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A male *Coenagrion puella* resembling *C. pulchellum* (Odonata: Coenagrionidae)

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Abstract

On 22 May 2016, a male *Coenagrion* sp. damselfly was observed in the county of Norfolk, Great Britain, which was finally assigned to *C. puella* despite its general visual appearance being very similar to *C. pulchellum*. This individual is placed on record, and potential causes for the aberration – including the possibility of hybridization – are discussed.

Zusammenfassung

Ein Männchen von *Coenagrion puella* ähnelt sehr stark *C. pulchellum* (Odonata: Coenagrionidae) – Am 22. Mai 2016 wurde in der Grafschaft Norfolk, Großbritannien, ein Männchen von *Coenagrion* sp. beobachtet und trotz seines *C. pulchellum* sehr ähnlichen Erscheinungsbildes schließlich als *C. puella* identifiziert. Dieser Artikel widmet sich diesem ungewöhnlichen Tier. Außerdem werden mögliche Ursachen für die Anomalie diskutiert, einschließlich der Möglichkeit einer Hybridisierung.

Introduction and Observations

Thorpe Marshes Nature Reserve is an important wetland reserve managed by the Norfolk Wildlife Trust, and is situated on the banks of the River Yare just outside Norwich in Norfolk, Great Britain (52°37.3’N, 1°21.1’E). The area contains a number of habitat types, but from an odonatological point of view the dyke-crossed grazing marshes are probably most important, along with the open water of the river and also flooded gravel workings. The site holds a good variety of Odonata, including *Aeshna isoceles*, and *Coenagrion puella* is common here (Durdin 2017).

On 22 May 2016, at around mid-day, Chris Durdin encountered a coenagrionid damselfly at Thorpe Marshes that superficially resembled a male *Coenagrion pulchellum*. Since this would be the first record for the site (the nearest known breeding populations being ca 5 km away to the east at Surlingham Marshes and Strumpshaw Fen, both also close to the River Yare), the individual was scrutinized closely and a number of photos taken (Fig. 1).

Several markings tended to suggest the damselfly was indeed *C. pulchellum* (Dijkstra & Lewington 2006), including:

i) broken antehumeral stripes;
ii) a strong, thickened, goblet-shaped mark on abdominal segment S2, clearly joined to the (distal) base of the segment;
iii) extensive dark markings on abdominal segment S9, occupying over half of the segment.

On the other hand, some points did not entirely support this identification, and while the individual was clearly a male *Coenagrion*, it possessed certain features more frequently seen in *C. puella*. These included:

i) the absence of a light-coloured bar between the post-ocular spots;
ii) the similar amount of black on abdominal segments S3 to S5 (c.f. Dragonflypix 2017)

Scrutiny of the pronotum revealed a smooth hind margin with a uniform pale border, and the whole pronotum was very typical of *C. puella* (Fig. 1). Although the anal appendages did not show particularly clearly in the photos, they too ap-

