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Birds, butterflies and flowers in the tropics are not more colourful than those at higher latitudes

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ABSTRACT

Aim The idea that species are generally more colourful at tropical latitudes has held great appeal among biologists since the days of exploration by early naturalists. However, advances in colour quantification and analysis only now allow an objective test of this idea. We provide the first quantitative analysis of the latitudinal gradient in colour on a broad scale using data from both animals and plants, encompassing both human-visible and ultraviolet colours.

Location Australia.

Methods We collected spectral reflectance data from 570 species or subspecies of birds, adult forms of 424 species or subspecies of butterflies and the flowers of 339 species of plants, from latitudes ranging from tropical forests and savannas at 9.25° S, to temperate forests and heathlands at 43.75° S. Colour patch saturation, maximum contrast between patches, colour diversity and hue disparity between patches were calculated for all species. Latitudinal gradients in colour were analysed using both regression analyses and comparisons of categorically temperate and tropical regions. We also provide phylogenetically independent contrast analyses.

Results The analyses which compared the colour traits of communities and the phylogenetically independent contrasts both show that species in the tropics are not more colourful than those at higher latitudes. Rather, the cross-species analyses indicate that species further away from the equator possess a greater diversity of colours, and their colours are more contrasting and more saturated than those seen in tropical species. These results remain consistent regardless of whether the mean or the maximum of coloration indices are considered.

Main conclusions We demonstrate that birds, butterflies and flowers display similar gradients of colourfulness across latitudes, indicating strong ecological and evolutionary cohesion. However, our data do not support the idea that tropical latitudes contain the most colourful species or house the more colourful biological communities.

Keywords
Biogeography, birds, butterflies, colour, flowers, latitude, tropical biology.

INTRODUCTION

Biologists have long theorized that life is more colourful in the tropics. Tropical imagery often features vividly coloured parrots and hibiscus flowers, exotic fruits, bright blue lizards, iridescent beetles and vibrant coral and fish. On exploring tropical Venezuela, Humboldt noted the 'bright-red flowers' and the 'colours in birds, fish, even crayfish (sky blue and yellow)!' (von Humboldt, 1992, p. 6). Fascinated by seemingly stark differences between tropical regions of the world and those further away from the equator, biologists have repeatedly attempted to delineate colour dissimilarities across latitudes (Darwin, 1859;

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Wallace, 1868, 1878, 2000; Poulton, 1890; Weevers, 1952; Wilson & von Neumann, 1972; Bailey, 1978; Adams *et al*., 2014). Differences in colouration have been taken for granted by many tropical biologists or ecologists. For example, in the *Naturalists guide to the tropics*, Lambertini writes 'tropical animals are synonymous with fantastical forms, but even more so, with brilliant colours', and Darwin's *Voyage of the Beagle* highlights 'the usual gaudy colouring of the inter-tropical productions' (Darwin, 1913, p. 407).

Despite enduring interest in the idea that tropical biota are more colourful, evidence has remained contradictory. On one hand, Weevers (1952) reported little difference in relative proportions of colours found in flowers at eight global locations at a range of latitudes, Bailey (1978) found no latitudinal gradient in the colourfulness of the passerine birds of North and Middle America and Burns *et al*. (2009) found no geographic pattern in the diversity of fruit colours. On the other hand, Wilson and von Neumann (1972) concluded that the inhabitants of tropical South America were the most colourful of the Pan-American avifauna, and Adams *et al*. (2014) concluded that butterflies (excluding the diverse, yet dull-coloured Hesperiids) in tropical Ecuador are more colourful than those in subtropical and temperate regions of North America. However, conclusions from these studies are limited, first due to their focus on single taxonomic groups, but second, and more seriously, because of their reliance on human-based assessment of coloration. Colour research has long been based upon qualitative measures, such as those derived using Munsell colour chip matching or colour counting, or has employed constructs based ultimately on human vision and psychophysics (such as HSI and CIE colour spaces). These methods neglect entire light wavebands (e.g. the ultraviolet, UV) of known visual importance to invertebrates, birds, reptiles and some mammals (Osorio & Vorobyev, 2008; Douglas & Jeffery, 2014). Advances in the quantification and human-independent treatment of colour data (Endler & Mielke, 2005; Andersson & Prager, 2006; Montgomerie, 2006) now allow much more informed appraisals of the ecology of colour traits in nature and the testing of evolutionary hypotheses (Stoddard & Prum, 2008; Kemp *et al*., 2015).

During this decade we have made rapid progress in understanding global biological patterns. Recent research has challenged our understanding of the ways species interact at temperate and tropical latitudes (Cornell & Hawkins, 1995; Cardillo, 2002; Hille Ris Lambers *et al*., 2002; Ollerton & Cranmer, 2002; Huston & Wolverton, 2009; Moles *et al*., 2011), and much discussion has ensued on related global pattern and tropical system hypotheses (Martin, 1996; Moller, 1998; Cardillo, 2002; Ollerton & Cranmer, 2002; Schemske *et al*., 2009). In light of this, we provide here a thorough, quantitative review of the colourful tropics hypothesis as colour is a crucial facet of many species interactions, including intra- and interspecific communication, sexual selection, competition for mates or pollinators, and camouflage from predators (Endler, 1983, 1990; Caro, 2005). Resolving the colourful tropics hypothesis will contribute to the debate about the strength of interactions between tropical species, and is an important part of establishing what is quantitatively different about the tropical regions of the world.

In this study, we have applied the principles and techniques of objective colour appraisal to achieve the most taxonomically broad test to date of whether species are more colourful at lower latitudes. We quantified the spectral characteristics of colour phenotypes in three major taxonomic groups (birds, butterflies and the flowers of angiosperms) across a consistent latitudinal gradient spanning cool temperate, temperate, subtropical and tropical regions. Crucially, we parameterised colourfulness according to four objective indices (namely, colour diversity, colour saturation, hue disparity and colour contrast; visually described in Fig. 1), that integrate different aspects of phenotypic colour, include the UV portion of the colour spectrum and are entirely independent of the human visual system.

METHODS

We studied 1333 species native to the eastern states of Australia, a geographic cline spanning more than 30° of latitude (a species list is given in Appendix S1 in Supporting Information). We used reflectance spectrometry to quantify the colour patches of 570 bird species or subspecies held in museums and national collections (details in Appendix S2). Reflectance spectra of flowers of 339 angiosperm species or subspecies were measured during the spring of 2012 at 17 sites between Cairns, Queensland and southern Tasmania, Australia (details in Appendices S2 & S5). Wave-band-limited photography was used to assess colour patches of 424 butterfly species or subspecies held in national collections (details in Appendix S2). Our dataset had a broad taxonomic spread, including 76 families of birds, 74 families of plants and all 6 butterfly families present in Australia (some species shown in Fig. 2; a full list is in Appendix S1).

The major aim of the sampling was to capture all of the colours displayed on three representative individuals. For birds and butterflies, this is on males in their adult form. We sampled the colours displayed on the dorsal side of butterflies. Measurements of birds were taken of each of six main body patches (throat, breast, belly, crown, back and rump), with supplementary scans taken of body regions that displayed additional colours or shades (including wing bars, epaulets, nape, cheek, forehead, lower belly and tail feathers, following Stoddard & Prum, 2011). Flower sampling targeted the dominant colours of the adaxial surface of a perianth or showy bract, or large display stamens, and excluded endangered species, species known to possess strong ontogenic colour variation and species with flowers so small they could not be accurately measured (full details of the methodology are presented in Appendix S2).

We undertook a visual system-independent appraisal based on the 'segment analysis' approach of Endler (1990). This involves integrating the area under reflectance curves in four equal spectral segments (UV 300–400 nm; short-wave 400–500 nm; mid-wave 500–600 nm; long-wave 600–700 nm), thereby providing data on relative segment reflectance (details in Appendix S2). Our novel wave-band-limited photography methods achieved an analogous assessment of butterfly colour.

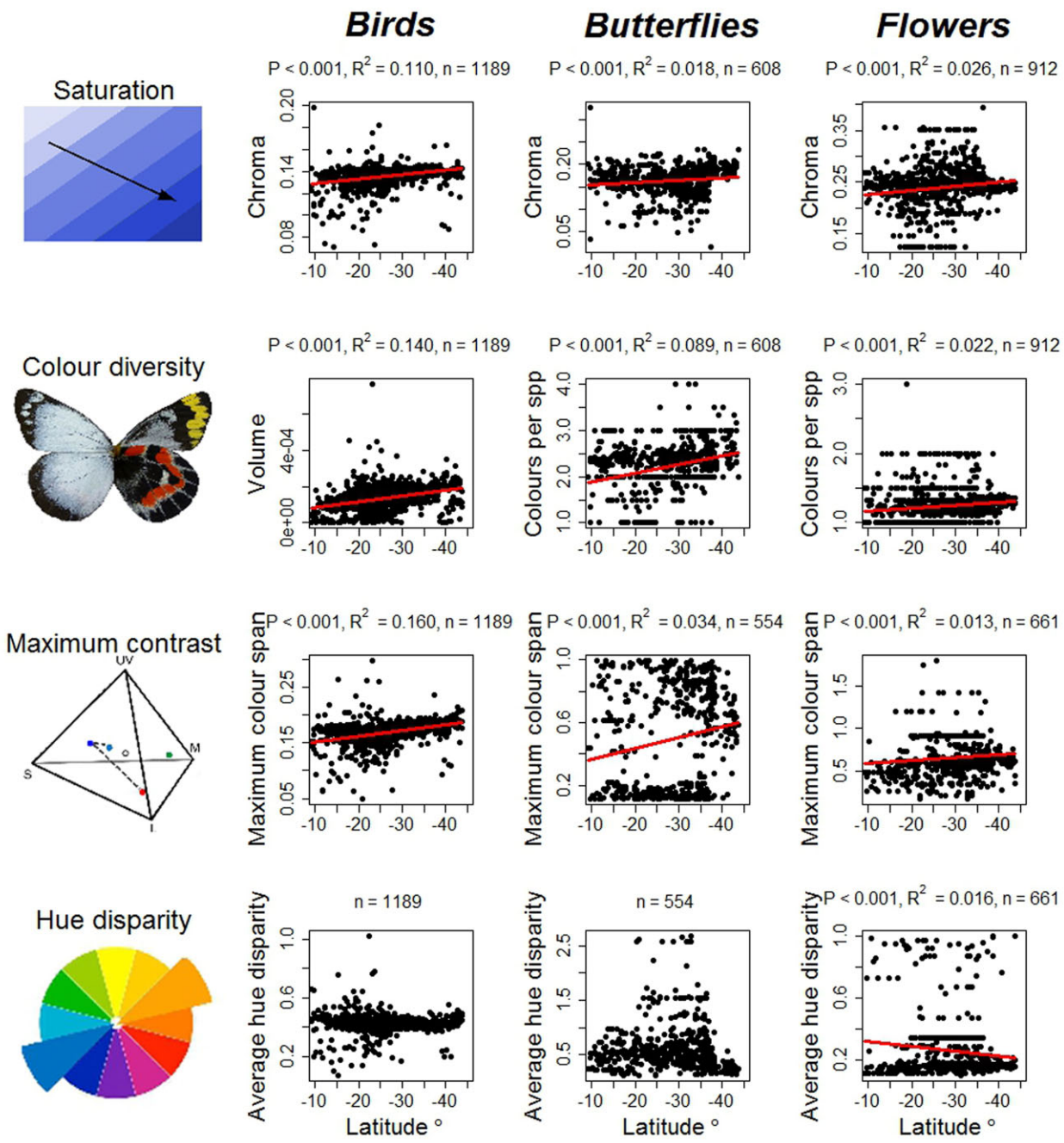

Figure 1 Visual representations of four indices of 'colourfulness' and the latitudinal gradients in these metrics for birds, butterflies and flowers. Colour saturation is the richness or intensity of the colour (Endler & Mielke, 2005). Colour diversity is the diversity of colours displayed by a species, calculated as volume in tetrahedral space or count of dominant colours. The butterfly wing on the left has lower colour diversity than the wing on the right. Maximum contrast is the greatest Euclidian distance achieved between patch colours on a species. Average hue disparity indicates the mean difference between all patch hues on a species (hue is best understood as the 'colour', e.g. 'yellow' or 'red'); this differs from colour contrast as it considers only difference in hue, and does not consider differences in saturation of colour patches. Data points are means of the trait values of all species in a spatial grid cell. Analyses presented are cross-species comparative (without phylogenetic corrections), and significant correlations are denoted by red regression lines. All three taxa have greater colour saturation, greater maximum contrast between their colour patches and greater diversity of colours in temperate regions. There is no latitudinal gradient in the average hue disparity in either butterflies or birds, but flowers have greater disparity between the hues of their colour patches at lower latitudes. Figures are best visualised in colour using the on-line versions of the paper.

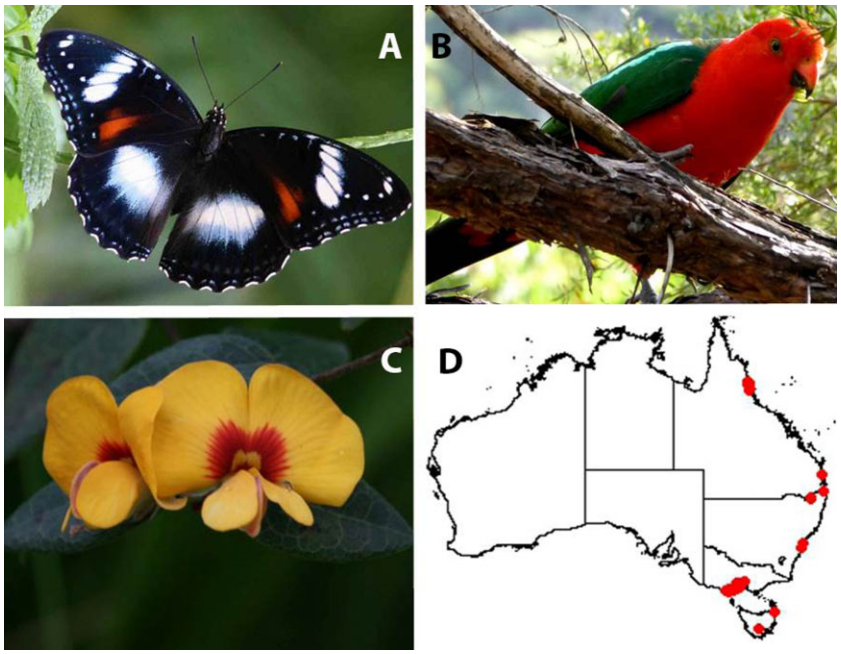

Figure 2 We measured the colours of 424 species of butterfly, 570 species of bird and the flowers of 339 species of angiosperm native to the eastern states of Australia. (a) The great eggfly (*Hypolimnas bolina*). Photograph by D.J.K. (b) Australian king parrot (*Alisterus scapularis*). Photograph by R.L.D. (c) Handsome flat-pea (*Platylobium formosum*), a Fabaceae species, with typical pea flower morphology). Photograph by D.J.K. (d) Locations of flower sampling sites. Figures are best visualised in colour using the on-line versions of the paper.

The analysis weights each segment equally, and neither relies upon the visual sensitivity of any particular species nor makes any assumptions about colour perception. Our study includes many species, and as different species are likely to be viewed by a broad range of ecologically relevant viewers (predators, prey, pollinators, conspecifics) it is more appropriate to not assume any one specific visual model. Segment reflectances were adjusted using the Michaelis–Menton transformation (Endler & Mielke, 2005) to account for approximately log-normal nature of opponency-based processing that is fundamental to colour perception in both vertebrates and invertebrates. We calculated four indices of 'colourfulness' for each species: colour patch saturation, colour diversity, maximum contrast and average hue disparity (Fig. 1; details in Appendix S2).

Data on species geographic ranges were sourced from the *Atlas of living Australia* (ALA; http://www.ala.org.au). For 38 species of butterfly that had too few or no range records, range presence was calculated following ranges in Braby (2000). Colour traits were mapped onto respective species ranges and filtered into a grid with 0.5° (latitude and longitude) sized cells using Biodiverse (Laffan *et al.*, 2010). For each cell we calculated the mean of the trait values for all species present, which was exported for analysis.

We fitted linear regressions to establish if there is a cross-species latitudinal pattern in colourfulness, with latitude as the independent variable and either chroma, colour diversity, maximum colour contrast or average hue disparity as the dependent variable. We analysed birds, butterflies and flowers separately to allow the distinction of patterns with potentially different direction and/or strength between groups. Because colour data are typically non-normal (Endler & Mielke, 2005), we permuted the residuals in order to relax the normality assumption of the linear model and thereby improve the precision of regression outputs (Wang *et al.*, 2012; Winkler *et al.*, 2014). These analyses were fitted with the mvabund package 3.9.1 (Wang *et al.*, 2012) in R 3.1.0 (R Core Team, 2014).

We began with a quantification of the latitudinal gradient in colour because this maximizes both the power and the biological information of the analysis. However, we also wanted to know whether the tropics were different from non-tropical areas, as the categorisation of latitudes into 'tropical' or 'temperate' may better reflect some definitions of the hypothesis (Poulton, 1890; Adams *et al.*, 2014). To address this question we performed *t*-tests, applying the aforementioned permutation technique but with a temperate/tropical categorical predictor variable (splitting latitudes at the tropic of Capricorn: 23.43° S).

As our main aim was to establish if the community as a whole is generally more colourful at tropical latitudes than further away from the equator our analyses have focused on the mean trait values of all the species in a spatial grid cell. However, we have also calculated the maximum of the trait values for all species present in the grid cells and applied the same linear regression technique as above to ask whether the patterns we see for average colour also apply to the most colourful species in our dataset.

To evaluate whether a change in colourfulness has consistently been associated with a shift in geographic range through the evolutionary history of our species, we performed phylogenetically independent contrast analyses (PICs). We only included species with a range extending less than 10° of latitude. We used the midpoint of each species' range as the independent variable, and the colour index as the dependent variable in each analysis. Birds, butterflies and flowers were again analysed separately, to allow for the possibility that different selective processes might be acting on the different groups. A phylogeny of plants was derived using Phylomatic v3 (Webb *et al.*, 2008, with tree version R20120829), a phylogeny of bird species was constructed using birdtree.org (Jetz *et al.*, 2012) and a phylogeny

of the butterflies was created using the relationships published in the literature (list of references and details in Appendix S2, phylogenies in Appendix S1). Contrasts were calculated using Phylocom [analysis of trait evolution (function 'aotf'); Webb *et al.*, 2008] and analysed using linear regressions forced through the origin (details in Appendix S2). We calculated contribution indices for each node in the phylogeny, which estimate the degree to which present-day trait variation is affected by an individual nodal divergence; contributions vary between 0 and 1 and can be interpreted in similar manner to an R^2 value.

We also ran ANOVA analyses to assess if the incorporation of flowers from all growth forms into our analyses of the latitudinal patterns in coloration of flowers could have affected the results. These analyses compared the colour trait values of herbs, shrubs, trees and climbers, and demonstrated that there were no significant differences in the coloration of the growth forms (Appendix S4).

RESULTS

Contrary to the predictions of the colourful tropics hypothesis, our cross-species analyses showed that birds, butterflies and flowers had significantly higher colour saturation, maximum contrast and colour diversity at higher latitudes (all $P < 0.002$ except maximum contrast of flowers $P = 0.006$; Fig. 1 and results tables in Appendix S3). Flowers have greater average hue disparity in lower latitudes ($P = 0.001$). However, there was no significant latitudinal gradient in the disparity of hues on birds or butterflies. That is, flowers at lower latitudes (tropical regions) tend to have fewer distinct colours than do flowers at higher latitudes; however, where tropical species do use more than one colour in their flowers, they display more diverse hues. Temperate species more often have flowers that display numerous distinct colours that differ greatly in saturation of the same or similar hue.

A comparison of the colour saturation, diversity, maximum contrast and hue disparity of taxa in categorically tropical (> 23.43° latitude) versus non-tropical ranges confirmed that tropical species are not more colourful than species with non-tropical ranges, except for flowers displaying with more disparate hues in the tropics (Appendix S3).

Our cross-species analyses have shown that the most colourful species are more often found at higher latitudes. For all three taxa, maximum trait values of colour saturation, diversity and maximum contrast of the communities in each cell are all lower at lower latitudes. Birds and flowers also demonstrate lower maximum values of hue disparity in tropical regions, but there was no significant latitudinal pattern in the maximum signal of this trait in butterflies (Appendix S3). That is, the patterns for maximum colourfulness in the community were similar to those seen for mean colourfulness of the community.

Phylogenetic analyses showed that angiosperm flowers have significantly greater maximum contrast at higher latitudes ($P = 0.046$). All other phylogenetic analyses returned non-significant results (Appendix S3).

Overall, latitude explains little of the variation in colouration in flowers and butterflies. It does, however, explain more of the variation in bird colours; that latitude explains 16% of the variation in maximum contrast of colours and 14% of variation in colour diversity of all birds across the range is not insubstantial.

In butterflies, the split between the Nymphalidae family (which consists of browns, nymphs and danaines) and the Lycaenidae (which includes the blues, coppers and hairstreaks) contributes strongly to variation in all colourfulness metrics (colour diversity contribution = 0.22, colour saturation contribution = 0.3, maximum colour contrast contribution = 0.33, average hue disparity contribution = 0.15; the contribution scores approximate the proportion of present-day variation in a trait that are attributable a particular divergence – see Methods and Webb *et al.*, 2008, for details). Nymphalidae make up one-fifth of the Australian butterfly fauna, and are diverse in colour and pattern. The largest nymphalid subfamily, the Satyrinae, are unusual in their pattern of diversity with the temperate zone having considerably more species than tropical regions (Braby, 2000). Another divergence that contributed substantially to variation across butterfly species is that between the Hesperiidae (the 'skippers') and the remainder of the Papilionoidea (the butterflies, i.e. day-flying Lepidoptera). The divergence between these families affords much of the present-day variation in butterfly maximum colour span (contribution = 0.35), colour saturation (contribution = 0.28) and average hue disparity (contribution = 0.12). The Hesperiidae constitute a highly species-rich family, in which most adults are a 'sombre brown' colour (Braby, 2000); the dull-coloured hesperids may have also contributed to the result of greater colourfulness in temperate species by 'flooding' the tropical fauna with their large diversity.

