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Comment

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Møller and co-workers (Møller *et al.* 2007) observe an 'elevated frequency of abnormalities in barn swallows (*Hirundo rustica*) at Chernobyl' and 'can think of no alternative explanations other than exposure to radiation that can have caused the observed patterns'. However, an obvious alternative hypothesis (e.g. Pikulik & Plenin 1994) is that apparent impacts on birds may be due to ecosystem changes resulting from the abandonment of contaminated land. In this and previous papers, Møller and co-workers downplay key limitations, namely: (i) probable confounding due to land use changes in the abandoned areas since the accident, and (ii) weak dosimetry and inappropriate grouping of 'Chernobyl' study sites.

(i) The 1986 Chernobyl accident caused an area of approximately 30 km radius (the '30 km zone') to be evacuated. Towns, villages and farms are abandoned, livestock were evacuated and former farmland is now rough grassland with shrubs and trees. Forestry has ceased and hunting is strictly controlled (though some poaching occurs). Since 1989, large increases in populations of large mammals (e.g. elk, *Alces alces*, wild boar, *Sus scrofa*, wolves, *Canis lupus*) and some rare birds (e.g. black stork, *Ciconia nigra*, white-tailed eagle, *Haliaeetus albicilla*) have been reported in the 30 km zone (Pikulik & Plenin 1994; Baker & Chesser 2000). In contrast, Pikulik & Plenin (1994) note population reductions in bird species commonly associated with human habitation. Barn swallows are commonly associated with human habitation and their population is influenced by farming practices (e.g. Møller 2001; Beecher *et al.* 2002 and see the electronic supplementary material).

Møller and co-workers (Møller *et al.* 2007) discuss a 'general deterioration of farming in Ukraine since 1990' which 'should have negative effects in both control and contaminated areas, predicting increases in the frequency of abnormalities', but they do not apparently consider the abandonment of contaminated lands to be a potential confounding factor (apparently, two of their sites within, the others very close to the exclusion zone). Changes in farming practices, habitat and wildlife community in and around the exclusion zone may well have had negative effects on barn swallows at the Chernobyl sites compared with the Kanev 'control' area (see also electronic supplementary material).

(ii) Estimates of radiation exposures are fundamental to impact studies. External dose rates are estimated (fig. 3 in Møller *et al.* 2005, 2007), but are not presented at all clearly. From the information available, doses at the most contaminated Chernobyl site are approximately 100 times greater than at the least contaminated Chernobyl site. It is therefore inappropriate, for statistical analyses, to group these sites of widely varying dose rates into a single Chernobyl category as Møller *et al.* (2005, 2007) have done (see also electronic supplementary material).

This is a particular problem when considering the hypothesized decrease in mutation rates from 1991 to 2006 at the Chernobyl sites (fig. 2, Møller *et al.* 2007). External dose rates at these sites would have approximately halved during this period (from Jacob *et al.* 1996). At the most contaminated site, the external dose rate would have declined from approximately 60 to 30 $\mu Gy\,h^{-1}$; at the least contaminated site, it would have declined from approximately 0.6 to 0.3 $\mu Gy\,h^{-1}$. Thus, dose rate differences between different Chernobyl sites are much greater than changes at a given site over time. If mutation rates are so sensitive to dose rates that significant reductions are caused by the factor of two time-change, as hypothesized by Møller *et al.* (2007), then the grouping together of Chernobyl sites (which vary in dose rate by approx. 100 times) *must* be inappropriate.

I further note that, though the presentation of sample site information in these papers is extremely unclear, different Chernobyl sites appear to have been studied in different years during the 1991–2004 period (Møller *et al.* 2005), further invalidating the assessment of time changes in mutation rates. For example, according to Møller *et al.* (2005), six Chernobyl sites studied in 1996 were not sampled again during 2000–2004 (see electronic supplementary material).

Given the apparently interesting results of Møller *et al.* (2007) and others (e.g. Ryabtsev *et al.* 1994), we should not rule out possible negative influences of radiation on birds. However, it is very possible that apparent impacts on barn swallows are instead due to the abandonment of land by people. The weight of past evidence (e.g. IAEA 1992) is that radiation exposures currently pertaining in the vast majority of the 30 km zone cause no significant harm to animal populations. Studies to test this hypothesis should continue, but it should not be rejected without strong, reproducible, refuting evidence from both laboratory and field studies. Chesser & Baker (2006) have recommended minimum criteria for radioecology research at Chernobyl. I believe that the study of Møller and co-workers (Møller *et al.* 2007) is a long way from meeting these criteria. Møller and co-workers' (Møller *et al.* 2007) extrapolation of

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postulated radiation effects on barn swallows to the controversial issue of human health impacts is premature.

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