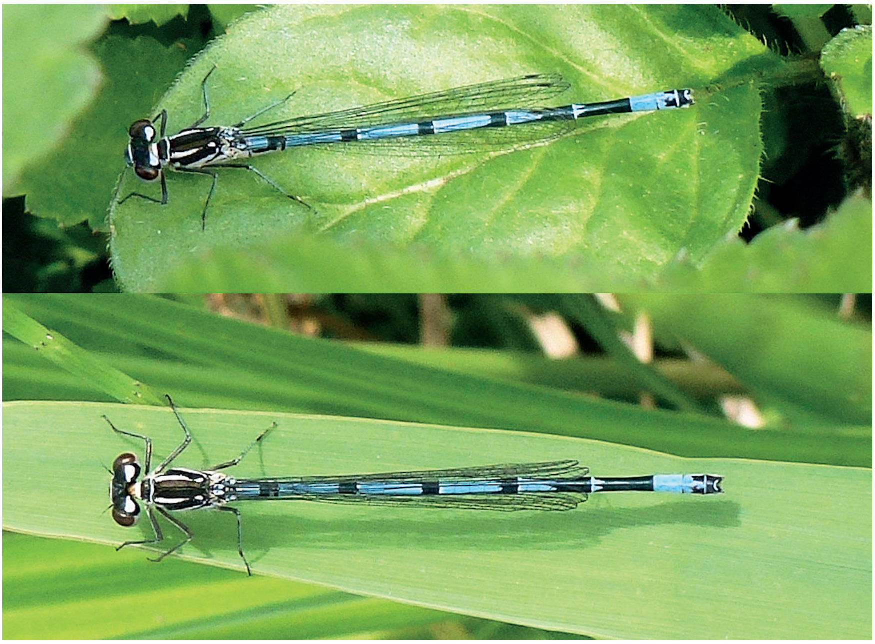

Figure 1. Male *Coenagrion puella* observed on 22-v-2016 at Thorpe Marshes, Norfolk, Great Britain. – Abbildung 1: Männchen von *Coenagrion puella*, beobachtet am 22.05. 2016 in Thorpe Marshes, Norfolk, Großbritannien. Photos: Chris Durdin

peared more compatible with *C. puella* than *C. pulchellum*. Since structural features are more reliable than visual appearance for identification purposes, it was concluded that, despite its superficial resemblance to *C. pulchellum*, the damselfly was in reality an aberrant male *C. puella*. This individual is here placed on record.

Discussion

In Europe, many female *Coenagrion* spp. occur in at least two colour forms, reflecting the common occurrence of female polymorphism amongst the Zygoptera (Fincke et al. 2005). The visual appearance of males tends, however, to be more constant, though subtle variations in patterning are regularly reported (e.g., Hammond 1983; Sternberg & Buchwald 1999; Thompson & Rouquette 2004; Michalczuk et al. 2009; Holzinger & Komposch 2012). The greatest degree of variation is normally seen in *C. pulchellum*, the English vernacular names Variable Damselfly or Variable Bluet highlighting this phenotypic flexibility. On a pan-European scale, the very dark forms found in southern and eastern areas have sometimes been given sub-specific status (Dijkstra & Lewington 2006), though the validity of this is now questioned (Boudot 2014). In north-western Europe, although 'more typical' forms are common, there is still considerable variation in the strength of the pale antehumeral stripes and, to a lesser degree, the amount of black on the abdomen. A pale form, often with similar markings to *C. puella* on abdominal segment S2, has been referred to as f. *puellaeformis* (Dijkstra & Lewington 2006). Structural features, for example the shape of the pronotum, are however constant.

Coenagrion puella, the sister species to *C. pulchellum* (Swaegers et al. 2014), normally shows greater constancy in male appearance. Some variation does, however, still exist – notably in the strength of the dark markings on the abdomen (Hammond 1983; Holzinger & Komposch 2012; Nature22 2012; Dragonflypix 2017). Variations in the strength of the markings on abdominal segment S9 are particularly well documented (Nature22 2012). In addition, while *C. puella* normally lacks the pale bar between the post-ocular spots on the head found in several other *Coenagrion* species, including *C. pulchellum*, a few individuals of unknown provenance do show a bar despite being otherwise typical of *C. puella*, as illustrated by e.g. Curd & Curd (2011).

While recognizing the phenotypic variation that is possible in *C. puella*, the divergence from 'more typical patterning' that is shown by the Norfolk individual described above does seem noteworthy. Not only are several abdominal features (e.g., the strength of markings on both segments S2 & S9) simultaneously near the extremes of the normal range, but to the author's knowledge the occurrence of interrupted antehumeral stripes has not before been documented in *C. puella*. This damselfly is evidently showing somewhat more extensive dark patterning than is typical of the species, at least in Great Britain (Brooks et al. 2014), and it seems worth briefly considering possible explanations for why this might be so, beyond the individual simply representing the far extreme of the species' natural variation.