The divergence that contributes most heavily to variation in the number of flower colours per species is the divergence between the Fabaceae (the pea family) and the Polygalaceae (the milkworts). The flowers of the Fabaceae most often have more than one colour displayed across the different floral display features of the banner, keel and wings (Fig. 2c). The most important split for maximum contrast between colours in flowers was the monocot–eudicot divergence; it contributed greatly to the variation in this trait (contribution = 0.82). Many of the monocots exhibit highly contrasting colours, for example *Diuris sulphurea* R.Br. (tiger orchid), *Diplarrena moraea* Labill. (white iris) and *Wurmbea biglandulosa* (R.Br.) T.D.Macfarl.

The passerines and parrots are responsible for most of variation in bird coloration, which is unsurprising given that these groups are both diverse and famously colourful. The divergence of passerines and parrots from the near-passerines is responsible for the largest contribution to present-day variation in bird colour diversity (contribution = 0.43) and average hue disparity (contribution = 0.39). The split of the parrots from the passerines also influences much of the variation in colour diversity (contribution = 0.25), which is not unexpected as some parrots such as *Psephotus varius* Clark (Mulga parrot), *Neophema splendida* Gould (scarlet-chested parrot) and

Glossopsitta porphyrocephala Dietrichsen (purple-crowned lorikeet) display a dazzling collection of colours.

DISCUSSION

Contrary to predictions, both the cross-species and phylogenetically independent results have shown that tropical species of birds, butterflies and flowers are not more colourful than their temperate counterparts. In fact, the cross-species analyses indicate that species further away from the equator on average possess a greater diversity of colours, and their colours are more contrasting and more saturated than those seen in tropical species. Our cross-species analyses have also demonstrated that the higher-latitude regions tend to contain the most colourful species. This finding runs counter to the accepted paradigm, but – as we explore below – is consistent with some theories and empirical evidence regarding the ecology and evolution of colour in nature.

Several hypotheses have been proposed as to why life in the tropics may be more colourful than in temperate or arctic systems. Many of the key arguments for the evolution of greater colouration at lower latitudes stemmed from the idea that biotic interactions are of greater importance and strength in the tropics (Schemske *et al*., 2009). For example, several biologists have suggested that high predation pressure at tropical latitudes drives the evolution of striking aposematic colouration (a warning signal of unprofitability or noxiousness of prey), which is predominantly seen in tropical organisms (Wallace, 1878; Gauld *et al*., 1992). However, the idea that there is a latitudinal gradient in biotic interactions is still a topic of debate, with inconsistent support provided by the broadest datasets and by most recent meta-analyses and data syntheses (Hille Ris Lambers *et al*., 2002; Moles *et al*., 2011; Ollerton *et al*., 2011; Poore *et al*., 2012). Even if there is a latitudinal gradient in predation pressure (and the evidence is mixed; Cornell & Hawkins, 1995; Martin, 1996; Kelly *et al*., 2008), aposematic colouration is only one possible response. An alternative adaptive response is crypsis in which visual camouflage is achieved by the use of low contrast and unsaturated colours, making the organism simply less apparent against its background (Endler, 1983, 1993; Gomez & Théry, 2004). Our results are consistent with the idea that tropical animal species may be employing such a strategy. A different explanation might be needed for flowers that have to balance potential florivory with the attraction of pollinators. Early indications are that there may be an increase in florivory with increasing latitude (Kelly *et al*., 2008); however a broader quantification of this pattern would be worthwhile.

Sexual selection can lead to the evolution of colourful displays for communication with and competition for potential mates (Endler, 1983; Iwasa & Pomiankowski, 1995). If there is greater sexual selection (perhaps mediated by stronger impacts of parasitism and parasite diversity; Hamilton & Zuk, 1982) in diverse tropical regions (Owens *et al*., 1999), then we would expect greater colouration at lower latitudes. However, stronger sexual selection would not just lead to more colourful sexual ornamentation but also to a greater extent of dichromatism and size dimorphism between the sexes. There is conflicting evidence as to whether latitudinal gradients in sexual dichromatism or dimorphism exist (Bailey, 1978; Cardillo, 2002; Tuomaala *et al*., 2012), and as such the existence of a latitudinal gradient in sexual selection is unresolved.

Birds, butterflies and flowers all play different roles within ecosystems, so it is worthwhile considering the similarities and differences between results for these clades. The display colours of flowers are primarily a signal to pollinators, which requires a visually conspicuous signal. In contrast, the colours of birds and butterflies are likely to be driven by both sexual selection (which can drive the evolution of gaudy displays; Endler, 1983), and natural selection (such as predation, which can select for cryptic or camouflage colouration in both predators and prey; Endler, 1983; Caro, 2005). Predation may be the key difference between the selection pressures experienced by animals and plants, reflected in the differences in results between these taxa. Angiosperms were the only taxonomic group to show a higher mean community value in a trait in the tropics, signalling with within-flower patches having more different hues at lower latitudes. Perhaps the need to always be apparent, while experiencing different predation pressures, favours such flower colouration in tropical environments; the lack of this pattern in birds and butterflies may reflect their different ecological roles, as potential predators or prey (Clusella Trullas *et al*., 2007; Hetem *et al*., 2009; Vanderwerf, 2012; Arista *et al*., 2013; Geen & Johnston, 2014; Guindre-Parker & Love, 2014; Zheng *et al*., 2014; Koski & Ashman, 2015). The abiotic environment will play an important role in shaping the colouration of many species of plants and animals (Vanderwerf, 2012; Arista *et al*., 2013; Guindre-Parker & Love, 2014; Zheng *et al*., 2014; Koski & Ashman, 2015). However, it is interesting that we have shown the same latitudinal gradients in colouration evident in an ectothermic animal as in an endothermic animal, despite the differences in roles that coloration can play in thermoregulation for such groups (Clusella Trullas *et al*., 2007; Hetem *et al*., 2009; Geen & Johnston, 2014).

Part of the rationale for the colourful tropics hypothesis has rested on an assumption of higher availability of resources at lower latitudes (Wallace, 1878). The production of some colours is known to be dependent on the acquisition of resources. For example, nutritional status can affect the development of red or yellow colours, as carotenoid-based pigments cannot be synthesized but only ingested (McGraw, 2006), and diet may affect the production of melanin-based and structural colours (Hill, 2006; but see Kemp *et al*., 2012). However, recent research into global patterns of net primary productivity (NPP) has suggested that temperate forests may have a higher productivity than tropical forests (Huston & Wolverton, 2009).

The light environment in which an organism resides can affect its colour signals (Koski & Ashman, 2015; Endler, 1993; Gomez & Théry, 2004; Douglas *et al*., 2010). Many predictions for greater colourfulness in the tropics supposed that habitats in this region comprise large stretches of shady, closed-canopy rain forest, and that therefore tropical species must utilize more

complex colour patterns (Douglas *et al*., 2010), with high colour saturation, a range of strongly varying colours and high contrast between colour patches in order for visual communication with conspecifics, mates or pollinators to be effective (Endler, 1993; Gomez & Théry, 2004). However, the assumption that tropical regions are covered by shady closed-canopy forest overlooks the great abundance of tropical dry forest and savanna ecotypes in equatorial areas (the coverage of tropical rain forest in the study area is relatively low at *c*. 1.2%, but this biome only covers 7% of the globe's land mass; Freeman, 2005). It also discounts the fact that rain forests are not only found in the tropics, but extend to high latitudes in the form of cool temperate rain forest (e.g., New Zealand's rain forests). Further, temperate latitudes have lower incident solar radiation than tropical latitudes, and experience fewer daylight hours through the year (Freeman, 2005), although the daylight hours are still relatively high during the seasons of greater invertebrate activity. That is, the assertion that a darker environment drives the evolution of greater coloration may be the very reason that temperate species are more colourful.

Most of our PIC analyses indicated no significant gradient in colourfulness, while most of our cross-species analyses showed higher colour towards higher latitudes. Our study is not the first report of latitudinal gradients being supported by cross-species but not phylogenetic analyses. Cardillo (2002) found that the latitudinal gradient in sexual dichromatism in birds was due to a few deep divergences in the phylogeny and therefore no significant gradient was reflected in their PICs. There are two possible explanations for discordance between these two approaches. First, higher *P*-values in phylogenetic analyses might result from the lower statistical power associated with incompletely resolved phylogenetic trees (and thus, a lower overall sample size). Second, the cross-species pattern might be due to a few major divergences deep in our taxonomic groups that have been associated with changes in both range and colour, which may have been an important factor leading to species being more colourful in temperate rather than tropical ranges. Either way, our phylogenetic analyses confirm that the lack of phylogenetic independence of cross-species data has not obscured a trend for species to be more colourful in the tropics.

This study has only covered one of the continents, namely Australia. While the flora and fauna of Australia are taxonomically rather different from other regions, we have no particular reason to expect that Australia will exhibit distinct ecological and evolutionary processes or different patterns across broad latitudinal space from those seen on other continents. Our study area contains habitat types including tropical rain forest, savanna, temperate woodland and heathland, and has covered 34.5° of latitude and 2,818,523 km^2, which is a large breadth of biomes and space. However, further studies asking whether our results extend to all continents would be worthwhile.

The idea that tropical species are the most colourful on the planet has long fascinated naturalists and persists to the present (Darwin, 1859; Wallace, 1868, 1878, 2000; Poulton, 1890; Weevers, 1952; Wilson & von Neumann, 1972; Bailey, 1978; Lambertini, 2000; Adams *et al*., 2014). It is likely that the diverse yet cryptically coloured little brown birds and butterflies of the tropics are simply less memorable; the 'wow' factor of the few dazzlingly coloured species encountered may be enough to dominate impressions and memories of tropical regions in such visual animals as ourselves. For instance, after a few years digesting his experiences on the Malay Archipelago, Wallace lectured that 'for every group of brightly coloured tropical birds, there is another of equal extent whose limits are plain and sober, so that it is doubtful, whether, in proportion to the whole, more gay coloured birds are found in the tropics than in the temperate regions' (Wallace, 2000). Regardless of his own reasoning, Wallace remained captivated by the colourful tropics hypothesis and often wrote about how organisms *were* more colourful in the tropics (Wallace, 1868, 1878). Recent research has seen many of the traditional assumptions about tropical regions being challenged or disproven (Hille Ris Lambers *et al*., 2002; Huston & Wolverton, 2009; Moles *et al*., 2011; Poore *et al*., 2012), and while our data do likewise, they also indicate a potentially fundamental biological phenomenon. That birds, butterflies and flowers display similar gradients of colourfulness across latitudes indicates strong ecological and evolutionary cohesion. That tropical species are not more colourful than temperate species may refresh scientific discussion about the evolutionary and ecological drivers of colour, and their relative importance in shaping organisms' phenotypes. We have demonstrated here that the expectation that tropical latitudes would contain the most colourful species is not supported by empirical data, and that it is time to abandon this hypothesis, despite its colourful appeal.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of this article at the publisher's web-site.

Appendix S1 Species lists and phylogenies.
Appendix S2 Detailed methods.
Appendix S3 Results tables.
Appendix S4 ANOVA comparisons of different plant growth forms.
Appendix S5 Flower collections.

BIOSKETCH

Rhiannon Dalrymple is interested in macroecological and latitudinal gradients in ecology. Her current focus is exploring patterns in traits across communities, with particular interest in the relative influence of different selection pressures in affecting animal and plant colour.

Editor: Greg Jordan

R.L. Dalrymple, D.J. Kemp, H. Flores-Moreno, S.W. Laffan, T.E. White, F.A. Hemmings, M.Tindall, and A.T. Moles, *(Global Ecology and Biogeography)* Birds, butterflies and flowers in the tropics are not more colorful than those in higher latitudes

Appendix 1 – Species list and phylogenies

Table S1: Study species

Bird taxonomy following Christidis and Boles (2008); subspecies following Schodde and Mason (1999), and Simpson and Day (2010). Butterfly taxonomy following Braby (2000). Plant taxonomy following APGIII of the Australian Plant Census (Centre for Australian National Biodiversity Research, Viewed [01.01.2015]).

Taxonomic group	Family	Species
Bird	Acanthizidae	*Acanthiza apicalis albiventris*
Bird	Acanthizidae	*Acanthiza chrysorrhoa*
Bird	Acanthizidae	*Acanthiza ewingii ewingii*
Bird	Acanthizidae	*Acanthiza ewingii rufifrons*
Bird	Acanthizidae	*Acanthiza katherina*
Bird	Acanthizidae	*Acanthiza lineata alberti*
Bird	Acanthizidae	*Acanthiza lineata lineata*
Bird	Acanthizidae	*Acanthiza nana flava*
Bird	Acanthizidae	*Acanthiza nana modesta*
Bird	Acanthizidae	*Acanthiza nana nana*
Bird	Acanthizidae	*Acanthiza pusilla diemenensis*
Bird	Acanthizidae	*Acanthiza pusilla pusilla*
Bird	Acanthizidae	*Acanthiza reguloides nesa*
Bird	Acanthizidae	*Acanthiza reguloides reguloides*
Bird	Acanthizidae	*Acanthiza reguloides squamata*
Bird	Acanthizidae	*Acanthiza uropygialis*
Bird	Acanthizidae	*Acanthornis magna*
Bird	Acanthizidae	*Aphelocephala leucopsis leucopsis*
Bird	Acanthizidae	*Aphelocephala nigricincta*
Bird	Acanthizidae	*Calamanthus fuliginosus*
Bird	Acanthizidae	*Chthonicola sagittata*
Bird	Acanthizidae	*Gerygone albogularis*
Bird	Acanthizidae	*Gerygone fusca*
Bird	Acanthizidae	*Gerygone levigaster cantator*

Bird	Acanthizidae	*Gerygone levigaster levigaster*
Bird	Acanthizidae	*Gerygone magnirostris*
Bird	Acanthizidae	*Gerygone mouki amalia*
Bird	Acanthizidae	*Gerygone mouki richmondi*
Bird	Acanthizidae	*Gerygone palpebrosa flavida*
Bird	Acanthizidae	*Gerygone palpebrosa personata*
Bird	Acanthizidae	*Hylacola cauta*
Bird	Acanthizidae	*Hylacola pyrrhopygia*
Bird	Acanthizidae	*Oreoscopus gutturalis*
Bird	Acanthizidae	*Origma solitaria*
Bird	Acanthizidae	*Pycnoptilus floccosus*
Bird	Acanthizidae	*Pyrrholaemus brunneus*
Bird	Acanthizidae	*Sericornis citreogularis cairnsi*
Bird	Acanthizidae	*Sericornis citreogularis citreogularis*
Bird	Acanthizidae	*Sericornis frontalis frontalis*
Bird	Acanthizidae	*Sericornis frontalis laevigaster*
Bird	Acanthizidae	*Sericornis frontalis tweedi*
Bird	Acanthizidae	*Sericornis humilis*
Bird	Acanthizidae	*Sericornis keri*
Bird	Acanthizidae	*Sericornis magnirostris dubius*
Bird	Acanthizidae	*Sericornis magnirostris magnirostris*
Bird	Acanthizidae	*Sericornis magnirostris viridior*
Bird	Acanthizidae	*Smicrornis brevirostris brevirostris*
Bird	Acanthizidae	*Smicrornis brevirostris flavescens*
Bird	Accipitridae	*Accipiter cirrocephalus*
Bird	Accipitridae	*Accipiter fasciatus*
Bird	Accipitridae	*Accipiter novaehollandiae*
Bird	Accipitridae	*Aquila audax*
Bird	Accipitridae	*Aviceda subcristata*
Bird	Accipitridae	*Circus approximans*
Bird	Accipitridae	*Circus assimilis*
Bird	Accipitridae	*Elanus axillaris*
Bird	Accipitridae	*Elanus scriptus*
Bird	Accipitridae	*Haliaeetus leucogaster*
Bird	Accipitridae	*Haliastur sphenurus*
Bird	Accipitridae	*Hamirostra melanosternon*
Bird	Accipitridae	*Hieraaetus morphnoides*
Bird	Accipitridae	*Lophoictinia isura*
Bird	Accipitridae	*Milvus migrans*
Bird	Acrocephalidae	*Acrocephalus australis*
Bird	Aegothelidae	*Aegotheles cristatus*
Bird	Alaudidae	*Mirafra javanica horsfieldii*
Bird	Alaudidae	*Mirafra javanica rufenscens*
Bird	Alcedinidae	*Ceyx azurea*
Bird	Alcedinidae	*Ceyx pusilla*
Bird	Anatidae	*Anas castanea*
Bird	Anatidae	*Anas gracilis*
Bird	Anatidae	*Anas rhynchotis*

Bird	Anatidae	*Anas superciliosa*
Bird	Anatidae	*Aythya australis*
Bird	Anatidae	*Biziura lobata*
Bird	Anatidae	*Cereopsis novaehollandiae*
Bird	Anatidae	*Chenonetta jubata*
Bird	Anatidae	*Cygnus atratus*
Bird	Anatidae	*Dendrocygna arcuata*
Bird	Anatidae	*Dendrocygna eytoni*
Bird	Anatidae	*Malacorhynchus membranaceus*
Bird	Anatidae	*Nettapus coromandelianus*
Bird	Anatidae	*Nettapus pulchellus*
Bird	Anatidae	*Oxyura australis*
Bird	Anatidae	*Stictonetta naevosa*
Bird	Anatidae	*Tadorna radjah*
Bird	Anatidae	*Tadorna tadornoides*
Bird	Anhingidae	*Anhinga novaehollandiae*
Bird	Anseranatidae	*Anseranas semipalmata*
Bird	Apodidae	*Aerodramus terraereginae*
Bird	Apodidae	*Apus pacificus*
Bird	Apodidae	*Hirundapus caudacutus*
Bird	Ardeidae	*Ardea ibis*
Bird	Ardeidae	*Ardea intermedia*
Bird	Ardeidae	*Ardea modesta*
Bird	Ardeidae	*Ardea pacifica*
Bird	Ardeidae	*Ardea sumatrana*
Bird	Ardeidae	*Botaurus poiciloptilus*
Bird	Ardeidae	*Butorides striatus*
Bird	Ardeidae	*Egretta garzetta*
Bird	Ardeidae	*Egretta novaehollandiae*
Bird	Ardeidae	*Egretta picata*
Bird	Ardeidae	*Ixobrychus dubius*
Bird	Ardeidae	*Ixobrychus flavicollis*
Bird	Ardeidae	*Nycticorax caledonicus*
Bird	Artamidae	*Artamus cinereus*
Bird	Artamidae	*Artamus cyanopterus*
Bird	Artamidae	*Artamus leucorynchus*
Bird	Artamidae	*Artamus minor*
Bird	Artamidae	*Artamus personatus*
Bird	Artamidae	*Artamus superciliosus*
Bird	Artamidae	*Cracticus mentalis*
Bird	Artamidae	*Cracticus nigrogularis*
Bird	Artamidae	*Cracticus quoyi*
Bird	Artamidae	*Cracticus tibicen terraereginae*
Bird	Artamidae	*Cracticus tibicen tibicen*
Bird	Artamidae	*Cracticus torquatus*
Bird	Artamidae	*Strepera fuliginosa*
Bird	Artamidae	*Strepera graculina*
Bird	Artamidae	*Strepera versicolor arguta*

Bird	Artamidae	*Strepera versicolor melanoptera*
Bird	Artamidae	*Strepera versicolor versicolor*
Bird	Atrichornithidae	*Atrichornis rufescens rufescens*
Bird	Burhinidae	*Burhinus grallarius*
Bird	Cacatuidae	*Cacatua galerita*
Bird	Cacatuidae	*Cacatua sanguinea*
Bird	Cacatuidae	*Cacatua tenuirostris*
Bird	Cacatuidae	*Callocephalon fimbriatum*
Bird	Cacatuidae	*Calyptorhynchus banksii*
Bird	Cacatuidae	*Calyptorhynchus funereus*
Bird	Cacatuidae	*Calyptorhynchus lathami*
Bird	Cacatuidae	*Eolophus roseicapillus*
Bird	Cacatuidae	*Lophochroa leadbeateri*
Bird	Cacatuidae	*Nymphicus hollandicus*
Bird	Cacatuidae	*Probosciger aterrimus*
Bird	Campephagidae	*Coracina lineata*
Bird	Campephagidae	*Coracina maxima*
Bird	Campephagidae	*Coracina novaehollandiae melanops*
Bird	Campephagidae	*Coracina novaehollandiae novaehollandiae*
Bird	Campephagidae	*Coracina papuensis artamoides*
Bird	Campephagidae	*Coracina papuensis hypoleuca*
Bird	Campephagidae	*Coracina papuensis oriomo*
Bird	Campephagidae	*Coracina tenuirostris tenuirostris*
Bird	Campephagidae	*Lalage leucomela leucomela*
Bird	Campephagidae	*Lalage leucomela yorki*
Bird	Caprimulgidae	*Caprimulgus macrurus*
Bird	Casuariidae	*Casuarius casuarius johnsonii*
Bird	Casuariidae	*Dromaius novaehollandiae*
Bird	Charadriidae	*Charadrius australis*
Bird	Charadriidae	*Charadrius ruficapillus*
Bird	Charadriidae	*Elseyornis melanops*
Bird	Charadriidae	*Erythrogonys cinctus*
Bird	Charadriidae	*Vanellus miles*
Bird	Charadriidae	*Vanellus tricolor*
Bird	Ciconiidae	*Ephippiorhynchus asiaticus*
Bird	Cisticolidae	*Cisticola exilis*
Bird	Cisticolidae	*Cisticola juncidis laveryi*
Bird	Climacteridae	*Climacteris affinis affinis*
Bird	Climacteridae	*Climacteris erythrops*
Bird	Climacteridae	*Climacteris melanura melanura*
Bird	Climacteridae	*Climacteris picumnus melanotus*
Bird	Climacteridae	*Climacteris picumnus picumnus*
Bird	Climacteridae	*Climacteris picumnus victoriae*
Bird	Climacteridae	*Cormobates leucophaeus intermedius*
Bird	Climacteridae	*Cormobates leucophaeus metastasis*
Bird	Climacteridae	*Cormobates leucophaeus minor*
Bird	Columbidae	*Chalcophaps indica*

