Peafowl, Chickens and Parrots: Evolution and Disease Patterns.

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Based on emerging DNA and fossil evidence, the order Galliformes emerged c. 76 million years ago (mya), the family Phasianidae c. 40 mya and the genus Pavo (peafowl) c. 30 mya. Peafowl are compared to other Galliformes and Psittaciformes in regards to their biology and to how the males are thought to have evolved their spectacular trains. Rather than pair bond like parrots, peafowl have a polygynous, lek mating system and a positive correlation between tail length, mating success and chick survivability has been demonstrated. Peafowl show some similarities in disease patterns to domestic chicken, eg. susceptibility to coccidiosis and mycoplasmosis but there are interesting differences, eg. increased susceptiblity to histomoniasis (blackhead) and resistance to Marek's disease. Peacocks look spectacular but they have been declared pests in some tropical areas of Australia. Their call is loud, they can be strong flyers and their droppings are messy. Peahens are particularly susceptible to fox predation. Peafowl can make wonderful pets in parks or country property settings but they are generally not a good choice in urban areas.

How the Blue Peacock (*Pavo cristatus*) evolved its spectacular train has been a question that has intrigued evolutionists since Darwin's time, but the long train is just one of a number of points of difference between peacocks and the mainstay of pet avian practice, parrots. In this paper peafowl are compared to other Galliformes and to parrots in terms of their biology, attributes as pets and disease patterns. The term 'peahen' refers to the female, 'peacock' to male and peafowl to either gender. Some points relate to Galliformes vs Psittaciformes generally, some are unique to the highly derived *Pavo cristatus*. Table 1

Evolution

Evidence from current day bird distribution, morphology and DNA sequencing calibrated against recently discovered dated fossil finds are increasingly supporting an emergence of modern birds somewhere in Gondwana around 100 million years ago. Based on evidence reviewed by Harrison et al. (2004), there appears to have been an initial separation of the Paleognaths (ratites) and Neognaths (all other birds). Amongst the Neognaths, the Gallianseres were one of the first groups to split from the remaining Neoaves, which they did around 90 mya. Subsequently Galliformes split from Anseriformes around 76 mya.[1] Around this time Africa and India had separated from Gondwana and were travelling north, but there were intermittent East African-Antarctic connections via the Kerguelen Plateau at times of low sea levels. From a geological point of view, it would still have been possible, on occasions, albeit increasingly more difficult, for some birds to wade, fly, swim and/or island hop to reach Africa from Antarctica, or *vice versa*. Alternatively, it would be plausible that some early modern birds, including Galliformes could have hitched a ride on 'island India' as it travelled north.

Of the remaining Neoaves, the Falconiforme/parrot lineage emerged c.74 mya and split into Falconiformes and parrots c. 72 mya. At least 13 lineages, including Galliformes and Psittaciformes, survived the Cretaceous-Tertiary boundary extinction event into modern times.

Table 1. Some anatomical comparisons between peafowl and a 'typical' parrot		
	Peafowl (*Pavo cristatus*)	**'Typical' Parrot (*Eclectus roratus*)**
Feet and legs	Anisodactyl Cursorial Spurs in males Feet used in defence and aggression, males lunge forward feet first.	Zygodactyl Arboreal No spurs Use feet as a grasping device, brain development (dorsal Wulst) reflects this.
Feathers	Dramatic iridescence Coverts on back modified to become a spectacular train with fishtail, curved and oscellus-bearing feathers.	Little iridescence but unique psittaccofulvin pigments produce feathers with red coloration. No train
Beak	Pointed	Hooked
Respiratory tract	Tympaniform syringeal membranes controlled by three main muscle groups> loud honking call	Complex muscles groups surrounding syringeal membranes > complex vocalisations and speech capability
Gastrointestinal tract	Large paired caeca Gall bladder present	Vestigial caeca Gall bladder absent
Blood	Lymphocytes higher than typical in parrots	Heterophils higher than typical in peafowl
Reproduction	Polygynous – lek mating Clutch size 7-10 Incubation 27-30 days Precocious chicks Hen cares for young Mature at around 2 years Life expectancy 25-30 years	Life long pair bonds Clutch size 2 Incubation 26 days Altricial chicks Both parents care for young Mature around 4 years Life expectancy 25-30 years