In some coenagrionid damselflies increases in dark pigmentation can be produced by maturation under unnatural (more specifically, laboratory – and hence possibly low UV) conditions (Barnard et al. 2015), but here the effect seems to be general rather than marking-specific. Although genetic as well as physiological factors are no doubt involved, Corbet (1999) also details numerous instances in Odonata where phenotype is seemingly influenced by environmental factors, as revealed by habitat-specific or regional differences in appearance, the latter often presenting as a character gradient. That this appears to be the very first reported instance of such a highly *pulchellum*-like patterning in *C. puella* might however argue against a general broad-scale environmental factor being involved in its induction, though it should be noted that individuals showing a smaller selection of *pulchellum*-like characters have already been reported (e.g. iSpot 2017). It could perhaps be maintained that any other such extreme individuals have previously been passed over as *C. pulchellum*, but given the highly localized distribution of that species in Britain and the much more widespread nature of *C. puella*, it seems unlikely that, at least in the UK, this would have happened in each and every previous instance. Instead, a more specific cause could well be involved in producing the 'aberrant' phenotype.

Pathogen attack or injury during development are two factors which might lead to a localized melanization of specific individuals (Åbro 1999). While this sort of phenomenon could potentially explain the origin of certain damselflies with random extraneous dark markings, such effects are perhaps less able to explain the idiosyncrasies of the Norfolk individual. Here increases in the amount of melanization seem to be centred very much on specific features such that they are converted from *puella*-like patternings towards more *pulchellum*-like forms. As an alternative explanation, it is possible that some type of genetic factor is involved. Although modern molecular studies on population biology and the phylogeography of Odonata are still in their relative infancy, and some technical issues remain to be fully addressed (see e.g., Ferreira et al. 2014), the potential for significant hybridization between certain closely-related damselfly species once isolation barriers have been breached has recently been well established. A good example involves the situation in north-eastern Spain where *Ischnura graellsii* hybridizes readily with recently-invading populations of *I. elegans* (Sanchez-Guillen et al. 2011). Subsequent directional backcrossing then leads to introgression of *graellsii* DNA into the *I. elegans* population (Sanchez-Guillen et al. 2011). In a more subtle and steady state situation, a low but readily detectable level of hybrid formation between *Calopteryx haemorrhoidalis* and *C. splendens* occurring in sympatry at a site in central Italy has also recently been demonstrated both morphologically and genetically by Lorenzo-Carballa et al. (2014); this complements other work on hybridization in the Calopterygidae (e.g., Hayashi et al. 2005; Keränen et al. 2013).

Within the genus *Coenagrion*, the potential for hybridization between *C. puella* and *C. pulchellum* has been suggested in the past by Bilek (1963) and by Freeland & Conrad (2002). A recent molecular study by Lowe et al. (2008) found that, in Britain, the two species are genetically well-separated and, although their analysis included only one site where the two species were truly sympatric, no convincing evidence for significant regular hybridization was detected. Some low frequency of hybrid formation cannot, however, be entirely ruled out. Patterns of hybridization and genetic introgression are known to be complex, both at the spatial and temporal levels (e.g., Good et al. 2003), and in the work of Lowe et al. (2008) cluster analysis using the program STRUCTURE (Pritchard et al. 2000) did occasionally identify individuals of both *Coenagrion* species that had a small, but non-zero, component of the genetic fingerprint that was assignable to the alternative cluster. Indeed it has recently been argued that hybridization and genetic introgression are far easier and more common than previously thought (Mallet 2005, 2008), with some 10 % of all animal species currently known to be involved in at least some degree of hybrid formation (Mallet 2005).

As with most phenotypic variation, the exact cause of the ‘aberration’ shown by the male *C. puella* reported in the present paper must currently remain unknown. It is possible that this individual simply represents the extreme end of the natural variation present within the species, the phenotype even perhaps being further influenced by the effects of unusual environmental conditions. Alternatively, it seems at least theoretically possible that the individual might be a hybrid carrying some genetic material from *C. pulchellum* (though not necessarily being just a simple F-1 hybrid). In the absence of detailed molecular studies this must, however, remain as speculation. Perhaps similar individuals will be encountered at this or other sites in the future, allowing more detailed analysis to be undertaken. Whatever the underlying reasons for the aberration, the individual from Thorpe Marshes certainly emphasizes the need for due care when identifying unexpected damselflies in the field.

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