Bird	Columbidae	*Columba leucomela*
Bird	Columbidae	*Ducula bicolor spilorrhoa*
Bird	Columbidae	*Geopelia cuneata*
Bird	Columbidae	*Geopelia humeralis*
Bird	Columbidae	*Geopelia striata*
Bird	Columbidae	*Geophaps plumifera*
Bird	Columbidae	*Geophaps scripta*
Bird	Columbidae	*Leucosarcia picata*
Bird	Columbidae	*Lopholaimus antarcticus*
Bird	Columbidae	*Macropygia amboinensis phasianella*
Bird	Columbidae	*Ocyphaps lophotes*
Bird	Columbidae	*Phaps chalcoptera*
Bird	Columbidae	*Phaps elegans*
Bird	Columbidae	*Phaps histrionica*
Bird	Columbidae	*Ptilinopus magnificus*
Bird	Columbidae	*Ptilinopus regina*
Bird	Columbidae	*Ptilinopus superbus*
Bird	Coraciidae	*Eurystomus orientalis pacificus*
Bird	Corcoracidae	*Corcorax melanorhamphos*
Bird	Corcoracidae	*Struthidea cinerea*
Bird	Corvidae	*Corvus bennetti*
Bird	Corvidae	*Corvus coronoides*
Bird	Corvidae	*Corvus mellori*
Bird	Corvidae	*Corvus orru cecilae*
Bird	Corvidae	*Corvus tasmanicus tasmanicus*
Bird	Cuculidae	*Cacomantis castaneiventris*
Bird	Cuculidae	*Cacomantis flabelliformis*
Bird	Cuculidae	*Cacomantis pallidus*
Bird	Cuculidae	*Cacomantis variolosus*
Bird	Cuculidae	*Centropus phasianinus*
Bird	Cuculidae	*Chalcites basalis*
Bird	Cuculidae	*Chalcites lucidus lucidus*
Bird	Cuculidae	*Chalcites lucidus plagosus*
Bird	Cuculidae	*Chalcites minutillus barnardi*
Bird	Cuculidae	*Chalcites minutillus russatus*
Bird	Cuculidae	*Cuculus optatus*
Bird	Cuculidae	*Eudynamys orientalis*
Bird	Cuculidae	*Scythrops novaehollandiae*
Bird	Dasyornithidae	*Dasyornis brachypterus*
Bird	Dasyornithidae	*Dasyornis broadbenti broadbenti*
Bird	Dasyornithidae	*Dasyornis broadbenti caryochrous*
Bird	Dicruridae	*Dicrurus bracteatus*
Bird	Estrildidae	*Emblema pictum*
Bird	Estrildidae	*Erythrura gouldiae black face*
Bird	Estrildidae	*Erythrura gouldiae crimson face*
Bird	Estrildidae	*Erythrura trichroa*
Bird	Estrildidae	*Heteromunia pectoralis*
Bird	Estrildidae	*Lonchura castaneothorax*

Bird	Estrildidae	*Neochmia modesta*
Bird	Estrildidae	*Neochmia phaeton*
Bird	Estrildidae	*Neochmia temporalis minor*
Bird	Estrildidae	*Neochmia temporalis temporalis*
Bird	Estrildidae	*Poephila acuticauda*
Bird	Estrildidae	*Poephila cincta atropygialis*
Bird	Estrildidae	*Poephila cincta cincta*
Bird	Estrildidae	*Poephila personata*
Bird	Estrildidae	*Stagonopleura bella*
Bird	Estrildidae	*Stagonopleura guttata*
Bird	Estrildidae	*Taeniopygia bichenovii*
Bird	Estrildidae	*Taeniopygia guttata*
Bird	Eurostopodidae	*Eurostopodus argus*
Bird	Eurostopodidae	*Eurostopodus mystacalis*
Bird	Falconidae	*Falco berigora*
Bird	Falconidae	*Falco cenchroides*
Bird	Falconidae	*Falco longipennis*
Bird	Falconidae	*Falco peregrinus*
Bird	Falconidae	*Falco subniger*
Bird	Glareolidae	*Glareola maldivarum*
Bird	Glareolidae	*Stiltia isabella*
Bird	Gruidae	*Grus antigone*
Bird	Gruidae	*Grus rubicunda*
Bird	Halcyonidae	*Dacelo leachii*
Bird	Halcyonidae	*Dacelo novaeguineae*
Bird	Halcyonidae	*Syma torotoro flavirostris*
Bird	Halcyonidae	*Tanysiptera sylvia*
Bird	Halcyonidae	*Todiramphus chloris colcloughi*
Bird	Halcyonidae	*Todiramphus chloris sordidus*
Bird	Halcyonidae	*Todiramphus macleayii*
Bird	Halcyonidae	*Todiramphus pyrrhopygia*
Bird	Halcyonidae	*Todiramphus sanctus*
Bird	Hirundinidae	*Hirundo ariel*
Bird	Hirundinidae	*Hirundo neoxena*
Bird	Hirundinidae	*Hirundo nigricans*
Bird	Jacanidae	*Irediparra gallinacea*
Bird	Maluridae	*Amytornis barbatus*
Bird	Maluridae	*Amytornis goyderi*
Bird	Maluridae	*Amytornis striatus*
Bird	Maluridae	*Malurus amabilis*
Bird	Maluridae	*Malurus cyaneus cyaneus*
Bird	Maluridae	*Malurus cyaneus cyanochlamys*
Bird	Maluridae	*Malurus lamberti assimilis*
Bird	Maluridae	*Malurus lamberti lamberti*
Bird	Maluridae	*Malurus leucopterus*
Bird	Maluridae	*Malurus melanocephalus cruentatus*
Bird	Maluridae	*Malurus melanocephalus melanocephalus*

Bird	Maluridae	*Malurus splendens emmottorum*
Bird	Maluridae	*Malurus splendens melanotus*
Bird	Maluridae	*Stipiturus malachurus malachurus*
Bird	Maluridae	*Stipiturus ruficeps*
Bird	Megaluridae	*Cincloramphus cruralis*
Bird	Megaluridae	*Cincloramphus mathewsi*
Bird	Megaluridae	*Eremiornis carteri*
Bird	Megaluridae	*Megalurus gramineus*
Bird	Megaluridae	*Megalurus timoriensis alisteri*
Bird	Megapodiidae	*Alectura lathami*
Bird	Megapodiidae	*Leipoa ocellata*
Bird	Megapodiidae	*Megapodius reinwardt*
Bird	Meliphagidae	*Acanthagenys rufogularis*
Bird	Meliphagidae	*Acanthorhynchus tenuirostris dubius*
Bird	Meliphagidae	*Acanthorhynchus tenuirostris tenuirostris*
Bird	Meliphagidae	*Anthochaera carunculata carunculata*
Bird	Meliphagidae	*Anthochaera chrysoptera chrysoptera*
Bird	Meliphagidae	*Anthochaera chrysoptera tasmanica*
Bird	Meliphagidae	*Anthochaera paradoxa*
Bird	Meliphagidae	*Anthochaera phrygia*
Bird	Meliphagidae	*Ashbyia lovensis*
Bird	Meliphagidae	*Certhionyx variegatus*
Bird	Meliphagidae	*Cissomela pectoralis*
Bird	Meliphagidae	*Conopophila albogularis*
Bird	Meliphagidae	*Conopophila rufogularis*
Bird	Meliphagidae	*Entomyzon cyanotis cyanotis*
Bird	Meliphagidae	*Entomyzon cyanotis griseigularis*
Bird	Meliphagidae	*Epthianura albifrons*
Bird	Meliphagidae	*Epthianura aurifrons*
Bird	Meliphagidae	*Epthianura crocea crocea*
Bird	Meliphagidae	*Epthianura tricolor*
Bird	Meliphagidae	*Glycichaera fallax claudi*
Bird	Meliphagidae	*Glyciphila melanops*
Bird	Meliphagidae	*Grantiella picta*
Bird	Meliphagidae	*Lichenostomus chrysops barroni*
Bird	Meliphagidae	*Lichenostomus chrysops chrysops*
Bird	Meliphagidae	*Lichenostomus cratitius*
Bird	Meliphagidae	*Lichenostomus fasciogularis*
Bird	Meliphagidae	*Lichenostomus flavescens*
Bird	Meliphagidae	*Lichenostomus flavicollis*
Bird	Meliphagidae	*Lichenostomus flavus flavus*
Bird	Meliphagidae	*Lichenostomus frenatus*
Bird	Meliphagidae	*Lichenostomus fuscus fuscus*
Bird	Meliphagidae	*Lichenostomus hindwoodi*
Bird	Meliphagidae	*Lichenostomus keartlandi*
Bird	Meliphagidae	*Lichenostomus leucotis leucotis*

Bird	Meliphagidae	*Lichenostomus melanops meltoni*
Bird	Meliphagidae	*Lichenostomus ornatus*
Bird	Meliphagidae	*Lichenostomus penicillatus leilavalensis*
Bird	Meliphagidae	*Lichenostomus penicillatus penicillatus*
Bird	Meliphagidae	*Lichenostomus plumulus*
Bird	Meliphagidae	*Lichenostomus unicolor*
Bird	Meliphagidae	*Lichenostomus versicolor versicolor*
Bird	Meliphagidae	*Lichenostomus virescens*
Bird	Meliphagidae	*Lichmera indistincta ocularis*
Bird	Meliphagidae	*Manorina flavigula flavigula*
Bird	Meliphagidae	*Manorina melanocephala leachi*
Bird	Meliphagidae	*Manorina melanocephala lepidota*
Bird	Meliphagidae	*Manorina melanocephala melanocephala*
Bird	Meliphagidae	*Manorina melanocephala titaniota*
Bird	Meliphagidae	*Manorina melanophrys*
Bird	Meliphagidae	*Meliphaga gracilis gracilis*
Bird	Meliphagidae	*Meliphaga lewinii lewinii*
Bird	Meliphagidae	*Meliphaga lewinii mab*
Bird	Meliphagidae	*Meliphaga notata*
Bird	Meliphagidae	*Melithreptus affinis*
Bird	Meliphagidae	*Melithreptus albogularis albogularis*
Bird	Meliphagidae	*Melithreptus albogularis inoptinatus*
Bird	Meliphagidae	*Melithreptus brevirostris*
Bird	Meliphagidae	*Melithreptus gularis gularis*
Bird	Meliphagidae	*Melithreptus gularis laetior*
Bird	Meliphagidae	*Melithreptus lunatus lunatus*
Bird	Meliphagidae	*Melithreptus validirostris*
Bird	Meliphagidae	*Myzomela erythrocephala*
Bird	Meliphagidae	*Myzomela obscura harterti*
Bird	Meliphagidae	*Myzomela sanguinolenta*
Bird	Meliphagidae	*Philemon argenticeps kempi*
Bird	Meliphagidae	*Philemon buceroides yorki*
Bird	Meliphagidae	*Philemon citreogularis citreogularis*
Bird	Meliphagidae	*Philemon corniculatus monarchus*
Bird	Meliphagidae	*Phylidonyris niger niger*
Bird	Meliphagidae	*Phylidonyris novaehollandiae canescens*
Bird	Meliphagidae	*Phylidonyris novaehollandiae novaehollandiae*
Bird	Meliphagidae	*Phylidonyris pyrrhoptera*
Bird	Meliphagidae	*Plectorhyncha lanceolata*
Bird	Meliphagidae	*Purnella albifrons*
Bird	Meliphagidae	*Ramsayornis fasciatus*
Bird	Meliphagidae	*Ramsayornis modestus*
Bird	Meliphagidae	*Sugomel niger*

Bird	Meliphagidae	*Trichodere cockerelli*
Bird	Meliphagidae	*Xanthotis flaviventer*
Bird	Meliphagidae	*Xanthotis macleayana*
Bird	Menuridae	*Menura alberti*
Bird	Menuridae	*Menura novaehollandiae edwardi*
Bird	Menuridae	*Menura novaehollandiae novaehollandiae*
Bird	Menuridae	*Menura novaehollandiae victoriae*
Bird	Meropidae	*Merops ornatus*
Bird	Monarchidae	*Arses kaupi*
Bird	Monarchidae	*Arses telescophthalmus lorealis*
Bird	Monarchidae	*Carterornis leucotis*
Bird	Monarchidae	*Grallina cyanoleuca*
Bird	Monarchidae	*Machaerirhynchus flaviventer secundus*
Bird	Monarchidae	*Monarcha melanopsis*
Bird	Monarchidae	*Myiagra alecto*
Bird	Monarchidae	*Myiagra cyanoleuca*
Bird	Monarchidae	*Myiagra inquieta*
Bird	Monarchidae	*Myiagra rubecula*
Bird	Monarchidae	*Myiagra ruficollis*
Bird	Monarchidae	*Symposiarchus trivirgatus albiventris*
Bird	Monarchidae	*Symposiarchus trivirgatus melanorrhoa*
Bird	Motacillidae	*Anthus novaeseelandiae bistriatus*
Bird	Motacillidae	*Anthus novaeseelandiae novaeseelandiae*
Bird	Nectariniidae	*Dicaeum hirundinaceum*
Bird	Nectariniidae	*Nectarinia jugularis frenata*
Bird	Neosittidae	*Daphoenositta chrysoptera chrysoptera*
Bird	Neosittidae	*Daphoenositta chrysoptera leucoptera*
Bird	Neosittidae	*Daphoenositta chrysoptera striata*
Bird	Oriolidae	*Oriolus flavocinctus*
Bird	Oriolidae	*Oriolus sagittatus*
Bird	Oriolidae	*Sphecotheres vieilloti flaviventris*
Bird	Oriolidae	*Sphecotheres vieilloti vieilloti*
Bird	Orthonychidae	*Orthonyx spaldingii*
Bird	Orthonychidae	*Orthonyx temminckii*
Bird	Otididae	*Ardeotis australis*
Bird	Pachycephalidae	*Colluricincla boweri*
Bird	Pachycephalidae	*Colluricincla harmonica brunnea*
Bird	Pachycephalidae	*Colluricincla harmonica harmonica*
Bird	Pachycephalidae	*Colluricincla harmonica strigata*
Bird	Pachycephalidae	*Colluricincla harmonica superciliosa*
Bird	Pachycephalidae	*Colluricincla megarhyncha*
Bird	Pachycephalidae	*Colluricincla woodwardi*

Bird	Pachycephalidae	*Falcunculus frontatus*
Bird	Pachycephalidae	*Oreoica gutturalis*
Bird	Pachycephalidae	*Pachycephala inornata*
Bird	Pachycephalidae	*Pachycephala lanioides fretorum*
Bird	Pachycephalidae	*Pachycephala melanura robusta*
Bird	Pachycephalidae	*Pachycephala olivacea*
Bird	Pachycephalidae	*Pachycephala pectoralis glaucura*
Bird	Pachycephalidae	*Pachycephala pectoralis pectoralis*
Bird	Pachycephalidae	*Pachycephala rufiventris pallida*
Bird	Pachycephalidae	*Pachycephala rufiventris rufiventris*
Bird	Pachycephalidae	*Pachycephala rufogularis*
Bird	Pachycephalidae	*Pachycephala simplex peninsulae*
Bird	Paradisaeidae	*Phonygammus keraudrenii gouldii*
Bird	Paradisaeidae	*Ptiloris magnificus*
Bird	Paradisaeidae	*Ptiloris paradiseus*
Bird	Paradisaeidae	*Ptiloris victoriae*
Bird	Pardalotidae	*Pardalotus punctatus punctatus*
Bird	Pardalotidae	*Pardalotus quadragintus*
Bird	Pardalotidae	*Pardalotus rubricatus rubricatus*
Bird	Pardalotidae	*Pardalotus rubricatus yorki*
Bird	Pardalotidae	*Pardalotus striatus melanocephalus*
Bird	Pardalotidae	*Pardalotus striatus ornatus*
Bird	Pardalotidae	*Pardalotus striatus striatus*
Bird	Pardalotidae	*Pardalotus striatus substriatus*
Bird	Pardalotidae	*Pardalotus striatus uropygialis*
Bird	Pedionomidae	*Pedionomus torquatus*
Bird	Pelicanidae	*Pelecanus conspicillatus*
Bird	Petroicidae	*Drymodes brunneopygia*
Bird	Petroicidae	*Drymodes superciliaris*
Bird	Petroicidae	*Eopsaltria australis australis*
Bird	Petroicidae	*Heteromyias cinereifrons*
Bird	Petroicidae	*Melanodryas cucullata*
Bird	Petroicidae	*Melanodryas vittata kingi*
Bird	Petroicidae	*Melanodryas vittata vittata*
Bird	Petroicidae	*Microeca fascinans*
Bird	Petroicidae	*Microeca flavigaster flavissima*
Bird	Petroicidae	*Microeca flavigaster laetissima*
Bird	Petroicidae	*Microeca griseoceps*
Bird	Petroicidae	*Peneonanthe pulverulenta leucura*
Bird	Petroicidae	*Petroica boodang boodang*
Bird	Petroicidae	*Petroica boodang leggii*
Bird	Petroicidae	*Petroica goodenovii*
Bird	Petroicidae	*Petroica multicolor*
Bird	Petroicidae	*Petroica phoenicea*
Bird	Petroicidae	*Petroica rodinogaster inexpectata*
Bird	Petroicidae	*Petroica rodinogaster rodinogaster*
Bird	Petroicidae	*Petroica rosea*
Bird	Petroicidae	*Poecilodryas cerviniventris*

Bird	Petroicidae	*Poecilodryas superciliosa*
Bird	Petroicidae	*Tregellasia capito nana*
Bird	Petroicidae	*Tregellasia leucops albigularis*
Bird	Phalacrocoracidae	*Microcarbo melanoleucos melanoleucos*
Bird	Phalacrocoracidae	*Phalacrocorax carbo*
Bird	Phalacrocoracidae	*Phalacrocorax fuscescens*
Bird	Phalacrocoracidae	*Phalacrocorax sulcirostris*
Bird	Phalacrocoracidae	*Phalacrocorax varius*
Bird	Phasianidae	*Coturnix pectoralis*
Bird	Phasianidae	*Coturnix ypsilophorus*
Bird	Phasianidae	*Excalfactoria chinensis*
Bird	Pittidae	*Pitta erythrogaster*
Bird	Pittidae	*Pitta versicolor*
Bird	Podargidae	*Podargus ocellatus plumiferus*
Bird	Podargidae	*Podargus papuensis*
Bird	Podargidae	*Podargus strigoides*
Bird	Podicipedidae	*Podiceps cristatus australis*
Bird	Podicipedidae	*Poliocephalus poliocephalus*
Bird	Podicipedidae	*Tachybaptus novaehollandiae novaehollandiae*
Bird	Pomatostomidae	*Pomatostomus halli*
Bird	Pomatostomidae	*Pomatostomus ruficeps*
Bird	Pomatostomidae	*Pomatostomus superciliosus*
Bird	Pomatostomidae	*Pomatostomus temporalis rubeculus*
Bird	Pomatostomidae	*Pomatostomus temporalis temporalis*
Bird	Psittacidae	*Alisterus scapularis*
Bird	Psittacidae	*Aprosmictus erythropterus*
Bird	Psittacidae	*Barnardius zonarius barnardi*
Bird	Psittacidae	*Cyclopsitta diophthalma macleayana*
Bird	Psittacidae	*Cyclopsitta diophthalma marshalli*
Bird	Psittacidae	*Eclectus roratus macgillivrayi*
Bird	Psittacidae	*Geoffroyus geoffroyi*
Bird	Psittacidae	*Glossopsitta concinna*
Bird	Psittacidae	*Glossopsitta porphyrocephala*
Bird	Psittacidae	*Glossopsitta pusilla*
Bird	Psittacidae	*Lathamus discolor*
Bird	Psittacidae	*Melopsittacus undulatus*
Bird	Psittacidae	*Neophema chrysogaster*
Bird	Psittacidae	*Neophema chrysostoma*
Bird	Psittacidae	*Neophema elegans*
Bird	Psittacidae	*Neophema pulchella*
Bird	Psittacidae	*Neophema splendida*
Bird	Psittacidae	*Neopsephotus bourkii*
Bird	Psittacidae	*Northiella haematogaster haematogaster*
Bird	Psittacidae	*Northiella haematogaster haematorrous*

Bird	Psittacidae	*Pezoporus wallicus*
Bird	Psittacidae	*Platycercus adscitus*
Bird	Psittacidae	*Platycercus caledonicus*
Bird	Psittacidae	*Platycercus elegans elegans*
Bird	Psittacidae	*Platycercus elegans flaveolus*
Bird	Psittacidae	*Platycercus elegans nigrescens*
Bird	Psittacidae	*Platycercus eximius*
Bird	Psittacidae	*Platycercus venustus*
Bird	Psittacidae	*Polytelis anthopeplus*
Bird	Psittacidae	*Polytelis swainsonii*
Bird	Psittacidae	*Psephotus chrysopterygius*
Bird	Psittacidae	*Psephotus haematonotus*
Bird	Psittacidae	*Psephotus varius*
Bird	Psittacidae	*Psitteuteles versicolor*
Bird	Psittacidae	*Trichoglossus chlorolepidotus*
Bird	Psittacidae	*Trichoglossus haematodus moluccanus*
Bird	Psophodidae	*Cinclosoma castaneothorax*
Bird	Psophodidae	*Cinclosoma castanotum*
Bird	Psophodidae	*Cinclosoma cinnamomeum*
Bird	Psophodidae	*Cinclosoma punctatum punctatum*
Bird	Psophodidae	*Psophodes cristatus*
Bird	Psophodidae	*Psophodes olivaceus*
Bird	Ptilonorhynchidae	*Ailuroedus crassirostris*
Bird	Ptilonorhynchidae	*Ailuroedus melanotis*
Bird	Ptilonorhynchidae	*Amblyornis newtonianus*
Bird	Ptilonorhynchidae	*Ptilonorhynchus cerviniventris*
Bird	Ptilonorhynchidae	*Ptilonorhynchus maculatus*
Bird	Ptilonorhynchidae	*Ptilonorhynchus nuchalis*
Bird	Ptilonorhynchidae	*Ptilonorhynchus violaceus minor*
Bird	Ptilonorhynchidae	*Ptilonorhynchus violaceus violaceus*
Bird	Ptilonorhynchidae	*Scenopoeetes dentirostris*
Bird	Ptilonorhynchidae	*Sericulus chrysocephalus*
Bird	Rallidae	*Amaurornis cinerea*
Bird	Rallidae	*Amaurornis moluccana*
Bird	Rallidae	*Fulica atra*
Bird	Rallidae	*Gallinula tenebrosa*
Bird	Rallidae	*Gallirallus philippensis*
Bird	Rallidae	*Porphyrio porphyrio*
Bird	Rallidae	*Porzana fluminea*
Bird	Rallidae	*Porzana pusilla*
Bird	Rallidae	*Porzana tabuensis*
Bird	Rallidae	*Rallina tricolor*
Bird	Rallidae	*Rallus pectoralis*
Bird	Rallidae	*Tribonyx mortierii*
Bird	Rallidae	*Tribonyx ventralis*
Bird	Recurvirostridae	*Cladorhynchus leucocephalus*
Bird	Recurvirostridae	*Himantopus himantopus*