Groups	mya
Paleognaths/neognaths	101
Gallianseres/Neoaves	90
Magpie goose/duck+goose	66
Owl/other neoavians	80
Passerines/other neoavians	80
Falconiformes + parrots/rest	74
Falconiformes/parrot	72
Shorebirds/penguin,stork	74
Penguin/stork	**62 (fixed)**
Birds/crocodilian	183
Archosaurs/turtles	199

Table 2. Dating estimates for early avian divergences based on molecular data calibrated with penguin/stork fossils @ 62 mya (after Harrison *et al.*, 2004)

Within the Galliformes, the Phasianidae emerged over 35 mya with Numididae (Guinea fowl) a early widespread family with fossil evidence dating from before 30 mya from both France and Mongolia. (Helm-Bychowski KM and Wilson A., 1986) DNA evidence suggests the peafowl lineage began splitting off from the rest of the group around 30 mya and that peafowl show closer affinities to pheasants and turkeys than to jungle fowl and chickens, even though, geographically, peafowl and jungle fowl are both predominantly southern Asian and turkeys have only been found in North America. While the oldest definite turkey fossils date from 6-8 mya from Nebraska, they are thought to have been an off shoot from Asian Pheasants splitting c. 16-20 mya. As is the case with many other North American genera, founding Phasianidae populations, from which turkeys derived, are believed to have travelled across the Behring Strait. If this is so, it provides an explanation for the apparently paradoxical situation that disease patterns seen in peafowl show closer similarities to those in turkeys than to chickens. This will be explored further when individual diseases are discussed.[2]

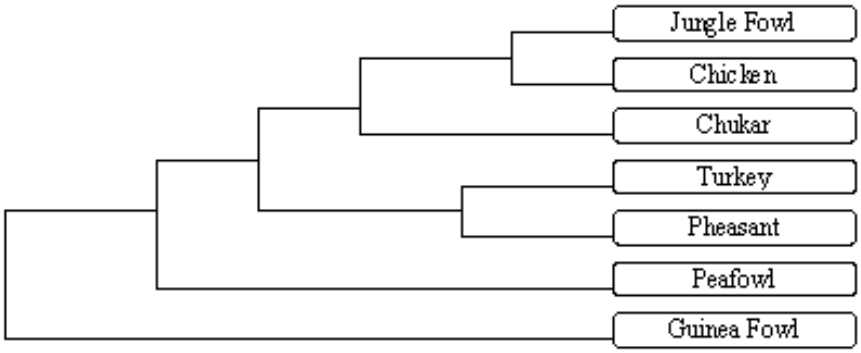

Figure 1. Most parsimonious branching order from nuclear gene maps for seven species of Phasianidae. Note that, in this analysis, Peafowl are more closely aligned to pheasants and turkeys than they are to chickens. After Helm-Bychowski and Wilson, 1986.

A land bridge existed between Africa and Asia from *c.*17 mya which expedited dispersal of many species between these land masses, perhaps including the ancestors of the peafowl. While the fossil record, to date, has not provided clues as to the geographical location of their common ancestor, molecular clock estimates place a split between the genus *Afropavo* (African peafowl) and *Pavo* (the Asian peafowl species) at *c.* 14 mya.

Peafowl are indigenous to India, Burma, Java, Ceylon, Malaya and the Congo.
In addition to the common Indian blue peafowl, *Pavo cristatus*, there are also three subspecies of the more flighty Java green peafowl: *Pavo multicus multicus*, *P.m. spicifer* and *P.m. imperator*. *Afropavo congensis*, the Congo peafowl from the jungles of Zaire, is the sole known species of the *Afropavo* genus. Chicks are precocious but Congo peafowl are monogamous and form long-term pair bonds, the males lack any train, hens lays small clutches of about 3 eggs and both parents care for the chicks. As evolutionary transition from exclusive female parental care to biparental care has not been observed in birds, it is likely that *Afropavo* is primitive. This suggests that elaborate male ornamentation and promiscuous mating systems evolved independently in the different Galliforme taxa.[3]

Evolution of the peacock's train

A peacock's train originates from the back and consists of three types of highly derived covert feathers: the longest ones end in a fish tail structure, curved feathers are found at the edge of the train and ocellus-bearing ('eye') feathers vary considerably in length, so that ocelli appear scattered throughout

the fanned train when the males display. Superficially such an elaborate train would seem to be a disadvantage in survival but, using the peacock as an example, Charles Darwin proposed that male ornament contains age and vigour dependent information and that vigorous, older males have demonstrated their survival ability better than young males. Choosy females who select well ornamented males are likely to have better survivability in their offspring.[4]

