underside of koilin layer of gizzard. Images 388-393.
- Microscopy – cervical papillae at anterior end but no obvious cordons. Images 394-398.
- Microscopy – spicules, caudal alae and papillae at posterior end of male. Images 399-402.
- Microscopy – large numbers of eggs in female. Images 403-404.
- Eggs ellipsoid, clear/colourless, thick smooth shell, no obvious operculum, usually with a well-formed larva visible. Images 405, 406, 408.
- 30 eggs from one chough:
  - length 40 µm ± 3 µm
  - width 21 µm ± 2 µm
- Described as nematodes of the Order Spirurida (spirurid worms). Not species of *Streptocara*, *Echinuria*, *Dyspharynx*, *Cosmocephalus or Tetrameres*, but identity unknown. See 9.3.5 of thesis.

Tapeworms and eggs from intestine of corvids

- Usually found as fragments up to 4 mm in width, cream coloured. Flattened. Fragments often tapered in size to one extremity. Images 346-348, 356.
- Identification not attempted. The commonest tapeworms found in corvids are *Hymenolepis* spp. and *Dilepis* spp. (see 9.2.4 in thesis).
- Eggs recovered from intestinal contents of corvids. Images 349-355.
  - Spherical/subspherical six-hooked hexacanth larva, length 44 µm ± 7 µm and width 40 µm ± 7 µm (31 eggs from five corvids [4 rooks, 1 carrion crow]).
  - Enclosed in single well-defined spherical/subspherical envelope, length 64 µm ± 14 µm and width 58 µm ± 13 µm (31 eggs from five corvids [4 rooks, 1 carrion crow]).

Thorny-headed worms from digestive tract of corvids

- White/grey when *in situ* in intestine. Attached to mucosa. Images 356-359, 409-416.
- Approximately 3-10 mm long, 1 mm wide. After storage in alcohol or formol saline, look white and less wrinkled.
- May be smooth and turgid and circular on cross-section, or corrugated and flaccid. Thin proboscis may be apparent grossly, protruding from one end. Cylindrical proboscis with many hooks visible on microscopy. Images 360-361, 417-418.
- The commonest species reported from corvids is *Plagiorhynchus (Prosthorhynchus) cylindraceus* (see 9.2.4 in thesis). Specimens from two choughs confirmed as *Plagiorhynchus (Prosthorhynchus) cylindraceus* by Mrs Eileen Harris at the Natural History Museum, London. But possibly other species also found in corvids.
- Eggs seldom seen in intestinal smears but when obtained from worms a variety of forms may be seen. Unclear if these represent different stages of development or different species.
    - a) Granular embryo within a thick-shelled membrane. Images 364-369.
        - Embryo forms an extended ellipse, length 46 µm ± 8 µm and width 16 µm ± 5 µm (28 eggs from one rook).
        - Enclosed in a thicker membrane which is ellipsoid, length 53 µm ± 10 µm and width 23 µm ± 7 µm (28 eggs from one rook).
    - b) Ellipsoid form with two (occasionally three) different layers. Images 362-363.
        - Inner layer is ellipsoid, length 44 µm ± 3 µm and width 21 µm ± 3 µm (5 eggs from 1 carrion crow).
        - Outer layer is ellipsoid, length 54 µm ± 8 µm and width 27 µm ± 4 µm (5 eggs from 1 carrion crow).
    - c) Larger ellipsoid form filled with granular material. Images 419-422.
        - Length 60 µm ± 6 µm and width 20 µm ± 4 µm (22 eggs from 1 chough).
    - d) Larger ellipsoid form with multiple layers and indistinct contents. Images 370-373.
        - Outer Length 70 µm ± 7 µm and width 30 µm ± 4 µm (27 eggs from 1 rook).

Coccidial oocysts from intestine of corvids

- Unsporulated oocysts are ellipsoid, thick-walled, often containing a contracted spherical sporont. Images 344 (a-c)
  - Ellipsoid oocyst wall - length 19 µm ± 3 µm and width 18 µm ± 3 µm (119 oocysts from five corvids [3 rooks, 1 jackdaw, 1 carrion crow]).
  - Spherical sporont, length 15 µm ± 3 µm and width 14 µm ± 3 µm. (39 unsporulated oocysts from two rooks).
- When sporulation was carried out, two sporocysts were present (one rook, one jackdaw, one carrion crow). Images 345 (a-c).
  - Ellipsoid oocyst length 21 µm ± 4 µm and width 18 µm ± 3 µm (25 sporulated oocysts from three corvids), containing two sporocysts of length 12 µm ± 3 µm and width 9 µm ± 2 µm (32 sporocysts from one jackdaw and one carrion crow).
- Described as isosporoid coccidia (see 9.2.4 in thesis). Probably several different species, possibly even within the same host.

Coccidial oocysts from faeces of choughs

- Spherical / subspherical, thick-walled, unsporulated with granular contents filling the oocyst. Images 344 (d-f).
- Length 21 µm ± 3 µm and width 20 µm ± 3 µm (38 oocysts from multiple faeces)
- Described as isosporoid coccidia (see 9.2.4 in thesis).

Chapter 10 – other passerines

Flukes and fluke eggs from digestive tract of house martins and swallows

- Flukes usually not seen grossly, but flukes or fluke eggs seen on microscopy of wet preparations from the intestine. Images 576-577.
- Eggs ovoid or ellipsoid, brown or gold in colour, with contents filling the shell. Operculum may be visible at one pole. Images 578-579.
- 33 eggs from two house martins:
    - length 33 µm ± 4 µm
    - width 22 µm ± 2 µm
- Identification not attempted in thesis. However, *Plagiorchis maculosus* is a well-recognised intestinal trematode of swallows and house martins in Europe (see 10.4 of thesis), and produces eggs of this order of magnitude.

Nematodes from airsacs of blackcap

- Long, thin, white worms, measuring up to 45mm. Images 574-575.
- Identified by Mrs Eileen Harris at the Natural History Museum, London, as *Diplotriaena tridens*.
- No images or measurements of eggs from the current study.

Coccidial oocysts from intestine of pied wagtail

- Spherical / subspherical, thick-walled, unsporulated with granular contents filling the oocyst. No images or measurements.
- Presumed to be isosporoid coccidia (see 10.3.5 in thesis).

Chapter 11 – pigeons and doves

Coccidial oocysts from pigeons/doves

- Unsporulated oocysts are spherical/sub-spherical, thick-walled, granular contents usually filling oocyst. Images 651-655.
  - 41 oocysts from one feral pigeon: mostly spherical/sub-spherical, length 20 µm ± 4 µm and width 19 µm ± 4 µm.
  - 25 oocysts from one woodpigeon: mostly spherical/sub-spherical, length 20 µm ± 3 µm and width 19 µm ± 3 µm.
  - 30 oocysts from one woodpigeon: mostly ovoid, length 19 µm ± 3 µm and width 16 µm ± 1 µm.
- Likely to be *Eimeria* spp., e.g. *E. labbeana* and *E. columbarum* (see 11.2.9 in thesis). Possibly several species, therefore described as *Eimeria* spp.

Hairworms from intestine of pigeons/doves

- Long thin worms barely visible to the naked eye, usually seen on microscopy of smears.
- Presumptive identification of worms in lower digestive tract as *Aonchotheca caudinflata* or *Baruscapillaria obsignata* (see 11.2.9 in thesis).
- Typical hairworm eggs (see below) seen in adult female worms. Images 656-657.
- Eggs brown or golden in colour, ellipsoid, with distinctive bipolar plugs that sometimes protrude. Images 658-662.
- Eggs thick-shelled, with granular contents that fill the egg.
- 35 hairworm eggs from one feral pigeon measured:
  - length 55 µm ± 6 µm
  - width 23 µm ± 3 µm

Small thin roundworms from intestine of pigeons/doves

- Small white worms, up to 1 cm long but thin, most likely to be seen on microscopy.
- Eggs ellipsoid, thin shell, granular contents almost filling the egg. Image 668.
- Inflated cuticle at anterior end of worm. Images 663-665.
- Male with bursal rays and spicules. Images 666-667.
- Presumptive identification as *Ornithostrongylus quadriradiatus* (see 11.3.10 in thesis).
- 36 eggs from one woodpigeon and one stock dove:
  - length 75 µm ± 8 µm
  - width 45 µm ± 4 µm

Tapeworms and eggs from intestine of pigeons/doves

- Usually found as fragments up to 4 mm in width, cream coloured. Flattened. Fragments often tapered in size to one extremity.
- Identification not attempted. The commonest tapeworms found in woodpigeons are *Hymenolepis* spp. and *Raillietina* spp. (see 11.2.9 in thesis).
- No images of tapeworms or tapeworm eggs from pigeons in the current study. See descriptions for tapeworms and their eggs in blackbirds and corvids above.

Flukes from intestine of pigeons/doves

- Flukes usually not seen grossly, but flukes or their eggs seen on microscopy of wet preparations from the intestine. Fluke eggs found in intestine may originate from flukes elsewhere in the body.
- Identification not attempted in thesis. Intestinal flukes of the genera *Echinostoma* and *Echinoparyphium* have been found in racing pigeons (Pennycott 1996a).
- No images or measurements are available from the current study.

Spironucleus (Hexamita) sp. in intestinal contents of pigeons/doves

- Motile protozoa that are difficult to detect microscopically unless they are actively moving. The greater the time interval between the death or euthanasia of the bird and microscopic examination of the material, the greater the likelihood that the organisms will stop moving and not be detected.
- Pyriform. Measure approximately 5-12 µm by 2-7 µm (approximately half the size of an avian red blood cell).
- No undulating membrane, axostyle or ventral sucker, but several flagella directed anteriorly or posteriorly are present.
- Move in a rapid darting fashion.
- Described in thesis as *Spironucleus* sp. (see 11.4.2).

Trichomonas sp. in upper digestive tract of pigeons/doves

- Motile protozoa that are difficult to detect microscopically unless they are actively moving. The greater the time interval between the death or euthanasia of the bird and microscopic examination of the material, the greater the likelihood that the organisms will stop moving and not be detected.
- Round, pyriform or crescent-shaped. Measure approximately 5-20 µm by 2-10 µm (about the same size as an avian red blood cell).
- Have a prominent undulating membrane, protruding axostyle, but no ventral sucker, and have several anterior flagella.
- Move in a relatively slow, rotational fashion.
- Presumptive identification as *Trichomonas gallinae* (see 11.2.5 in thesis).

Appendix IV: Antimicrobial Susceptibility Tests - Methodology and Results

Antimicrobial susceptibility tests - methodology

When considered appropriate, antimicrobial susceptibility tests were carried out by the disc diffusion method (BSAC 2013) using ISO Sensitest agar (Oxoid) and commercially available antimicrobial impregnated discs (Mast Group Ltd, UK). The antimicrobials selected varied during the period of the study, but reflected those used in the poultry industry or human medicine. In the years 1994 to February 2006, an organism was considered to be resistant to the antimicrobial in question if the zone of inhibition was less than or equal to 13mm. From March 2006, the zones of inhibition were assessed against a database of clinical breakpoints for different organisms, based on data published by the British Society for Antimicrobial Chemotherapy (BSAC 2013) and categorised as susceptible, resistant or intermediate. In September 2007, the amoxicillin disc was replaced by a cefpodoxime disc, to include testing for potential extended-spectrum beta-lactamase (ESBL)-producers. Further details of the discs used and the zone diameter breakpoints are shown in Tables 1-3.

References

BSAC (2013). British Society for Antimicrobial Chemotherapy. Methods for Antimicrobial Susceptibility Testing. http://bsac.org.uk/ Accessed 16/03/14.

Table 1: Antimicrobials included in testing panels 1994-2013.

Period	Antimicrobials included in testing panel
January 1994 – December 1999	Ampicillin; apramycin; clavulanic acid potentiated amoxicillin; enrofloxacin; furazolidone; neomycin; tetracycline; trimethoprim potentiated sulphonamide. No breakpoints.
January 2000-February 2006	Amoxicillin; ampicillin; apramycin; cephalexin; clavulanic acid potentiated amoxicillin; enrofloxacin; florfenicol (some); framycetin; neomycin; penicillin; sulphisoxazole; tetracycline; tilmicosin; trimethoprim potentiated sulphonamide; tylosin. No breakpoints.
March 2006 – August 2007	Amoxicillin; ampicillin; apramycin; clavulanic acid potentiated amoxicillin; enrofloxacin; lincomycin; neomycin; spectinomycin; tiamulin; tetracycline; trimethoprim potentiated sulphonamide; tylosin. Breakpoints based on BSAC data.
September 2007 - December 2013	Ampicillin; apramycin; cefpodoxime; clavulanic acid potentiated amoxicillin; enrofloxacin; lincomycin; neomycin; spectinomycin; tetracycline; tiamulin; trimethoprim potentiated sulphonamide; tylosin. Breakpoints based on BSAC data.

Table 2: Breakpoints for Gram-positive bacteria.

Antimicrobial	Disc content µg	Zone diameter breakpoints (mm) for Gram-positive bacteria*	
Ampicillin	10	S≥25	R<24
Apramycin	15	S≥15	R<14
Cefpodoxime	10	S≥20	R<19
Clavulanic acid potentiated amoxicillin	30	S≥20	R<19
Enrofloxacin	5	S≥20	R<16
Lincomycin	10	S≥18	R<17
Neomycin	10	S≥12	R<11
Spectinomycin	25	S≥15	R<14
Tetracycline	10	S≥20	R<19
Tiamulin	30	S≥20	R<19
Trimethoprim potentiated sulphonamide	25	S≥17	R<16
Tylosin	30	S≥22	R<21

*S - Susceptible. R- Resistant. For some antimicrobials there was an Intermediate category, where the measurement of the zone diameter lay between the zones set for Susceptible and Resistant. Staphylococci were also tested for beta lactamase production.

Table 3: Breakpoints for Enterobacteriaceae.

Antimicrobial	**Disc content µg**	**Zone diameter breakpoints (mm) for Enterobacteriaceae***	
Ampicillin	10	S≥15	R<11
Apramycin	15	S≥15	R<14
Cefpodoxime	10	S≥20	R<19
Clavulanic acid potentiated amoxicillin	30	S≥15	R<11
Enrofloxacin	5	S≥20	R<16
Florfenicol	30	S≥12	R<12
Lincomycin	10	S≥15	R<14
Neomycin	10	S≥12	R<11
Spectinomycin	25	S≥15	R<14
Tetracycline	10	S≥20	R<19
Tiamulin	30	S≥20	R<19
Trimethoprim potentiated sulphonamide	25	S≥16	R<15
Tylosin	30	S≥22	R<21

*S - Susceptible. R- Resistant. For some antimicrobials there was an Intermediate category, where the measurement of the zone diameter lay between the zones set for Susceptible and Resistant.

Table 4: *Salmonella* Typhimurium from finch and sparrow carcases January 1994 – December 2013

Antimicrobial	Number tested	Number resistant	Percentage resistant
Ampicillin	322	0	0
Amoxicillin	249	0	0
Amoxicillin plus clavulanic acid	322	0	0
Apramycin	322	0	0
Cefpodoxime	73	0	0
Cephalexin	173	0	0
Enrofloxacin	322	0	0
Florfenicol	160	0	0
Furazolidone	28	0	0
Neomycin	322	0	0
Sulphisoxazole	174	56	**32.2%**
Tetracycline	322	38	**11.8%**
Trimethoprim potentiated sulphonamide	322	0	0

No isolate was resistant to more than one group. ("Resistant" includes "Intermediate".)

Table 5: *Salmonella* Typhimurium from faeces from bird feeding station A (October 2001 to September 2003)

Antimicrobial	Number tested	Number resistant	Percentage resistant
Ampicillin	110	0	0
Amoxicillin	110	0	0
Amoxicillin plus clavulanic acid	110	0	0
Apramycin	110	0	0
Cephalexin	110	0	0
Enrofloxacin	110	0	0
Florfenicol	86	0	0
Neomycin	110	0	0
Sulphisoxazole	110	5	**4.5%**
Tetracycline	110	0	0
Trimethoprim potentiated sulphonamide	110	0	0

No isolate was resistant to more than one group. ("Resistant" includes "Intermediate".)

Table 6: Pathogenic strains of *Escherichia albertii* from finch carcases January 1994 – December 2013

Antimicrobial	Number tested	Number resistant	Percentage resistant
Ampicillin	125	1	**0.8%**
Amoxicillin	87	1	**1.1%**
Amoxicillin plus clavulanic acid	125	2	**1.6%**
Apramycin	125	1	**0.8%**
Cefpodoxime	38	0	0
Cephalexin	29	0	0
Enrofloxacin	125	4	**3.2%**
Florfenicol	15	0	0
Furazolidone	7	0	0
Neomycin	125	1	**1.6%**
Sulphisoxazole	29	1	**3.4%**
Tetracycline	125	1	**0.8%**
Trimethoprim potentiated sulphonamide	125	0	0

One isolate (from a siskin) was resistant to two groups of antimicrobial (β lactams and fluoroquinolones). No isolate was resistant to four or more different antimicrobial groups. ("Resistant" includes "Intermediate".)