Bird	Recurvirostridae	*Recurvirostra novaehollandiae*
Bird	Rhipiduridae	*Rhipidura albiscapa albiscapa*
Bird	Rhipiduridae	*Rhipidura albiscapa alisteri*
Bird	Rhipiduridae	*Rhipidura albiscapa keasti*
Bird	Rhipiduridae	*Rhipidura leucophrys*
Bird	Rhipiduridae	*Rhipidura rufifrons*
Bird	Rhipiduridae	*Rhipidura rufiventris*
Bird	Scolopacidae	*Gallinago hardwickii*
Bird	Scolopacidae	*Xenus cinereus*
Bird	Strigidae	*Ninox connivens*
Bird	Strigidae	*Ninox novaeseelandiae boobook*
Bird	Strigidae	*Ninox novaeseelandiae ocellata*
Bird	Strigidae	*Ninox rufa*
Bird	Strigidae	*Ninox strenua*
Bird	Sturnidae	*Aplonis metallica*
Bird	Threskiornithidae	*Platalea flavipes*
Bird	Threskiornithidae	*Platalea regia*
Bird	Threskiornithidae	*Plegadis falcinellus*
Bird	Threskiornithidae	*Threskiornis molucca*
Bird	Threskiornithidae	*Threskiornis spinicollis*
Bird	Timaliidae	*Zosterops lateralis cornwalli*
Bird	Timaliidae	*Zosterops lateralis lateralis*
Bird	Timaliidae	*Zosterops lateralis pinarochrous*
Bird	Timaliidae	*Zosterops lateralis vegetus*
Bird	Timaliidae	*Zosterops lateralis westernensis*
Bird	Timaliidae	*Zosterops luteus*
Bird	Turdidae	*Zoothera heinei*
Bird	Turdidae	*Zoothera lunulata*
Bird	Turnicidae	*Turnix maculosa*
Bird	Turnicidae	*Turnix melanogaster*
Bird	Turnicidae	*Turnix pyrrhothorax*
Bird	Turnicidae	*Turnix varia*
Bird	Turnicidae	*Turnix velox*
Bird	Tytonidae	*Tyto javanica*
Bird	Tytonidae	*Tyto longimembris*
Bird	Tytonidae	*Tyto novaehollandiae novaehollandiae*
Bird	Tytonidae	*Tyto tenebricosa multipunctata*
Bird	Tytonidae	*Tyto tenebricosa tenebricosa*
Butterfly	Hesperiidae	*Allora doleschallii doleschallii*
Butterfly	Hesperiidae	*Allora major major*
Butterfly	Hesperiidae	*Anisynta cynone cynone*
Butterfly	Hesperiidae	*Anisynta cynone gunneda*
Butterfly	Hesperiidae	*Anisynta dominula dominula*
Butterfly	Hesperiidae	*Anisynta dominula pria*
Butterfly	Hesperiidae	*Anisynta monticolae*
Butterfly	Hesperiidae	*Anisynta tillyardi*
Butterfly	Hesperiidae	*Antipodia atralba*

Butterfly	Hesperiidae	*Antipodia chaostola chaostola*
Butterfly	Hesperiidae	*Antipodia chaostola chares*
Butterfly	Hesperiidae	*Antipodia chaostola leucophaea*
Butterfly	Hesperiidae	*Arrhenes dschilus iris*
Butterfly	Hesperiidae	*Arrhenes marnas affinis*
Butterfly	Hesperiidae	*Badamia exclamationis*
Butterfly	Hesperiidae	*Borbo cinnara*
Butterfly	Hesperiidae	*Cephrenes augiades sperthias*
Butterfly	Hesperiidae	*Cephrenes trichopepla*
Butterfly	Hesperiidae	*Chaetocneme beata*
Butterfly	Hesperiidae	*Chaetocneme critomedia sphinterifera*
Butterfly	Hesperiidae	*Chaetocneme denitza*
Butterfly	Hesperiidae	*Chaetocneme porphyropis*
Butterfly	Hesperiidae	*Dispar compacta*
Butterfly	Hesperiidae	*Euschemon rafflesia alba*
Butterfly	Hesperiidae	*Euschemon rafflesia rafflesia*
Butterfly	Hesperiidae	*Hasora chromus chromus*
Butterfly	Hesperiidae	*Hasora discolor mastusia*
Butterfly	Hesperiidae	*Hasora khoda haslia*
Butterfly	Hesperiidae	*Herimosa albovenata albovenata*
Butterfly	Hesperiidae	*Herimosa albovenata weemala*
Butterfly	Hesperiidae	*Hesperilla chrysotricha cyclospila*
Butterfly	Hesperiidae	*Hesperilla crypsargyra crypsargyra*
Butterfly	Hesperiidae	*Hesperilla crypsargyra hopsoni*
Butterfly	Hesperiidae	*Hesperilla crypsigramma*
Butterfly	Hesperiidae	*Hesperilla donnysa aurantia*
Butterfly	Hesperiidae	*Hesperilla donnysa donnysa*
Butterfly	Hesperiidae	*Hesperilla flavescens flavescens*
Butterfly	Hesperiidae	*Hesperilla furva*
Butterfly	Hesperiidae	*Hesperilla idothea idothea*
Butterfly	Hesperiidae	*Hesperilla malindeva*
Butterfly	Hesperiidae	*Hesperilla mastersi*
Butterfly	Hesperiidae	*Hesperilla ornata monotherm*
Butterfly	Hesperiidae	*Hesperilla ornata ornata*
Butterfly	Hesperiidae	*Hesperilla picta*
Butterfly	Hesperiidae	*Hesperilla sarnia*
Butterfly	Hesperiidae	*Hesperilla sexguttata*
Butterfly	Hesperiidae	*Mesodina aeluropis*
Butterfly	Hesperiidae	*Mesodina halyzia halyzia*
Butterfly	Hesperiidae	*Mimene atropatene*
Butterfly	Hesperiidae	*Motasingha trimaculata dilata*
Butterfly	Hesperiidae	*Motasingha trimaculata trimaculata*
Butterfly	Hesperiidae	*Neohesperilla croceus*
Butterfly	Hesperiidae	*Neohesperilla senta*
Butterfly	Hesperiidae	*Neohesperilla xanthomera*
Butterfly	Hesperiidae	*Neohesperilla xiphiphora*
Butterfly	Hesperiidae	*Netrocoryne repanda expansa*

Butterfly	Hesperiidae	*Netrocoryne repanda repanda*
Butterfly	Hesperiidae	*Notocrypta waigensis proserpina*
Butterfly	Hesperiidae	*Ocybadistes hypomeloma hypomeloma*
Butterfly	Hesperiidae	*Ocybadistes hypomeloma vaga*
Butterfly	Hesperiidae	*Ocybadistes walkeri sothis*
Butterfly	Hesperiidae	*Oreisplanus munionga larana*
Butterfly	Hesperiidae	*Oreisplanus munionga munionga*
Butterfly	Hesperiidae	*Oreisplanus perornata*
Butterfly	Hesperiidae	*Parnara amalia*
Butterfly	Hesperiidae	*Parnara bada sida*
Butterfly	Hesperiidae	*Pasma tasmanicus*
Butterfly	Hesperiidae	*Pelopidas agna dingo*
Butterfly	Hesperiidae	*Pelopidas lyelli lyelli*
Butterfly	Hesperiidae	*Proeidosa polysema*
Butterfly	Hesperiidae	*Rachelia extrusa*
Butterfly	Hesperiidae	*Sabera caesina albifascia*
Butterfly	Hesperiidae	*Sabera fuliginosa fuliginosa*
Butterfly	Hesperiidae	*Signeta flammeata*
Butterfly	Hesperiidae	*Signeta tymbophora*
Butterfly	Hesperiidae	*Suniana lascivia lascivia*
Butterfly	Hesperiidae	*Suniana lascivia neocles*
Butterfly	Hesperiidae	*Suniana sunias rectivitta*
Butterfly	Hesperiidae	*Tagiades japetus janetta*
Butterfly	Hesperiidae	*Taractrocera anisomorpha*
Butterfly	Hesperiidae	*Taractrocera dolon dolon*
Butterfly	Hesperiidae	*Taractrocera ina*
Butterfly	Hesperiidae	*Taractrocera papyria papyria*
Butterfly	Hesperiidae	*Telicota ancilla ancilla*
Butterfly	Hesperiidae	*Telicota anisodesma*
Butterfly	Hesperiidae	*Telicota brachydesma*
Butterfly	Hesperiidae	*Telicota colon argeus*
Butterfly	Hesperiidae	*Telicota eurotas laconia*
Butterfly	Hesperiidae	*Telicota eurychlora*
Butterfly	Hesperiidae	*Telicota mesoptis mesoptis*
Butterfly	Hesperiidae	*Telicota ohara ohara*
Butterfly	Hesperiidae	*Toxidia andersoni*
Butterfly	Hesperiidae	*Toxidia doubledayi*
Butterfly	Hesperiidae	*Toxidia inornatus inornata*
Butterfly	Hesperiidae	*Toxidia melania*
Butterfly	Hesperiidae	*Toxidia parvulus*
Butterfly	Hesperiidae	*Toxidia peron*
Butterfly	Hesperiidae	*Toxidia rietmanni parasema*
Butterfly	Hesperiidae	*Toxidia rietmanni rietmanni*
Butterfly	Hesperiidae	*Toxidia thyrrhus*
Butterfly	Hesperiidae	*Trapezites eliena*
Butterfly	Hesperiidae	*Trapezites heteromacula*
Butterfly	Hesperiidae	*Trapezites iacchoides*

Butterfly	Hesperiidae	*Trapezites iacchus*
Butterfly	Hesperiidae	*Trapezites lutea glaucus*
Butterfly	Hesperiidae	*Trapezites lutea lutea*
Butterfly	Hesperiidae	*Trapezites macqueeni*
Butterfly	Hesperiidae	*Trapezites maheta*
Butterfly	Hesperiidae	*Trapezites petalia*
Butterfly	Hesperiidae	*Trapezites phigalia*
Butterfly	Hesperiidae	*Trapezites phigalioides*
Butterfly	Hesperiidae	*Trapezites praxedes*
Butterfly	Hesperiidae	*Trapezites sciron eremicola*
Butterfly	Hesperiidae	*Trapezites symmomus soma*
Butterfly	Hesperiidae	*Trapezites symmomus sombra*
Butterfly	Hesperiidae	*Trapezites symmomus symmomus*
Butterfly	Hesperiidae	*Trapezites taori*
Butterfly	Hesperoidea	*Telicota augias krefftii*
Butterfly	Lycaenidae	*Acrodipsas arcana*
Butterfly	Lycaenidae	*Acrodipsas aurata*
Butterfly	Lycaenidae	*Acrodipsas brisbanensis*
Butterfly	Lycaenidae	*Acrodipsas hirtipes*
Butterfly	Lycaenidae	*Acrodipsas illidgei*
Butterfly	Lycaenidae	*Acrodipsas mortoni*
Butterfly	Lycaenidae	*Acrodipsas myrmecophila*
Butterfly	Lycaenidae	*Anthene lycaenoides godeffroyi*
Butterfly	Lycaenidae	*Anthene seltuttus affinis*
Butterfly	Lycaenidae	*Arhopala centaurus centaurus*
Butterfly	Lycaenidae	*Arhopala madytus*
Butterfly	Lycaenidae	*Arhopala wildei wildei*
Butterfly	Lycaenidae	*Bindahara phocides yurgama*
Butterfly	Lycaenidae	*Candalides absimilis*
Butterfly	Lycaenidae	*Candalides acasta*
Butterfly	Lycaenidae	*Candalides consimilis consimilis*
Butterfly	Lycaenidae	*Candalides consimilis goodingi*
Butterfly	Lycaenidae	*Candalides cyprotus cyprotus*
Butterfly	Lycaenidae	*Candalides cyprotus pallescens*
Butterfly	Lycaenidae	*Candalides delospila*
Butterfly	Lycaenidae	*Candalides erinus erinus*
Butterfly	Lycaenidae	*Candalides geminus*
Butterfly	Lycaenidae	*Candalides gilberti*
Butterfly	Lycaenidae	*Candalides heathi alpinus*
Butterfly	Lycaenidae	*Candalides heathi doddi*
Butterfly	Lycaenidae	*Candalides heathi heathi*
Butterfly	Lycaenidae	*Candalides helenita helenita*
Butterfly	Lycaenidae	*Candalides hyacinthinus hyacinthinus*
Butterfly	Lycaenidae	*Candalides hyacinthinus simplexa*
Butterfly	Lycaenidae	*Candalides margarita margarita*
Butterfly	Lycaenidae	*Candalides xanthospilos*
Butterfly	Lycaenidae	*Catochrysops amasea*
Butterfly	Lycaenidae	*Catochrysops panormus platissa*

Butterfly	Lycaenidae	*Catopyrops ancyra mysia*
Butterfly	Lycaenidae	*Catopyrops florinda estrella*
Butterfly	Lycaenidae	*Catopyrops florinda halys*
Butterfly	Lycaenidae	*Danis danis serapis*
Butterfly	Lycaenidae	*Danis danis syrius*
Butterfly	Lycaenidae	*Deudorix democles democles*
Butterfly	Lycaenidae	*Deudorix diovis*
Butterfly	Lycaenidae	*Deudorix epijarbas dido*
Butterfly	Lycaenidae	*Deudorix epirus agimar*
Butterfly	Lycaenidae	*Erysichton lineatus lineatus*
Butterfly	Lycaenidae	*Erysichton palmyra tasmanicus*
Butterfly	Lycaenidae	*Euchrysops cnejus cnidus*
Butterfly	Lycaenidae	*Everes lacturnus australis*
Butterfly	Lycaenidae	*Famegana alsulus alsulus*
Butterfly	Lycaenidae	*Freyeria putli*
Butterfly	Lycaenidae	*Hypochrysops apelles apelles*
Butterfly	Lycaenidae	*Hypochrysops apollo apollo*
Butterfly	Lycaenidae	*Hypochrysops apollo phoebus*
Butterfly	Lycaenidae	*Hypochrysops byzos*
Butterfly	Lycaenidae	*Hypochrysops cleon*
Butterfly	Lycaenidae	*Hypochrysops cyane*
Butterfly	Lycaenidae	*Hypochrysops delicia delicia*
Butterfly	Lycaenidae	*Hypochrysops delicia duaringae*
Butterfly	Lycaenidae	*Hypochrysops digglesii*
Butterfly	Lycaenidae	*Hypochrysops elgneri barnardi*
Butterfly	Lycaenidae	*Hypochrysops elgneri elgneri*
Butterfly	Lycaenidae	*Hypochrysops epicurus*
Butterfly	Lycaenidae	*Hypochrysops hippuris nebulosis*
Butterfly	Lycaenidae	*Hypochrysops ignitus chrysonotus*
Butterfly	Lycaenidae	*Hypochrysops ignitus ignita*
Butterfly	Lycaenidae	*Hypochrysops miskini*
Butterfly	Lycaenidae	*Hypochrysops narcissus narcissus*
Butterfly	Lycaenidae	*Hypochrysops piceatus*
Butterfly	Lycaenidae	*Hypochrysops polycletus rovena*
Butterfly	Lycaenidae	*Hypochrysops pythias euclides*
Butterfly	Lycaenidae	*Hypochrysops theon cretatus*
Butterfly	Lycaenidae	*Hypochrysops theon medocus*
Butterfly	Lycaenidae	*Hypolycaena danis turneri*
Butterfly	Lycaenidae	*Hypolycaena phorbas phorbas*
Butterfly	Lycaenidae	*Ionolyce helicon hyllus*
Butterfly	Lycaenidae	*Jalmenus daemeli*
Butterfly	Lycaenidae	*Jalmenus eichhorni*
Butterfly	Lycaenidae	*Jalmenus evagoras eubulus*
Butterfly	Lycaenidae	*Jalmenus evagoras evagoras*
Butterfly	Lycaenidae	*Jalmenus icilius*
Butterfly	Lycaenidae	*Jalmenus ictinus*
Butterfly	Lycaenidae	*Jalmenus pseudictinus*
Butterfly	Lycaenidae	*Jamides aleuas coelestis*

Butterfly	Lycaenidae	*Jamides amarauge*
Butterfly	Lycaenidae	*Jamides cyta claudia*
Butterfly	Lycaenidae	*Jamides phaseli*
Butterfly	Lycaenidae	*Lampides boeticus*
Butterfly	Lycaenidae	*Leptotes plinius pseudocassius*
Butterfly	Lycaenidae	*Liphyra brassolis major*
Butterfly	Lycaenidae	*Lucia limbaria*
Butterfly	Lycaenidae	*Megisba strongyle nigra*
Butterfly	Lycaenidae	*Nacaduba berenice berenice*
Butterfly	Lycaenidae	*Nacaduba biocellata biocellata*
Butterfly	Lycaenidae	*Nacaduba cyanea arinia*
Butterfly	Lycaenidae	*Nacaduba kurava parma*
Butterfly	Lycaenidae	*Neolucia agricola agricola*
Butterfly	Lycaenidae	*Neolucia agricola insulana*
Butterfly	Lycaenidae	*Neolucia hobartensis hobartensis*
Butterfly	Lycaenidae	*Neolucia hobartensis monticola*
Butterfly	Lycaenidae	*Neolucia mathewi*
Butterfly	Lycaenidae	*Nesolycaena albosericea*
Butterfly	Lycaenidae	*Ogyris abrota*
Butterfly	Lycaenidae	*Ogyris aenone*
Butterfly	Lycaenidae	*Ogyris amaryllis amaryllis*
Butterfly	Lycaenidae	*Ogyris amaryllis amata*
Butterfly	Lycaenidae	*Ogyris amaryllis hewitsoni*
Butterfly	Lycaenidae	*Ogyris amaryllis meridionalis*
Butterfly	Lycaenidae	*Ogyris barnardi barnardi*
Butterfly	Lycaenidae	*Ogyris genoveva*
Butterfly	Lycaenidae	*Ogyris ianthis*
Butterfly	Lycaenidae	*Ogyris iphis iphis*
Butterfly	Lycaenidae	*Ogyris olane*
Butterfly	Lycaenidae	*Ogyris oroetes apiculata*
Butterfly	Lycaenidae	*Ogyris oroetes oroetes*
Butterfly	Lycaenidae	*Ogyris subterrestris subterrestris*
Butterfly	Lycaenidae	*Ogyris zosine zosine*
Butterfly	Lycaenidae	*Paralucia aurifer*
Butterfly	Lycaenidae	*Paralucia pyrodiscus*
Butterfly	Lycaenidae	*Paralucia spinifera*
Butterfly	Lycaenidae	*Petrelaea tombugensis*
Butterfly	Lycaenidae	*Philiris diana diana*
Butterfly	Lycaenidae	*Philiris diana papuana*
Butterfly	Lycaenidae	*Philiris fulgens kurandae*
Butterfly	Lycaenidae	*Philiris innotata*
Butterfly	Lycaenidae	*Philiris nitens lucina*
Butterfly	Lycaenidae	*Philiris nitens nitens*
Butterfly	Lycaenidae	*Philiris sappheira manskiei*
Butterfly	Lycaenidae	*Philiris ziska*
Butterfly	Lycaenidae	*Pithecops dionisius dionisius*
Butterfly	Lycaenidae	*Prosotas dubiosa dubiosa*
Butterfly	Lycaenidae	*Prosotas felderi*

Butterfly	Lycaenidae	*Prosotas nora auletes*
Butterfly	Lycaenidae	*Pseudalmenus chlorinda barringtonensis*
Butterfly	Lycaenidae	*Pseudalmenus chlorinda chlorinda*
Butterfly	Lycaenidae	*Pseudalmenus chlorinda chloris*
Butterfly	Lycaenidae	*Pseudalmenus chlorinda conara*
Butterfly	Lycaenidae	*Pseudalmenus chlorinda myrsilus*
Butterfly	Lycaenidae	*Pseudalmenus chlorinda zephyrus*
Butterfly	Lycaenidae	*Pseudodipsas cephenes*
Butterfly	Lycaenidae	*Pseudodipsas eone iole*
Butterfly	Lycaenidae	*Psychonotis caelius taygetus*
Butterfly	Lycaenidae	*Rapala varuna simsoni*
Butterfly	Lycaenidae	*Sahulana scintillata*
Butterfly	Lycaenidae	*Theclinesthes miskini arnoldi*
Butterfly	Lycaenidae	*Theclinesthes miskini eucalypti*
Butterfly	Lycaenidae	*Theclinesthes miskini miskini*
Butterfly	Lycaenidae	*Theclinesthes onycha capricornia*
Butterfly	Lycaenidae	*Theclinesthes onycha onycha*
Butterfly	Lycaenidae	*Theclinesthes serpentatus serpentatus*
Butterfly	Lycaenidae	*Theclinesthes sulpitius*
Butterfly	Lycaenidae	*Udara tenella*
Butterfly	Lycaenidae	*Zizeeria karsandra karsandra*
Butterfly	Lycaenidae	*Zizina labradus labdalon*
Butterfly	Lycaenidae	*Zizina labradus labradus*
Butterfly	Lycaenidae	*Zizula hylax attenuata*
Butterfly	Nymphalidae	*Acraea andromacha andromacha*
Butterfly	Nymphalidae	*Argynnina cyrila*
Butterfly	Nymphalidae	*Argynnina hobartia hobartia*
Butterfly	Nymphalidae	*Argynnina hobartia montana*
Butterfly	Nymphalidae	*Argynnina hobartia tasmanica*
Butterfly	Nymphalidae	*Argyreus hyperbius inconstans*
Butterfly	Nymphalidae	*Cethosia cydippe chrysippe*
Butterfly	Nymphalidae	*Charaxes latona*
Butterfly	Nymphalidae	*Cupha prosope prosope*
Butterfly	Nymphalidae	*Danaus affinis affinis*
Butterfly	Nymphalidae	*Danaus chrysippus petalia*
Butterfly	Nymphalidae	*Doleschallia bisaltide australis*
Butterfly	Nymphalidae	*Elymnias agondas australiana*
Butterfly	Nymphalidae	*Euploea alcathoe eichhorni*
Butterfly	Nymphalidae	*Euploea batesii*
Butterfly	Nymphalidae	*Euploea core corinna*
Butterfly	Nymphalidae	*Euploea darchia niveata*
Butterfly	Nymphalidae	*Euploea leucostictos*
Butterfly	Nymphalidae	*Euploea sylvester pelor*
Butterfly	Nymphalidae	*Euploea sylvester sylvester*
Butterfly	Nymphalidae	*Euploea tulliolus tulliolus*
Butterfly	Nymphalidae	*Geitoneura acantha*
Butterfly	Nymphalidae	*Geitoneura klugii*