Experimental work carried out since the 1990s has lent evidence based support to Darwin's original hypothesis. The number of feathers, specifically the number of ocelli in a peacock's tail has been shown to increase from age two up to the age of around six years and then remains static, so the tail is generally an 'honest' advertisement of age. Survey work has also shown that train length correlates positively with cell-mediated immunity and the heterophil - lymphocyte ratio, lending statistically based evidence that a large train can be an honest advertisement of vigour as well as age.[5]

Alongside evidence that large trains correlate positively with age and vigour, working with free range peafowl at Whipsnap Park in the UK, Marion Petrie and her colleagues have demonstrated that offspring of peacocks with large trains had better survivability than those with smaller tails. Surprisingly, peacocks with large trains also showed greater ability to withstand fox predation than those with smaller trains.

In experimental manipulations, Petrie and her co-workers found that peacocks that had ocelli cut from their tails had poorer breeding success than in previous seasons when they had full tails.[5] These, and their other findings, lend support to the theory that peahens are more likely to mate with peacocks that have larger trains and that peacocks with larger trains have a greater likelihood of fathering more offspring with greater long term survivability. In this case, what might appear superficially to be an extreme example of useless male ornament, can be of evolutionary advantage.[7]

In a free range situation peafowl are lek breeders with multiple males gathering to display and females making their choice between them. In a farming situation it is more typical to run a single male with two or three females. Experienced breeders advise that the best chance for a yearling hen to lay eggs is when she is in the same pen as a mature male. A two year old peacock with a longer train will be a better breeder than a peacock of the same age with a shorter one. Rather than just the overall visual display and number of ocelli, it may also be the louder rustle during display of a larger train also attracts choosy females.

The human-peacock bond and its role in the global spread of peafowl

Pet avian practice is driven by the human-bird bond, so it is relevant to explore this bond in relation to the pet bird species that we treat. The peacock is the national bird of India and peafowl have long been associated with royalty in that country, as well as in the Middle East and with the pharaohs of Egypt. They were known to be transported by early Phoenician mariners. Aristole, *c.* 350 BC, wrote about the peafowl biology and the practice of fostering peafowl eggs under chickens.[8] In Greek mythology Argos Pantoptes, the 'one who sees all', was a giant covered with hundreds of eyes who never slept as he only ever closed half of his eyes at any one time. When Juno, the immortal queen of the heavens, transferred Argos to the sky, his eyes were put into the tail of the peacock. The peacock was also considered sacred in by the early church in Europe.[9]

Peacocks were brought out to Australia by Europeans in the 1800s. In Victoria this was done by the Acclimatisation Society, a group dedicated to the deliberate release of wild birds, plants and animals thought to be aesthetically beautiful or of commercial benefit to humans. 'Harewood', the National Estate listed property where I live, was one of the original sites where pheasant, guinea fowl and peacock were released under the auspices of the Acclimatisation Society by William Lyall and his

family in the 1860s. As indicated in memoirs quoted here from one of William's granddaughters, none of these species ever established feral populations as it did elsewhere in more tropical regions of Australia.[10]

> *At his property at "Tooradin", William Lyall liberated pheasants and partridges in 1863, but he was always of the opinion that the dingoes had accounted for the loss of every one of them. When the family moved to "Harewood" in 1868, Silver and Golden China pheasants were liberated there and were seen for some years afterwards thriving in the tea-tree scrub, but were subsequently shot by trespassers. The following incident illustrates this:*
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> *One day a man arrived at "Harewood", holding two pheasants he had shot, and asked - "What kind of birds are those?" William Lyall replied: "You confounded idiot, they were my pheasants!" At "Harewood" there were also guinea-fowls and peacocks.*
>
> Bertha Lyall Ricardo[11]

While a mature peacock in prime condition can be mated to as many as five peahens, on a typical country property in southern Australia where peafowl range free as pets, because of the hens' greater susceptibility to predation, males will usually outnumber females. My own peacock, Edward (offspring of Victoria and Albert) was hatched at Harewood but raised at the clinic after his mother was killed by a fox when Edward was 10 days old. Edward has survived free-range for over 15 years, in spite feral foxes still being numerous. He is a great pet but aloft compared to a bonded parrot or a dog. He bangs on the door knob when he wants to be fed, keeps me company while gardening. He will call loudly and defiantly spread his tail and block the driveway when guests arrive, so that they have to drive their cars around him. At night he camps on the front porch or flies up into his favourite tree. At one stage I was given a peahen, but she was stressed out by Edward's incessant amorous advances and was taken by a fox several weeks after her arrival.