Table 7: *Escherichia fergusonii* from finch and sparrow carcases January 1994 – December 2013

Antimicrobial	Number tested	Number resistant	Percentage resistant
Ampicillin	6	0	0
Amoxicillin	1	0	0
Amoxicillin plus clavulanic acid	6	0	0
Apramycin	6	0	0
Cefpodoxime	5	0	0
Cephalexin	1	0	0
Enrofloxacin	6	0	0
Neomycin	6	0	0
Sulphisoxazole	1	0	0
Tetracycline	6	0	0
Trimethoprim potentiated sulphonamide	6	0	0

("Resistant" includes "Intermediate".)

Table 8: Other non-lactose fermenting *Escherichia* species from finch and sparrow carcases January 1994 – December 2013

Antimicrobial	Number tested	Number resistant	Percentage resistant
Ampicillin	32	4	**12.5%**
Amoxicillin	11	2	**18.2%**
Amoxicillin plus clavulanic acid	32	2	**6.2%**
Apramycin	32	0	0
Cefpodoxime	21	1	**4.8%**
Cephalexin	8	0	0
Enrofloxacin	32	0	0
Florfenicol	7	0	0
Neomycin	32	0	0
Sulphisoxazole	8	4	**50%**
Tetracycline	32	9	**28.1%**
Trimethoprim potentiated sulphonamide	32	0	0

Two isolates (from a house sparrow and a chaffinch) were resistant to two groups of antimicrobial (β lactams and tetracyclines). No isolate was resistant to four or more different antimicrobial groups. ("Resistant" includes "Intermediate".)

Table 9: Other non-lactose-fermenting *Escherichia* species from faeces from bird feeding station A (October 2001 to September 2003)

Antimicrobial	Number tested	Number resistant	Percentage resistant
Ampicillin	36	0	0
Amoxicillin	36	0	0
Amoxicillin plus clavulanic acid	36	0	0
Apramycin	36	0	0
Cephalexin	36	0	0
Enrofloxacin	36	0	0
Florfenicol	32	0	0
Neomycin	36	0	0
Sulphisoxazole	36	1	**2.8%**
Tetracycline	36	0	0
Trimethoprim potentiated sulphonamide	36	0	0

No isolate was resistant to more than one group. ("Resistant" includes "Intermediate".)

Table 10: *Yersinia enterocolitica* from finch and sparrow carcases January 1994 – December 2013

Antimicrobial	Number tested	Number resistant	Percentage resistant
Ampicillin	17	10	**58.8%**
Amoxicillin	7	3	**42.9%**
Amoxicillin plus clavulanic acid	17	4	**23.5%**
Apramycin	17	0	0
Cefpodoxime	10	0	0
Cephalexin	4	1	**25.0%**
Enrofloxacin	17	0	0
Florfenicol	3	0	0
Neomycin	17	0	0
Sulphisoxazole	4	1	**25.0%**
Tetracycline	17	0	0
Trimethoprim potentiated sulphonamide	17	0	0

No isolate was resistant to more than one group of antimicrobial. ("Resistant" includes "Intermediate".)

Table 11: *Yersinia enterocolitica* from faeces from bird feeding station A (October 2001 to September 2003)

Antimicrobial	Number tested	Number resistant	Percentage resistant
Ampicillin	14	1	**7.1%**
Amoxicillin	14	2	**14.3%**
Amoxicillin plus clavulanic acid	14	0	0
Apramycin	14	0	0
Cephalexin	14	0	0
Enrofloxacin	14	1	0
Florfenicol	14	0	0
Neomycin	14	0	0
Sulphisoxazole	14	1	**7.1%**
Tetracycline	14	0	0
Trimethoprim potentiated sulphonamide	14	0	0

No isolate was resistant to more than one group of antimicrobial. ("Resistant" includes "Intermediate")

Table 12: *Yersinia enterocolitica* from faeces from bird feeding station B (January 2001 to April 2001)

Antimicrobial	Number tested	Number resistant	Percentage resistant
Ampicillin	12	1	**8.3%**
Amoxicillin	12	2	**16.7%**
Amoxicillin plus clavulanic acid	12	0	0
Apramycin	12	0	0
Cephalexin	12	0	0
Enrofloxacin	12	1	0
Florfenicol	12	0	0
Neomycin	12	0	0
Sulphisoxazole	12	1	**7.1%**
Tetracycline	12	0	0
Trimethoprim potentiated sulphonamide	12	0	0

No isolate was resistant to more than one group of antimicrobial. ("Resistant" includes "Intermediate")

Appendix V: Isolation of *Salmonella enterica* from wild birds 1994 - 2013

Species or group of wild bird	Number of carcases cultured	Number negative for *Salmonella*	Number positive for *Salmonella*	*S.* Typhimurium phage type (or other serotype)
Finches and buntings	1012	716	296	DT40 x 180 DT56v x 102 RDNC x 7 DT1 x 3 DT120 x 2 DT193 x 1 DT208 x 1
Sparrows	110	51	59	DT56v x 28 DT40 x 27 DT41 x 2 RDNC x 2
Dunnocks	21	17	4	DT56v x 3 DT40 x 1
Tits	40	36	4	DT40 x 3 DT120 x 1
Finches, buntings, sparrows, dunnocks, tits (total)	**1183**	**820**	**363**	
Starlings	70	70	0	
Robins	20	20	0	
Blackbirds/thrushes	68	67	1	DT56v x 1
Starlings, robins, blackbirds and thrushes (total)	**158**	**157**	**1**	
Corvids	151	149	2	DT40 x 1 DT41 x 1
Other passerines	41	41	0	
Pigeons and doves	162	155	7	DT99 x 3 DT2 x 2 DT161 x 1 *S.* Liverpool x 1

Appendix V. Isolation of *Salmonella enterica* from wild birds 1994-2013

Species or group of wild bird	Number of carcases cultured	Number negative for Salmonella	Number positive for Salmonella	Serotype / phage type
Auks	73	71	2	DT161 x 1 RDNC x 1
Cormorants and shags	9	9	0	
Gulls	175	168	7	DT41 x 5 DT195 x 2
Fulmars, gannets and shearwaters	18	18	0	
Waders	9	9	0	
Seabirds (total)	**284**	**275**	**9**	
Ducks and geese	29	29	0	
Swans	120	119	1	DT41 x 1
Other waterfowl	3	3	0	
Waterfowl (total)	**152**	**151**	**1**	
Falcons, hawks and eagles	69	68	1	DT104 x 1
Owls	34	32	2	DT56v x 1 DT41 x 1
Raptors (total)	**103**	**100**	**3**	
Herons	10	9	1	DT41 x 1
Miscellaneous	33	33	0	

Appendix VI: Isolation of potentially pathogenic *E. albertii* * from different species of wild bird 1994-2013.

Species of bird	Initial number of carcases from which both intestine and liver were cultured	Number of birds from which *Salmonella* was isolated from liver and intestine (excluded)	Number in which no profile was recorded for NLF isolates (excluded)	Adjusted number tested for *E. albertii**	Number *E. albertii** positive	Number *E. albertii** negative
Blackbird	51	0	0	51	**2**	49
Blackcap	2	0	0	2	0	2
Brambling	3	2	0	1	0	1
Bullfinch	15	1	0	14	0	14
Bunting, reed	1	0	0	1	0	1
Buzzard	36	0	0	36	0	36
Chaffinch	292	43	0	249	**19**	230
Chiffchaff	2	0	0	2	0	2
Chough	24	0	0	24	**1**	23
Coot	2	0	0	2	0	2
Cormorant	3	0	0	3	0	3
Crossbill species	1	0	0	1	0	1
Crow, carrion	31	0	0	31	0	31
Diver, red-throated	1	0	0	1	0	1
Dove, collared	21	0	0	21	0	21
Dove, stock	1	0	0	1	0	1
Dunlin	1	0	0	1	0	1
Dunnock	21	4	0	17	**1**	16
Eagle, golden	2	0	0	2	0	2
Eider	9	0	0	9	0	9
Fieldfare	1	0	0	1	0	1
Fulmar	6	0	0	6	0	6
Gannet	10	0	0	10	0	10
Goldcrest	2	0	0	2	0	2
Goldfinch	52	22	0	30	**5**	25
Goose, Canada	3	0	0	3	0	3
Greenfinch	425	154	0	271	**36**	235
Grouse, black	1	0	0	1	0	1
Guillemot	20	1	0	19	0	19
Gull, black-headed	16	2	0	14	0	14
Gull, common	4	0	0	4	0	4
Gull, great black-backed	5	0	0	5	0	5

Appendix VI. Isolation of potentially pathogenic *E. albertii* from wild birds 1994-2013.

Species of bird	**Initial number of carcases from which both intestine and liver were cultured**	**Number of birds from which *Salmonella* was isolated from liver and intestine (excluded)**	**Number in which no profile was recorded for NLF isolates (excluded)**	**Adjusted number tested for *E. albertii****	**Number *E. albertii**** **positive**	**Number *E. albertii**** **negative**
Gull, herring	40	0	0	40	**1**	39
Gull, ivory	1	0	0	1	0	1
Gull, lesser black-backed	17	0	0	17	0	17
Gull, no ID	39	1	0	38	**2**	36
Harrier, hen	1	0	0	1	0	1
Heron, grey	8	0	0	8	0	8
Jackdaw	17	0	0	17	**1**	16
Kestrel	7	0	0	7	0	7
Kittiwake	1	0	0	1	0	1
Magpie	10	0	0	10	0	10
Mallard	4	0	0	4	0	4
Martin, house	7	0	0	7	0	7
Merganser, red-breasted	1	0	0	1	0	1
Merlin	1	0	0	1	0	1
Nuthatch	1	0	0	1	0	1
Owl, barn	18	0	0	18	**1**	17
Owl, eagle (feral)	1	0	0	1	0	1
Owl, short-eared	1	0	0	1	0	1
Owl, tawny	9	0	0	9	0	9
Oystercatcher	8	0	0	8	0	8
Peregrine	4	0	0	4	0	4
Pigeon, feral	80	3	0	77	**3**	74
Pipit, meadow	2	0	0	2	0	2
Puffin	1	0	0	1	0	1
Raven	4	0	0	4	0	4
Razorbill	1	0	0	1	0	1
Redpoll, lesser	11	5	3	3	**1**	2
Redwing	2	0	0	2	0	2
Robin	20	0	0	20	**1**	19
Rook	43	0	0	43	0	43
Shag	4	0	0	4	0	4
Shelduck	1	0	0	1	0	1
Siskin	206	45	0	161	**113**	48
Snipe, Jack	1	0	0	1	0	1
Sparrow, house	103	48	2	53	**3**	50

Appendix VI. Isolation of potentially pathogenic *E. albertii* from wild birds 1994-2013.

Species of bird	**Initial number of carcases from which both intestine and liver were cultured**	**Number of birds from which *Salmonella* was isolated from liver and intestine (excluded)**	**Number in which no profile was recorded for NLF isolates (excluded)**	**Adjusted number tested for *E. albertii****	**Number *E. albertii**** **positive**	**Number *E. albertii**** **negative**
Sparrow, tree	7	3	0	4	0	4
Sparrowhawk	11	0	0	11	0	11
Starling	69	0	0	69	**6**	63
Swallow	6	0	0	6	0	6
Swan, mute	78	0	0	78	0	78
Swan, whooper	4	0	0	4	0	4
Thrush, song	9	0	0	9	0	9
Tit, blue	19	0	0	19	0	19
Tit, coal	11	1	0	10	0	10
Tit, great	9	2	0	7	0	7
Tit, long-tailed	1	0	0	1	0	1
Treecreeper	3	0	0	3	0	3
Wagtail, pied	1	0	0	1	0	1
Warbler, willow	1	0	0	1	0	1
Waxwing	7	0	0	7	0	7
Woodcock	1	0	0	1	0	1
Woodpecker, great spotted	1	0	0	1	0	1
Woodpigeon	45	0	0	45	0	45
Wren	4	0	0	4	0	4
Yellowhammer	3	0	0	3	0	3
Total	**2029**	**337**	**5**	**1687**	**196**	**1491**

*API 20E profile 4144102 or 5144102. Non-lactose-fermenting (NLF), non-sorbitol fermenting (NSF).

Appendix VII: Isolates of potentially pathogenic *E. albertii* from different bird species – results of O86:K61 slide agglutination tests.

Species	Number of isolates tested	Number of isolates O86:K61 positive	Number of isolates O86:K61 negative
Blackbird	2	0	2
Chaffinch	17	17	0
Chough	1	0	1
Goldfinch	4	4	0
Greenfinch	19	19	0
Gull, herring	1	0	1
Gull, no ID	1	0	1
Jackdaw	1	0	1
Owl, barn	1	1	0
Pigeon, feral	2	0	2
Redpoll, lesser	1	1	0
Robin	1	0	1
Siskin	68	67	1
Sparrow, house	1	0	1
Starling	5	0	5

Appendix VIII: Summary of outcomes from wild bird disease surveillance at Ayr Disease Surveillance Centre 1994 – 2013

(Orders Passeriformes and Columbiformes)

The outcomes of surveillance in different species or groups of wild birds of the Orders Passeriformes and Columbiformes are listed in Table 1. The population of interest was defined as *wild birds of the Orders Passeriformes and Columbiformes found dead or sick in Scotland between 1994 and 2013*, and the different categories of outcome are described below. "NOS" refers to conditions "not otherwise specified".

Outcome category 1.
Hazard-specific (targeted) surveillance for specified pathogens or diseases (*Salmonella* spp., *Escherichia albertii*, *Mycoplasma* spp., avian influenza viruses and West Nile virus).

Outcome category 2.
A condition or infectious agent, known to be present in the population of interest (endemic disease), or one that was sufficiently common in other wild bird groups in the UK for it to be expected to occur in the population of interest. No additional significant information was obtained in the current study but general awareness was raised.

Outcome category 3.
As for Category 2 but further significant information was obtained in addition to raising general awareness.

Outcome category 4.
A re-emerging disease i.e. one that was previously present in the population of interest but which had declined to a low level or disappeared, but which re-appeared or significantly increased in prevalence during the study period.

Outcome category 5.

A disease or agent, previously known in wild birds of a particular group in a country other than the UK, which had never been described in that group of wild birds in the UK (exotic disease).

Outcome category 6.

A new disease or syndrome, previously unidentified in that group of wild birds in the UK or elsewhere, for which the aetiology or identity was not established.

Outcome category 7.

A new disease, syndrome or organism, previously unidentified in that group of wild birds in the UK or elsewhere, for which the aetiology has been established. May result from changes in existing pathogens, or may be caused by a previously unrecognised pathogen.

Table 1: Summary of outcomes from wild bird disease surveillance at Ayr Disease Surveillance Centre 1994 – 2013 (Orders Passeriformes and Columbiformes)

Diagnosis	Species or group of wild bird	Outcome category	Comments
Trauma	Finches, sparrows, dunnocks, tits	3	Variation by sex and month.
Pasteurellosis	Finches, sparrows, dunnocks, tits	2	Raised awareness.
Infection with *Salmonella* Typhimurium	Finches, sparrows, dunnocks, tits	1 & 4	Species of bird affected, changing pattern. Reduction in prevalence. Emergence of DT56v, regional variation. Different lesion scores. Seasonal patterns. Sex and age distribution. Antimicrobial susceptibility tests.
Infection with *Escherichia albertii*	Finches	1 & 7	Significance of API-20E profiles. Species of bird affected, changing pattern. Reduction in prevalence. Seasonal patterns. Sex and age distribution. Regional variation. Antimicrobial susceptibility tests.
Trichomonosis	Finches, sparrows, buntings, dunnocks, tits	5	Species of bird affected, changing pattern. Possible role of chaffinch in spread of disease. Seasonal patterns. Sex and age distribution. Regional variation. Different lesion scores.
Infection with *Suttonella ornithocola*	Tits	3	Possible role of carrier birds.
Infection with *Chlamydia psittaci*	Finches, tits	2	Raised awareness.
Capture myopathy	House sparrow	2	Raised awareness.

Appendix VIII. Summary of outcomes of wild bird disease surveillance.

Diagnosis	Species or group of wild bird	Outcome category	Comments
Avian pox	Dunnocks, house sparrows	2	Raised awareness. Absence in great tits.
Cutaneous papillomas	Chaffinches	2	Raised awareness.
Feather/skin abnormality NOS	Chaffinch, blue tit, house sparrow	2	Raised awareness.
Syngamid worms	House sparrow	2	Raised awareness.
Hairworms	Dunnocks	2	Raised awareness.
Isosporoid coccidia	Finches, house sparrows	2	Raised awareness.
Schistosome-like eggs in digestive tract	Dunnocks, house sparrow	6	Structures resembling schistosome eggs. Identity to be established.
Avian gastric yeasts	Greenfinches	5	Presence of organism, sometimes associated with pathology.
Fledgling CNS disorder	House sparrows	6	Non-suppurative encephalitis, cause unknown.
CNS condition NOS	House sparrow	2	Raised awareness.
Adverse environmental conditions	Finches, tits	2	Raised awareness.
Digestive tract condition NOS	Bunting, tits	2	Raised awareness.
Reproductive tract disorders	Finches	2	Raised awareness.
Neoplasia	Chaffinch	2	Raised awareness.
Infection with *Yersinia pseudo-tuberculosis*	Chaffinches	2	Raised awareness.
Cellulitis	Finches	2	Raised awareness.
Candidiasis	Chaffinch	2	Raised awareness.
Recovery of *Yersinia enterocolitica*	Finches, sparrows, pooled faeces	3	Seasonal pattern. Biotype 1a. Antimicrobial susceptibility tests.
Infection with *Staphylococcus aureus*	Chaffinch, house sparrow	2	Raised awareness.
Demonstration of MRSA	Chaffinch	7	First demonstration of MRSA in a wild bird.