Butterfly	Nymphalidae	*Heteronympha banksii banksii*
Butterfly	Nymphalidae	*Heteronympha banksii mariposa*
Butterfly	Nymphalidae	*Heteronympha cordace comptena*
Butterfly	Nymphalidae	*Heteronympha cordace cordace*
Butterfly	Nymphalidae	*Heteronympha cordace kurena*
Butterfly	Nymphalidae	*Heteronympha cordace legana*
Butterfly	Nymphalidae	*Heteronympha cordace wilsoni*
Butterfly	Nymphalidae	*Heteronympha merope merope*
Butterfly	Nymphalidae	*Heteronympha merope salazar*
Butterfly	Nymphalidae	*Heteronympha mirifica*
Butterfly	Nymphalidae	*Heteronympha paradelpha*
Butterfly	Nymphalidae	*Heteronympha penelope alope*
Butterfly	Nymphalidae	*Heteronympha penelope diemeni*
Butterfly	Nymphalidae	*Heteronympha penelope panope*
Butterfly	Nymphalidae	*Heteronympha penelope penelope*
Butterfly	Nymphalidae	*Heteronympha solandri*
Butterfly	Nymphalidae	*Hypocysta adiante adiante*
Butterfly	Nymphalidae	*Hypocysta angustata angustata*
Butterfly	Nymphalidae	*Hypocysta euphemia*
Butterfly	Nymphalidae	*Hypocysta irius*
Butterfly	Nymphalidae	*Hypocysta metirius*
Butterfly	Nymphalidae	*Hypocysta pseudirius*
Butterfly	Nymphalidae	*Hypolimnas alimena lamina*
Butterfly	Nymphalidae	*Hypolimnas anomala*
Butterfly	Nymphalidae	*Hypolimnas bolina nerina*
Butterfly	Nymphalidae	*Hypolimnas misippus*
Butterfly	Nymphalidae	*Junonia hedonia zelima*
Butterfly	Nymphalidae	*Junonia orithya albocincta*
Butterfly	Nymphalidae	*Junonia villida calybe*
Butterfly	Nymphalidae	*Lexias aeropa*
Butterfly	Nymphalidae	*Libythea geoffroy nicevillei*
Butterfly	Nymphalidae	*Melanitis leda bankia "dry form"*
Butterfly	Nymphalidae	*Melanitis leda bankia "wet form"*
Butterfly	Nymphalidae	*Mycalesis perseus perseus*
Butterfly	Nymphalidae	*Mycalesis sirius sirius*
Butterfly	Nymphalidae	*Mycalesis terminus terminus*
Butterfly	Nymphalidae	*Mynes geoffroyi guerini*
Butterfly	Nymphalidae	*Nesoxenica leprea elia*
Butterfly	Nymphalidae	*Oreixenica correae*
Butterfly	Nymphalidae	*Oreixenica kershawi kanunda*
Butterfly	Nymphalidae	*Oreixenica kershawi kershawi*
Butterfly	Nymphalidae	*Oreixenica lathoniella barnardi*
Butterfly	Nymphalidae	*Oreixenica lathoniella herceus*
Butterfly	Nymphalidae	*Oreixenica lathoniella laranda*
Butterfly	Nymphalidae	*Oreixenica lathoniella lathoniella*
Butterfly	Nymphalidae	*Oreixenica latialis latialis*
Butterfly	Nymphalidae	*Oreixenica latialis theddora*
Butterfly	Nymphalidae	*Oreixenica orichora orichora*

Butterfly	Nymphalidae	*Oreixenica orichora paludosa*
Butterfly	Nymphalidae	*Oreixenica ptunarra*
Butterfly	Nymphalidae	*Orsotriaena medus moira*
Butterfly	Nymphalidae	*Pantoporia consimilis consimilis*
Butterfly	Nymphalidae	*Pantoporia venilia moorei*
Butterfly	Nymphalidae	*Phaedyma shepherdi shepherdi*
Butterfly	Nymphalidae	*Polyura sempronius sempronius*
Butterfly	Nymphalidae	*Tellervo zoilus gelo*
Butterfly	Nymphalidae	*Tellervo zoilus zoilus*
Butterfly	Nymphalidae	*Tirumala hamata hamata*
Butterfly	Nymphalidae	*Tisiphone abeona abeona*
Butterfly	Nymphalidae	*Tisiphone abeona albifascia*
Butterfly	Nymphalidae	*Tisiphone abeona aurelia*
Butterfly	Nymphalidae	*Tisiphone abeona morrisi*
Butterfly	Nymphalidae	*Tisiphone abeona rawnsleyi*
Butterfly	Nymphalidae	*Tisiphone abeona regalis*
Butterfly	Nymphalidae	*Tisiphone helena*
Butterfly	Nymphalidae	*Vagrans egista propinqua*
Butterfly	Nymphalidae	*Vanessa itea*
Butterfly	Nymphalidae	*Vanessa kershawi*
Butterfly	Nymphalidae	*Vindula arsinoe ada*
Butterfly	Nymphalidae	*Yoma sabina parva*
Butterfly	Nymphalidae	*Ypthima arctous arctous*
Butterfly	Papilionidea	*Cressida cressida cressida*
Butterfly	Papilionidea	*Graphium agamemnon ligatus*
Butterfly	Papilionidea	*Graphium aristeus parmatum*
Butterfly	Papilionidea	*Graphium eurypylus lyacaonides*
Butterfly	Papilionidea	*Graphium eurypylus lycaon*
Butterfly	Papilionidea	*Graphium macfarlanei macfarlanei*
Butterfly	Papilionidea	*Graphium macleayanus macleayanus*
Butterfly	Papilionidea	*Graphium macleayanus moggana*
Butterfly	Papilionidea	*Graphium sarpedon choredon*
Butterfly	Papilionidea	*Ornithoptera priamus euphorion*
Butterfly	Papilionidea	*Ornithoptera priamus macalpinei*
Butterfly	Papilionidea	*Ornithoptera priamus poseidon*
Butterfly	Papilionidea	*Ornithoptera priamus pronomus*
Butterfly	Papilionidea	*Ornithoptera richmondia*
Butterfly	Papilionidea	*Pachliopta polydorus queenslandicus*
Butterfly	Papilionidea	*Papilio aegeus aegeus*
Butterfly	Papilionidea	*Papilio ambrax egipius*
Butterfly	Papilionidea	*Papilio anactus*
Butterfly	Papilionidea	*Papilio demoleus sthenelus*
Butterfly	Papilionidea	*Papilio fuscus capaneus*
Butterfly	Papilionidea	*Papilio fuscus indicatus*
Butterfly	Papilionidea	*Papilio ulysses joesa*
Butterfly	Papilionidea	*Protographium leosthenes leosthenes*
Butterfly	Pieridae	*Appias ada caria*
Butterfly	Pieridae	*Appias albina albina*

Butterfly	Pieridae	*Appias melania*
Butterfly	Pieridae	*Appias paulina ega*
Butterfly	Pieridae	*Belenois java teutonia*
Butterfly	Pieridae	*Catopsilia gorgophone gorgophone*
Butterfly	Pieridae	*Catopsilia pomona "dark form"*
Butterfly	Pieridae	*Catopsilia pomona "light form"*
Butterfly	Pieridae	*Catopsilia pyranthe crokera "dark form"*
Butterfly	Pieridae	*Catopsilia pyranthe crokera "pale form"*
Butterfly	Pieridae	*Catopsilia scylla etesia*
Butterfly	Pieridae	*Cepora perimale scyllara "dry season form"*
Butterfly	Pieridae	*Cepora perimale scyllara "wet season form"*
Butterfly	Pieridae	*Delias aganippe*
Butterfly	Pieridae	*Delias argenthona argenthona*
Butterfly	Pieridae	*Delias aruna inferna*
Butterfly	Pieridae	*Delias ennia nigidius*
Butterfly	Pieridae	*Delias ennia tindalii*
Butterfly	Pieridae	*Delias harpalyce*
Butterfly	Pieridae	*Delias mysis mysis*
Butterfly	Pieridae	*Delias nigrina*
Butterfly	Pieridae	*Delias nysa nysa*
Butterfly	Pieridae	*Elodina angulipennis*
Butterfly	Pieridae	*Elodina claudia*
Butterfly	Pieridae	*Elodina padusa*
Butterfly	Pieridae	*Elodina parthia*
Butterfly	Pieridae	*Elodina queenslandica queenslandica*
Butterfly	Pieridae	*Elodina walkeri*
Butterfly	Pieridae	*Eurema alitha*
Butterfly	Pieridae	*Eurema brigitta australis*
Butterfly	Pieridae	*Eurema hecabe hecabe*
Butterfly	Pieridae	*Eurema herla "wet season"*
Butterfly	Pieridae	*Eurema laeta sana*
Butterfly	Pieridae	*Eurema puella*
Butterfly	Pieridae	*Eurema smilax*
Butterfly	Riodinidae	*Praetaxila segecia punctaria*
Flower	Amaranthaceae	*Rhagodia candolleana*
Flower	Anacardiaceae	*Rhodosphaera rhodanthema*
Flower	Hemerocallidaceae	*Caesia parviflora var.parviflora*
Flower	Apiaceae	*Actinotus helianthi*
Flower	Apiaceae	*Actinotus minor*
Flower	Apiaceae	*Platysace ericoides*
Flower	Apiaceae	*Xanthosia pilosa*
Flower	Apocynaceae	*Hoya oligotricha*
Flower	Apocynaceae	*Tylophora barbata*
Flower	Araceae	*Calamus caryotoides*

Flower	Araceae	*Gymnostachys anceps*
Flower	Araceae	*Pothos longipes*
Flower	Araliaceae	*Polyscias purpurea*
Flower	Arecaceae	*Linospadix monostachya*
Flower	Asparagaceae	*Cordyline murchisoniae*
Flower	Asparagaceae	*Dichopogon strictus*
Flower	Asparagaceae	*Lomandra cylindrica*
Flower	Asparagaceae	*Lomandra filiformis*
Flower	Asparagaceae	*Lomandra glauca*
Flower	Asparagaceae	*Lomandra longifolia*
Flower	Asparagaceae	*Lomandra multiflora*
Flower	Asparagaceae	*Lomandra obliqua*
Flower	Asparagaceae	*Thysanotus patersonii*
Flower	Asparagaceae	*Thysanotus tuberosus*
Flower	Asparagaceae	*Sowerbaea juncea*
Flower	Asphodelaceae	*Bulbine bulbosa*
Flower	Asteraceae	*Argentipallium blandowskianum*
Flower	Asteraceae	*Argentipallium dealbatum*
Flower	Asteraceae	*Argentipallium obtusifolium*
Flower	Asteraceae	*Bedfordia arborescens*
Flower	Asteraceae	*Brachyscome multifida*
Flower	Asteraceae	*Cassinia aculeata*
Flower	Asteraceae	*Cassinia denticulata*
Flower	Asteraceae	*Cassinia longifolia*
Flower	Asteraceae	*Chrysocephalum apiculatum*
Flower	Asteraceae	*Chrysocephalum baxteri*
Flower	Asteraceae	*Coronidium oxylepis*
Flower	Asteraceae	*Coronidium rupicola*
Flower	Asteraceae	*Coronidium scorpioides*
Flower	Asteraceae	*Craspedia variabilis*
Flower	Asteraceae	*Lagenophora stipitata*
Flower	Asteraceae	*Leptorhynchos squamatus*
Flower	Asteraceae	*Olearia argophylla*
Flower	Asteraceae	*Olearia ciliata*
Flower	Asteraceae	*Olearia lirata*
Flower	Asteraceae	*Olearia microphylla*
Flower	Asteraceae	*Olearia phlogopappa*
Flower	Asteraceae	*Ozothamnus obcordatus*
Flower	Asteraceae	*Vernonia cinerea var.lanata*
Flower	Boraginaceae	*Trichodesma zeylanicum*
Flower	Campanulaceae	*Pratia pedunculata*
Flower	Campanulaceae	*Wahlenbergia queenslandica*
Flower	Campanulaceae	*Wahlenbergia stricta*
Flower	Capparaceae	*Capparis lucida*
Flower	Celastraceae	*Elaeodendron australe australe*
Flower	Colchicaceae	*Burchardia umbellata*
Flower	Colchicaceae	*Wurmbea biglandulosa*
Flower	Commelinaceae	*Pollia macrophylla*

Flower	Cunoniaceae	*Bauera rubioides pinkform*
Flower	Cunoniaceae	*Bauera rubioides whiteform*
Flower	Dilleniaceae	*Hibbertia acicularis*
Flower	Dilleniaceae	*Hibbertia bracteata*
Flower	Dilleniaceae	*Hibbertia empetrifolia*
Flower	Dilleniaceae	*Hibbertia hirticalyx*
Flower	Dilleniaceae	*Hibbertia linearis*
Flower	Dilleniaceae	*Hibbertia obtusifolia*
Flower	Dilleniaceae	*Hibbertia procumbens*
Flower	Dilleniaceae	*Hibbertia riparia*
Flower	Dilleniaceae	*Hibbertia scandens*
Flower	Dilleniaceae	*Hibbertia serpyllifolia*
Flower	Dilleniaceae	*Hibbertia vestita*
Flower	Dioscoreaceae	*Dioscorea transversa*
Flower	Doryanthaceae	*Doryanthes excelsa*
Flower	Droseraceae	*Drosera peltata*
Flower	Elaeocarpaceae	*Aristotelia peduncularis*
Flower	Elaeocarpaceae	*Tetratheca ericifolia*
Flower	Elaeocarpaceae	*Tetratheca pilosa latifolia*
Flower	Elaeocarpaceae	*Tetratheca thymifolia*
Flower	Ericaceae	*Brachyloma ciliatum*
Flower	Ericaceae	*Brachyloma daphnoides*
Flower	Ericaceae	*Epacris impressa pinkform*
Flower	Ericaceae	*Epacris impressa whiteform*
Flower	Ericaceae	*Epacris lanuginosa*
Flower	Ericaceae	*Epacris microphylla*
Flower	Ericaceae	*Epacris obtusifolia*
Flower	Ericaceae	*Gaultheria hispida*
Flower	Ericaceae	*Leucopogon biflorus*
Flower	Ericaceae	*Leucopogon microphyllus*
Flower	Ericaceae	*Leucopogon parviflorus*
Flower	Ericaceae	*Leucopogon virgatus*
Flower	Ericaceae	*Lissanthe strigosa*
Flower	Ericaceae	*Melichrus urceolatus*
Flower	Ericaceae	*Monotoca glauca*
Flower	Ericaceae	*Richea procera*
Flower	Ericaceae	*Sprengelia incarnata*
Flower	Ericaceae	*Styphelia triflora*
Flower	Ericaceae	*Woollsia pungens*
Flower	Escalloniaceae	*Anopterus glandulosus*
Flower	Euphorbiaceae	*Amperea xiphoclada*
Flower	Euphorbiaceae	*Bertya glandulosa Female*
Flower	Euphorbiaceae	*Bertya glandulosa Male*
Flower	Euphorbiaceae	*Claoxylon australe*
Flower	Euphorbiaceae	*Codiaeum variegatum var.moluccanum*
Flower	Euphorbiaceae	*Ricinocarpos pinifolius*
Flower	Fabacaeae	*Daviesia mimosoides*

Flower	Fabaceae	*Acacia aculeatissima*
Flower	Fabaceae	*Acacia calyculata*
Flower	Fabaceae	*Acacia floribunda*
Flower	Fabaceae	*Acacia granitica*
Flower	Fabaceae	*Acacia latisepala*
Flower	Fabaceae	*Acacia leprosa*
Flower	Fabaceae	*Acacia mearnsii*
Flower	Fabaceae	*Acacia paradoxa*
Flower	Fabaceae	*Acacia pruinosa*
Flower	Fabaceae	*Acacia ruppii*
Flower	Fabaceae	*Acacia suaveolens*
Flower	Fabaceae	*Acacia ulicifolia*
Flower	Fabaceae	*Acacia venulosa*
Flower	Fabaceae	*Acacia verticillata*
Flower	Fabaceae	*Acacia viscidula*
Flower	Fabaceae	*Acacia whitei*
Flower	Fabaceae	*Aotus ericoides*
Flower	Fabaceae	*Aotus subglauca*
Flower	Fabaceae	*Austrosteenisia blackii*
Flower	Fabaceae	*Bossiaea ensata*
Flower	Fabaceae	*Bossiaea obcordata*
Flower	Fabaceae	*Bossiaea obovata*
Flower	Fabaceae	*Castanospermum australe*
Flower	Fabaceae	*Daviesia latifolia*
Flower	Fabaceae	*Daviesia ulicifolia*
Flower	Fabaceae	*Desmodium nemorosum*
Flower	Fabaceae	*Dillwynia glaberrima*
Flower	Fabaceae	*Dillwynia glaberrima "red form"*
Flower	Fabaceae	*Dillwynia retorta sp.complex*
Flower	Fabaceae	*Glycine clandestina*
Flower	Fabaceae	*Gompholobium ecostatum*
Flower	Fabaceae	*Gompholobium glabratum*
Flower	Fabaceae	*Gompholobium grandiflorum*
Flower	Fabaceae	*Gompholobium huegelii*
Flower	Fabaceae	*Gompholobium minus*
Flower	Fabaceae	*Gompholobium virgatum*
Flower	Fabaceae	*Hardenbergia violacea*
Flower	Fabaceae	*Hovea graniticola*
Flower	Fabaceae	*Indigofera sericovexilla*
Flower	Fabaceae	*Jacksonia thesioides*
Flower	Fabaceae	*Mirbelia oxylobioides*
Flower	Fabaceae	*Mirbelia rubiifolia*
Flower	Fabaceae	*Ormosia ormondii*
Flower	Fabaceae	*Oxylobium ellipticum*
Flower	Fabaceae	*Phyllota grandiflora*
Flower	Fabaceae	*Phyllota phylicoides*
Flower	Fabaceae	*Platylobium obtusangulum*
Flower	Fabaceae	*Platylobium reflexum*

Flower	Fabaceae	*Platylobium triangulare*
Flower	Fabaceae	*Pultenaea daphnoides*
Flower	Fabaceae	*Pultenaea gunnii gunnii*
Flower	Fabaceae	*Pultenaea hartmannii*
Flower	Fabaceae	*Pultenaea humilis*
Flower	Fabaceae	*Pultenaea juniperina*
Flower	Fabaceae	*Pultenaea pedunculata*
Flower	Fabaceae	*Pultenaea prolifera*
Flower	Fabaceae	*Pultenaea tuberculata*
Flower	Fabaceae	*Sphaerolobium minus*
Flower	Fabaceae	*Stylosanthes humilis*
Flower	Fabaceae	*Stylosanthes scabra*
Flower	Goodeniaceae	*Brunonia australis*
Flower	Goodeniaceae	*Dampiera purpurea*
Flower	Goodeniaceae	*Dampiera stricta*
Flower	Goodeniaceae	*Goodenia geniculata*
Flower	Goodeniaceae	*Goodenia gracilis*
Flower	Goodeniaceae	*Goodenia heterophylla*
Flower	Goodeniaceae	*Goodenia lanata*
Flower	Goodeniaceae	*Goodenia ovata*
Flower	Goodeniaceae	*Goodenia rotundifolia*
Flower	Goodeniaceae	*Scaevola ramosissima*
Flower	Haloragaceae	*Gonocarpus humilis*
Flower	Haloragaceae	*Gonocarpus teucrioides*
Flower	Hemerocallidaceae	*Dianella caerulea var.caerulea*
Flower	Hemerocallidaceae	*Dianella caerulea var.vannata*
Flower	Hemerocallidaceae	*Dianella revoluta*
Flower	Hemerocallidaceae	*Dianella tasmanica*
Flower	Hemerocallidaceae	*Geitonoplesium cymosum*
Flower	Hypericaceae	*Hypericum gramineum*
Flower	Iridaceae	*Diplarrena moraea*
Flower	Iridaceae	*Libertia paniculata*
Flower	Iridaceae	*Patersonia fragilis*
Flower	Iridaceae	*Patersonia occidentalis*
Flower	Iridaceae	*Patersonia sericea*
Flower	Lamiaceae	*Faradaya splendida*
Flower	Lamiaceae	*Hemigenia purpurea*
Flower	Lamiaceae	*Prostanthera melissifolia*
Flower	Lamiaceae	*Westringia tenuicaulis*
Flower	Lauraceae	*Cassytha filiformis*
Flower	Lauraceae	*Cassytha pubescens*
Flower	Lauraceae	*Endiandra monothyra*
Flower	Lentibulariaceae	*Utricularia uniflora*
Flower	Lentibulariaceae	*Utricularia dichotoma*
Flower	Lentibulariaceae	*Utricularia lateriflora*
Flower	Linderniaceae	*Artanema fimbriatum*
Flower	Loganiaceae	*Logania albiflora*
Flower	Loganiaceae	*Mitrasacme pilosa var.stuartii*