When in full tail (from September to February) Edward does the 'lek thing' and spends much of his time displaying. Occasionally Edward flares his irises and has a go at Paddy, Harewood's caretaker with his feet and spurs. For his part Paddy chooses to accept his status as beta male in good humour. He notes that Edward only seems to get grumpy when he's hungry, the rest of the time he's fine. I get displayed to but not attacked. Human visitors and children are generally left alone, with Edward hiding if there are too many strangers around. With the pecking order comfortably established, peace and tranquillity prevails.

The same cannot be said in tropical Queensland, where foxes are not prevalent and feral peafowl populations are thriving to the extent that, in some areas, they have been officially declared a pest species. In Townsville, for example, people complain of unpleasant droppings, scratching up gardens, loud noisy calling, birds creating traffic hazards, competing with local wildlife and stealing food off picnic plates. A culling program operates and people are advised to avoid feeding the birds and not to leave dog or cat food out where they can get it.[12]

Diet and husbandry

Peafowl are omnivorous and generally not particularly finicky. In North America they are typically fed game bird starter, layer or maintenance feed but these are not readily available in Australia. Protein and calcium levels in chicken rations designed for rapid growth or constant egg laying may be too high if fed as a sole diet for peafowl but they can be useful as part of the diet. Feeding a mix of good quality

dried dog food, corn, grains, seeds, grass, greens, table scraps and some chicken rations is appropriate.

If kept confined, pens should be covered as peacocks are strong flyers. Flights should be at least 3.5 metres wide and 2 metres high to accommodate the tail. Length is determined by the number of birds to be kept in the pen, with a minimum of 6 metres recommended for a trio of breeders.

Diseases

Diseases that are seen in peafowl at Highbury Vet Clinic (HVC) include blackhead, coccidiosis (especially in juveniles), worm parasites, arthritis, foot and leg deformities and chronic respiratory disease/sinusitis. Injuries from predator attacks may involve degloving injuries of the dorsal head and neck. We diagnosed a single case of diabetes mellitus in 'Peter', a white peacock some years ago and he was successfully maintained on once daily insulin injections for many years.

We typically use drug dosages recommended for domestic chickens for peafowl. Reference ranges for haematological values (standard error in brackets) in peacocks based on the work of Møller and Petrie[5] include leukocytes 1.33 (0.09), lymphocytes 40.33 (2.30), monocytes 3.63 (0.49), heterophils 52.67 (2.79), eosinophils 4.03 (0.52), basophils 1.20 (0.15), hematocrit (%) 42.26 (0.69), heterophil to lymphocyte ratio 1.52 (0.14).[5]

Viral diseases and chlamydophilosis

Marek's Disease is commonly diagnosed in chickens at HVC but it has not been seen in peafowl. The literature suggests that peafowl are resistant. In an outbreak at San Diego Zoo in the 1970s, peafowl did not show any clinical signs or antibody titres against the disease in spite of being kept in close proximity with jungle fowl and chickens in which there were clinical signs, antibody titres and deaths.[13]

Virological surveillance work in China indicates that avian infectious bronchitis coronavirus (IBV) can replicate in peafowl but is non-pathogenic. The same virus innoculated into chickens resulted in deaths from nephritis.[14] Peafowl are moderately susceptible to Avian Influenza and Newcastle Disease. The custom of close human-bird contact and the keeping pet peafowl along with pet poultry in domestic situations has been cited as a risk factor in the transmission of these zoonotic avian diseases in Asia.[15]

Of common parrot diseases, circovirus and polyomavirus are not currently recognised as problems in peafowl. While chlamydophilosis is commonly diagnosed in parrots and occasionally diagnosed in chickens at HVC (based primarily on clinical signs and serology) it has not been recognised in peafowl. Peafowl would be expected to be susceptible to chlamydophilosis, low occurrence may reflect the lower numbers of peafowl seen, relative resistance and their housing under less intensive conditions.