Appendix VIII. Summary of outcomes of wild bird disease surveillance.

Diagnosis	Species or group of wild bird	Outcome category	Comments
Demonstration of *E. coli* O157	Pooled faeces	7	First demonstration of *E. coli* O157 at a garden feeding station.
Ixodes ricinus ticks	Chaffinches	2	Raised awareness.
Failure to detect *Mycoplasma* spp.	Finches and house sparrows	1	42 birds screened.
Failure to detect avian influenza viruses	Finches, sparrows, buntings, dunnocks, tits	1	384 birds screened.
Failure to detect West Nile virus	Finches, sparrows, buntings, dunnocks, tits	1	267 birds screened.

Appendix VIII. Summary of outcomes of wild bird disease surveillance.

Diagnosis	Species or group of wild bird	Outcome category	Comments
Trauma	Blackbirds, thrushes, robins, starlings	2	Raised awareness.
Pasteurellosis	Song thrushes, starlings	2	Raised awareness.
Infection with *Salmonella* Typhimurium	Blackbirds, thrushes, robins, starlings	1	Absence of disease in this group of birds.
Infection with *Escherichia albertii*	Blackbirds, thrushes, robins, starlings	1	Absence of disease in this group of birds.
Trichomonosis	Blackbirds, thrushes, robins, starlings	5	Absence of disease in this group of birds other than 1 blackbird and 1 robin.
Infection with *Chlamydia psittaci*	Robins	3	Importance of robins.
Avian pox	Starlings	2	Raised awareness.
Feather/skin abnormality NOS	Blackbird, robin	2	Raised awareness.
Coccidiosis	Blackbirds, song thrush	3	Importance in blackbirds.
Significant helminthosis	Blackbirds, starling	3	Importance in blackbirds.
Schistosome-like eggs in digestive tract	Blackbirds, redwing	6	Structures resembling schistosome eggs. Associated with granulomatous enteritis and/or hepatitis. Identity to be established.
Fledgling CNS disorder	Starlings	6	Non-suppurative encephalitis, cause unknown.
Mycotic encephalitis	Starling	2	Raised awareness.
Mycotic pneumonia / airsacculitis	Blackbirds, starling	3	Importance in blackbirds.
Adverse environmental conditions	Redwings, fieldfares, robins, starlings	2	Raised awareness.
Impacted gizzard	Robin	2	Raised awareness.
Reproductive tract disorders	Blackbird, starling	2	Raised awareness.

Appendix VIII. Summary of outcomes of wild bird disease surveillance.

Diagnosis	Species or group of wild bird	Outcome category	Comments
Infection with *Yersinia pseudo-tuberculosis*	Starling	2	Raised awareness.
Infection with *Staphylococcus aureus*	Robin, song thrush	2	Raised awareness.
Cellulitis, abscess	Blackbirds, robin	2	Raised awareness.
Developmental abnormalities	Starlings	2	Raised awareness.
Poisoning	Blackbird	2	Raised awareness.
Isolation of *Mycoplasma sturni*	Blackbirds, starlings	1 & 5	Frequent isolation from blackbirds and starlings.
Failure to detect avian influenza viruses	Blackbirds, thrushes, robins, starlings	1	50 birds screened.
Failure to detect West Nile virus	Blackbirds, thrushes, robins, starlings	1	75 birds screened.

Appendix VIII. Summary of outcomes of wild bird disease surveillance.

Diagnosis	Species or group of wild bird	Outcome category	Comments
Trauma	Corvids, including choughs	2	Raised awareness.
Malnourished fledglings	Corvids	2	Raised awareness.
Mycotic pneumonia / airsacculitis	Corvids	3	Disease confined to jackdaws.
Avian tuberculosis	Corvids	3	Disease confined to jackdaws.
Significant helminthosis (general)	Corvids	3	Differences between species of corvid.
Significant helminthosis (choughs)	Choughs	7	Importance of gastro-intestinal parasites in choughs. First description of gizzard worms and thorny-headed worms in UK choughs.
Isosporoid coccidia	Corvids, including choughs	2	Raised awareness.
Corvid respiratory syndrome	Corvids	3	Respiratory syndrome of corvids associated with *Mycoplasma gallisepticum*-like organisms and *Pasteurella multocida*.
Respiratory tract condition NOS	Corvids	2	Raised awareness.
Isolation of *Mycoplasma sturni*	Corvids	1 & 5	Frequent isolation from corvids.
Detection of *Mycoplasma gallisepticum*	Corvids, including choughs	1 & 7	Detection by PCR in choughs, carrion crows, rooks. First isolation from corvids (choughs).
Infection with *Chlamydia psittaci*	Corvids	3	Importance in corvids.
Pasteurellosis	Corvids	2	Raised awareness.
Avian pox	Corvids	3	Differences between species of corvid.
Feather/skin abnormality NOS	Corvids	2	Raised awareness.
Cnemidocoptic mange	Corvids	2	Raised awareness.

Appendix VIII. Summary of outcomes of wild bird disease surveillance.

Diagnosis	Species or group of wild bird	Outcome category	Comments
Ornithonyssus sp. mites	Corvids	5	Importance of *Ornithonyssus* mites in corvids, and first description in UK corvids.
Developmental abnormalities of the eyes	Choughs	7	First description of this condition in chough nestlings.
Necrotic oesophagitis	Corvids, including choughs	6	Necrotic oesophagitis, cause unknown.
Infection with *Salmonella* Typhimurium	Corvids, including choughs	1	Absence of disease in this group of birds.
Infection with *Escherichia albertii*	Corvids, including choughs	1	Absence of disease in this group of birds.
Trichomonosis	Corvids, including choughs	3	Absence of disease in this group of birds.
Adverse environmental conditions	Corvids, including choughs	2	Raised awareness.
Reproductive tract disorders	Corvids, including choughs	2	Raised awareness.
Infection with *Yersinia pseudo-tuberculosis*	Choughs	3	Importance in choughs.
Infection with *Staphylococcus aureus*	Corvids	2	Raised awareness.
Arthritis and cellulitis	Corvids, including choughs	2	Raised awareness.
Beak abnormalities	Corvids	2	Raised awareness.
Neoplasia	Corvids	2	Raised awareness.
Poisoning	Corvids	2	Raised awareness.
Candidiasis	Corvids	2	Raised awareness.
Bursal cryptosporidiosis	Corvids	2	Raised awareness.
Failure to detect avian influenza viruses	Corvids, including choughs	1	93 birds screened.
Failure to detect West Nile virus	Corvids, including choughs	1	105 birds screened.

Appendix VIII. Summary of outcomes of wild bird disease surveillance.

Diagnosis	Species or group of wild bird	Outcome category	Comments
Trauma	Other passerines	2	Raised awareness.
Infection with *Salmonella* Typhimurium	Other passerines	1	Absence of disease in this group of birds.
Infection with *Escherichia albertii*	Other passerines	1	Absence of disease in this group of birds.
Coccidiosis	Other passerines	2	Raised awareness.
Adverse environmental conditions	Other passerines	2	Raised awareness.
Mycotic pneumonia / airsacculitis	Other passerines	2	Raised awareness.
Infection with *Yersinia pseudo-tuberculosis*	Other passerines	2	Raised awareness.
Avian gastric yeasts	Other passerines	5	Presence of organism in waxwing, possibly associated with pathology.
Diplotriaena tridens in the anterior airsacs of a blackcap	Other passerines	2	Raised awareness.
Failure to detect avian influenza viruses	Other passerines	1	21 birds screened.
Failure to detect West Nile virus	Other passerines	1	11 birds screened.

Diagnosis	Species or group of wild bird	Outcome category	Comments
Trauma	Pigeons and doves	2	Raised awareness.
Pasteurellosis	Pigeons and doves	2	Raised awareness.
Infection with *Salmonella* Typhimurium	Pigeons and doves	1 & 2	Raised awareness.
Infection with *Escherichia albertii*	Pigeons and doves	1	Absence of disease in this group of birds.
Trichomonosis	Pigeons and doves	2	Raised awareness.
Infection with *Chlamydia psittaci*	Pigeons and doves	2	Raised awareness.
Avian tuberculosis	Pigeons and doves	2	Raised awareness.
Avian pox	Pigeons and doves	2	Raised awareness.
Infection with PPMV-1	Pigeons and doves	2	Raised awareness.
Inclusion body hepatitis	Pigeons and doves	3	Known in UK racing pigeons, first report in UK feral pigeons.
Circovirus infection	Pigeons and doves	3	Known in UK racing pigeons, first report in UK feral pigeons.
Coccidiosis	Pigeons and doves	2	Raised awareness.
Spironucleus (*Hexamita*) infection	Pigeons and doves	3	Known in UK racing pigeons, first report in UK feral pigeons and woodpigeon.
Significant helminthosis	Pigeons and doves	3	*Ornithostrongylus* known in UK racing pigeons, first report in UK woodpigeon and stock dove.
Metabolic bone disease	Pigeons and doves	2	Raised awareness.
Arthritis, cellulitis, granulomata	Pigeons and doves	2	Raised awareness.
Adverse environmental conditions	Pigeons and doves	2	Raised awareness.

Appendix VIII. Summary of outcomes of wild bird disease surveillance.

Diagnosis	Species or group of wild bird	Outcome category	Comments
Mycotic pneumonia / airsacculitis	Pigeons and doves	2	Raised awareness.
E. coli septicaemia	Pigeons and doves	2	Raised awareness.
Reproductive tract disorders	Pigeons and doves	2	Raised awareness.
Haemoparasites	Pigeons and doves	2	Raised awareness.
Neoplasia	Pigeons and doves	2	Raised awareness.
Failure to detect avian influenza viruses	Pigeons and doves	1	56 birds screened.
Failure to detect West Nile virus	Pigeons and doves	1	72 birds screened.

SAC avian necropsy form (1994)

Weight	
Head / oropharynx	
Crop	
Proventriculus / gizzard	
Small intestine	
Caeca	
Smears	
Heart	
Liver	
Trachea, lungs and airsacs	
Kidneys	
Spleen	
Vent	
Reproductive tract	
Nerves	
Muscles / bones / joints	
Feet	
Yolk sac	
Bursa of Fabricius	
Other	

POSTMORTEM EXAMINATION CHECKLIST (SAC, 1999)

A) **IDENTITY**

NAME

ADDRESS

TELEPHONE NUMBER

SPECIES

AGE

B) **EXTERNAL EXAMINATION**

WEIGHT FOR AGE

HEAD

NECK / CROP

BODY

VENT

LEGS / FEET

WINGS

PLUMAGE

C) BREAST MUSCLE

LEG MUSCLE

SUBCUTANEOUS FAT

CROP

KEEL BONE

D) THYMUS GLANDS

JUGULAR VEINS

VAGUS NERVES

E) INFRAORBITAL SINUS
CHOANA
NASAL CAVITY
TONGUE
OESOPHAGUS
LARYNX
TRACHEA

F) THORACIC AIR SACS, HORIZONTAL AND OBLIQUE SEPTA
THYROID
PARATHYROID
SYRINX AND BRONCHI
PERICARDIUM
HEART
LUNGS

G) ABDOMINAL FAT
LIVER
GALL BLADDER
SPLEEN

H) PROVENTRICULUS
GIZZARD
PANCREAS
DUODENUM
SMALL INTESTINE
CAECUM
CAECAL TONSIL
LARGE INTESTINE
BURSA OF FABRICIUS
ABDOMINAL AIR SACS

I) KIDNEYS
ADRENAL GLANDS
OVARY / TESTES
INFUNDIBULUM
MAGNUM
ISTHMUS
UTERUS
BURSA OF FABRICIUS

J) BRACHIAL PLEXUS
INTERCOSTAL NERVES
SCIATIC NERVE
SACRAL PLEXUS
AORTIC PLEXUS
INTESTINAL NERVE (OF REMAK)

K) RIBS
FEMORAL HEAD
TIBIOFEMORAL JOINT (KNEE)
INTERTARSAL JOINT (HOCK)
DIGITS
FOOTPADS
HUMERO-ULNAR JOINT (ELBOW)
BONE MARROW

L) BRAIN
SPINE / SPINAL CORD

GBH*i* POST MORTEM EXAMINATION (2005)

Common name:
Scientific name:

PME Number (IOZ/LIV/SAC/WVIC - PM No (four digits) -Year):
AM Number (IOZ/LIV/SAC/WVIC - AM No (four digits) -Year):
In house PME Number:
Report type (Opportunist or Systematic)?
GBW Number (GBW site id – Bird number):
PM Date:
Pathologist:

Name, Address & Tel. No of Finder:

NGR (6 digits):

Date found:
Date received:
Summary history:

Euthanased ?
If euthanasia, describe method:

Carcass state (Fresh/ Frozen):

Carcass condition (Freshly dead/ mild autolysis/ moderate decomposition/ advanced decomposition):

Sex (Male/ Female/ Undetermined):

Age (Nestling/ / Juvenile/ First year (of life)/ Adult):

Body condition (Emaciated/ Thin/ Normal/ Fat):
BWG Fat score (0-8):

Carcass weight (g):
[Inaccurate values in parentheses e.g. wet, scavenged]

Wing length (mm):
Maximum tarsus length (mm):

Photos(s) taken (Y/N)?
Xray(s) taken (Y/N)?

Leg ring present (Y/N)?
Ring No:

Gross post mortem findings

Integument (plumage, moult, uropygial gland, subcut.)		
Sensory (eyes, ears, nostrils)		
Muscular		Total Sup. Pect. Mass (g)
Skeletal		
Cavities		
Digestive		
Liver		(g)
Respiratory		Lungs (g)
Cardio-vascular		Heart (g)
Lympho-reticular (Spleen, Bursa, Thymus)		Spleen (g)
Urinary		Total Kidney (g)
Endocrine (Thyroid, Adrenal)		
Reproductive		
Nervous		

Key:

NA Not available; NE Not examined

NLD No lesions detected; Values in parentheses not reliable.

PARASITOLOGY

MICROBOLOGY

MISCELLANEOUS

HISTOLOGY

DIAGNOSIS

Significant diseases or conditions thought to contribute to the death of the animal

Incidental diseases or conditions not thought to contribute to the death or condition causing it

Comments:

CAUSE OF DEATH:

Trauma / Predation (Avian/ Mammal/ Undetermined)/ Infectious disease (Pathogen)/ Other/ Undetermined

**This report is based on gross findings and may be modified after the laboratory findings are known.*

*(*Delete when PME report complete).*

Pathologist name and date:

SAC AVIAN POSTMORTEM FORM (2006)

EXAMINATION OF LIVE BIRDS:

Method of euthanasia： Barbiturate overdose/ Cervical dislocation

Weight	
Head/Oropharynx	
Crop	
Proventriculus and gizzard	
Small intestine	
Caeca	
Smears	
Heart	
Liver	
Trachea	
Lungs and airsacs	
Kidneys	
Spleen	
Thymus/Bursa of Fabricius	
Muscles/Bones	
Joints/Nerves	
Feet/Vent	
Yolk Sac	
Reproductive tract	
Other	

LABORATORY INSTRUCTIONS

Sensitivity test required ☐

Tissues retained in formal saline ☐

Tissues retained in deep freeze in avian PM room ☐

Tissues retained in deep freeze in "Shed" ☐

Avian influenza surveillance

Tissues/swabs to biochemistry fridge pending dispatch to VLA:

Bulked viscera ☐

Intestine ☐

Cloacal swab ☐

Tracheal swab ☐

Wildlife Surveillance Form attached? YES/NO

VLA Avian Virology Submission Form attached? YES/NO

Feathers in fridge in "Shed" YES/NO

Carcase Disposal Tag:

SAC AVIAN POSTMORTEM FORM (2009-2013)

Examination of live birds: **Submission Reference No.**

Method of euthanasia: **Barbiturate overdose / cervical dislocation**

(□ = examined, no significant abnormalities detected)

(n/e = not examined, n/a = not applicable)

Bird identification				
Weight				
External examination: **Head** **Neck/crop/body** **Vent** **Legs/feet** **Wings** **Plumage**				
Body condition				

Subcutaneous tissues, breast and leg muscles, keel bone				
Crop and contents				
Thymus				
Infra-orbital sinus				
Choana, palate, tongue				
Oesophagus				
Larynx and trachea				
Thyroid and parathyroid				
Heart and pericardium				

Syrinx, bronchi, lungs, thoracic airsacs				
Liver and gall bladder				
Spleen				
Proventriculus / gizzard and contents				
Pancreas				

Duodenum and contents				
Small intestine and contents				
Caeca and contents				
Rectum and contents				
Bursa of Fabricius				
Abdominal air sacs				
Kidneys				
Sex, reproductive tract				
Bones, joints, tendons				
Peripheral nerves				
Brain, spine, spinal cord				
Other eg yolk sac				
Autolysis: 1 = fresh, 5 = putrid, m= mummified				
Comments and differential diagnosis				

Submission reference
B……

R= routine bacteriology, An= anaerobic culture, F=fungal culture, M=mycoplasma culture

Bird number	Liver	Heart	Caecum / Intestine	Spleen	Other (specify)

Tick if selective culture for Salmonella is required ☐

Tissues for virology…….