Flower	Loganiaceae	*Mitrasacme polymorpha*
Flower	Melastomataceae	*Melastoma affine*
Flower	Meliaceae	*Aglaia sapindina*
Flower	Menispermaceae	*Sarcopetalum harveyanum*
Flower	Myrsinaceae	*Myrsine subsessilis*
Flower	Myrtaceae	*Acmena smithii*
Flower	Myrtaceae	*Angophora hispida*
Flower	Myrtaceae	*Callistemon rigidus*
Flower	Myrtaceae	*Calytrix tetragona*
Flower	Myrtaceae	*Corymbia gummifera*
Flower	Myrtaceae	*Darwinia fascicularis fascicularis*
Flower	Myrtaceae	*Eucalyptus amygdalina*
Flower	Myrtaceae	*Euryomyrtus ramosissima*
Flower	Myrtaceae	*Euryomyrtus ramosissima ramosissima*
Flower	Myrtaceae	*Homoranthus virgatus*
Flower	Myrtaceae	*Kunzea ambigua*
Flower	Myrtaceae	*Kunzea capitata*
Flower	Myrtaceae	*Kunzea obovata*
Flower	Myrtaceae	*Leptospermum continentale*
Flower	Myrtaceae	*Leptospermum laevigatum*
Flower	Myrtaceae	*Leptospermum lanigerum*
Flower	Myrtaceae	*Leptospermum microcarpum*
Flower	Myrtaceae	*Leptospermum myrsinoides*
Flower	Myrtaceae	*Leptospermum scoparium*
Flower	Myrtaceae	*Leptospermum semibaccatum*
Flower	Myrtaceae	*Leptospermum squarrosum*
Flower	Myrtaceae	*Leptospermum trinervium*
Flower	Myrtaceae	*Melaleuca nodosa*
Flower	Myrtaceae	*Melaleuca squarrosa*
Flower	Myrtaceae	*Micromyrtus sessilis*
Flower	Myrtaceae	*Rhodomyrtus trineura capensis*
Flower	Olaceceae	*Olax stricta*
Flower	Oleaceae	*Ligustrum australianum*
Flower	Oleaceae	*Notelaea ovata*
Flower	Orchidaceae	*Diuris sulphurea*
Flower	Phyllanthaceae	*Breynia oblongifolia*
Flower	Phyllanthaceae	*Phyllanthus hirtellus*
Flower	Phyllanthaceae	*Poranthera ericoides*
Flower	Phyllanthaceae	*Poranthera microphylla*
Flower	Picrodendraceae	*Micrantheum ericoides*
Flower	Picrodendraceae	*Pseudanthus ligulatus*
Flower	Picrodendraceae	*Pseudanthus pauciflorus pauciflorus*
Flower	Pittosporaceae	*Billardiera mutabilis*
Flower	Pittosporaceae	*Billardiera scandens*
Flower	Pittosporaceae	*Pittosporum bicolor*
Flower	Pittosporaceae	*Pittosporum revolutum*
Flower	Pittosporaceae	*Pittosporum undulatum*

Flower	Plantaginaceae	*Veronica gracilis*
Flower	Polygalaceae	*Comesperma calymega*
Flower	Polygalaceae	*Comesperma ericinum*
Flower	Polygalaceae	*Comesperma volubile*
Flower	Primulaceae	*Maesa dependens var.pubescens*
Flower	Proteaceae	*Banksia aemula*
Flower	Proteaceae	*Banksia integrifolia*
Flower	Proteaceae	*Banksia spinulosa var.collina*
Flower	Proteaceae	*Conospermum ellipticum*
Flower	Proteaceae	*Conospermum hookeri*
Flower	Proteaceae	*Conospermum longifolium*
Flower	Proteaceae	*Conospermum taxifolium*
Flower	Proteaceae	*Grevillea buxifolia buxifolia*
Flower	Proteaceae	*Grevillea linearifolia*
Flower	Proteaceae	*Grevillea oleoides*
Flower	Proteaceae	*Grevillea parallela*
Flower	Proteaceae	*Grevillea sphacelata*
Flower	Proteaceae	*Grevillea steiglitziana*
Flower	Proteaceae	*Grevillea viridiflava*
Flower	Proteaceae	*Hakea actites*
Flower	Proteaceae	*Isopogon anemonifolius*
Flower	Proteaceae	*Isopogon anethifolius*
Flower	Proteaceae	*Isopogon petiolaris*
Flower	Proteaceae	*Lambertia formosa*
Flower	Proteaceae	*Persoonia falcata*
Flower	Proteaceae	*Strangea linearis*
Flower	Ranunculaceae	*Clematis aristata*
Flower	Rhamnaceae	*Cryptandra lanosiflora*
Flower	Rhamnaceae	*Pomaderris apetala maritima*
Flower	Rhamnaceae	*Pomaderris aspera*
Flower	Rhamnaceae	*Spyridium scortechinii*
Flower	Rosaceae	*Rubus rosifolius*
Flower	Rubiaceae	*Atractocarpus benthamianus*
Flower	Rubiaceae	*Atractocarpus hirtus*
Flower	Rubiaceae	*Coprosma quadrifida Female*
Flower	Rubiaceae	*Coprosma quadrifida Male*
Flower	Rubiaceae	*Cyclophyllum protractum*
Flower	Rubiaceae	*Ixora timorensis*
Flower	Rubiaceae	*Psychotria sp.Danbulla*
Flower	Rutaceae	*Boronia amabilis*
Flower	Rutaceae	*Boronia anemonifolia*
Flower	Rutaceae	*Boronia floribunda*
Flower	Rutaceae	*Boronia parviflora*
Flower	Rutaceae	*Boronia pilosa*
Flower	Rutaceae	*Boronia rosmarinifolia*
Flower	Rutaceae	*Boronia serrulata*
Flower	Rutaceae	*Eriostemon australasius*
Flower	Rutaceae	*Leionema ambiens*

Flower	Rutaceae	*Leionema rotundifolium*
Flower	Rutaceae	*Nematolepis squamea squamea*
Flower	Rutaceae	*Phebalium squamulosum*
Flower	Rutaceae	*Phebalium woombye*
Flower	Rutaceae	*Philotheca buxifolia buxifolia*
Flower	Rutaceae	*Philotheca epilosa*
Flower	Rutaceae	*Philotheca queenslandica*
Flower	Rutaceae	*Philotheca reichenbachii*
Flower	Rutaceae	*Zieria arborescens*
Flower	Rutaceae	*Zieria laevigata*
Flower	Rutaceae	*Zieria laxiflora*
Flower	Santalaceae	*Choretrum candollei*
Flower	Santalaceae	*Leptomeria acida*
Flower	Santalaceae	*Leptomeria drupacea*
Flower	Sapindaceae	*Cupaniopsis baileyana*
Flower	Sapindaceae	*Dodonaea falcata*
Flower	Sapindaceae	*Dodonaea lanceolata subsessilifolia*
Flower	Sapindaceae	*Synima macrophylla*
Flower	Solanaceae	*Solanum inaequilaterum*
Flower	Solanaceae	*Solanum laciniatum*
Flower	Solanaceae	*Solanum pungetium*
Flower	Stackhousiaceae	*Stackhousia monogyna*
Flower	Stylidaceae	*Stylidium graminifolium*
Flower	Thymelaeaceae	*Pimelea axiflora*
Flower	Thymelaeaceae	*Pimelea drupacea*
Flower	Thymelaeaceae	*Pimelea humilis*
Flower	Thymelaeaceae	*Pimelea latifolia*
Flower	Thymelaeaceae	*Pimelea ligustrina ligustrina*
Flower	Thymelaeaceae	*Pimelea linifolia*
Flower	Thymelaeaceae	*Pimelea octophylla*
Flower	Tremandraceae	*Tetratheca shiressii*
Flower	Urticaceae	*Australina pusilla muelleri*
Flower	Urticaceae	*Urtica incisa*
Flower	Violaceae	*Hybanthus monopetalus*
Flower	Violaceae	*Viola hederacea*
Flower	Violaceae	*Viola silicestris*
Flower	Xanthorrhoeaceae	*Xanthorrhoea arenaria*
Flower	Xanthorrhoeaceae	*Xanthorrhoea johnsonii*
Flower	Xanthorrhoeaceae	*Xanthorrhoea minor*
Flower	Xyridaceae	*Xyris bracteata*
Flower	Xyridaceae	*Xyris operculata*
Flower	Zingiberaceae	*Alpinia caerulea*
Flower	Zingiberaceae	*Alpinia modesta*

Bird phylogeny

(Casuarius_casuarius:104.901031,(Leipoa_ocellata:98.176964,(Geophaps_plumifera:86.060669,(Grus_antigone:84.83239,(Cacomantis_castaneiventris:84.536766,((((Probosciger_aterrimus:38.811775,Callocephalon_fimbriatum:38.811771):8.954046,((Geoffroyus_geoffroyi:15.734047,Eclectus_roratus:15.734048):18.889141,((Psephotus_chrysopterygius:12.552645,Platycercus_caledonicus:12.552645):19.00293,(Neophema_chrysogaster:14.79632,Neophema_elegans:14.79632):16.759254):3.067613):13.14263):33.907963,((Menura_alberti:60.046989,Atrichornis_rufescens:60.046989):7.4518,((Prionodura_newtoniana:59.875847,(Climacteris_affinis:2.417189,Climacteris_melanurus:2.417189):57.45866):4.009264,(((Amytornis_barbatus:19.060053,Amytornis_goyderi:19.060053):24.817051,((Pardalotus_quadragintus:42.610928,(((Lichenostomus_flavescens:21.188255,Lichenostomus_frenatus:21.188255):11.998004,((Meliphaga_gracilis:22.438744,(Lichenostomus_flavus:18.688795,Lichenostomus_hindwoodi:18.688797):3.749948):8.272303,Ashbyia_lovensis:30.711048):2.475212):1.629712,(((Lichenostomus_flavicollis:24.488903,Melithreptus_affinis:24.488903):3.593242,Trichodere_cockerelli:28.082146):5.629327,(Xanthotis_macleayanus:23.692085,Xanthotis_flaviventer:23.692085):10.019388):1.104499):7.794956):0.099046,((Acanthiza_katherina:19.961197,(Acanthornis_magna:15.163625,Aphelocephala_nigricincta:15.163625):4.797571):2.060468,((Calamanthus_fuliginosus:14.755479,(Hylacola_cauta:8.332712,Hylacola_pyrrhopygia:8.332712):6.422767):5.398283,(Origma_solitaria:16.423893,(Sericornis_keri:12.190347,Sericornis_humilis:12.190347):4.233546):3.729869):1.867902):20.688309):1.16713):14.23068,(((Machaerirhynchus_flaviventer:29.382902,Cracticus_mentalis:29.382902):14.436057,((Cinclosoma_castanotum:26.208591,((Manucodia_keraudrenii:20.71195,(Arses_telescophthalmus:6.094185,Arses_kaupi:6.094185):14.617765):3.095182,Corvus_tasmanicus:23.807133):2.401459):3.782545,((Colluricincla_woodwardi:9.977165,Colluricincla_boweri:9.977166):9.505881,Pachycephala_rufogularis:19.483046):10.508089):13.827824):10.14336,(((((Eopsaltria_pulverulenta:24.728077,Tregellasia_capito:24.728077):16.021303,Heteromyias_albispecularis:40.749382):3.308519,(Drymodes_brunneopygia:1.279482,Drymodes_superciliaris:1.279482):42.778419):1.924515,Poecilodryas_cerviniventris:45.982414):5.534996,((Eremiornis_carteri:33.056648,Cisticola_juncidis:33.056644):14.734374,(Poephila_personata:16.864016,Erythrura_trichroa:16.864016):30.927004):3.726391):2.444909):4.145463):5.77733):3.613676):14.17499):2.618828,(Collocalia_terraereginae:83.983788,Syma_torotoro:83.983765):0.308831):0.244157):0.295629):1.228271):12.116307):6.724064);

Angiosperm phylogeny

((((((((((elaeodendron_australe_australe,stackhousia_monogyna)celastraceae,((tetratheca_pilosa_latifolia,tetratheca_ericifolia,tetratheca_shiressii,tetratheca_thymifolia)tetratheca,((((pseudanthus_pauciflorus_pauciflorus,pseudanthus_ligulatus)pseudanthus,micrantheum_ericoides)picrodendraceae,(breynia_oblongifolia,phyllanthus_hirtellus,(poranthera_ericoides,poranthera_microphylla)poranthera)phyllanthaceae),(codiaeum_variegatum_var.moluccanum,amperea_xiphoclada,claoxylon_australe,ricinocarpos_pinifolius)euphorbiaceae,hybanthus_monopetalus,hypericum_gramineum)malpighiales))celastrales_to_malpighiales,(((((pomaderris_apetala_

maritima,pomaderris_aspera)pomaderris,cryptandra_lanosiflora,spyridium_scortechinii)pomaderreae,(australina_pusilla_muelleri,urtica_incisa)urticaceae),rubus_rosifolius)rosales,(((acacia_aculeatissima,acacia_calyculata,acacia_floribunda,acacia_granitica,acacia_latisepala,acacia_leprosa,acacia_mearnsii,acacia_paradoxa,acacia_pruinosa,acacia_ruppii,acacia_suaveolens,acacia_ulicifolia,acacia_venulosa,acacia_verticillata,acacia_viscidula,acacia_whitei)acacia,((austrosteenisia_blackii,(glycine_clandestina,hardenbergia_violacea)),(bossiaea_obovata,(mirbelia_rubiifolia,phyllota_phylicoides,jacksonia_thesioides,pultenaea_prolifera),(gompholobium_glabratum,gompholobium_grandiflorum,gompholobium_virgatum)gompholobium)),(ormosia_ormondii,hovea_graniticola)genistoids)),(comesperma_calymega,comesperma_ericinum,comesperma_volubile)comesperma))),((((((philotheca_buxifolia_buxifolia,philotheca_epilosa,philotheca_queenslandica,philotheca_reichenbachii)philotheca,nematolepis_squamea_squamea,(boronia_anemonifolia,boronia_floribunda,boronia_parviflora,boronia_pilosa,boronia_rosmarinifolia,boronia_serrulata)boronia,(phebalium_squamulosum,phebalium_woombye)phebalium,leionema_rotundifolium,(zieria_arborescens,zieria_laevigata,zieria_laxiflora)zieria)rutaceae,aglaia_sapindina),((dodonaea_lanceolata_subsessilifolia,dodonaea_falcata)dodonaea,cupaniopsis_baileyana,synima_macrophylla)sapindaceae),((pimelea_ligustrina_ligustrina,pimelea_axiflora,pimelea_drupacea,pimelea_humilis,pimelea_latifolia,pimelea_linifolia,pimelea_octophylla)pimelea,capparis_lucida)malvales_to_brassicales),((rhodomyrtus_trineura_capensis,darwinia_fascicularis_fascicularis,acmena_smithii,angophora_hispida,(leptospermum_continentale,leptospermum_laevigatum,leptospermum_lanigerum,leptospermum_microcarpum,leptospermum_myrsinoides,leptospermum_scoparium,leptospermum_semibaccatum,leptospermum_squarrosum,leptospermum_trinervium)leptospermum,((callistemon_rigidus,(melaleuca_nodosa,melaleuca_squarrosa)melaleuca),(calytrix_tetragona,(micromyrtus_sessilis,homoranthus_virgatus))),corymbia_gummifera,eucalyptus_amygdalina,(kunzea_ambigua,kunzea_capitata,kunzea_obovata)kunzea)myrtaceae,melastoma_affine))malvids),(gonocarpus_humilis,gonocarpus_teucrioides)gonocarpus),((((((((((vernonia_cinerea_var.lanata,((brachyscome_multifida,(olearia_ciliata,olearia_lirata,olearia_microphylla,olearia_phlogopappa)olearia),((cassinia_aculeata,cassinia_denticulata,cassinia_longifolia)cassinia,ozothamnus_obcordatus))),argentipallium_obtusifolium,bedfordia_arborescens,leptorhynchos_squamatus,(coronidium_oxylepis,coronidium_rupicola)coronidium,lagenophora_stipitata)asteraceae,(brunonia_australis,(goodenia_geniculata,goodenia_gracilis,goodenia_heterophylla,goodenia_lanata,goodenia_ovata,goodenia_rotundifolia)goodenia)goodeniaceae),stylidium_graminifolium),(pratia_pedunculata,(wahlenbergia_queenslandica,wahlenbergia_stricta)wahlenbergia)campanulaceae)asterales,(((actinotus_minor,platysace_ericoides,xanthosia_pilosa)apiaceae,polyscias_purpurea),(billardiera_scandens,(pittosporum_bicolor,pittosporum_revolutum,pittosporum_undulatum)pittosporum)pittosporaceae)),(((((mitrasacme_pilosa_var.stuartii,mitrasacme_polymorpha)mitrasacme,logania_albiflora)loganiaceae,tylophora_barbata),((atractocarpus_benthamianus,atractocarpus_hirtus)atractocarpus,cyclophyllum_protractum,psychotria_sp.Danbulla)rubiaceae)gentianales,((ligustrum_australianum,notelaea_ovata)oleaceae,(((prostanthera_melissifolia,faradaya_splendida,hemigenia_purpurea,westringia_tenuicaulis)lamiaceae,(utricularia_dichotoma,utricularia_lateriflora,utricularia_uniflora)utricularia),veronica_gracilis)),trichodesma_zeylanicum)),((maesa_dependens_var.pubescens,myrsine_subsessilis)primulaceae,((brachyloma_ciliatum,brachyloma_daphnoides)brachyloma,(leucopogon_biflorus,leucopogon_microphyllus,leucopogon_parviflorus,leucopogon_virgatus)leucopogon,lissanthe_strigosa,melichrus_urceolat

us,monotoca_glauca,(epacris_lanuginosa,epacris_microphylla,epacris_obtusifolia)epacris,gaultheria_hispida,richea_procera,woollsia_pungens)ericaceae))ericales_to_asterales,(drosera_peltata,rhagodia_candolleana)caryophyllales),(((leptomeria_drupacea,leptomeria_acida)leptomeria,choretrum_candollei)santalaceae,olax_stricta)santalales),(hibbertia_acicularis,hibbertia_bracteata,hibbertia_empetrifolia,hibbertia_hirticalyx,hibbertia_linearis,hibbertia_obtusifolia,hibbertia_procumbens,hibbertia_riparia,hibbertia_scandens,hibbertia_serpyllifolia,hibbertia_vestita)hibbertia),((grevillea_buxifolia_buxifolia,grevillea_linearifolia,grevillea_oleoides,grevillea_parallela,grevillea_sphacelata,grevillea_steiglitziana,grevillea_viridiflava)grevillea,persoonia_falcata,(conospermum_ellipticum,conospermum_hookeri,conospermum_longifolium,conospermum_taxifolium)conospermum,hakea_actites,isopogon_petiolaris,(lambertia_formosa,banksia_aemula),strangea_linearis)proteaceae)sabiales_to_asterales,(clematis_aristata,sarcopetalum_harveyanum))eudicots,((((caesia_parviflora_var.parviflora,dichopogon_strictus,sowerbaea_juncea,(thysanotus_patersonii,thysanotus_tuberosus)thysanotus)liliaceae,(((libertia_paniculata,(patersonia_fragilis,patersonia_occidentalis)patersonia)iridaceae,(bulbine_bulbosa,(lomandra_cylindrica,lomandra_filiformis,lomandra_glauca,lomandra_longifolia,lomandra_multiflora,lomandra_obliqua)lomandra,(xanthorrhoea_arenaria,xanthorrhoea_johnsonii,xanthorrhoea_minor)xanthorrhoea)xanthorrhoeaceae),(linospadix_monostachya,pollia_macrophylla,(xyris_bracteata,xyris_operculata)xyris)commelinids)),dioscorea_transversa),(calamus_caryotoides,pothos_longipes,gymnostachys_anceps)araceae))poales_to_asterales,((cassytha_filiformis,cassytha_pubescens)cassytha,endiandra_monothyra)lauraceae)magnoliales_to_asterales;

