



Introduction to topical collection “Sexual selection, sexual conflict and aging”

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Superficially it might appear that sexual selection, sexual conflict and aging are at best, only loosely linked, but increasingly studies are finding associations between the three. The work making up this topical collection explores these links even further. Here, we set the scene a little by introducing these general themes and how they can be related.

Sexual selection – the selection occurring as a result of advantages some individuals have over members of the same sex and species purely related to reproduction (Darwin 1871) – is responsible for many differences between the sexes. For example, mate competition explains why one sex (typically males) have weapons that are lacking, or much smaller, in the other sex. Similarly, mate choice underpins the evolution of elaborate displays or vibrant pigmentation that make males of many species much more conspicuous than their female counterparts. Sexual selection can generate sexual conflict – divergent evolutionary interests of the sexes (Parker 1979) – in two ways. Firstly, by affecting traits in one sex that serve the fitness interests of that sex, but depress the fitness of the other sex (Parker 1979). Mating frequency, duration, and parental care are frequently subjected to this kind of sexual conflict, and as an example, female waterstriders have evolved structures that enable them to thwart unwanted male mating attempts (e.g. Arnqvist and Rowe 1995). Secondly, sexual selection sets up evolutionary tug-of-wars over optimal values of traits that are shared between the sexes (Rice

and Chippindale 2001), for example there can be sexually antagonistic selection on body-size, with each sex having a different optimal size (e.g. Calsbeek and Sinervo 2004). These conflicts are effectively inevitable in nature once sexual selection is operating (although experimentally we can suppress effects: discussed in Hosken et al. 2009). So how could sexual selection and the conflicts it generates affect aging – the general decline in physiological and reproductive performance and increase in mortality risk with age that begin after maturity?

Potential impacts are myriad but they can be envisaged as being either proximate or evolutionary. A proximate effect could arise because sexual selection frequently favours traits that are energetically expensive to express, and competition, including reproductive competition, can be wasteful. In crickets for example, mating calls can elevate metabolic rate by about 60% (Bailey et al. 1993), male fighting can increase metabolic rate eight-fold over resting rates (Hack 1997) and higher metabolic rate can be associated with shorter-lifespan (Okada et al. 2011). In other words, the direct costs of investing in sexual selection, whether metabolic or associated with injury, reduce lifespan and may affect how quickly, or how much, individuals age. In some sense it was these apparent costs that lead Darwin (1871) to envisage sexual selection in the first place – sexually selected traits did not appear to increase an organism’s fit to the environment and did not aid them in the general struggle for life.

From an evolutionary perspective, it is widely recognised that changes in the net strength of selection over a lifespan have a major impact on aging (Rose 1991); *Drosophila* selected for increased late-life reproduction show increased life-spans for example (Partridge and Fowler 1992). Sexual selection contributes to net selection and therefore should affect aging, and because it usually acts differentially on the sexes, sexual selection may lead to sex-differences in lifespan and aging (reviewed in Bonduriansky et al. 2008). There are a number of studies that now confirm this general prediction, although not always

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precisely as anticipated. For example, experimental evolution with flies and beetles shows that rather than rates of aging being elevated by sexual selection (as predicted by some theory: Promislow 2003), baseline mortality is elevated instead, and that the magnitude of these effects is sex-specific (e.g. Maklakov et al. 2007; Archer et al. 2015).

Finally, evolutionary conflicts resulting from sexually antagonistic selection – largely generated by sexual selection – have also been shown to impact sex differences in health and aging. For example, in field crickets there are signs that there is sexual conflict over the scheduling of age-dependent reproductive investment, and as a result, over longevity and mortality trajectories (Archer et al. 2012). Additionally, in humans, sexual conflict might help explain the health-survival paradox (men tend to have higher mortality than women at all ages but better health at old age) (Archer et al. 2018). In short, there is no direct selection on human females after menopause, but this is not true of males. Thus, male older-age benefit alleles should accumulate in populations even if these alleles are detrimental to females, generating more masculinised gene-expression in older populations, and moving females away from health-optimising expression patterns.

These are just some of the ways that sexual selection and conflict could affect aging and we only present a small snapshot of the evidence available that speaks to the interactions between the three. Despite the studies done to date, the precise nature and effect of sexual selection on aging is less understood than that of natural selection's effects and predicting the precise impacts is complicated (Bonduriansky et al. 2008). The studies that follow will help in this regard and will hopefully spur further research into aging by students of sexual selection.

Declarations

Conflict of interests The authors declare no competing interest.

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