Worm egg / coccidial oocyst count……

Wet preparations (state bird number and sites)

Bird number	Duodenum	Upper si	Lower si	Caecum

Histopathology

Send on……Brain/lung/liver/kidney/spleen/intestine/caecum/heart/skeletal muscle/bursa of Fabricius/other tissue ☐

Retain (2/12 months) Brain/lung/liver/kidney/spleen/intestine/caecum/heart/skeletal muscle/bursa of Fabricius/other tissue ☐

Tissues retained in deep freeze ☐

(Specify which tissues, which freezer, discard date)

Toxicology/rodenticide screen/Serology/ Other

Avian influenza surveillance and West Nile virus surveillance (Avian Virology, VLA)

Bulked viscera	☐	**Brain**	☐
Intestine	☐	**Kidney**	☐
Cloacal swab	☐		
Tracheal swab	☐		

Carcase Disposal Tag:

Veterinary signature……

Date of necropsy……..

Appendix X: List of images of pathological lesions, parasites and parasite eggs from wild birds of the Orders Passeriformes and Columbiformes.

Images are attached separately in removable electronic storage medium at the inside back cover of this volume, and on-line at http://datashare.is.ed.ac.uk/

Chapter 3, part 1. Images of pox, papillomas and other skin conditions in finches, sparrows, buntings, dunnocks and tits.

1 & 2. Pox in dunnock – on digits (bird 1) and large mass below one eye (bird 2). 9854.jpg and D5241.jpg

3. Pox in dunnock – large mass below one eye. D5243.jpg

4. Pox in dunnock – cut section of lesion. D5247.jpg

5. Pox in dunnock. Histopathology. H&E x400. Ballooning of epithelial cells, with large intracytoplasmic inclusion bodies (Bollinger bodies). D7040.jpg

6. Pox lesions on head and neck of house sparrow. 9403.jpg

7. Pox lesions on head and neck of house sparrow. 9401.jpg

8. Cutaneous papilloma on foot of chaffinch. 8842.jpg

9. Cutaneous papilloma on foot of chaffinch. 8799.jpg

10. Cutaneous papilloma on foot of chaffinch. D2186.jpg

11 & 12. Cutaneous papilloma on foot of chaffinch. 4304.jpg and 4299.jpg

13. Skin disorder of unknown cause in house sparrow. *Staphylococcus aureus* isolated. D8998.JPG

14. Skin disorder of unknown cause in house sparrow. *Staphylococcus aureus* isolated. D9000.JPG

Chapter 3, part 2. Images of parasite eggs, coccidial oocysts, "megabacteria" and other miscellaneous findings in finches, sparrows, buntings, dunnocks and tits.

15a & 15b. Syngamid eggs from house sparrow. Operculum visible at both poles. D7425.jpg and D7424.jpg

16a & 16b. Syngamid eggs from house sparrow. Operculum visible at both poles. D7431.jpg and D7434.jpg

17 a-c. Unsporulated coccidial oocysts (smaller form) from chaffinches. D9897.jpg, D9900.jpg and D9938.jpg

18 a-c. Unsporulated coccidial oocysts (larger form) from chaffinches. D9896.jpg, D9898.jpg and D9901.jpg

19. Unsporulated coccidial oocysts from greenfinch. 6219.jpg

20. Sporulated isosporoid oocyst from bullfinch. Two sporocysts visible. 3476.jpg

21. Avian gastric yeasts ("megabacteria") from greenfinch. Wet preparation from proventriculus. Large bacilli measuring 20-70µm by 1-5µm. 6217.jpg

22. Schistosome-like eggs in mucosa of intestine of dunnock 2. x100. D9733.jpg

23a & 23b. Schistosome-like eggs from intestinal contents of dunnock 1. Smaller type. D9193.jpg and D9192.jpg

24a & 24b. Schistosome-like eggs from intestinal contents of dunnock 1. Smaller type. D9186.jpg and D9183.jpg

25a & 25b. Schistosome-like eggs from intestinal contents of dunnock 2. Larger type. D9797.jpg and D9187.jpg

26. Schistosome-like eggs from intestinal contents of dunnock 1. Smaller and larger types. D9191.jpg

27a & 27b. Schistosome-like eggs from intestinal contents of dunnock 2, emerging from shells. Hatching, or artefact caused by freezing? D9786.jpg and D9796.jpg

28a & 28b. Schistosome-like eggs from intestinal contents of dunnock 2, emerging from shells. Hatching, or artefact caused by freezing? D9801.jpg and D9795.jpg

29a & 29b. Schistosome-like eggs from intestinal contents of dunnock 3. Larger type. D10211.jpg and D10215.jpg

30a & 30b. Schistosome-like eggs from intestinal contents of dunnock 3. Larger type. D10216.jpg and D10217.jpg

31a & 31b. Schistosome-like eggs from intestinal contents of dunnock 3. Smaller type. D10214.jpg and D10219.jpg

32a & 32b. Empty egg shells of schistosome-like eggs from intestinal contents of dunnock 3. D10212.jpg and D10213.jpg

33a & 33b. Schistosome-like eggs from intestinal contents of house sparrow. Smaller type. D9848.jpg and D9850.jpg

34a & 34b. Schistosome-like eggs from intestinal contents of house sparrow. Smaller type. D9854.jpg and D9856.jpg

35a & 35b. Schistosome-like eggs from intestinal contents of house sparrow. Larger type. D9851.jpg and D9849.jpg

36a & 36b. Schistosome-like eggs from intestinal contents of house sparrow. Larger type. D9852.jpg and D9845.jpg

37. For comparison: egg of the schistosome *Trichobilharzia filiformis* from a swan. Image courtesy of Dr Jana Bulantova, Charles University, Prague. Image5.tif

38 a-c. Hairworm eggs from intestinal contents of dunnock. D9957.jpg, D9958.jpg and D9959.jpg

Chapter 4. Images of salmonellosis in finches, sparrows, buntings, dunnocks and tits.

39. Salmonellosis in greenfinch. Nodules in oesophagus and crop (opened). 5989.jpg

40. Salmonellosis in greenfinch. Nodules in liver. 5997.jpg

41. Salmonellosis in greenfinch. Enlarged spleen with nodules. 5986.jpg

42. Salmonellosis in greenfinch. Enlarged spleen with nodules. 5998.jpg

43. Salmonellosis in greenfinch. Nodules in oesophagus. D9124.JPG

44. Salmonellosis in greenfinch. Nodules in oesophagus. D9127.JPG

45. Salmonellosis in greenfinch. Distended oesophagus (unopened). D9128.JPG

46. Salmonellosis in greenfinch. Oesophagus opened - necrotic mucosa. D9129.JPG

47. Salmonellosis in greenfinch. Nodules in liver. D9126.JPG

48. Salmonellosis in chaffinch. Nodules in liver and spleen. 8035.jpg

49. Salmonellosis in house sparrow. Nodules in oesophagus. 7721.jpg

50. Salmonellosis in house sparrow. Nodules at caeca. 7726.jpg

51 & 52. Salmonellosis in house sparrow and tree sparrow. Thickened crop (unopened). 8027.jpg and 8050.jpg

53. Salmonellosis in house sparrow. Pericarditis, perihepatitis and peritonitis. 8058.jpg

54. Salmonellosis in house sparrow. Infection of shoulder joint. 8599.jpg

55. Salmonellosis in house sparrow. Lesions in oesophagus and liver. 8801.jpg

56. Salmonellosis in house sparrow. Lesions in oesophagus and liver. 8804.jpg

57. Salmonellosis in house sparrow. Nodules in liver. 8803.jpg

58. Salmonellosis in house sparrow. Large yellow caseous abscesses communicating with shoulder joints. D275.JPG

59. Salmonellosis in house sparrow. Large yellow caseous abscess with concentric rings, communicating with shoulder joint. D276.JPG

60. Salmonellosis in house sparrow. Distended oesophagus (unopened). D2945.jpg

61. Salmonellosis in house sparrow. Oesophagus opened - necrotic mucosa. D2947.jpg

62. Salmonellosis in dunnock. Purulent peritonitis visible in unopened carcase. D2973.jpg

63. Salmonellosis in dunnock. Purulent peritonitis. D2974.jpg

64. Salmonellosis in dunnock. Purulent peritonitis visible in unopened carcase. D1633.JPG

65. Salmonellosis in dunnock. Focal liver necrosis. D349.JPG

66. Salmonellosis in great tit. Nodules in lungs. 6126.jpg

67 & 68. Salmonellosis in great tit. Large abscess on liver, perihepatitis, nodules in spleen. 6129.jpg and 6126.jpg

69. Salmonellosis in redpoll. Nodules in oesophagus. D4587.jpg

70. Salmonellosis in redpoll. Nodules in oesophagus. D6301.jpg

Chapters 5 and 6. Images of *E. albertii* bacteraemia and trichomonosis in finches and buntings.

71. *E. albertii* bacteraemia in siskin. Much food in oesophagus. 6712.jpg

72. *E. albertii* bacteraemia in greenfinch. Much food in crop and gizzard. 5205.jpg

73. *E. albertii* bacteraemia in greenfinch. Much food in crop and gizzard. 5208.jpg

74. Trichomonosis in greenfinch. Oesophageal necrosis. D273a.JPG

75. Trichomonosis in chaffinch. Necrosis in oesophagus and around larynx. D219.JPG

76. Trichomonosis in chaffinch. Necrosis in oesophagus and around larynx. D2600.jpg

77. Trichomonosis in chaffinch. Oesophageal necrosis. D782.JPG

78. Trichomonosis in greenfinch. Unopened oesophagus. D821.JPG

79. Trichomonosis in greenfinch. Oesophagus opened. D822.JPG

80. Trichomonosis in greenfinch. Food removed. Diffuse necrotic oesophagitis. D823.JPG

81. Trichomonosis in greenfinch. Linear necrosis of oesophagus. D923.JPG

82. Trichomonosis in chaffinch. Necrotic oesophagitis and serositis (oesophagus unopened). D970.JPG

83. Trichomonosis in greenfinch. Necrotic oesophagitis (unopened). D1073.JPG

84. Trichomonosis in greenfinch. Oesophagus opened - much food, necrotic mucosa. D1074.JPG

85. Trichomonosis in chaffinch. Unopened oesophagus. D1079.JPG

86. Trichomonosis in chaffinch. Oesophagus opened - necrotic plaques. D1080.JPG

87. Trichomonosis in yellowhammer. Necrotic oesophagitis. D1683.jpg

88. Trichomonosis in yellowhammer. Necrosis around larynx and in oropharynx. D1685.jpg

89. Trichomonosis in reed bunting. Severe thickening and necrosis of oesophagus. D3400.jpg

90. Trichomonosis in reed bunting. Severe thickening and necrosis of oesophagus. D3401.jpg

91. Trichomonosis in bullfinch. Severe cellulitis over oesophagus. D5647.jpg

92. Trichomonosis in bullfinch. Oesophagus opened - much food. D5648.jpg

93. Trichomonosis in bullfinch. Food removed - necrotic oesophagitis. D5649.jpg

94. Chaffinch with trichomonosis. Concurrent candidiasis affecting oropharynx and subcutaneous tissues. D8306.JPG

95. Chaffinch with trichomonosis. Concurrent candidiasis affecting oropharynx and subcutaneous tissues. D8307.JPG

96. Chaffinch with trichomonosis. Concurrent candidiasis affecting oropharynx and subcutaneous tissues. D8308.JPG

Chapter 8, part 1. Images of trichomonosis, chlamydiosis, pox and other skin conditions in blackbirds, thrushes, robins and starlings.

97. Blackbird with trichomonosis. Yellow necrotic plaques in oesophagus. Lower oesophagus partially obstructed. D3996.jpg

98. Blackbird with trichomonosis. Areas of ulceration in oesophagus. D3998.jpg

99. Yellow nodule in oropharynx of robin. From site with trichomonosis in finches. Possible trichomonosis? Also chlamydiosis (see below). D1736.jpg

100. Chlamydiosis (and trichomonosis?) in robin. Necrotic hepatitis, fibrinous airsacculitis. D1737.jpg

101. Pox lesions around eyes and commissures of beak of starling. 9260.jpg

102. Pox lesions around eyes and commissures of beak of starling. 9258.jpg

103. Pox lesions on head of starling. Above and below beak. 7555.jpg

104. Pox in starling - underside of skin. Multiple nodules visible. 7560.jpg

105. Fungal skin infection of blackbird. Head, neck, upperside of wings. D1358.JPG

106. Fungal skin infection of blackbird. Thickening and scabbing of skin. D1355.JPG

107. Fungal skin infection of blackbird. Thickening and scabbing of skin. D1356.JPG

108. Fungal skin infection of blackbird. Thickening and scabbing of skin. D1359.JPG

109. Fungal skin infection of blackbird. Thickening and scabbing of skin. D1360.JPG

110. Feather loss and crusting of skin of head and neck of robin - cause unknown. Fungal infection suspected. 3604.jpg

Chapter 8, part 2. Images of coccidiosis in blackbirds, thrushes, robins and starlings.

111. Large numbers of unsporulated coccidial oocysts from song thrush. D7051.jpg

112. Large numbers of unsporulated coccidial oocysts from song thrush. D7052.jpg

113 – 115. Unsporulated coccidial oocysts from blackbird. D6915.jpg, D6914.jpg and D6913.jpg

116 – 118. Unsporulated coccidial oocysts from blackbird. D6911.jpg, D6907.jpg and D6905.jpg

119 & 120. Sporulated isosporoid coccidia from intestine of blackbird. D8677.jpg and D8678.jpg

121 & 122. Sporulated isosporoid coccidia from intestine of blackbird. D8681.jpg and D8682.jpg

123. Coccidiosis in blackbird 1. Heavy lymphoid cell infiltration into lamina propria, muscularis and serosa of intestine. H&E x 100. D8745.jpg

124. Coccidiosis in blackbird 1. Heavy lymphoid cell infiltration into lamina propria of intestine. H&E x100. D8744.jpg

125. Coccidiosis in blackbird 1. Heavy lymphoid cell infiltration in intestine. H&E x100. D8758.jpg

126. Coccidiosis in blackbird 1. Many coccidial stages and heavy lymphoid cell infiltration in lamina propria of intestine. H&E x400. D8763.jpg

127. Coccidiosis in blackbird 1. Oocysts in epithelial cells of villi of intestine. H&E x400. D8765.jpg

128. Coccidiosis in blackbird 1. Many coccidial stages and heavy lymphoid cell infiltration in lamina propria of intestine. H&E x400. D8767.jpg

129. Coccidiosis in blackbird 1. Many coccidial stages and heavy lymphoid cell infiltration in lamina propria of intestine. H&E x400. D8770.jpg

130. Coccidiosis in blackbird 1. Many coccidial stages in epithelial cells of crypt. H&E x400. D8771.jpg

131. Coccidiosis in blackbird 1. Mononuclear inflammatory cell infiltration into muscle layers and serosa of intestine. H&E x400. D8772.jpg

132. Coccidiosis in blackbird 2. Coccidial stages, heavy lymphocytic infiltration. H&E x400. D6978.jpg

133. Coccidiosis in blackbird 2. Coccidial stages, heavy lymphocytic infiltration. H&E x400. D6977.jpg

134. Coccidiosis in blackbird 2. Coccidial stages, heavy lymphocytic infiltration. H&E x400. D6975.jpg

135. Coccidiosis in blackbird 2. Coccidial stages, heavy lymphocytic infiltration. H&E x400. D6974.jpg

136. Coccidiosis in blackbird 2. Coccidial stages, heavy lymphocytic infiltration. H&E x400. D6972.jpg

137. Coccidiosis in blackbird 2. Coccidial stages, heavy lymphocytic infiltration. H&E x400. D6970.jpg

138. Coccidiosis in blackbird 2. Coccidial stages, heavy lymphocytic infiltration. H&E x400. D6968.jpg

Chapter 8, part 3. Images of helminths and helminth eggs in blackbirds, thrushes, robins and starlings.

139 & 140. Hairworm eggs from intestine of blackbird. Distinctive plugs at both poles. D9625.jpg and D9630.jpg.

141. Hairworm eggs from oesophagus of blackbird. Distinctive plugs at both poles. D7406.jpg.

142. *Porrocaecum* worms from intestine of blackbird. D9268.JPG

143. *Porrocaecum* worms from intestine of starling. D10135.jpg

144a & 144b. *Porrocaecum* eggs from blackbird. Eggs ellipsoid, thick scalloped shell. Operculum sometimes visible at poles. D7135.jpg and D7129.jpg.

145a & 145b. *Porrocaecum* eggs from blackbird. Eggs ellipsoid, thick scalloped shell. Operculum sometimes visible at poles. D7122.jpg and D7121.jpg.

146a & 146b. *Porrocaecum* eggs from blackbird. Eggs ellipsoid, thick scalloped shell. Operculum sometimes visible at poles. D8661.jpg and D8659.jpg.

147a & 147b. *Porrocaecum* eggs from blackbird. Eggs ellipsoid, thick scalloped shell. Operculum sometimes visible at poles. D9611.jpg and D9607.jpg.

148a & 148b. *Porrocaecum* eggs from blackbird. Eggs ellipsoid, thick scalloped shell. Operculum sometimes visible at poles. D6864.jpg and D6870.jpg.

149 & 150. *Porrocaecum* eggs from starling. Eggs ellipsoid, thick scalloped shell. D10057.jpg and D10058.jpg.