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(MOTHS, (((Badamia exclamationis,(Allora doleschallii,Allora major),(Hasora chromus,Hasora discolor,Hasora khoda)), (Tagiades japetus,Netrocoryne repanda, (Chaetocneme beata,Chaetocneme critomedia,Chaetocneme denitza, Chaetocneme porphyropis), Euschemon rafflesia), ((Telicota ancilla,Telicota anisodesma,Telicota augias, Telicota brachydesma, Telicota colon, Telicota eurotas, Telicota eurychlora, Telicota mesoptis, Telicota ohara),(Arrhenes dschilus,Arrhenes marnas),Borbo cinnara,(Cephrenes augiades,Cephrenes trichopepla),Mimene atropatene,Notocrypta waigensis,(Ocybadistes walkeri,Ocybadistes hypomeloma),(Pelopidas agna,Pelopidas lyelli), (Sabera caesina,Sabera fuliginosa),(Suniana sunias,Suniana lascivia)), ((Anisynta cynone,Anisynta dominula,Anisynta monticolae,Anisynta tillyardi), (Antipodia atralba,Antipodia chaostola),Dispar compacta,(Hesperilla chrysotricha,Hesperilla crypsigramma,Hesperilla flavescens flavescens,Hesperilla furva, Hesperilla idothea, Hesperilla malindeva, Hesperilla mastersi, Hesperilla picta, Hesperilla sarnia, Hesperilla sexguttata,Hesperilla crypsargyra,Hesperilla donnysa,Hesperilla ornata),Herimosa albovenata, (Mesodina aeluropis, Mesodina halyzia), Motasingha trimaculata,(Neohesperilla croceus, Neohesperilla senta, Neohesperilla xanthomera, Neohesperilla xiphiphora), Pasma tasmanicus, (Parnara amalia, Parnara bada),(Oreisplanus perornata,Oreisplanus munionga),Rachelia extrusa, Proeidosa polysema, (Signeta flammeata,Signeta tymbophora),(Toxidia andersoni,Toxidia

doubledayi, Toxidia inornatus,Toxidia melania,Toxidia parvulus,Toxidia peron,Toxidia thyrrhus,Toxidia rietmanni),(Trapezites taori,Trapezites eliena,Trapezites heteromacula,Trapezites iacchoides,Trapezites iacchus,Trapezites macqueeni,Trapezites maheta,Trapezites petalia,Trapezites phigalia,Trapezites phigalioides,Trapezites praxedes,Trapezites sciron,Trapezites lutea,Trapezites symmomus),(Taractrocera anisomorpha,(Taractrocera dolon,(Taractrocera ina,Taractrocera papyria))))),((((Graphium agamemnon,Graphium aristeus,Graphium macfarlanei,Graphium sarpedon,Graphium macleayanus,Graphium eurypylus),Protographium leosthenes),((Papilio aegeus,Papilio ambrax,Papilio anactus, Papilio demoleus, Papilio ulysses,Papilio fuscus,(Pachliopta polydorus,Cressida cressida,(Ornithoptera richmondia,Ornithoptera priamus)))),(((((((Delias aganippe,Delias argenthona,Delias aruna,Delias harpalyce,Delias mysis,Delias nigrina,Delias nysa,Delias ennia),Cepora perimale),Belenois java),Appias ada,Appias albina,Appias melania,Appias paulina),(Elodina angulipennis,Elodina claudia,Elodina padusa,Elodina parthia,Elodina queenslandica,Elodina walkeri)),((Catopsilia gorgophone, Catopsilia pomona, Catopsilia pyranthe, Catopsilia scylla),(Eurema alitha, Eurema brigitta, Eurema hecabe, Eurema herla, Eurema laeta, Eurema puella, Eurema smilax))),((Libythea geoffroy,((((Tellervo zoilus,(((Danaus affinis,Danaus chrysippus),Tirumala hamata),(Euploea batesii,Euploea core, Euploea darchia, Euploea leucostictos, Euploea tulliolus,Euploea sylvester))))),(((((((Doleschallia bisaltide,((Yoma sabina,((Junonia hedonia,(Junonia orithya,Junonia villida)))),(Hypolimnas alimena,Hypolimnas anomala,Hypolimnas bolina,Hypolimnas misippus))),(((Vanessa itea,Vanessa kershawi)),Mynes geoffroyi))),((((((Cupha prosope ,Vagrans egista),Argyreus hyperbius),Vindula arsinoe),(Cethosia cydippe,Acraea andromacha)), (Lexias aeropa,(Phaedyma shepherdi,(Pantoporia consimilis,Pantoporia venilia)))))))),(((Polyura sempronius,Charaxes latona),((Elymnias agondas,Melanitis leda), (Ypthima arctous,(((Mycalesis perseus,(Mycalesis sirius, Mycalesis terminus)),(Orsotriaena medus,(((((((Geitoneura acantha,Geitoneura klugii),(Heteronympha mirifica,Heteronympha paradelpha,Heteronympha solandri,Heteronympha banksii,Heteronympha merope,Heteronympha penelope,Heteronympha cordace)),(Hypocysta adiante,Hypocysta angustata,Hypocysta euphemia,Hypocysta irius,Hypocysta metirius,Hypocysta pseudirius)) ,(Nesoxenica leprea,(Argynnina cyrila,Argynnina hobartia)))), ((Tisiphone helena,Tisiphone abeona),(Oreixenica correae,Oreixenica ptunarra,Oreixenica kershawi,Oreixenica lathoniella,Oreixenica latialis,Oreixenica orichora))))))))))))),(Praetaxila segecia,(((Acrodipsas hirtipes,(Acrodipsas illidgei,Acrodipsas arcana)),Acrodipsas aurata,(Acrodipsas brisbanensis,Acrodipsas myrmecophila),Acrodipsas mortoni),(Arhopala wildei,(Arhopala madytus,Arhopala centaurus)),(Anthene lycaenoides,Anthene seltuttus),Bindahara phocides, (Candalides absimilis,Candalides acasta,Candalides consimilis,Candalides cyprotus,Candalides delospila,Candalides erinus,Candalides geminus,Candalides gilberti,Candalides heathi,Candalides helenita,Candalides hyacinthinus,Candalides margarita,Candalides xanthospilos),(Catochrysops amasea,Catochrysops panormus,Catopyrops ancyra,Catopyrops florinda),Danis danis,(Deudorix democles,Deudorix diovis,Deudorix epijarbas,Deudorix epirus),(Erysichton lineatus,Erysichton palmyra),Euchrysops cnejus,Everes lacturnus,Famegana alsulus,Freyeria putli,(Hypochrysops apelles,Hypochrysops apollo,Hypochrysops byzos,Hypochrysops cleon,Hypochrysops cyane,Hypochrysops

delicia,Hypochrysops digglesii,Hypochrysops elgneri,Hypochrysops epicurus,Hypochrysops hippuris,Hypochrysops ignitus,Hypochrysops miskini,Hypochrysops narcissus ,Hypochrysops piceatus,Hypochrysops polycletus,Hypochrysops pythias,Hypochrysops theon),(Hypolycaena danis,Hypolycaena phorbas),Ionolyce helicon,(Jalmenus daemeli,Jalmenus eichhorni,Jalmenus evagoras,Jalmenus icilius,Jalmenus ictinus,Jalmenus pseudictinus),(Jamides aleuas,Jamides amarauge,Jamides cyta,Jamides phaseli),Lampides boeticus,Leptotes plinius,Liphyra brassolis,Lucia limbaria,Megisba strongyle,(Nacaduba berenice,Nacaduba biocellata,Nacaduba cyanea,Nacaduba kurava),(Neolucia mathewi,Neolucia hobartensis,Neolucia agricola),Nesolycaena albosericea,(Ogyris abrota,Ogyris aenone,Ogyris barnardi,Ogyris genoveva,Ogyris ianthis,Ogyris iphis, Ogyris olane,Ogyris subterrestris,Ogyris zosine,Ogyris oroetes,Ogyris amaryllis),(Paralucia aurifer,Paralucia pyrodiscus,Paralucia spinifera),Petrelaea tombugensis,(Philiris fulgens,Philiris innotata,Philiris sappheira,Philiris ziska,Philiris diana,Philiris nitens),Pithecops dionisius,(Prosotas dubiosa,Prosotas felderi,Prosotas nora),Pseudalmenus chlorinda,(Pseudodipsas cephenes,Pseudodipsas eone),Psychonotis caelius,Rapala varuna,Sahulana scintillata,Udara tenella,Zizeeria karsandra,(Theclinesthes sulpitius,Theclinesthes serpentatus,Theclinesthes onycha,Theclinesthes miskini,Zizula hylax,Zizina labradus)))))));

Appendix 2 – Detailed methods

SAMPLING

Taxa 1: Birds

We measured the color of all terrestrial bird species native to the east coast of Australia for which good quality specimens exist (taxonomy following Christidis and Boles (2008); subspecies following Schodde and Mason (1999), and Simpson and Day (2010)). Hybrids or introduced species were excluded. This dataset therefore includes 570 bird species or subspecies, which is all except one species proper native to our sampling range.

We captured spectral readings from skin specimens sourced from The Queensland Museum in South Brisbane, the Australian National Wildlife Collection (ANWC) at CSIRO in Canberra and The Australian Museum in Sydney. We measured up to three representative male specimens, using breeding plumage if it was distinct for the species (species with two males: 2.4%; species with one male: 1.8%; Dalrymple *et al.*, 2015). Analyses which examined potential fading in colors of museum specimens have provided strong support for the use of such specimens for color sampling purposes (Endler & Thery, 1996; Armenta *et al.*, 2008; Chui & Doucet, 2009); Nevertheless, we ensured all specimens sampled were less than 65 years old.

For each species, measurements were taken of each of six main body patches (throat, breast, belly, crown, back and rump); for certain species scans were also taken of body regions which displayed additional colors (including wing-bars, epaulets, nape, cheek, forehead,

lower-belly and tail-feathers; following Stoddard & Prum, 2011). Scans were taken within homogenous areas of discrete color patches, and as far as possible from patch boundaries. Spectra were captured using a spectrometer (Ocean Optics USB2000+, coupled with a PX-2 pulsed xenon light source) over the wavelength range of 300 to 700 nm. The spectrometer was driven by a computer running Ocean Optics SpectraSuite software, with integration time (analogous to 'shutter speed' on a camera) set to 100 ms, and with 10 spectra averaged per measurement. Samples were measured from a constant working distance of 10 mm using a block-mounted reflectance probe. This setup excludes ambient light (Armenta *et al.*, 2008; Chui & Doucet, 2009) while directing both the PX-2 illumination and the angle of spectrometer probe capture to 90° relative to the plane of the sample (Eaton & Lanyon, 2003; Armenta *et al.*, 2008; Doucet & Hill, 2009; Butler *et al.*, 2010; Delhey *et al.*, 2013). An Ocean Optics Spectralon standard and clean, black felt were used to calibrate the spectrometer against white and dark standards, respectively.

Taxa 2: Butterflies

We assessed the dorsal coloration of all native eastern-Australian butterfly species for which undamaged specimens existed in the Australian National Insect Collection (ANIC), CSIRO, Canberra. We followed the taxonomy of Braby (2000). This datset therefore includes 424 species or subspecies; it covered 347 of the 398 species proper that are native to the entire of Australia (Braby, 2004). That is, all of the butterfly diversity in the country exept for 51 species was accounted for in our dataset, which does not include those with ranges only in the states of Western Australia, South Australia or the Northern Territory. While there is a possibility that the few species with ranges in the Eastern states that are unrepresented in the collections are small and inconspicuous, which could be a source of potential bias, it could

aslo be that they are species found in restricted ranges, or in more remote or unsampled regions. Hybrids, introduced species and rare vagrants were again excluded. Butterflies commonly exhibit marked seasonal variation in wing color – termed polyphenism (Shapiro, 1976)– and although such variation may be complex and multivariate (e.g. Rienks, 1985; Kemp, 2001) it is often possible to identify discrete seasonal phenotypes. We have included such variation by sampling individuals of each morph where representative specimens were available, using Braby (Braby, 2000) as a framework for defining seasonal morphs.

We measured butterfly color using waveband-limited photography because 1) reflectance spectrometry of butterfly wings is often destructive, 2) the fragile nature of museum specimens required minimal physical contact for preservation, and 3) it enabled better sampling of the small and complex color patterns. We used an approach designed to furnish analogous data as that derived by reflectance spectrometry of flowers and birds to enable comparison of taxa. We achieved this by photographing trays of specimens illuminated sequentially by light spanning four discrete spectral regions (four 100 nm regions from 300 – 700 nm). Trays were photographed inside a purpose-built light box fitted with four classes of light-emitting diodes (LEDs) (see figure A1). The box was lined on the inside with aluminium foil, and draped with curtains of black felt to exclude ambient light. A tripod-mounted digital camera was arranged on top of the box, seated in a fitted hole cut into the upper face. The camera itself was overlain with black felt to exclude ambient light. An internal panel in the box seated arrays of the four LED classes, which illuminated specimen trays situated below. The four classes of LED were selected to emit light in one of four 100 nm spectral segment bands: UV (300-400 nm), short-wave (S: 400-500 nm), mid-wave (M: 500-600 nm) and long-wave (L: 600-700 nm) (following Endler & Mielke, 2005). The

emission peaks of these LED classes were 350 nm, 461nm, 545 nm and 650 nm, respectively. The LEDs were sourced from Roithner LaserTechnik (Vienna, Austria) – models UVTOP355-FW-TO18 (UV), LED545-04 (M), and ELD-650-523 (L) and Kingbright Electronic Co. (New Taiwan City, Taiwan) – model WP7104QBC/G (S).

We established that the data collected using the light box is comparable to measures obtained via reflectance spectrometry before image collection began, confirming that the approaches were giving consistent results. We achieved this by first capturing reflectance spectra of 20 objects that spanned the color spectrum (including 12 Rosco Supergel color swatches and a range of differentially reflective white objects). We then photographed these objects along with a spectralon standard and calculated their brightness using the methods described above. Correlations of brightness estimates in our four spectral ranges (UV, S, M and L) obtained via spectrometry versus photography yielded R^2 values between 0.79 and 0.98. Across all segments, the correlation has an R^2 value of 0.83 between the two assessment methods. This procedure supported the use of a UV/IR bandpass filter for the UV photographs, given the greater agreement between spectrometry and photography when using this filter ($R^2 = 0.98$) as opposed to without it ($R^2 = 0.36$).

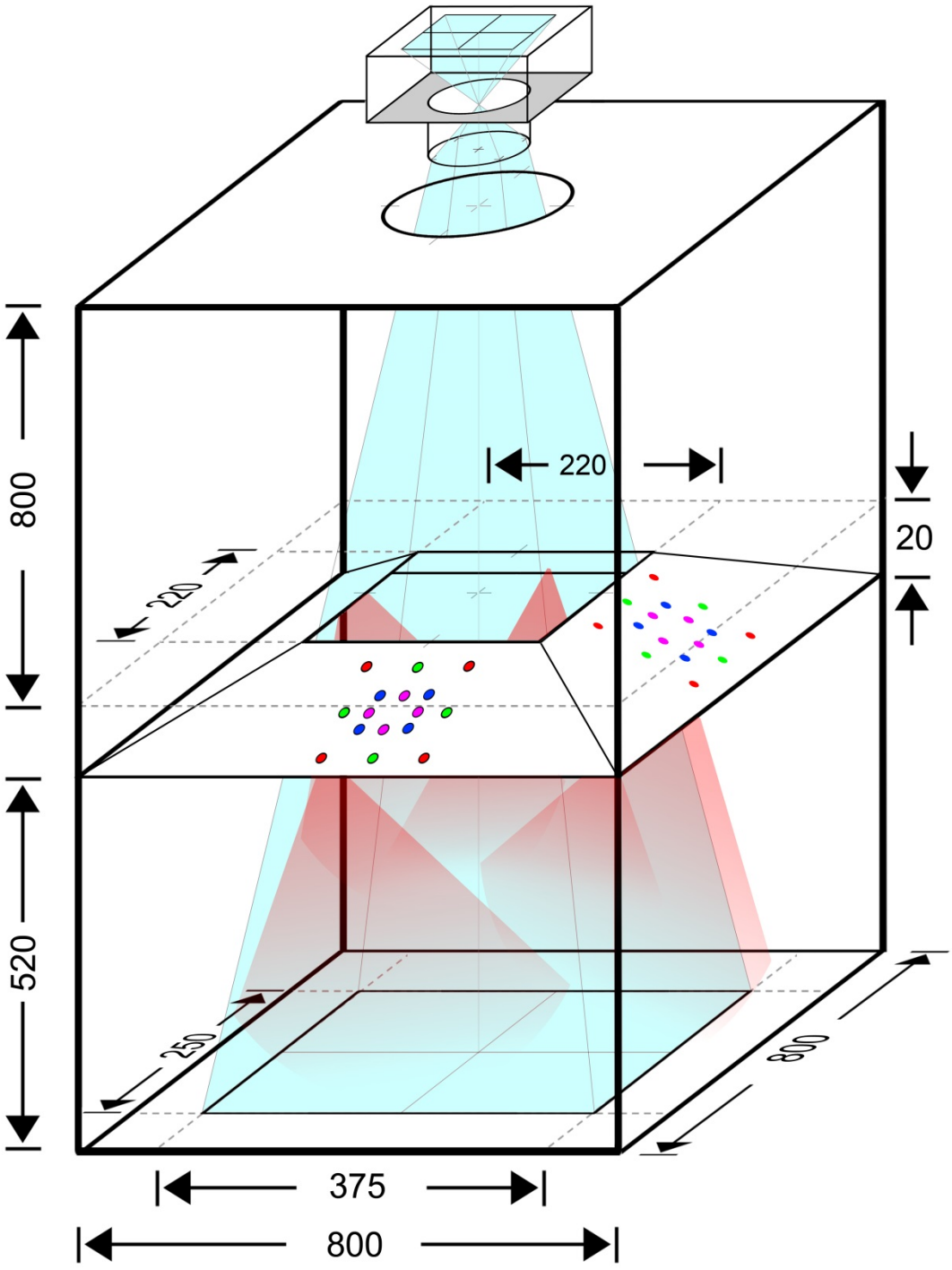

Figure A1: Schematic of the butterfly photography setup. The figure is not drawn to scale, but dimensions are given in mm. The region of camera capture is indicated in light blue, and the illumination paths of several red LEDs indicated purely for illustrative purposes.

The photography setup allowed the camera to capture two-thirds of a museum specimen tray of butterflies in a single photograph, which required four overlapping photographs capturing each corner of each tray per illumination class (UV, S, M and L). Each tray was therefore photographed a total of 16 times (four photographs per LED class). This ensured closer, clearer photos of the butterflies in each corner, and produced multiple redundant images of many specimens.

We captured greyscale images of trays under each LED class. For any given color patch on each species, we were therefore able derive the relative amount of light reflected under each of the four spectral wavebands. For example, using the L (red-light) photographs, we could calculate the amount of red light (600-700 nm) reflected by a particular color patch. These quantities were standardized against the amount of such light reflected by the white standard in each photograph, as achieved by dividing patch brightness by standard brightness. We used this approach to measure dorsal coloration for up to three males of each species. Replicates were limited by availability in the collection, but we achieved three replicates for 93.2 % of species (with only a single replicate for 2.1 % of species).

For each species we recognized discrete color patches as those that extended greater than 100 pixels in the image (analogous to a circle of 2 mm diameter). Where there were diffuse gradients between two or more color patches, we measured the largely discrete areas of each patch but not the intergrades between them. We also captured standard color photographs of each tray (using a Panasonic DMC-TZ30) and used these to select representative specimens

(those in pristine condition, i.e., without fading, fat stains, scuffing or damaged edges), and to define individual color patches.

We assessed color patch brightness by importing images into Photoshop CS6 13.0 (Adobe Systems Incorperated, CA, USA). Patches were selected using the lasso or elliptical marquee tools, or the magic wand tool (set to a tolerance value of 6.0). We used the Photoshop tools to highlight regions of each patch that were clearly demarcated from color boundaries, and used the 'histogram' tool to yield average pixel brightness on a 0-255 scale. We maximised the selected area of each patch in order to average across any minor within-patch brightness fluctuations (due to scale angles, shadowing, etc). We similarly quantified the brightness of the spectralon standard in each photograph. We excluded photographs wherein the white standard proved to be saturated (i.e. yielded an averaged brightness value of 255).

Red spot correction

The LED which emitted light at 300-400 nm, 400-500 nm and 500-600 nm did so evenly across the photographed area of each tray. However, due to their relatively narrow emission angle, 600-700 nm LED radiated more light towards the centre of the box than at its periphery. Consequently, specimens at the periphery of each photograph appeared artificially duller than those situated nearer the centre. We corrected for this by quantifying the difference in red-light emission across the viewing pane of the camera, and applying a brightness correction based upon relative specimen positioning. This was achieved by photographing the Spectralon standard (under the red light) across the field of camera view an array of 20 x 20 mm cells against a standard cardboard background. Each of these

photographs was imported into Photoshop and overlayed with a grid of 8 columns and 12 rows, and the Spectralon brightness measured for each grid cell. The Spectralon standard was often situated in the same grid cell across multiple photographs, wherein we averaged the brightness measurements for that cell. Overall brightness among the photographs was standardised according to the brightness value registered from the same predesignated 20 x 20 mm cell on the cardboard background. This precluded a measure of spectralon brightness in this cell, which we derived using the average of all adjacent grid cells.

We used this approach to define a brightness correction factor to apply across the field-of-view of red LED photographs. Specifically, this correction factor was calculated by dividing Spectralon brightness in each grid cell by maximum Spectralon brightness across all cells. We henceforth used these correction factors to adjust the red brightness measures of butterfly patches according to their position in the camera's field of view.

Taxa 3: Flowers of Angiosperms

During spring and early summer in 2012 we surveyed the colors of wild angiosperm flowers at five latitudes in Australia. We sampled 17 sites (See figure A2), centred around Cairns (16° 44.3'S – 17° 1.8'S), Brisbane (27 ° 10.8' S – 28 ° 15.6' S°S), Sydney (33 ° 35' – 34 ° 50.8' S), Melbourne (38° 35.8'S – 37° 58.2' S) and the state of Tasmania (41° 15.1' – 43° 4.55'S). We aimed to include four habitat types at each latitudinal zone where possible: rainforest, grassland, woodland and heathland. Sites were sampled out of order along the latitudinal range to avoid any sampling bias from an interaction between phenology and

climate (sampling was performed in the order: Brisbane, Sydney, Cairns, Tasmania, Melbourne).

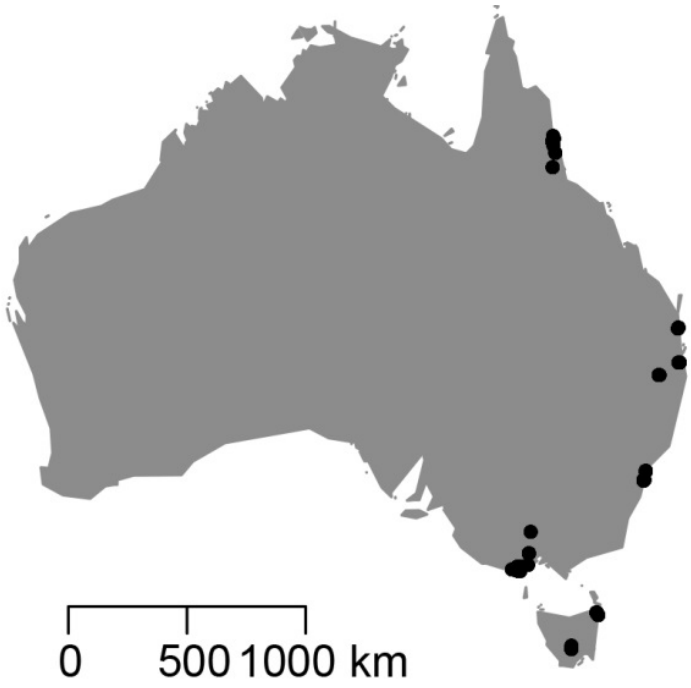

Figure A2: Map of sampling locations across the Eastern states of Australia.