Worm Parasites and coccicidiosis

Capillaria**,** intestinal round worms (Ascaridia) and caecal round worms (*Heterakis gallinae*) are all commonly diagnosed. Regular worming with levamisole, ivomectin or moxidectin is recommended. Coccidiosis is primarily a problem in juveniles housed with adults and is treated with toltrazuril (Baycox, Bayer) or amprolium (Coccivet, Vetafarm). Care needs to be taken as toltrazuril is bitter and irritant to mucus membranes. Palatability in water is poor, but we have also had problems with tracheitis if it is syringed orally and birds struggle and aspirate the drug. Crop dosing is safer. Because of their poor resistance, housing young peafowl (under 5 months of age) with older birds should be

avoided. Routine worming and preventative treatment for coccidiosis is recommended.

Histomoniasis (Blackhead)

Blackhead is caused by the amoeboid organism *Histomonas meleagris* which induces a characteristic severe typhlitis and hepatitis with typical map-shaped lesions on the surface of the liver. *Histomonas* can be directly transmitted but it is fragile and is more commonly carried by the caecal round worm, *Heterakis gallinae*. Chickens can carry both organisms and shed *Histomonas* infected *Heterakis* eggs in their droppings but chickens are generally resistant to disease caused by the organism and only rarely show any clinical signs. As the disease is classically described, turkeys are much more susceptible than chickens and if they come into contact with infected chicken droppings turkeys generally become very ill and some will die.

Like turkeys, peafowl are susceptible to blackhead and often die from the disease if it is left untreated. Exposure to *Heterakis* infected chicken droppings is not consistently part of the history. Interestingly, at HVC, while we have not diagnosed even mild forms of blackhead in pet chickens, of which we see many, we have diagnosed blackhead in native button quail (*Turnix* spp), of which we see very few. Turkeys (north America), peacocks (southern Asia) and Australian button quail are native to widely different parts of the world but all are members of the order Galliformes and all possess large paired caeca. A case could be made that chickens, having been domesticated and raised under semi-intensive conditions for hundreds of generations, have been selected for resistance to this disease, while the other susceptible Galliforme species have not been as intensively reared over as many generations and consequently have not been so selected. Parrots do not get blackhead, their caeca are vestigial.

Clinical signs of blackhead, including weakness, diarrhoea, weight loss and lethargy, are non-specific and can be confused with worm parasitism and/or coccidiosis, both of which may occur concurrently. Juveniles that are just beginning to free range in pens or in areas where there have been older peacocks or chickens passing *Histomonas* contaminated *Heterakis* eggs are particularly at risk but older birds may also be affected. Definitive diagnosis of blackhead in an individual live bird can be difficult. Finding *Heterakis* egg on faecal flotation and elevated liver enzymes on blood biochemistry is highly suggestive and warrants treatment. Endoscopy could enable visualisation of liver or caecal lesions but we typically treat, based on index of suspicion, using metronidazole @ 30 mg/kg orally bid to treat the *Histomonas* along with worming with levamisole or ivomectin to treat the *Heterakis* and supportive treatment with antibiotics (eg amoxicillin with clavulonic acid @ 50 mg/kg orally bid), fluid therapy and crop feeding.

Respiratory Disease

Respiratory tract infections with nasal discharge and swollen sinuses are occasionally seen in peafowl. As well as bacterial infections (eg. with *Aliganenes* (Bordetella) spp), peafowl are susceptible to both *Mycoplasma gallinarum* and *Mycoplasma meleagris* and to chlamydophilosis. Squamous metaplasia associated with hypovitaminosis A may damage respiratory epithelial cells and predispose to disease. In addition to identifying the underlying cause and treating appropriately, surgical lancing and drainage may be indicated.[16]

Devocalisation

Surgical devocalisation by chemically or surgically cauterising the syringeal membranes has been successfully carried out in peacocks. However, in my opinion, the technique (which is the same as described for devocalising roosters) carries an unacceptably high risk of morbidity and mortality in otherwise well birds. I encourage re-homing rather than devocalisation and recommend quieter species

of pet birds for suburban back gardens. Peacocks can be great bonded pets but they are not for everyone, especially not in closely settled areas.

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