151 & 152. *Porrocaecum* eggs from starling. Eggs ellipsoid, thick scalloped shell. D10059.jpg and D10063.jpg.

153. Cross-section of *Porrocaecum*. H&E section x100. D6963.jpg

154. Cross-section of *Porrocaecum*. Eggs visible. H&E section x100. D6965.jpg

155. Cross-section of *Porrocaecum*. Eggs in worm. H&E section x400. D6966.jpg

156 & 157. Syngamid eggs from song thrush. Eggs smooth-shelled, ellipsoid, operculum visible at both poles. D7064.jpg and D7062.jpg.

158 & 159. Syngamid eggs from blackbird. Eggs smooth-shelled, ellipsoid, operculum visible at both poles. D7416.jpg and D7417.jpg.

160 & 161. Syngamid eggs from starling. Eggs smooth-shelled, ellipsoid, operculum visible at both poles. D6782.jpg and D6787.jpg.

162. *Porrocaecum* roundworms (left) and tapeworms (right) from blackbird. D9275.JPG

163 & 164. Tapeworm eggs from blackbird. Hexacanth larvae within large well-defined envelopes. D9645.jpg and D9649.jpg.

165. Tapeworm eggs from intestine of redwing. Hexacanth larvae within large well-defined envelopes. D8395.jpg.

166. Tapeworm egg from intestine of redwing. Hexacanth larva within large well-defined envelope. D8399.jpg.

167 & 168. Tapeworm eggs from blackbird. Hexacanth larvae within well-defined envelopes. D8695.jpg and D8696.jpg.

169 & 170. Tapeworm eggs from intestine of blackbird. Hexacanth larvae within two well-defined envelopes. D4887.jpg and D4886.jpg.

171 & 172. Tapeworm eggs from blackbird. Hexacanth larvae within two well-defined envelopes. D5730.jpg and D5735.jpg.

173 & 174. Tapeworm eggs from blackbird. Hexacanth larvae within two well-defined envelopes. D5736.jpg and D5740.jpg.

175 & 176. Tapeworm eggs from intestine of redwing. Hexacanth larvae enclosed in a thick envelope and a larger thin-walled envelope. D9329.jpg and D9328.jpg.

177 & 178. Tapeworm eggs from intestine of redwing. Hexacanth larvae enclosed in a thick envelope and a larger thin-walled envelope. D9327.jpg and D9323.jpg.

179. Thorny-headed worms in intestine of blackbird. Possibly *Sphaerirostris* sp. Fresh. D8310.JPG

180. Thorny-headed worms from blackbird. Possibly *Sphaerirostris* sp. Stored in formol saline. D9271.JPG

181. Thorny-headed worms from two blackbirds. Probably *Plagiorhynchus* sp. Stored in formol saline. D9273.JPG

182. Proboscis of thorny-headed worm from redwing. Probably *Plagiorhynchus* sp. D3132.jpg

183. Proboscis of thorny-headed worm from redwing. Probably *Plagiorhynchus* sp. D3131.jpg

184. Proboscis of thorny-headed worm from blackbird. Possibly *Sphaerirostris* sp. D7555.jpg

185a & 185b. Thorny-headed worm eggs from blackbird. Embryo within thick membrane. Probably *Plagiorhynchus* sp. D7005.jpg and D7007.jpg.

186a & 186b. Thorny-headed worm eggs from blackbird. Embryo within thick membrane. Probably *Plagiorhynchus* sp. D7015.jpg and D7012.jpg.

187a & 187b. Thorny-headed worm eggs from blackbird. Embryo within multiple layers. Possibly *Sphaerirostris* sp. D8354.jpg and D8355.jpg.

188a & 188b. Thorny-headed worm eggs from blackbird. Embryo within multiple layers. Possibly *Sphaerirostris* sp. D10084.jpg and D10086.jpg.

189 & 190. Thorny-headed worm eggs from blackbird. Embryo within multiple layers. Possibly *Sphaerirostris* sp. D10087.jpg and D10091.jpg.

191 – 193. Small fluke eggs from intestinal contents of redwing. Operculum may be visible at one pole. D9279, D9281 and D9290.jpg.

194 – 196. Small fluke eggs from intestinal contents of redwing. Operculum may be visible at one pole. D9292, D9295 and D9299.jpg.

197 & 198. Small fluke eggs from intestinal contents of fledgling robin. Operculum may be visible at one pole. 4392.jpg and 4391.jpg

Chapter 8, part 4. Images of schistosome-like eggs in blackbirds, and other eggs for comparison.

199. Necrotic hepatitis in blackbird 1. Schistosome-like eggs found in liver and intestine. D2845.jpg

200. Schistosome-like eggs in intestinal contents of blackbird 1. x40. D4860.jpg

201. Schistosome-like eggs in intestinal mucosa and contents of blackbird 1, plus tapeworm. x40. D4868.jpg

202. Schistosome-like eggs from intestinal contents of blackbird 1, plus tapeworm. x100. D4869.jpg

203. Schistosome-like eggs from intestinal contents of blackbird 1. x100. D4866.jpg

204. For comparison. Schistosome-like eggs in mucosa of intestine of dunnock. x100. D9733.jpg

205a & 205b. Schistosome-like eggs from intestinal contents of blackbird 3. Smaller type. D9657.jpg and D9666.jpg

206a & 206b. Schistosome-like eggs from intestinal contents of blackbird 3. Smaller type. D9651.jpg and D9659.jpg

207a & 207b. Schistosome-like eggs from intestinal contents of blackbird 1. Larger type. D6829.jpg and D6844.jpg

208a & 208b. Schistosome-like eggs from intestinal contents of blackbird 1. Larger type. D6827.jpg and D6832.jpg

209a & 209b. Schistosome-like eggs from intestinal contents of blackbird 1. Larger type. D6856.jpg and D6859.jpeg

210. For comparison: Schistosome-like eggs from intestinal contents of dunnock. D9191.jpg

211a & 211b. For comparison: Schistosome-like eggs from intestinal contents of dunnock. D9188.jpg and D9187.jpg

212a & 212b. For comparison: Schistosome-like eggs from intestinal contents of house sparrow. Smaller type. D9848.jpg and D9850.jpg

213a & 213b. For comparison: Schistosome-like eggs from intestinal contents of house sparrow. Larger type. D9852.jpg and D9845.jpg

214a & 214b. For comparison: Schistosome-like eggs from intestinal contents of house sparrow. Larger type. D9851.jpg and D9849.jpg

215a & 215b. For comparison: Schistosome-like eggs from intestinal contents of redwing. Larger type. D10167.jpg and D10173.jpg

216a & 216b. For comparison: Schistosome-like eggs from intestinal contents of redwing. Smaller type. D10170.jpg and D10168.jpg

217 & 218. For comparison: *Schistosoma japonicum* eggs in unstained wet mount of human faeces. Eggs measure 70-100µm by 55-64µm. DPDx - Laboratory Identification of Parasitic Diseases of Public Health Concern. http://www.cdc.gov/dpdx/schistosomiasis/gallery.html#xsection

219 & 220. For comparison: *Schistosoma japonicum* eggs in unstained wet mount of human faeces. Eggs measure 70-100µm by 55-64µm. DPDx - Laboratory Identification of Parasitic Diseases of Public Health Concern. http://www.cdc.gov/dpdx/schistosomiasis/gallery.html#xsection

221a & 221b. For comparison: Schistosome-like eggs from intestinal contents of tawny owl. True parasites or pseudoparasites from prey? D8428.jpg and D8427.jpg

222a & 222b. For comparison: Schistosome-like eggs from intestinal contents of sparrowhawk. True parasites or pseudoparasites from prey? D5060.jpg and D5061.jpg

223a & 223b. For comparison: Schistosome-like egg from blackbird (left) and tapeworm egg from same bird (right). D4875.jpg and D4887.jpg

224 & 225. For comparison: Schistosome-like egg from blackbird (left) and tapeworm egg from same bird (right). D4884.jpg and D4886.jpg

226. Schistosome-like eggs in blackbird 1 liver. H&E x100. D5124.jpg

227. Schistosome-like eggs in blackbird 1 liver. H&E x100. D5125.jpg

228. Schistosome-like eggs in blackbird 1 liver. H&E x100. D5128.jpg

229. Schistosome-like eggs in blackbird 1 liver. H&E x100. D5129.jpg

230. Schistosome-like eggs in blackbird 1 liver. H&E x100. D5132.jpg

231. Schistosome-like eggs in blackbird 1 liver. H&E x100. D5140.jpg

232. For comparison: *Schistosoma japonicum* eggs in hepatic portal tract. https://en.wikipedia.org/wiki/Schistosomiasis

233. For comparison: *Schistosoma haematobium* infection of the bladder. https://www.studyblue.com/switch/cpt.html

234. Schistosome-like eggs in blackbird 1 liver. H&E x400. D5142.jpg

235. Schistosome-like eggs in blackbird 1 liver. H&E x400. D5143.jpg

236. For comparison: *Heterobilharzia americana* in liver. https://sites.google.com/site/vetpathforum/infectious-organisms

237. For comparison: *Heterobilharzia americana* in small intestine. https://sites.google.com/site/vetpathforum/infectious-organisms

238. For comparison: intestinal granuloma associated with *Schistosoma mansoni*. http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=21151

239. For comparison: *Schistosoma mansoni* egg in gall bladder. http://www.ijcasereportsandimages.com/archive/2014/006-2014-ijcri/CR-10395-06-2014-manes/ijcri-1039506201495-manes-full-text.php

240. Schistosome-like eggs in blackbird 1 liver. H&E x400. D5146.jpg

241. Schistosome-like eggs in blackbird 1 liver. H&E x400. D5154.jpg

242. Schistosome-like eggs in blackbird 1 intestine. H&E x40. D5156.jpg

243. Schistosome-like eggs in blackbird 1 intestine. H&E x40. D5159.jpg

244. Schistosome-like eggs in blackbird 1 intestine. H&E x100. D5163.jpg

245. Schistosome-like eggs in blackbird 1 intestine. H&E x100. D5165.jpg

246. Schistosome-like eggs in blackbird 1 intestine. H&E x400. D5167.jpg

247. Schistosome-like eggs in blackbird 1 intestine. H&E x400. D5168.jpg

248. Schistosome-like eggs in blackbird 1 intestine. H&E x400. D5169.jpg

249. Schistosome-like eggs in blackbird 1 intestine. H&E x400. D5177.jpg

250. Schistosome-like eggs in blackbird 1 intestine. H&E x400. D5171.jpg

251. For comparison: eggs of *Schistosoma mansoni* in colon. http://www.ucdmc.ucdavis.edu/pathology/education/residency_program/caseofthemonth/201103/final.html

252. For comparison: egg of *Schistosoma mansoni* in granuloma. http://www.askjpc.org/wsco/wsc/wsc96/96wsc03.htm

253. Necrotic hepatitis in blackbird 2. Schistosome-like eggs seen in liver on histopathology. D2359.jpg

254a & 254b. Schistosome-like eggs in liver of blackbird 2. H&E x400. D9434.jpg and D9435.jpg

255a & 255b. Schistosome-like eggs in liver of blackbird 2. H&E x400. D9436.jpg and D9437.jpg

256a & 256b. Schistosome-like eggs in liver of blackbird 2. H&E x400. D9438.jpg and D9439.jpg

257a & 257b. Schistosome-like eggs in liver of blackbird 2. H&E x400. D9440.jpg and D9441.jpg

258a & 258b. Schistosome-like eggs in liver of blackbird 2. H&E x400. D9442.jpg and D9443.jpg

259. For comparison: eggs of *Schistosoma haematobium* in bladder. http://emedicine.medscape.com/article/2055346-overview

260a. For comparison: Schistosome eggs in mucosa of intestine of mute swan. H&E x400. D4621.jpg.

260b. For comparison: Schistosome eggs in mucosa of intestine of mute swan. H&E x400. D4622. jpg.

261a. For comparison: Schistosome eggs in mucosa of intestine of mute swan. H&E x400. D8551. jpg.

261b. For comparison: Schistosome eggs in mucosa of intestine of mute swan. H&E x100. D8552. jpg.

262a. For comparison: Schistosome eggs in mucosa of intestine of mute swan. H&E x100. D5697. jpg.

262b. For comparison: Schistosome eggs in mucosa of intestine of mute swan. H&E x100. D5698. jpg.

263a. For comparison: *Porrocaecum* eggs from female worm in intestine of blackbird. H&E x400. D6966. jpg.

263b. For comparison: hairworm eggs in tongue of buzzard. H&E x400. D6922. jpg.

264a & 264b. For comparison: *Syngamus* eggs in lung of carrion crow. H&E x400. D8605.jpg and D8607.jpg

265 - 267. For comparison: *Echinuria* eggs from female worm in proventriculus of swan. H&E x400. D9447.jpg, D9450.jpg and D9452.jpg

268 & 269. For comparison: thorny-headed worm eggs from female worm in intestine of rook. H&E x400. D8117.jpg and D8119.jpg

270. For comparison: thorny-headed worm eggs from female worm in intestine of mute swan. H&E x400. D5705.jpg

271. For comparison: coccidial oocysts in mucosa of intestine of blackbird. H&E x400. D6978.jpg.

Chapter 8, part 5. Images of fledgling CNS disorder in starlings, and aspergillosis in blackbirds.

272. CNS disorder in starling. Torticollis. D6441.jpg

273. CNS disorder in starling. Torticollis. D6442.jpg

274. CNS disorder in starling. Torticollis. 3695.jpg

275. CNS disorder in starling. Torticollis. 3690.jpg

276. CNS disorder in starling. Torticollis. 3692.jpg

277. CNS disorder in starling. Torticollis. 3689.jpg

278. Fledgling starling - CNS disorder. Histopathology – non-suppurative encephalitis. x200. Image courtesy of A. Wood. 2177 (x20).jpg

279. Fledgling starling - CNS disorder. Histopathology – non-suppurative encephalitis. Protozoa visible at arrow. x400. Image courtesy of A. Wood. Starling protozoa.jpg.

280. Three blackbird nestlings that died from aspergillosis. 8977.jpg

281. Yellow nodules in the lungs of the three blackbird nestlings. *Aspergillus fumigatus* isolated. 8978.jpg

282. Aspergillosis in immature blackbird. Yellow nodules in lungs and airsacs. 9175.jpg

283. Aspergillosis in immature blackbird. Yellow nodules in lungs and airsacs. 9177.jpg

284. Aspergillosis in immature blackbird. Yellow nodules in lungs and airsacs. 9179.jpg

285. Aspergillosis in immature blackbird. Yellow nodules in lungs. D855.JPG

Chapter 8, part 6. Images of miscellaneous conditions in starlings and blackbirds.

286. *Yersinia pseudotuberculosis* in starling. Enlarged liver, necrotic foci. D331.JPG

287. *Yersinia pseudotuberculosis* in starling. Enlarged spleen, necrotic foci. D333.JPG

288. Young starling. No eyes. D75.JPG

289. Young starling. No eyes. Skin reflected from head. D77.JPG

290. Young blackbird. Enlarged liver, cause unknown. D319.JPG

291. Young blackbird. Enlarged spleen, cause unknown. D321.JPG

292. Young blackbird. Liver enlarged, cause unknown. 8295.jpg

293. Young blackbird. Liver enlarged, cause unknown. 8285.jpg

Chapter 9, part 1. Images of trauma, malnourished fledglings, mycotic pneumonia / airsacculitis and avian tuberculosis in corvids.

294. Trauma in rook. Airgun injury. D707.JPG

295. Trauma in rook. Airgun injury. D708.JPG

296. Trauma in rook. Airgun injury. D710.JPG

297. Head trauma in jackdaw. Fractured skull, torticollis. D3616.jpg

298. Malnourished fledgling rook. Poor feathering. D3987.jpg

299. Malnourished fledgling rook. Poor feathering. D3992.jpg

300. Mycotic pneumonia and airsacculitis in jackdaw. Fungal hyphae consistent with *Aspergillus* sp. seen on histopathology. 9510.jpg

301. Mycotic pneumonia and airsacculitis in jackdaw, extending to spinal abscess. Fungal hyphae consistent with *Aspergillus* sp. seen on histopathology. 9514.jpg

302. Mycotic pneumonia and airsacculitis in jackdaw, extending to spinal abscess. Fungal hyphae consistent with *Aspergillus* sp. seen on histopathology. 9516.jpg

303. Nodules in lung of jackdaw. *Aspergillus fumigatus* isolated. Same bird had lesions of avian tuberculosis elsewhere (see below). 8742.jpg

304. Nodules in liver and spleen of jackdaw, and on serosa of duodenum. Avian tuberculosis. 8744.jpg

305. Nodules in gizzard and spleen of jackdaw, and on serosa of duodenum. Avian tuberculosis. 8746.jpg

306. Avian tuberculosis in jackdaw. Excess pericardial fluid, irregular pale areas on myocardium, diffuse enlargement of liver. D1985.jpg

307. Avian tuberculosis in jackdaw. Enlarged spleen with nodules and miliary foci. D1986.jpg

Chapter 9, part 2. Images of syngamid worms, hairworms, roundworms and coccidia in corvids.

