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Use of anthropogenic material for extended ornamented phenotype in two fairy-wren species

Jaden Salett[1]*, James A. Kennerley[1], Ryan Jack[1], Jon Coleman[2, 3], Michael S. Webster[1, 4], William E. Feeney[3, 5] and Jordan Boersma[1]*

[1]Cornell Lab of Ornithology, Ithaca, New York, United States of America
[2]Queensland Bird Research and Banding Group, Birds Queensland, Brisbane QLD 4000, Australia
[3]Wildlife Research and Education Institute, Brisbane QLD 4000, Australia
[4]Department of Neurobiology and Behavior, Cornell University, Ithaca, New York, United States of America
[5]Doñana Biological Station, Seville, Spain
*Corresponding authors. Email: jet243@cornell.edu and jordan.boersma@gmail.com

Abstract. Birds often advertise their quality to potential mates through sexual displays that complement their colourful plumage. Some species use materials to enhance their attractiveness, such as colourful fruits and anthropogenic materials in display arenas in bowerbirds (Ptilonorhynchidae). Here we report the first observations of anthropogenic materials in sexual displays by two fairy-wren *Malurus* species. On two separate occasions and sites, we witnessed a male White-winged and male Red-backed Fairy-wren carrying a piece of plastic as a substitute for a flower petal during a petal display. These displays are used across *Malurus* species and are thought to increase fitness, particularly through greater extra-pair paternity. Given increasing plastic pollution globally, the use of anthropogenic materials as part of extended phenotypes in birds and other animals will likely increase and it will be important to understand the effect this has on populations.

Introduction

Sexually selected ornaments are well documented across avian taxa, typically involving colourful plumage that aids in attraction of mates (Møller & Pomiankowski 1993). Some passerines further advertise their quality through alterations of the physical environment, i.e. through their extended phenotype (Dawkins 1982; Turner 2004; Schaedelin & Taborsky 2009; Blamires 2013; Wells 2015). For instance, Black Wheatears *Oenanthe leucura* signal mate quality by carrying heavy stones to nest sites (Moreno *et al.* 1994), bowerbirds (Ptilonorhynchidae) build and decorate elaborate display arenas (Borgia 1985), and fairy-wrens (Maluridae) present colourful natural materials as ornamentation enhancement to females (Rowley 1991; Karubian & Alvarado 2003; Boersma *et al.* 2023).

Fairy-wrens *Malurus* spp. are model organisms for studies on sexual selection because of their elaborate plumage, sexual display behaviour, and pronounced sexual promiscuity (Dunn & Cockburn 1999; Webster *et al*. 2007, 2008). Males often embark on extra-territorial forays to display to extra-pair females, which likely enhance their reproductive fitness via extra-pair paternity (Rowley 1991; Karubian & Alvarado 2003). Several species often use extended phenotypes, presenting flower petals, berries, or leaves to their mates, extra-pair females, or even other males that complement or contrast their sexually selected plumage as part of an elaborate display (Rowley 1991; Leitão *et al*. 2018). Although these so-called 'petal displays' are well documented in this genus, here we report the first use of anthropogenic materials during such displays in two fairy-wren species.

Study species and sites

Most fairy-wren species are sexually dichromatic, with males having elaborate (hereafter 'ornamented') plumage that aids in attraction of mates, whereas females exhibit more cryptic ('unornamented') plumage (Rowley 1991). Males of many *Malurus* species, such as the White-winged *M. leucopterus* and Red-backed Fairy-wrens *M. melanocephalus* that we report on here, typically alternate between ornamented plumage in the breeding season and unornamented plumage the rest of the year, until retaining ornamented plumage later in life (Tidemann 1989; Karubian 2002).

The observation of the White-winged Fairy-wren was made on the outskirts of the city of Kalgoorlie–Boulder, Western Australia, at South Boulder waste-water treatment plant (30°48′33″S, 121°29′35″E). This area was dominated by saltbush *Atriplex* sp. and bluebush *Maireana* sp., interspersed with scattered eucalypts *Eucalyptus* sp. There was minimal ground cover, leaving the bare lateritic soils exposed between the shrubs and trees. As this was an active work site, the habitat was heavily human-altered with damaged vegetation, tyre tracks gouging deep ruts, soil heaped into mounds and ridges, and there was rubbish scattered across the landscape, including many pieces of white soft plastic caught on shrubs and fences.

The observation on the Red-backed Fairy-wren occurred at a long-term bird ecology field site in south-eastern Queensland on the western fringe of Lake Samsonvale (27°16′S, 152°51′E). This study site has many habitats, ranging from grassland with sparse eucalypts to remnant old-growth rainforest and lake-edge wetlands. The dominant understorey species is the invasive Common Lantana *Lantana camara*, which is present across habitats at our site. Three fairy-wren species are present at the site: Variegated *M. lamberti*, Superb *M. cyaneus* and Red-backed, of which most are colour-banded, including ~200 Red-backed Fairy-wrens. Study efforts at this site began in 2012, and occur annually (except 2020–2021) from July to January, and centre on colour-banding and monitoring nests of all three fairy-wren species. Nests are marked using orange flagging tape tied to trees and shrubs

Figure 1. Ornamented male White-winged Fairy-wren carrying an unusually large, white object at South Boulder waste-water treatment plant, Kalgoorlie–Boulder, Western Australia, 31 January 2017 (Macaulay Library catalogue numbers: left ML115465921, right ML115465891). Photos: James A. Kennerley

Figure 2. Red-backed Fairy-wrens, Samsonvale, Queensland, 11 August 2025. Left: ornamented male with unornamented Red-backed Fairy-wren alongside petal-carried material, Middle: enlarged photograph of the coloured flagging tape carried into the net by the ornamented male, Right: ornamented male held in-plane with petal-carried object. Photos: Jaden Salett

5–10 m from nests to allow efficient navigation to nests during checks by personnel. Many broad-spanning ecological studies have been conducted here, mainly encompassing the colour-banded fairy-wren populations and their brood parasites (Feeney *et al*. 2018; Kennerley *et al.* 2019; Poje *et al.* 2019; Richardson *et al.* 2019; Carr *et al.* 2020; Hawkins *et al.* 2020; Boersma *et al.* 2023; Kessler *et al.* 2024; Resendiz *et al.* 2024; Corneliussen *et al.* 2025; Feeney *et al.* 2025).