To be included, sites had to be below an altitude of 1000 m, had to be within a national park, and had to be in good condition (no evidence of recent disturbance, low in introduced species). Five transects of approximately 100 m were sampled at each site in grassland, woodland and heathland. Sampling transects were approximately 200 m in rainforest sites due to the low density of flowering species at any time in this vegetation type (Williams & Adams, 2010). These transects generally followed existing trails in national parks and aimed to sample as much of the floristic diversity at the site as feasible (Altshuler, 2003; Arnold *et al.*, 2009b; Arnold *et al.*, 2009a; McEwen & Vamosi, 2010). Our aim was to sample flowers of three individuals from all flowering angiosperm species in each site, with the exception of endangered species, non-native species, species known to possess strong ontogenic color

variation, and species with flowers so small they could not be accurately measured. We were hindered in only being able to sample those species which we could reach with an extending pole-pruner. While this means that the taller overstory trees of rainforests, for example, could not be sampled, there is no reason to expect that this will effect the patterns in colouration across latitudes as habitats were treated the same across our study range.

Plants were identified using site species lists, regional floras and keys, herbarium records, and by our expert taxonomist (F.A.H.), following the APGIII taxonomy of the Australian Plant Census (Centre for Australian National Biodiversity Research, Viewed [01.01.2015]). Plants were all identified to species; those for which this was not possible were excluded. Many species were identified to subspecies or variety. We treated multiple subspecies as separate replicates. For species where color distinguishes varieties, or multiple varieties were identified, we retained variety and subspecies units. A total of 339 species were measured across our 17 sites, with many species encountered at multiple sites (only 14.1 % of species had less than three individuals). A complete record of species and sites sampled, including GPS coordinates and descriptions of sites, and dates of collections is outlined in supporting information 4. There are upwards of 14 000 known angiosperm species native the Eaatern Australian states that make up our study range (derived from the Atlas of Living Australia - ALA: http://www.ala.org.au) , however as our sites were in only four habitat types, hugging coastal fringes and capped altitudinally there would be far fewer than this present in sampling location. None the less, we have sampled a more modest proportion of the Angiosperm diversity in the eastern Australian states than that achieved for birds and butterflies. However, as we have decoupled the temporal order of sampling from latitude there is no reason to expect any bias with reference to colour in the species sampled.

We captured reflectance spectra from a single flower taken from three different individual plants from each species. We ensured that replicate flowers for each species were collected from plants growing at least 1 m apart. Flowers were collected and kept moist and cool (in plastic bags with damp paper towel, first in a cooler and then in a refrigerator) until measured. All measurements were done within 6 hours of collection. Spectra were captured following the methodology used for birds, with a few modifications. First, due to difference in texture of plumage and petal surfaces the spectrometer was held at an angle of 45° in relation to the plane of the sample (Chittka & Menzel, 1992; Stuart-Fox *et al.*, 2004; Heuschen *et al.*, 2005; Kemp, 2007; Schaefer *et al.*, 2008; Toomey *et al.*, 2010; de Jager *et al.*, 2011). Second, we first scanned flower petals with the spectrometer to identify any color patterns which might not have been visible to the human eye (those with UV reflectance); reflectance spectra were then taken of the dominant colors of the adaxial surface of the perianth or showy bracts (McEwen & Vamosi, 2010; de Jager *et al.*, 2011) of a single flower per individual. Third, small petals (less than 10 mm^2) were arranged similarly to roof-tiles on a substrate of black tape in order to present a measurable surface area for homologous colors (Menzel & Shmida, 1993; Chittka *et al.*, 1994).

ANALYSIS

Analysis of color

Flower and bird spectra were binned to 1 nm intervals and clipped to the 300-700 nm range. Negative value spikes resulting from electric noise (which were all less than 1.5 %) were substituted with zeros (as per Maia *et al.*, 2013). Instead of averaging analogous individual

spectra to calculate a mean species spectra for a patch (which can give odd shapes if colors differ, even slightly) we instead calculated the mean of total reflectance in each of four segment bands (300-400 nm, 400-500 nm, 500-600 nm, 600-7000 nm). The relative reflectances in these four bands were used to calculate our colorfulness indices. In this way we have undertaken a visual system-independent appraisal based on the 'segment analysis' approach of Endler (1990).

The average segment reflectance values from bird and flower spectra, and those from butterfly photographs, were used to calculate chroma (saturation) of every color patch. Average segment reflectances for every color patch were then used to calculate X, Y and Z coordinates for location in tetrahedral color space projection, using the equations by Endler and Meilke (2005). From the relative positon that the X Y and Z coordinates place each species' colors into the tetrahedron we calculated other metrics: maximum contrast between any two colors on a species, and average disparity between hues. The maximum contrast between color patches was calculated as the maximum Euclidean distance between the colors displayed by each species in tetrahedral space (Endler & Mielke, 2005). Average hue disparity between all color patches on a species (also referred to as color complementarity) is the angular difference between points in color space, and represents a measure of chromatic difference independent of saturation (ranging from 0 for identical hues and 1.0 for 'complementary' hues).

Due to differences in sampling techniques between taxa, the diversity of color patches was calculated as the volume that each bird species' color patches occupied in a tetrahedral space

(using relative segment reflectances plotted in TetraColorSpace (Stoddard & Prum, 2008)), and as the number of dominant display colors in flowers and butterflies. Dominant colors were 1) assessed using spectometer or UV photographs (and are thereby not hindered by being of human-visual color assessment), 2) of patch size large enough to sample, and 3) not forming a color intergrade between two other dominant color patches.

Range data

ALA range data were filtered for taxon ID issues, inaccurate spatial precision or invalidity and similar spatial record issues (spatially suspect, precision uncertainty greater than 10 000 m, record issues affecting spatial resolution such as coordinates do not match supplied state or coordinates are centre of state). Species occurrence data were only taken for the states spanned by our study range. All bird and angiosperm species had more than 10 range records; however, butterfly range records are thinner in the ALA database. For butterfly species that had fewer than 10 range records available, we produced range data following Braby (2000) by creating presences in spatial cells in which the given species' range covered more than 25%. Range records for birds and butterflies subspecies were edited from full species occurrence records where necessary (following Schodde & Mason, 1999; Simpson & Day, 2010) using ArcGIS10.1 (ESRI, CA, USA). Intergradations or hybrid zones of subspecies were not included in the ranges of the subspecies. For plant ranges, cleared/non-native/building vegetation types, and cultivated or garden escape plant records were filtered out.

Phylogenetic independent contrast analysis

A phylogeny for the butterflies was created from the relationships published in the literature (Caterino *et al.*, 2001; Eastwood & Hughes, 2003; Braby, 2004; de Jong, 2004; Megens *et al.*, 2004; Wahlberg *et al.*, 2005; Braby *et al.*, 2006; Zhang *et al.*, 2008; Kodandaramaiah, 2009; Wahlberg *et al.*, 2009; Warren *et al.*, 2009; Kodandaramaiah *et al.*, 2010; Simonsen *et al.*, 2010; Zhang *et al.*, 2011) (phylogeny in supporting information 3); if all relationships between butterfly species in a genus could not be resolved, the genus is represented as a polytomy; if relationships between all butterfly genera could not be resolved, the tribe or family is represented as a polytomy. A phylogeny of bird species was constructed using birdtree.org (Jetz *et al.*, 2012), using an Ericson backbone, and creating a consensus Bayesian inference tree from 1000 trees using 9993 OTUs. From these 1000 trees one was chosen in random and branch lengths were removed, as these trees tend to differ in branch lengths but not in topology.

For both flower and butterfly species we have performed Phylogenetically Independent Contrast (PIC) analysis for the number of colors per species on every species; PIC analysis for maximum color span and average hue disparity was performed on species that have two or more colors, and PIC analysis of chroma was performed on species that have one color only. For the birds, we have performed this test on color volume, maximum contrast and average hue disparity. We have not performed it on chroma for birds because as a minimum of six patches were measured per species, we do not have a single trait measurement to use for this contrast analysis (and an average of the six values is not a meaningful summary statistic for a species). We excluded species where there were distinct color forms measured that are not recognised subsp. or var. rank (such as wet or dry season morphs), or monecious

angiosperm species (as there may be more than one trait for the species, not included in analysis).

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Appendix 3 - results tables

Analyses of the mean of colour trait values in the bird community

Linear regression

	R^2	*Residual Df*	*F*	*P value*	*Model intercept, regression slope*
Chroma - Intercept		1189			0.1200
Chroma - Latitude	0.110	1188	152.143	0.001	-0.0004
Volume - Intercept		1189			0.0001
Volume - Latitude	0.140	1188	193.064	0.001	-0.000003
Maximum colour span - Intercept		1189			0.1400
Maximum colour span - Latitude	0.160	1188	226.295	0.001	-0.0010
Average hue disparity - Intercept		1189			0.4200
Average hue disparity - Latitude	0.000	1188	0.003	0.96	0.0000

Stepwise regression

	R^2	*Residual Df*	*F*	*P value*	*Model intercept, regression slope*
Chroma - Intercept		1189			0.13745
Chroma - Stepwise Latitude	0.06944	1188	88.66	0.001	-0.00498
Volume - Intercept		1189			0.00015
Volume - Stepwise Latitude	0.0862	1188	112.06	0.001	-0.00004
Maximum colour span - Intercept		1189			0.17334
Maximum colour span - Stepwise Latitude	0.08614	1188	111.99	0.001	-0.0119
Average hue disparity - Intercept		1189			0.41853
Average hue disparity - Stepwise Latitude	0.00032	1188	0.38	0.528	0.0021

Analyses of the maximum of colour trait values in the bird community

Linear regression

	R^2	*Residual Df*	*F*	*P value*	*Model intercept, regression slope*
Chroma - Intercept		873			0.47453
Chroma - Latitude	0.0092	872	8.1	0.006	-0.00081
Volume - Intercept		873			-0.69615
Volume - Latitude	0.2454	872	283.6	0.001	-0.07961
Maximum colour span - Intercept		873			0.0003
Maximum colour span - Latitude	0.1353	872	136.5	0.001	-0.00021
Average hue disparity - Intercept		873			1.48375
Average hue disparity - Latitude	0.0386	872	35	0.001	-0.00399

Stepwise regression

	R^2	*Residual Df*	*F*	*P value*	*Model intercept, regression slope*
Chroma - Intercept		873			0.4973
Chroma - Stepwise Latitude	0.00029	872	0.26	0.617	-0.0022
Volume - Intercept		873			1.7704
Volume - Stepwise Latitude	0.15048	872	154.46	0.001	-0.936
Maximum colour span - Intercept		873			0.0069
Maximum colour span - Stepwise Latitude	0.0685	872	64.12	0.001	-0.0023
Average hue disparity - Intercept		873			1.6085
Average hue disparity - Stepwise Latitude	0.02788	872	25.01	0.001	-0.0509

Analyses of the mean of colour trait values in the butterfly community

Linear regression

	R^2	*Residual Df*	*F*	*P value*	*Model intercept, regression slope*
Chroma - Intercept		608			0.14942
Chroma - Latitude	0.0179	607	11.06	0.001	-0.00053
Colours per species - Intercept		608			1.68764
Colours per species - Latitude	0.0888	607	59.12	0.001	-0.01868
Maximum colour span - Intercept		554			0.30005
Maximum colour span - Latitude	0.0336	553	19.22	0.001	-0.00688
Average hue disparity - Intercept		554			0.67031
Average hue disparity - Latitude	0.0017	553	0.92	0.346	0.00212

Stepwise regression

	R^2	*Residual Df*	*F*	*P value*	*Model intercept, regression slope*
Chroma - Intercept		608			0.1663
Chroma - Stepwise Latitude	0.007	607	4.401	0.043	-0.0062
Colours per species - Intercept		608			2.3234
Colours per species - Stepwise Latitude	0.089	607	59.124	0.001	-0.346
Maximum colour span - Intercept		554			0.5245
Maximum colour span - Stepwise Latitude	0.018	553	10.056	0.001	-0.0978
Average hue disparity - Intercept		554			0.6235
Average hue disparity - Stepwise Latitude	0.003	553	1.426	0.218	-0.0514

Analyses of the maximum of colour trait values in the butterfly community

Linear regression

	R^2	*Residual Df*	*F*	*P value*	*Model intercept, regression slope*
Chroma - Intercept		318			0.1987
Chroma - Latitude	0.04007	317	13.232	0.002	-0.0011
Colours per species - Intercept		318			2.6683
Colours per species - Latitude	0.04711	317	15.673	0.001	-0.0365
Maximum colour span - Intercept		318			0.1167
Maximum colour span - Latitude	0.02447	317	7.951	0.004	-0.0014
Average hue disparity - Intercept		318			1.3677
Average hue disparity - Latitude	0.00014	317	0.046	0.816	-0.0013

Stepwise regression

	R^2	*Residual Df*	*F*	*P value*	*Model intercept, regression slope*
Chroma - Intercept		318			0.24
Chroma - Stepwise Latitude	0.092	317	32	0.001	-0.031
Colours per species - Intercept		318			4.009
Colours per species - Stepwise Latitude	0.088	317	31	0.001	-0.939
Maximum colour span - Intercept		318			0.175
Maximum colour span - Stepwise Latitude	0.101	317	36	0.001	-0.054
Average hue disparity - Intercept		318			1.543
Average hue disparity - Stepwise Latitude	0.045	317	15	0.001	-0.439

Analyses of the mean of colour trait values in the flower community

Linear regression

	R^2	*Residual Df*	*F*	*P value*	*Model intercept, regression slope*
Chroma - Intercept		912			0.21644
Chroma - Latitude	0.0261	911	24.4	0.001	-0.00084
Colours per species - Intercept		912			1.11859
Colours per species - Latitude	0.0217	911	20.2	0.001	-0.00446
Maximum colour span - Intercept		661			0.56288
Maximum colour span - Latitude	0.0133	660	8.9	0.006	-0.00319
Average hue disparity - Intercept		661			0.34842
Average hue disparity - Latitude	0.0155	660	10.4	0.001	0.00303

Stepwise regression

	R^2	*Residual Df*	*F*	*P value*	*Model intercept, regression slope*
Chroma - Intercept		912			0.2459
Chroma - Stepwise Latitude	0.04994	911	47.89	0.001	-0.0198
Colours per species - Intercept		912			1.2622
Colours per species - Stepwise Latitude	0.01394	911	12.88	0.002	-0.0612
Maximum colour span - Intercept		661			0.6778
Maximum colour span - Stepwise Latitude	0.03112	660	21.2	0.001	-0.0926
Average hue disparity - Intercept		661			0.2503
Average hue disparity - Stepwise Latitude	0.0065	660	4.32	0.042	0.0373

Analyses of the maximum of colour trait values in the flower community

Linear regression

	R^2	*Residual Df*	*F*	*P value*	*Model intercept, regression slope*
Chroma - Intercept		645			0.1823
Chroma - Latitude	0.2	644	161	0.001	-0.0052
Colours per species - Intercept		645			0.0486
Colours per species - Latitude	0.31	644	290	0.001	-0.0739
Maximum colour span - Intercept		645			-0.473
Maximum colour span - Latitude	0.24	644	208	0.001	-0.0396
Average hue disparity - Intercept		645			-0.1429
Average hue disparity - Latitude	0.26	644	229	0.001	-0.0115

Stepwise regression

	R^2	*Residual Df*	*F*	*P value*	*Model intercept, regression slope*
Chroma - Intercept		645			0.35
Chroma - Stepwise Latitude	0.13	644	99	0.001	-0.071
Colours per species - Intercept		645			2.362
Colours per species - Stepwise Latitude	0.14	644	105	0.001	-0.821
Maximum colour span - Intercept		645			0.765
Maximum colour span - Stepwise Latitude	0.11	644	77	0.001	-0.432
Average hue disparity - Intercept		645			0.216
Average hue disparity - Stepwise Latitude	0.12	644	87	0.001	-0.128

Phylogenetically independent contrasts

	R^2	*Residual .D.f*	*T value*	*Model*	*P value*	*n contrasts*
BIRD volume	0.020	61	-1.1249	0.0000021	0.2651	62
BIRD maximum colour span	0.046	61	1.7162	0.0012400	0.0912	62
BIRD average hue disparity	0.004	61	0.4741	0.0041500	0.6371	62
FLOWER chroma	0.006	130	-0.880	0.0005310	0.381	131
FLOWER number of colours	0.001	167	0.3035	0.0051800	0.7619	168
FLOWER maximum colour span	0.075	52	2.0453	0.0074700	0.0459	53
FLOWER average hue disparity	0.025	52	1.147	0.0071300	0.2566	53
BUTTERFLY chroma	0.000	13	0.0196	0.0020700	0.9847	14
BUTTERFLY number of colours	0.004	54	0.4867	0.0115000	0.6284	55
BUTTERFLY maximum colour span	0.011	43	-0.6769	0.0006240	0.5021	44
BUTTERFLY average hue disparity	0.001	43	-0.1588	0.0042800	0.8746	44

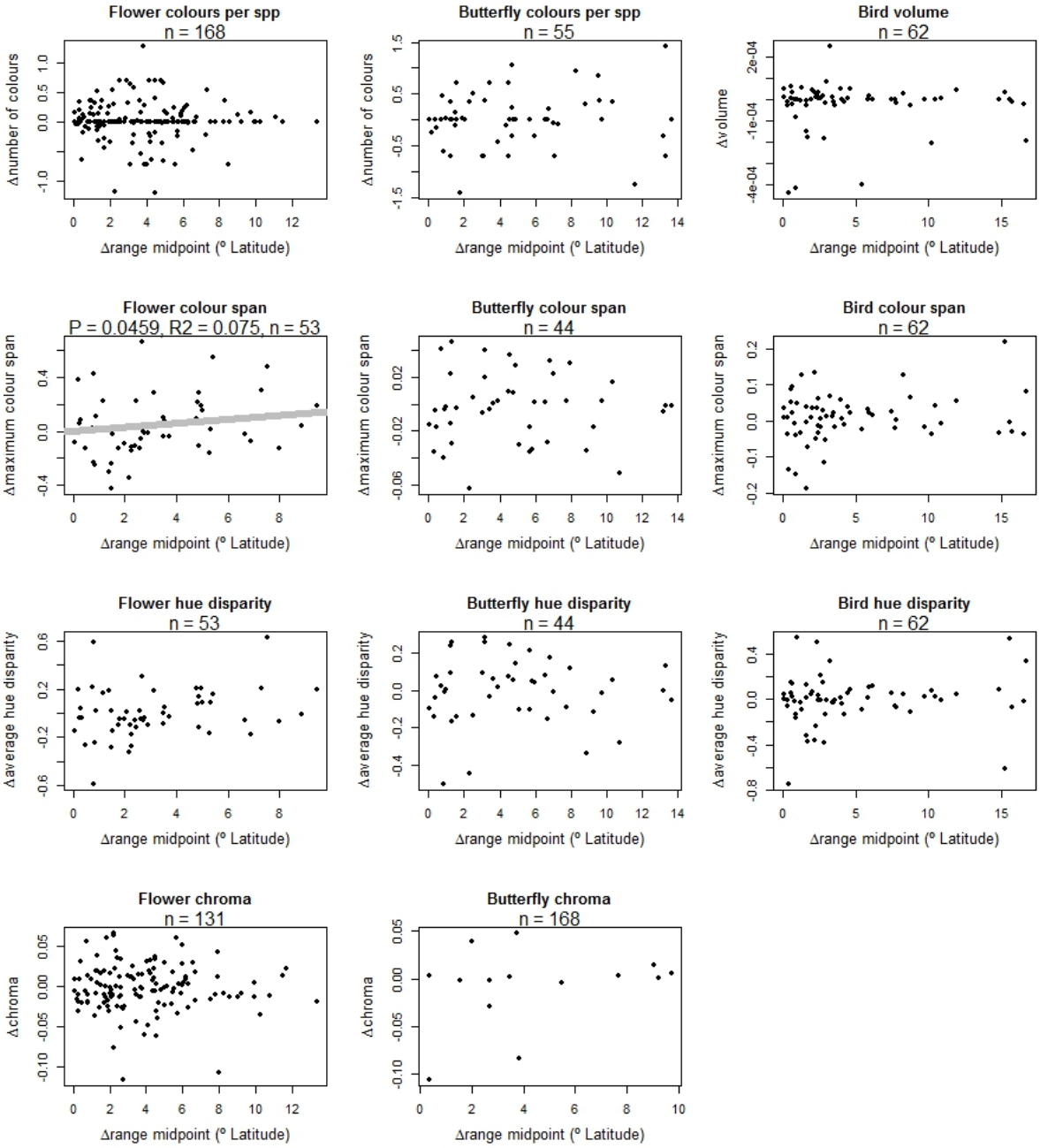

Figure A3: Phylogentically independent contrasts for flowers, butterflies and birds. The X axes represent change in range midpoint in º latitude between sister species. The Y axes represents change in trait value between sister species. None of the tests yielded significant results; that is, while a difference in colour traits can be detected across latitudes cross-species, a change in range has not been associated with a change in any colour traits through the evolutionary history of our species.

Appendix 4 – ANOVA comparisons of different plant growth forms

To determine if the latitudinal gradient in flower colouration may be impacted by growth form of the plants, we examined the flower colour data using ANOVA analyses. We identified the Angiosperm species to the growth forms herb, shrub, tree or climber (mostly using PlantNET: http://plantnet.rbgsyd.nsw.gov.au/, and Australian Tropical Rainforest Plants Edition 6: http://www.anbg.gov.au/cpbr/cd-keys/rfk/), excluding any unusual species which do not fit any of these categories. In our species list (appendix 3) 17 species identified as climbers, 79 as herbs, 24 as trees, and 215 as shrubs.

We compared the colour trait values of the four categories using ANOVA analyses. There was no significant difference in the colour saturation, colour diversity, hue disparity or maximum colour contrast between the four growth forms.

Trait	Sums of squares	F value	P value
Chroma	0.0115	1.408	0.24

Trait	Sums of squares	F value	P value
Hue disparity	0.0111	0.524	0.667

Trait	Sums of squares	F value	P value
Maximum contrast	0.438	1.37	0.259

Trait	Sums of squares	F value	P value
Number of colours per spp	1.27	1.682	0.171