308. Gapeworms (*Syngamus trachea*) in trachea of rook. 5319.jpg

309. Gapeworms (*Syngamus trachea*) in nasal passages of rook. Spill-over from large numbers in trachea. 8961.jpg

310. *Cyathostoma* sp. from mouth of jackdaw. Each division is 1mm. D4319.jpg

311. *Cyathostoma* sp. in mouth of rook nestling. D4839.jpg

312. Syngamid worms from rook – *Syngamus trachea* (top and bottom) and *Cyathostoma* sp. (middle). D4958.jpg

313 & 314. *Syngamus trachea* eggs from rook. Smooth-walled, ellipsoid, operculum at both poles. Well-developed morula. 4217.jpg and D8994.jpg

315 & 316. *Syngamus trachea* eggs from carrion crow. Smooth-walled, ellipsoid, operculum at both poles. Well-developed morula. D5840.jpg and D5843.jpg

317 & 318. *Syngamus trachea* eggs from carrion crow. Smooth-walled, ellipsoid, operculum at both poles. Well-developed morula. D7723.jpg and D7729.jpg

319. Emphysema under mandible of immature rook with heavy burden of gapeworms. 8941.jpg

320. Granulomatous pneumonia in carrion crow associated with gapeworms. H&E x100. D8603.jpg

321. Granulomatous pneumonia in carrion crow associated with gapeworms. Adult worm. H&E x400. D8604.jpg

322. Granulomatous pneumonia in carrion crow associated with gapeworms. Gapeworm egg. H&E x400. D8605.jpg

323. Granulomatous pneumonia in carrion crow associated with gapeworms. Gapeworm eggs in granuloma. H&E x400. D8607.jpg

324. Stomatitis in adult rook associated with large numbers of hairworms. Also severe respiratory disease. D2966.jpg

325. Stomatitis in adult rook associated with large numbers of hairworms. Also severe respiratory disease. D2967.jpg

326. Stomatitis in immature rook. Many hairworms. Also respiratory disease. D4153.jpg

327. Stomatitis in immature rook. Many hairworms. Also respiratory disease. D4154.jpg

328. Hairworms and eggs from oesophagus of rook. 7247.jpg

329. Hairworm eggs from mouth of carrion crow. Distinctive plugs at both poles. 5532.jpg

330 & 331. Hairworm eggs from intestinal contents of rook. Distinctive plugs at both poles. D5662.jpg and D5666.jpg

332 & 333. Hairworm eggs from intestinal contents of rook. Distinctive plugs at both poles. D5671.jpg and D5673.jpg

334 & 335. Hairworm eggs from intestinal contents of rook. Distinctive plugs at both poles. Hairworms present in upper and lower digestive tracts. D8812.jpg and D8813.jpg.

336 - 338. Hairworm eggs from intestinal contents of rook. Distinctive plugs at both poles. Hairworms present in upper and lower digestive tracts. D8814.jpg and D8816.jpg.

339. Carrion crow with thickened intestinal wall. Large roundworms (*Porrocaecum* sp.) and tapeworms.D7747.jpg

340 & 341. *Porrocaecum* sp. eggs from intestine of carrion crow. Eggs ellipsoid, thick scalloped shells. Operculum sometimes visible at poles. D7708.jpg and D7711.jpg

342 & 343. *Porrocaecum* sp. eggs from intestine of carrion crow. Eggs ellipsoid, thick scalloped shells. Operculum sometimes visible at poles. D7716.jpg and D7717.jpg

344 a-c. Unsporulated isosporoid coccidial oocysts from carrion crow. D9724.jpg, D9727.jpg and D9728.jpg

344 d-f. Unsporulated isosporoid coccidial oocysts from chough. D9601.jpg, D9602.jpg and D9604.jpg

345 a-c. Isosporoid coccidial oocysts containing two sporocysts from carrion crow. D9595.jpg, D9596.jpg and D9599.jpg

Chapter 9, part 3. Images of tapeworms and thorny-headed worms in corvids.

346. Tapeworms in intestine of rook. 6913.jpg

347. Tapeworms from intestine of rook. 7933.jpg

348. Tapeworms from intestine of rook. 7937.jpg

349 & 350. Tapeworm eggs from intestine of carrion crow. Hexacanth larvae inside larger envelopes. D7730.jpg and D7731.jpg

351 & 352. Tapeworm eggs from intestine of rook. Hexacanth larvae inside larger envelopes. D8978.jpg and D8989.jpg

353 – 355. Tapeworm eggs from intestine of rook. Hexacanth larvae inside larger envelopes. D8982.jpg, D8983.jpg and D8987.jpg

356. Thorny-headed worm (centre) and tapeworms from rook. D8079.jpg

357. Thorny-headed worms in intestine of rook. D7945.JPG

358. Thorny-headed worms in intestine of rook. D7947.JPG

359. Thorny-headed worms in intestine of rook (stored in formol saline). D7950.JPG

360. Proboscis of thorny-headed worm from intestine of carrion crow. D6722.jpg

361. Proboscis of thorny-headed worm from intestine of carrion crow. D6723.jpg

362 & 363. Eggs from thorny-headed worm from intestine of carrion crow. D6727.jpg

364 - 366. Eggs from thorny-headed worm from intestine of rook. D10125.jpg, D10094.jpg and D10098.jpg

367 - 369. Eggs from thorny-headed worm from intestine of rook. Same bird as images 364-366. D8103.jpg, D8109.jpg and D8110.jpg

370 - 372. Eggs from thorny-headed worm from intestine of rook. Same bird as images 364-369. Larger eggs, multiple layers, contents less distinct. D10126.jpg, D10127.jpg and D10129.jpg

373 a-c. Eggs from thorny-headed worm from intestine of rook. Same bird as images 364-369. Larger eggs, multiple layers, contents less distinct. D10130.jpg, D10132.jpg and D10133.jpg

374. Thorny-headed worms in intestine of rook – histopathology H&E x40. D8114.jpg

375. Thorny-headed worms in intestine of rook – histopathology H&E x100. D8115.jpg

376. Thorny-headed worms in intestine of rook – histopathology H&E x100. D8116.jpg

377. Eggs in thorny-headed worm from intestine of rook – histopathology H&E x400. D8117.jpg

378. Eggs in thorny-headed worm from intestine of rook – histopathology H&E x400. D8120.jpg

Chapter 9, part 4. Images of hairworms, gapeworms, gizzard worms and thorny-headed worms in choughs.

379. Necrotic stomatitis in chough - many hairworms. 9808.jpg

380. Necrotic stomatitis in chough - many hairworms. Oblique view. 9810.jpg

381 & 382. Hairworm eggs from chough. Barrel-shaped, with plug at both poles. D3894.jpg and D3896.jpg.

383. Hairworm egg from chough. Barrel-shaped, with plug at both poles. D3904.jpg

384 & 385. *Syngamus trachea* (gapeworm) eggs from chough. Ellipsoid, smooth walled, operculum at both poles. Well-formed morula. D3892.jpg and D3898.jpg

386 & 387. *Syngamus trachea* (gapeworm) eggs from chough. Ellipsoid, smooth walled, operculum at both poles. Well-formed morula. D3902.jpg and D3908.jpg

388. Gizzard worms in underside of koilin layer of gizzard of chough. Koilin layer peeled back, exposing ulcerated gizzard mucosa. D2862.jpg

389. Gizzard worms in underside of koilin layer of gizzard of chough. Large defect with ragged edges in koilin layer. D2863.jpg

390. Mucosa of gizzard black, roughened, ulcerated. D2859.jpg

391. Worms removed from gizzard of chough. Up to 16mm long and 1mm wide. D2864.jpg

392. Gizzard of chough. Dark degenerating koilin layer caused by gizzard worms. D3369.jpg

393. Gizzard of chough. Gizzard worms on underside of koilin layer. D3370.jpg

394. Gizzard worm from chough. D3493.jpg

395. Gizzard worm from chough. Anterior end – cervical papillae but no obvious cordons. D3494.jpg

396. Gizzard worm from chough. Anterior end – cervical papillae but no obvious cordons. D3495.jpg

397. Gizzard worm from chough. Anterior end – cervical papillae but no obvious cordons. D3502.jpg

398. Gizzard worm from chough. Anterior end – cervical papillae but no obvious cordons. D3503.jpg

399. Gizzard worm from chough. Posterior end of male – caudal alae and spicule. D3499.jpg

400. Gizzard worm from chough. Posterior end of male – caudal alae and spicule. D3497.jpg

401. Gizzard worm from chough. Posterior end of male – caudal alae and papillae. D3500.jpg

402. Gizzard worm from chough. Posterior end of male – caudal alae and spicule. D3501.jpg

403. Gizzard worm from chough. Female with many eggs. D3504.jpg

404. Gizzard worm from chough. Many eggs near female. D3505.jpg

405 & 406. Gizzard worm from chough. Eggs containing larvae. D3958.jpg and D3960.jpg

407 & 408. Left – syngamid egg from chough. Right – gizzard worm eggs from chough. D3966.jpg and D3962.jpg

409. Thorny-headed worms and tapeworms in intestine of chough. D3490.jpg

410. Thorny-headed worms and tapeworms in intestine of chough. D3491.jpg

411. Thorny-headed worms from chough (from alcohol). D3437.jpg

412. Thorny-headed worms in chough. Wall of intestine thickened, much sand in contents of upper intestine. D5227.jpg

413. Thorny-headed worms in lower intestine of chough. Wall of intestine thickened. D5231.jpg

414. Thorny-headed worms in lower intestine of chough. Contents haemorrhagic. D5232.jpg

415. Thorny-headed worms removed from intestine of chough. D5236.jpg

416. Thorny-headed worms removed from intestine of chough (stored in alcohol). Each division is 1mm. D5239.jpg

417. Proboscis of thorny-headed worm from chough. D5551.jpg

418. Proboscis of thorny-headed worm from chough. D5552.jpg

419 & 420. Eggs of thorny-headed worm from chough. D5555.jpg and D5560.jpg

421 & 422. Eggs of thorny-headed worm from chough. D5565.jpg and D5568.jpg

Chapter 9, part 5. Images of corvid respiratory syndrome (CRS) and respiratory tract conditions not otherwise specified in corvids.

423. Corvid respiratory syndrome. Bird 5. Rook. Mild pericarditis, extensive pneumonia. PCR for *Mycoplasma gallisepticum* positive. 8693.JPG

424. Corvid respiratory syndrome. Bird 5. Rook. Dorsal aspect of lungs. Extensive grey-coloured pneumonia and pleurisy, and multiple small yellow nodules in lungs. PCR for *Mycoplasma gallisepticum* positive. 8695.JPG

425. Corvid respiratory syndrome. Bird 5. Rook. Ventral aspect of lungs. Extensive grey-coloured pneumonia and pleurisy, and multiple small yellow nodules in lungs. PCR for *Mycoplasma gallisepticum* positive. 8697.JPG

426. Corvid respiratory syndrome. Bird 9. Carrion crow. Nodules in lungs (dorsal aspect). Mixed bacteria and *Candida albicans* isolated. D4467.jpg

427. Corvid respiratory syndrome. Bird 9. Carrion crow. Nodules in lungs, pleurisy on surface (ventral aspect). Mixed bacteria and *Candida albicans* isolated. D4469.jpg

428. Corvid respiratory syndrome. Bird 9. Carrion crow. Also caseous debris around larynx and elsewhere in oropharynx. Mixed bacteria and *Candida albicans* isolated. Moderate hairworms. D4466.jpg

429. Corvid respiratory syndrome. Bird 11. Rook. Fibrinous pericarditis, perihepatitis and airsacculitis. PCR for *Mycoplasma gallisepticum* and for *Chlamydia psittaci* positive. D295.JPG

430. Corvid respiratory syndrome. Bird 11. Rook. Severe airsacculitis. PCR for *Mycoplasma gallisepticum* and for *Chlamydia psittaci* positive. D296.JPG

431. Corvid respiratory syndrome. Bird 14. Carrion crow. Fibrinous pericarditis and airsacculitis. PCR for *Mycoplasma gallisepticum* and for *Chlamydia psittaci* positive. D3180.jpg

432. Corvid respiratory syndrome. Bird 14. Carrion crow. Fibrinous pericarditis and airsacculitis. PCR for *Mycoplasma gallisepticum* and for *Chlamydia psittaci* positive. D3182.jpg

433. Corvid respiratory syndrome. Bird 14. Carrion crow. Fibrinous airsacculitis and pneumonia. PCR for *Mycoplasma gallisepticum* and for *Chlamydia psittaci* positive. D3185.jpg

434. Corvid respiratory syndrome. Bird 14. Carrion crow. Areas of fawn-coloured pneumonia. PCR for *Mycoplasma gallisepticum* and for *Chlamydia psittaci* positive. D3186.jpg

435. Corvid respiratory syndrome. Bird 15. Rook. Severe fibrinous pericarditis and airsacculitis, and granulomatous pneumonia. Mixed bacteria including *Pasteurella multocida* isolated. D5358.jpg

436. Corvid respiratory syndrome. Bird 15. Rook. Airsac opened - severe fibrinous airsacculitis. Mixed bacteria including *Pasteurella multocida* isolated. D5360.jpg

437. Corvid respiratory syndrome. Bird 15. Rook. Granulomatous pneumonia. Mixed bacteria including *Pasteurella multocida* isolated. D5362.jpg

438. Corvid respiratory syndrome. Bird 15. Rook. Ventral aspect of lungs - granulomatous pneumonia. Mixed bacteria including *Pasteurella multocida* isolated. D5363.jpg

439. Corvid respiratory syndrome. Bird 16. Rook. Severe fibrinous pericarditis and airsacculitis. PCR for *Mycoplasma gallisepticum* positive. D2969.jpg

440. Corvid respiratory syndrome. Bird 16. Rook. Severe fibrinous pericarditis and airsacculitis. Granulomas in lungs. PCR for *Mycoplasma gallisepticum* positive. D2970.jpg

441. Corvid respiratory syndrome. Bird 16. Rook. Granulomas in lungs. PCR for *Mycoplasma gallisepticum* positive. D2971.jpg

442. Corvid respiratory syndrome. Bird 16. Rook. Granulomas in lungs – cut surfaces. PCR for *Mycoplasma gallisepticum* positive. D2972.jpg

443. Corvid respiratory syndrome. Bird 17. Rook. Pericarditis, airsacculitis, pneumonia. Enlarged liver. PCR for *Mycoplasma gallisepticum* positive. D4301.jpg

444. Corvid respiratory syndrome. Bird 17. Rook. Fibrinous pericarditis. PCR for *Mycoplasma gallisepticum* positive. D4303.jpg

445. Corvid respiratory syndrome. Bird 17. Rook. Red exudative pneumonia plus pale nodules. PCR for *Mycoplasma gallisepticum* positive. D4305.jpg

446. Corvid respiratory syndrome. Bird 18. Rook. Thoracic and abdominal airsacculitis. PCR for *Mycoplasma gallisepticum* and for *Chlamydia psittaci* positive. D4156.jpg

447. Corvid respiratory syndrome. Bird 18. Rook. Purulent debris on underside of sternum. PCR for *Mycoplasma gallisepticum* and for *Chlamydia psittaci* positive. D4158.jpg

448. Corvid respiratory syndrome. Bird 18. Rook. Thoracic and abdominal airsacculitis. PCR for *Mycoplasma gallisepticum* and for *Chlamydia psittaci* positive. D4160.jpg

449. Corvid respiratory syndrome. Bird 18. Rook. Red lung consolidation with grey granulomas. PCR for *Mycoplasma gallisepticum* and for *Chlamydia psittaci* positive. D4166.jpg

450. Corvid respiratory syndrome. Bird 18. Rook. Red lung consolidation with grey granulomas (ventral surface). PCR for *Mycoplasma gallisepticum* and for *Chlamydia psittaci* positive. D4167.jpg

451. Corvid respiratory syndrome. Bird 19. Rook. Enlarged liver, extensive airsacculitis. D4642.jpg

452. Corvid respiratory syndrome. Bird 19. Rook. Airsac reflected. D4645.jpg

453. Corvid respiratory syndrome. Bird 19. Rook. Small foci of pneumonia. D4647.jpg

454. Corvid respiratory syndrome. Bird 19. Rook. Excess mucus, green nodule caused by sinusitis extending into palate. D4641.jpg

455. Corvid respiratory syndrome. Bird 20. Jackdaw. Ocular discharge and peri-orbital loss of feathers. Sinusitis and pneumonia. D4133.jpg

456. Corvid respiratory syndrome. Bird 20. Jackdaw. Purulent sinusitis. Also pneumonia. D4135.jpg

457. Respiratory tract condition NOS. Bird 22. Lung from hooded crow. Focal pneumonia and pleurisy. Mixed bacteria isolated. 4804.jpg

458. Respiratory tract condition NOS. Bird 29. Lung from carrion crow. Cream-coloured area of pneumonia. Heavy growth of *Pasteurella haemolytica* – like bacteria isolated. 5953.jpg

459. Respiratory tract condition NOS. Bird 29. Heart from carrion crow. Purulent pericarditis. Heavy growth of *Pasteurella haemolytica* – like bacteria isolated. 5955.jpg

460 & 461. Respiratory tract condition NOS. Bird 29. Carrion crow. Left: Caseous debris on either side of tongue and laryngeal mound. Right: Caseous debris around underside of tongue (removed). Heavy growth of *Candida albicans* and *Pasteurella haemolytica* – like bacteria isolated. 5959.jpg and 5957.jpg

462. Respiratory tract condition NOS. Bird 31. Adult rook. Abdomen filled with yellow fluid. 7734.jpg

463. Respiratory tract condition NOS. Bird 31. Adult rook. Enlarged liver with tiny necrotic foci. Fibrinous pericarditis, perihepatitis, airsacculitis, pneumonia. Heavy growths of *E. coli* isolated. 7738.jpg

464. Respiratory tract condition NOS. Bird 36. Carrion crow with loss of feathers from around eye. Lice and mites present. Airsacculitis and pneumonia. Mixed bacteria isolated. 9054.jpg

465. Respiratory tract condition NOS. Bird 39. Immature rook. Caseous airsacculitis visible through abdominal wall. D936.JPG

466. Respiratory tract condition NOS. Bird 39. Immature rook. Heart and liver partially covered by extensive caseous pericarditis, perihepatitis and airsacculitis. Mixed bacteria isolated. D938.JPG

467. Respiratory tract condition NOS. Bird 39. Immature rook. Heart and liver partially covered by extensive caseous pericarditis, perihepatitis and airsacculitis. Portion of airsac removed. Mixed bacteria isolated. D940.JPG

468. Respiratory tract condition NOS. Bird 40. Carrion crow. Euthanased in early stages. Pericarditis, perihepatitis, enlarged liver. Mixed bacteria and *Candida albicans* isolated from lung and sinus. D4487.jpg

469. Respiratory tract condition NOS. Bird 40. Carrion crow. Euthanased in early stages. Cross-section through beak – purulent sinusitis. Mixed bacteria and *Candida albicans* isolated from lung and sinus. D4489.jpg

Chapter 9, part 6. Images of pox, feather loss, *Cnemidocoptes*, *Ornithonyssus*, lice and feather mites in corvids.