Observations

White-winged Fairy-wren

On 31 January 2017 at South Boulder waste-water treatment plant, JAK observed and photographed an ornamented male White-winged Fairy-wren carrying a piece of white material in the manner of a petal display (Figure 1). The size, structure and reflectance of this object suggested that it was a piece of white soft plastic, consistent with material from a single-use carrier bag. Similar items were numerous in shrubs surrounding the work site. Additionally, the absence of white flowers in the surrounding area supported the notion that the material was a fragment of soft plastic. This individual was the only ornamented male in a group of 12 individuals; the others were unsexed as they had unornamented plumage. Multiple birds in the group were heard vocalising, likely implying an aggregation with the specific intent of breeding, or this particular male displaying to many females. This was a casual observation at a site where no research takes place, so the frequency of this behaviour there is unknown.

Red-backed Fairy-wren

During targeted mist-netting involving play-back for Red-backed Fairy-wrens on 11 August 2025, an unornamented bird, likely a female, was captured in the net. Approximately 30 seconds after, JB observed an unusually long and directional flight from a male Red-backed Fairy-wren into the net. Upon approaching the net, JB noticed an orange object lying slightly above the captured individual within the same trammel line (Figure 2), indicating that the male had carried the item into the net during a petal-carrying display.

JB noticed that the object was larger than in past field observations of petal-carrying behaviour. The material was stiff yet brittle, piecing apart easily when extracted from the mist-net, and was likely a piece of orange flagging tape used to mark a nest from a previous year. After processing and releasing both captured individuals, we searched the area to find older flagging tape for comparison; the colour, texture, and brittleness of old orange flagging tape closely matched the object found with the individual in the net.

Discussion

Male fairy-wrens are widely documented to exhibit petal-carrying behaviour, which can include carrying flowers, dried leaves, berries, grasses, or rarely insects (Rowley 1991; Karubian & Alvarado 2003). On separate occasions, we observed a White-winged and a Red-backed Fairy-wren apparently carrying plastic during petal displays. White-winged Fairy-wrens have previously been documented to carry petals in a wide range of hues (from pink and yellow to purple, blue, and white: Rowley 1991; Higgins *et al*. 2001), whereas Red-backed Fairy-wrens are most frequently observed with *Lantana* flower petals on the red–yellow colour spectrum (Welklin 2020; Baldassarre *et al.* 2024). Given our long-term fieldwork on Red-backed Fairy-wrens, this occasion of using anthropogenic material for a petal display likely demonstrates a rare, possibly opportunistic, occurrence of this behaviour.

Our search for published material and media in the Macaulay Library (macaulaylibrary.org) found no previous documentation of any fairy-wren species using anthropogenic material for petal displays. Thus, to the best of our knowledge, our observations of White-winged and Red-backed Fairy-wrens are the first evidence of anthropogenic material being used in a sexual display in the *Malurus* genus. Use of anthropogenic materials for an extended ornamented phenotype has been well documented in other species, such as bowerbirds; e.g. male Satin Bowerbirds *Ptilonorhynchus violaceus* commonly decorate their bowers with anthropogenically derived blue items (Wojcieszek *et al.* 2006; Lavers *et al.* 2025). To our knowledge, our observations are the first records outside of bowerbirds and wheatears (Moreno *et al.* 1994) of a bird using an artificial material for a sexual display.

Petal carrying is known to be a primary mechanism for extra-pair copulation in the Red-backed Fairy-wren, which underlies fitness differences across male phenotypes (Baldassarre *et al.* 2016; Dowling & Webster 2017), and is likely to operate in a similar fashion in many other fairy-wren species, although Leitão *et al*. (2018) found petal displays mostly directed toward social mates and rival males in the Lovely Fairy-wren *Malurus amabilis*. Continued work will determine whether petal displays with flagging tape increase in frequency within the three fairy-wren species at our main study site at Lake Samsonvale, where this tape is a readily available resource offering a larger colourful material than in the local plants (Appendix 1). It is also likely that other fairy-wrens also use anthropogenic materials (such as plastics) in petal displays, given the proximity of many species to large human settlements, although so far this behaviour has been unrecognised or unreported. Other *Malurus* researchers that we contacted had neither direct nor indirect knowledge of anthropogenic materials being used in fairy-wren petal displays (Anne Peters pers. comm.; Joe Welklin pers. comm.). We hope that the ever-increasing use of participatory science platforms like eBird (ebird.org) and iNaturalist (inaturalist.org) will allow us to better characterise the frequency of these occurrences.

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Appendix 1. (a) Flagging tape typically used to mark nests of Variegated, Superb and Red-backed Fairy-wrens. (b–f). Plant and fungal matter available for petal displays at Lake Samsonvale, Queensland. Photos: Jaden Salett & Jordan Boersma