470. Pox nodules in jackdaw. 7462.jpg

471. Pox nodules in jackdaw. Ventral aspect. 7466.jpg

472. Pox nodules on toes of magpie. 5861.jpg

473. Pox nodules on toes of magpie. 5865.jpg

474 & 475. Feather loss in immature jackdaw. Cause unknown. 4331.jpg and 4333.jpg

476. Immature magpie. Feather loss from inner and outer aspects of both legs. Died from necrotic enteritis. D4028.jpg

477. Cnemidocoptic mange (scaly leg) in rook. 7163.jpg

478. Cnemidocoptic mange (scaly leg) in rook. 7165.jpg

479. Early cnemidocoptic mange (scaly leg) in rook. 7167.jpg

480. Early cnemidocoptic mange (scaly leg) in rook. 9326.jpg

481. Cnemidocoptic mange (scaly leg) in carrion crow. 4097.jpg

482 - 484. *Cnemidocoptes* sp. mites from rook. Adult female (left), adult male (middle), larva (right). 7256.jpg, 7264.jpg, and 7254.jpg

485. Large numbers of northern fowl mite (*Ornithonyssus* sp.) on rook. 8263.jpg

486. Large numbers of northern fowl mite (*Ornithonyssus* sp.) on rook. 8268.jpg

487. Large numbers of northern fowl mite (*Ornithonyssus* sp.) on rook (different bird). 3608.jpg

488. Northern fowl mite (*Ornithonyssus* sp.) from rook. 3940.jpg

489 - 490. Left: anal plate from northern fowl mite (*Ornithonyssus* sp.) from rook – ovoid, with anterior anus. Right: anal plate from red mite (*Dermanyssus* sp.) from chicken – cup-shaped, with posterior anus. Mites partially cleared in KOH. 3945.jpg and 3966.jpg

491. Lice and mites on rook. D1653.jpg

492. Lice and mites on rook. D1652.jpg

493. Lice and mites on rook. D1654.jpg

494. Lice from rook. D2960.jpg

495. Lice from rook (closer). D2960.jpg

496. Feather loss in immature rook – many lice. Also heavy burden of mixed internal parasites. D5101.jpg

497. Feather loss in immature rook – many lice. Also heavy burden of mixed internal parasites. D5108.jpg

498. Feather loss in immature rook – many louse eggs around eye and corner of beak. Also heavy burden of mixed internal parasites. D5103.jpg

499. Feather loss in immature rook – many louse eggs under mandible. Also heavy burden of mixed internal parasites. D5105.jpg

500. Feather loss in immature rook – many lice. Also heavy burden of mixed internal parasites. D5107.jpg

501. Feather mite from chough. Male. D5001.jpg

502. Feather mite from chough. Male. D5003.jpg

503. Feather mite from chough. Female. D5000.jpg

504. Feather mite from chough. Female. D5002.jpg

Chapter 9, part 7. Images of eye/brain abnormalities in young choughs.

505. Immature chough. Corneal opacity. D92.JPG

506. Immature chough. Corneal opacity. D93.JPG

507. Immature chough. Corneal opacity. D95.JPG

508. Immature chough. Corneal opacity. D3518.jpg

509. Immature chough. Corneal opacity. D3520.jpg

510. Immature chough. Corneal opacity. D3525.jpg

511. Eye abnormality in chough fledgling. Corneal opacity of left eye. D4924.jpg

512. Eye abnormality in chough fledgling. Green discoloration of cornea of right eye. D4925.jpg

513. Eye abnormality in chough fledgling. Disparity in size of globes – left eye larger. D4926.jpg

514. Eye abnormality in chough fledgling. Disparity in size of globes – left eye (larger). D4928.jpg

515. Eye abnormality in chough fledgling. Disparity in size of globes – right eye (smaller). D4929.jpg

516. Eye abnormality in chough fledgling. Disparity in size of globes – left eye larger. D4932.jpg

517. Eye abnormality in chough fledgling. Disparity in size of globes. Right eye larger. D98.JPG

518. Eye abnormality in chough fledgling. Disparity in size of globes. Right eye larger. D99.JPG

519. Corneal opacity in chough - histopathology. H&E x 400. Vacuolation of corneal epithelium. D4843.jpg

520. Corneal opacity in chough - histopathology. H&E x 400. Vacuolation of corneal epithelium. D4845.jpg

521. Corneal opacity in chough - histopathology. H&E x 400. Vacuolation of corneal epithelium. D4858.jpg

522. Corneal opacity in chough - histopathology. H&E x 400. Vacuolation of corneal epithelium. D4859.jpg

523. Brain abnormality (hydrocephalus) in chough nestling aged 4 weeks (left). No gross brain abnormalities in bird on right. D4814.jpg

524. Brain abnormality (hydrocephalus) in chough nestling aged 4 weeks (above). No gross brain abnormalities in bird below. D4816.jpg

525. Brain abnormality (hydrocephalus) in chough nestling aged 4 weeks. D4821.jpg

526. Chough nestling aged 4 weeks. No obvious hydrocephalus. D4824.jpg

527. Brain abnormality (hydrocephalus) in chough nestling aged 4 weeks (lower). No gross brain abnormalities in bird above. D4825.jpg

528. Brain abnormality (hydrocephalus) in chough nestling aged 4 weeks (left). No gross brain abnormalities in bird on right. D4827.jpg

Chapter 9, part 8. Images of necrotic oesophagitis and other digestive tract conditions not otherwise specified in corvids.

529. Necrotic oesophagitis in immature chough (Bird 1). Food in upper oesophagus. D6551.jpg

530. Necrotic oesophagitis in immature chough (Bird 1). Yellow serositis over oesophagus and trachea. D6552.jpg

531. Necrotic oesophagitis in immature chough (Bird 1). Food particles attached to necrotic mucosa. No food in gizzard. D6555.jpg

532. Necrotic oesophagitis in immature chough (Bird 1). Necrotic mucosa (food particles removed). D6559.jpg

533. Necrotic oesophagitis in immature chough (Bird 2). Food in upper oesophagus. D6560.jpg

534. Necrotic oesophagitis in immature chough (Bird 2). Yellow serositis over oesophagus and trachea. D6562.jpg

535. Necrotic oesophagitis in immature chough (Bird 2). Mucosa of oesophagus yellow/orange and necrotic. D6564.jpg

536. Necrotic oesophagitis in immature chough (Bird 3). Yellow serositis over oesophagus and trachea. D6565.jpg

537. Necrotic oesophagitis in immature chough (Bird 3). Thickening of oesophagus (unopened). D6566.jpg

538. Necrotic oesophagitis in immature chough (Bird 3). Mucosa of oesophagus yellow/orange and necrotic. D6569.jpg

539. Necrotic oesophagitis in immature chough (Bird 4). Thickening of oesophagus (unopened). D6591.jpg

540. Necrotic oesophagitis in immature chough (Bird 4). Mucosa of oesophagus yellow/orange and necrotic. D6594.jpg

541. Necrotic oesophagitis in immature chough (Bird 4). Mucosa of oesophagus yellow/orange and necrotic. D6597.jpg

542. Fledgling jackdaw found under garden feeder. Impacted gizzard. D964.JPG

543. Fledgling jackdaw found under garden feeder. Impacted intestine. D963.JPG

544. Fledgling jackdaw found under garden feeder. Impacted intestine. D962.JPG

545. Liver abnormality in carrion crow. Cause not established. D2181.jpg

556. Liver abnormality in carrion crow. Cause not established. D2182.jpg

547. Carrion crow. Grey debris in oropharynx, small nodules in oesophagus. Moderate hairworm eggs in oropharynx. Mixed bacteria isolated. Histopathology – heterophilic granulomas in oesophagus. D3171.jpg

548. Carrion crow. Grey debris in oropharynx, small nodules in oesophagus. Moderate hairworm eggs in oropharynx. Mixed bacteria isolated. Histopathology – heterophilic granulomas in oesophagus. D3173.jpg

Chapter 9, part 9. Images of adverse environmental conditions, *Yersinia pseudotuberculosis*, cellulitis, neoplasia and poisoning in corvids.

549. Rook nestlings - nests destroyed in high winds. D4831.jpg

550. *Yersinia pseudotuberculosis* in chough. Infected elbow joint. D4963.jpg

551. *Yersinia pseudotuberculosis* in chough. Fine focal liver necrosis. D4966.jpg

552. *Yersinia pseudotuberculosis* in chough. Fine focal necrosis in spleen. D4968.jpg

553. Cellulitis in adult rook. No significant bacteria isolated. D1519.jpg

554. Cellulitis in adult rook. No significant bacteria isolated. D8075.jpg

555. Cellulitis in adult rook. No significant bacteria isolated. D8077.jpg

556. Cellulitis in adult rook. No significant bacteria isolated. D8078.jpg

557. Cellulitis in neck of adult magpie. Mixed bacteria isolated. D3081.jpg

558. Abscess below eye of rook. *Staphylococcus* sp. isolated. D6518.jpg

559. Abscess below eye of rook. *Staphylococcus* sp. isolated. D6520.jpg

560. Tumour in rook - squamous cell carcinoma. Nodules on mucosa of oesophagus (opened). D1655.jpg

561. Tumour in rook - squamous cell carcinoma. Nodules on mucosa of oesophagus (opened). D1656.jpg

562. Tumour in rook - squamous cell carcinoma. Diffuse neoplastic infiltration around larynx. D1657.jpg

563. Accidental diazinon poisoning in raven. Stomach contents - lamb scrotum and rubber ring, and lamb tail. D3612.jpg

564. Accidental diazinon poisoning in raven. Stomach contents - lamb scrotum (opened) and rubber ring. D3615.jpg

565. Accidental diazinon poisoning in raven. Many unhatched fly eggs on carcase. D3609.jpg

Chapter 10. Images of miscellaneous conditions in "Other Passeriformes".

566. Trauma in waxwing. Enlarged pale liver. Blood around heart and in abdomen. D1878.JPG

567. Trauma in waxwing. Many berries in oesophagus. D1877.JPG

568. *Yersinia pseudotuberculosis* infection in house martin. Pale foci and dark haemorrhages on liver. D1085.jpg

569. *Yersinia pseudotuberculosis* infection in house martin. Pale foci and dark haemorrhages on liver. Pale nodules in enlarged spleen. D1086.jpg

570. *Yersinia pseudotuberculosis* infection in house martin. Pale area of necrosis on palate. D1087jpg.

571. *Yersinia pseudotuberculosis* infection in house martin. Large cream-coloured granuloma on palate (different bird). D279.jpg.

572. Mycotic pneumonia in waxwing. Most of one lung replaced by cream-coloured mass. *Aspergillus fumigatus* isolated. 8186.JPG

573. Hippoboscid flies and pupal cases from house martin nest. 9118.JPG

574. Nematodes in airsacs of blackcap. *Diplotriaena* sp. D326.JPG

575. Nematodes removed from airsacs of blackcap. *Diplotriaena* sp. D343.JPG

576. Intestinal fluke from house martin. Many eggs visible. 4244.JPG

577. Intestinal flukes from house martin. Many eggs visible. 4411.JPG

578. Eggs from intestinal fluke from house martin. 4246.JPG

579. Eggs from intestinal fluke from house martin. 4248.JPG

Chapter 11, part 1. Images of avian tuberculosis in pigeons and doves.

580. Avian tuberculosis in woodpigeon. Large cream raised nodules throughout liver. 5196.jpg

581. Avian tuberculosis in woodpigeon. Large fawn-coloured raised nodule in lung. 5197.jpg

582. Avian tuberculosis in woodpigeon. Spleen replaced by large cream mass. 5199.jpg

583. Avian tuberculosis in woodpigeon. Pale nodules in wall of intestine. 5201.jpg

584. Avian tuberculosis in woodpigeon. Marked atrophy of breast muscles. 5193.jpg

585. Avian tuberculosis in woodpigeon. Much gelatinous abdominal fluid. Multiple pale foci in liver. D6013.jpg

586. Avian tuberculosis in woodpigeon. Multiple pale foci in liver. D6015.jpg

587. Avian tuberculosis in woodpigeon. Large fawn nodule in lung. D6021.jpg

588. Avian tuberculosis in woodpigeon. Spleen replaced by large cream mass. D6019.jpg

589. Avian tuberculosis in woodpigeon. Cut section of spleen. D6020.jpg

590. Avian tuberculosis in woodpigeon. Pale nodules in wall of intestine. Fluid intestinal contents. D6024.jpg

591. Avian tuberculosis in woodpigeon. Nodule on head. 8060.jpg

592. Avian tuberculosis in woodpigeon. Nodule on head – skin removed. 8062.jpg

593. Avian tuberculosis in woodpigeon. Nodule on head – opened. 8064.jpg

594. Avian tuberculosis in woodpigeon. Mucosa of intestine thickened, orange-coloured, fissured. 8070.jpg

595. Avian tuberculosis in woodpigeon. Mucosa of oesophagus thickened and orange-coloured. 8110.jpg

596. Avian tuberculosis in woodpigeon. Enlarged liver with multiple small pale foci. 8108.jpg

597. Avian tuberculosis in woodpigeon. Enlarged liver with a few pale foci. Pericarditis. 8194.jpg

598. Avian tuberculosis in woodpigeon. Greatly enlarged pale spleen (top), most of lung replaced by fawn mass (lower left), pale plaques and nodules on dark liver (lower right). 9773.jpg

599. Avian tuberculosis in woodpigeon. Mucosa of intestine thickened, granular, fissured. 9775.jpg

600. Avian tuberculosis in woodpigeon. Adhesions between heart, duodenum and liver. 8914.jpg

601. Avian tuberculosis in woodpigeon. Adhesions between heart, duodenum and liver. 8916.jpg

602. Avian tuberculosis in woodpigeon. Heart covered in pale plaques and nodules. 8918.jpg

603. Avian tuberculosis in woodpigeon. Pale nodules on cut surface of spleen. 8922.jpg

604. Cutaneous form of avian tuberculosis in collared dove. 4277.jpg

605. Cutaneous form of avian tuberculosis in collared dove. 4279.jpg

606. Cutaneous form of avian tuberculosis in collared dove. Cut section. 4283.JPG

607. Cutaneous form of avian tuberculosis in woodpigeon. Dorsal aspect. 4269.jpg

608. Cutaneous form of avian tuberculosis in woodpigeon. Ventral aspect. 4271.jpg

609. Avian tuberculosis in feral pigeon. Large mass between crop and skin. D874.JPG

610. Avian tuberculosis in feral pigeon. Large mass (opened) between crop and skin. D877.JPG

611. Urates in joints and under the skin of the foot of woodpigeon with avian tuberculosis. 8192.jpg

612. Urates in joints (hips, knees and hocks) of woodpigeon with avian tuberculosis. 8207.jpg

613. Urates in joints (tarsometatarsal) of woodpigeon with avian tuberculosis. 8205.jpg

614. Avian tuberculosis in woodpigeon. Ziehl-Neelsen stained smear from liver, showing acid-alcohol-fast bacilli. ATB2li.jpg

615. Avian tuberculosis in woodpigeon. Ziehl-Neelsen stained smear from liver, showing acid-alcohol-fast bacilli. ATB4li.jpg

Chapter 11, part 2. Images of pox in pigeons and doves.

616. Pox in woodpigeon (confirmed). Nodules around eye. D283.JPG

617. Pox in woodpigeon (confirmed). Nodules on digits. D284.JPG

618. Pox in woodpigeon (confirmed). Nodules on digits. D285.JPG

619. Pox in woodpigeon (confirmed). Large nodule around upper mandible. D350.JPG

620. Pox in woodpigeon (confirmed). Large nodule around upper mandible. D351.JPG

621. Pox in woodpigeon (confirmed). Large nodule around upper mandible, yellow debris on palate. D352.JPG

622. Pox in woodpigeon (confirmed). Nodules on digits. D612.JPG

623. Pox in woodpigeon (confirmed). Nodules on lower beak and around eye. D4913.JPG

624. Pox in woodpigeon (confirmed). Nodules on lower beak and around eye. D4914.JPG

625. Pox in woodpigeon (confirmed). Nodules on digits. D5798.JPG

626. Pox in woodpigeon (confirmed). Dry masses on wing. 8117.JPG

627. Pox in woodpigeon (confirmed). Dry masses on wing. 8121.JPG

628. Pox in woodpigeon (confirmed). Dry masses on wing. 8125.JPG

629. Pox in woodpigeon - histopathology. H&E x 400. Many “Bollinger bodies” (intracytoplasmic inclusions). pox3.jpg

630. Enlarged liver in woodpigeon with confirmed pox. *Leucocytozoon* detected on liver histopathology. 8127.JPG

631. Enlarged liver in woodpigeon with confirmed pox. *Leucocytozoon* detected in blood cells on liver histopathology. H&E x 400. Image courtesy of Alisdair Wood. wpliver40.jpg

632. Enlarged liver in woodpigeon with confirmed pox. *Leucocytozoon* detected on liver histopathology. Eosinophilic round structures compressing host blood cell nuclei into narrow crescents. H&E x 1000. Image courtesy of Alisdair Wood. wpliver100.jpg

Chapter 11, part 3. Images of trichomonosis, PPMV-1, salmonellosis, inclusion body hepatitis and circovirus infection in pigeons and doves.

633. Presumed trichomonosis in woodpigeon. Yellow caseous lesions in oropharynx and oesophagus. D39.JPG

634. Presumed trichomonosis in woodpigeon. Yellow caseous debris on palate. D41.JPG

635. Presumed trichomonosis in woodpigeon. Yellow caseous lesions in oropharynx and oesophagus. D4240.JPG

636. Presumed trichomonosis in woodpigeon. Yellow caseous lesions in oropharynx and oesophagus. D4241.JPG

637. Confirmed trichomonosis in woodpigeon. Yellow caseous lesions in oropharynx and oesophagus. D1232.JPG

638. Presumed trichomonosis in collared dove. Yellow caseous lesions in oropharynx and oesophagus. 144.JPG

639. Trichomonosis in collared dove (confirmed). Yellow caseous lesions in oropharynx. D368. JPG

640. Trichomonosis (confirmed) in stock dove. Swollen face with crusted exudate. D8320. JPG

641. Trichomonosis (confirmed) in stock dove. Yellow caseous exudate under skin of face, extending from infra-orbital sinus. D8321. JPG

642. Trichomonosis (confirmed) in stock dove. Caseous debris on palate and in infra-orbital sinus. D8322.JPG

643. Feral pigeon. Pigeon paramyxovirus-1 (PPMV-1) infection. Bird ataxic. 5624.JPG

644. Feral pigeon. Pigeon paramyxovirus-1 (PPMV-1) infection. Bird ataxic. 5622.JPG

645. Nodules on ventral aspect of liver of feral pigeon. *Salmonella* Typhimurium isolated. 4441.JPG

646. Nodules on ventral aspect of liver of feral pigeon. Cut surface. *Salmonella* Typhimurium isolated. 4443.JPG

647. Salmonellosis in feral pigeon. Pneumonia and pleurisy. 8703.JPG

648. Inclusion body hepatitis in feral pigeon. Pericarditis, perihepatitis, enlarged liver. 4599.JPG

649a. Inclusion body hepatitis in feral pigeon. Basophilic intra-nuclear inclusion bodies. H&E x 100. D7777.jpg

649b. Inclusion body hepatitis in feral pigeon. Basophilic intra-nuclear inclusion bodies. H&E x 400. D7779.jpg

650. Circovirus and secondary bacterial infection of bursa of feral pigeon. Yellow nodular granuloma in lumen of bursa of Fabricius. D4951.jpg

Chapter 11, part 4. Images of internal parasites, arthritis, granuloma, neoplasia and crop milk in pigeons and doves.

651. Coccidial oocysts from woodpigeon. Different sizes. woodpigeon6.jpg

652a & 652b. Coccidial oocysts from woodpigeon. Different sizes. Woodpigeon2.jpg and Woodpigeon5.jp

653a-c. Coccidial oocysts from feral pigeon. D9575.jpg, D9576.jpg and D9578.jpg

654 a-c. Coccidial oocysts from collared dove. cdove1.jpg, cdove2.jpg, cdove3.jpg

655 a-c. Coccidial oocysts from collared dove. cdove8.jpg, cdove9.jpg, cdove10.jpg

656 & 657. Hairworm eggs (ellipsoid, plug at both poles) inside female worm. From intestine of feral pigeon. D9562.jpg and D9563.jpg

658 a-c. Hairworm eggs from intestine of feral pigeon. D9571.jpg, D9580.jpg and D9583.jpg

659a & 659b. Hairworm eggs and coccidial oocysts from intestine of feral pigeon. D9581.jpg and D9582.jpg.

660. Hairworm egg (ellipsoid, plug at both poles) and coccidial oocyst from intestine of woodpigeon. woodpigeon7.jpg

661 & 662. Hairworm eggs (ellipsoid, plug at both poles) and coccidial oocysts from intestine of woodpigeon. woodpigeon8.jpg and woodpigeon9.jpg

663. *Ornithostrongylus quadriradiatus* in intestine of stock dove. Inflated cuticle at anterior end of worm. D8367.jpg

664. *Ornithostrongylus quadriradiatus* in intestine of stock dove. Inflated cuticle at anterior end of worm. D8373.jpg

665. *Ornithostrongylus quadriradiatus* in intestine of stock dove. Inflated cuticle at anterior end of worm. D8374.jpg

666. *Ornithostrongylus quadriradiatus* in intestine of stock dove. Male worm with bursal rays. D8378.jpg

667. *Ornithostrongylus quadriradiatus* in intestine of woodpigeon. Male worm with bursal rays and spicules. 4469.jpg

668. *Ornithostrongylus quadriradiatus* in intestine of stock dove. Eggs inside female worm. Eggs ellipsoid, thin-walled, granular contents. D8387.jpg

669. Infected elbow joint. Collared dove. No significant bacteria isolated. 6390.JPG

670. Infected elbow joint (opened). Collared dove. No significant bacteria isolated. 6392.JPG

671. Granuloma in feral pigeon, extending into crop. Initial damage due to trauma? D3440.jpg

672. Granuloma in feral pigeon. Feathers and scabs removed. Granuloma extending into crop. Initial damage due to trauma? D3444.jpg

673. Pedunculated chondrosarcoma on wing of feral pigeon. D4096.jpg

674. Pedunculated chondrosarcoma on wing of feral pigeon. D4098.jpg

675. Pedunculated chondrosarcoma on wing of feral pigeon. Cut-section. D4100.jpg

676. Adult woodpigeon. Shot. Thickened crop due to production of “crop milk”. D5203.jpg

677. Adult woodpigeon. Shot. Thickened crop due to production of “crop milk”. Unopened crop. D5205.jpg

678. Adult woodpigeon. Shot. Thickened crop due to production of “crop milk”. Opened crop. D5206.jpg

Appendix XI: Location of carcases

The locations at which the carcases of different taxonomic groups of birds were found are presented in Table 1, based on the definitions given in Chapter 2 (Materials and Methods). If the precise location was not available, it was described as "not recorded". The percentages of carcases found in each different area are shown in Figures 1-5.

Table 1: Location of carcases

Group	N/W	N/E	C/W	C/E	S/W	S/E	NR
Finches, sparrows, buntings, dunnocks and tits	178	300	82	141	483	59	35
Blackbirds, thrushes, robins and starlings	9	8	18	12	106	6	58
Corvids	0	7	65	6	94	5	115
Other passerines	2	6	6	2	20	2	11
Pigeons and doves	3	3	44	5	63	2	92
Total	192	324	215	166	766	74	311

N/W=northwest; N/E=northeast; C/W=central west; C/E=central east; S/W=southwest; S/E=southeast; NR=not recorded

Figure 1: Percentages of carcases of finches, sparrows, buntings, dunnocks and tits found in each area

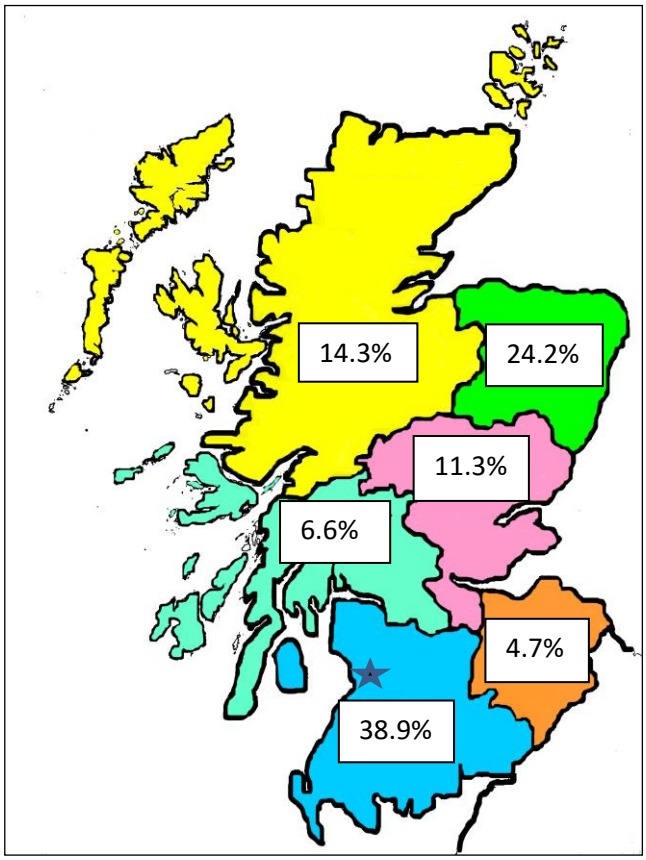

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Figure 2: Percentages of carcases of blackbirds, thrushes, robins and starlings found in each area

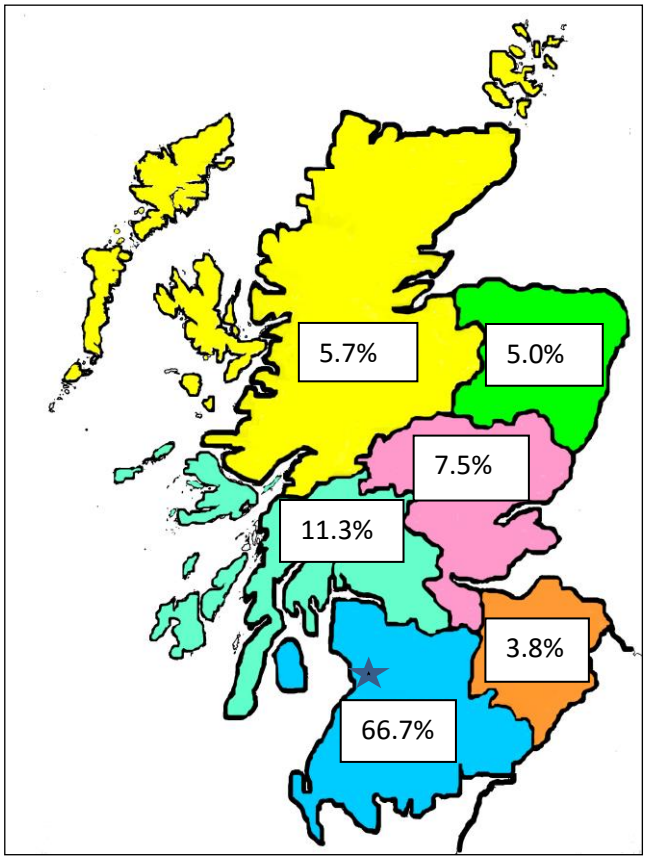

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Figure 3: Percentages of carcases of corvids found in each area

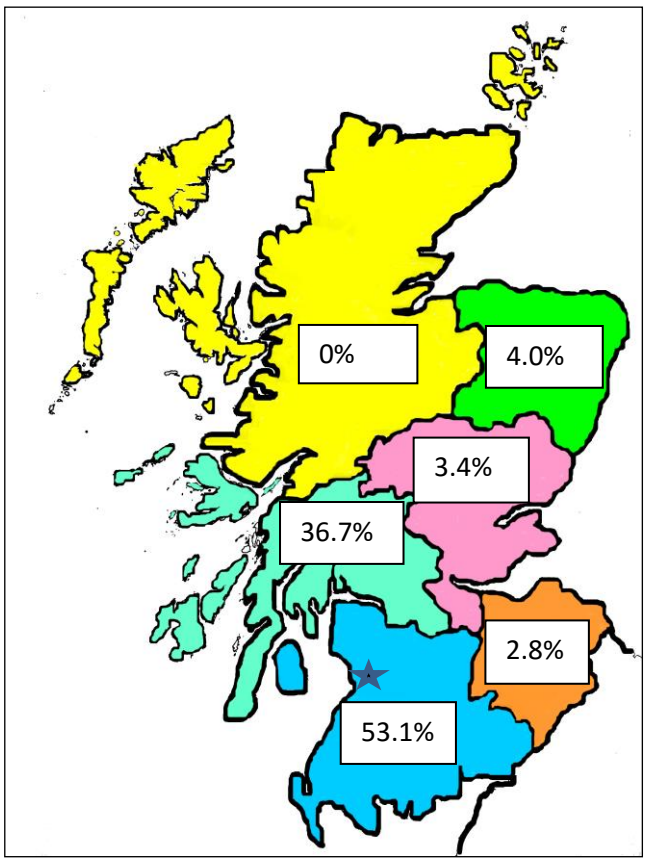

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Figure 4: Percentages of carcases of "other passerines" found in each area

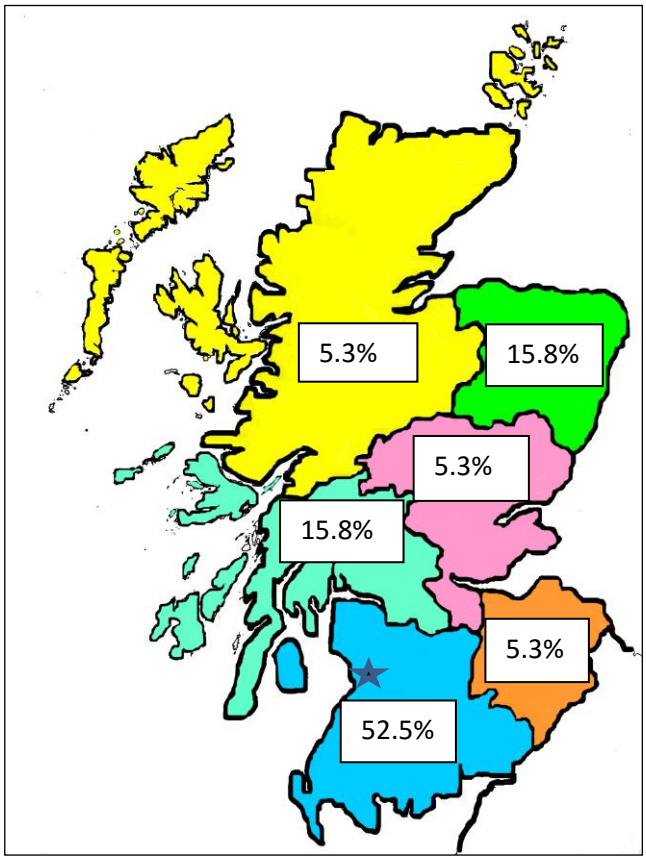

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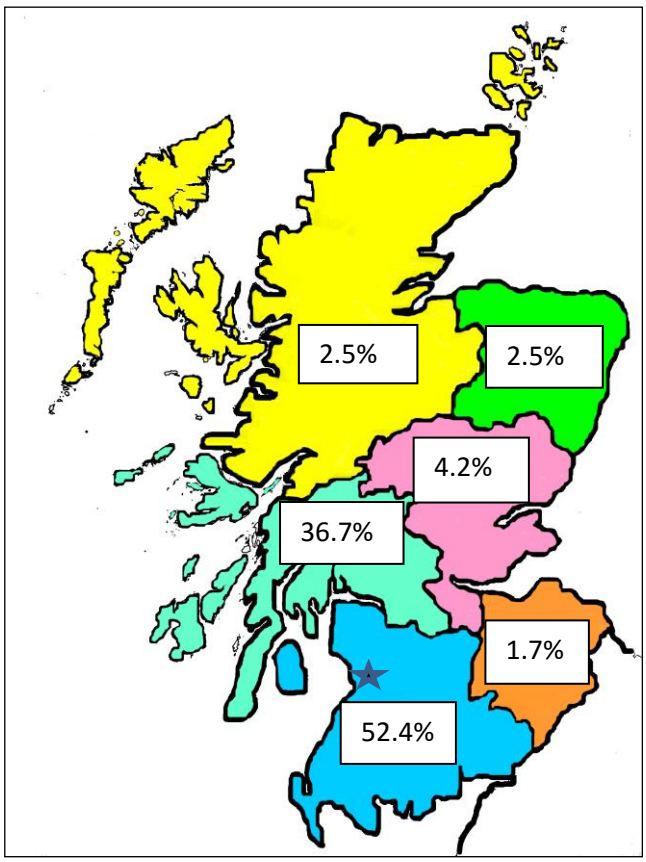
Figure 5: Percentages of carcases of pigeons and doves found in each area



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