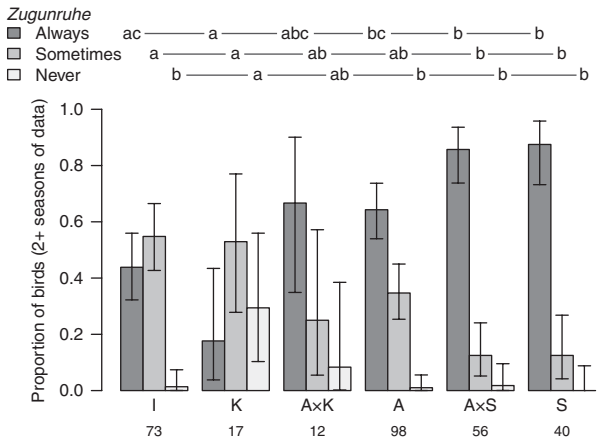

Figure 4. Consistency of individual birds' *Zugunruhe* behaviour by population. Shown are the proportions of birds for each population that engaged in *Zugunruhe* always (i.e. 'migrants'), sometimes (middle row: 'mixed') and never (bottom row: 'residents'). Included are birds for which data were available for at least two seasons (spring or autumn); numbers on the x-axis are total numbers of birds included from each group, and error bars are 95% confidence intervals. Letters shown above bars indicate significant pairwise differences: groups that do not share a letter are significantly different. For example, in the 'Always' category, Kenyan stonechats share an 'a' with Irish birds and Kenyan–Austrian hybrids, but not with the remaining groups, from which they differ significantly. Among non-hybrid groups, Siberian stonechats had the highest proportion of migrants and Kenyan stonechats had the highest proportion of 'residents'. Irish, Kenyan, and Austrian groups all had substantial numbers of 'mixed' individuals that sometimes engaged in *Zugunruhe*.

Zugunruhe during that first autumn (significantly different from 50% by Binomial test, $p = 0.042$). Patterns also differed starkly among populations, with the lowest proportions of consistent *Zugunruhe* in Kenyan (18%) and Irish (44%) stonechats and the highest in Siberian and Siberian × Austrian stonechats (86–88%). The proportion of birds showing mixed patterns was highest in Kenyan and Irish stonechats (53–55%) and lowest in Siberian and Siberian × Austrian stonechats (13%). The proportion of birds that never engaged in *Zugunruhe* was significantly greater than zero only in the Kenyan group (29%).

Timing of *Zugunruhe*

Effect of population

Populations varied significantly in all aspects of *Zugunruhe* timing (Fig. 5A, B). Among migratory populations, Siberian stonechats began autumn *Zugunruhe* earlier than all other groups; Irish birds started afterwards, followed by Austrian birds. Kenyan stonechats, with a small sample size ($n = 8$), had start dates not significantly different from Irish or Austrian birds. Irish and Siberian stonechats all showed mean autumn *Zugunruhe* at approximately the same time, but Austrian birds had significantly later mean dates; Kenyan stonechats were similar to all three. Irish stonechats ended *Zugunruhe* significantly earlier than Austrian and Siberian birds (which themselves had similar end dates); Kenyan stonechats showed intermediate end dates that did not significantly differ from those of the other populations. Irish, Kenyan, and Austrian birds all showed relatively short autumn *Zugunruhe* durations compared to Siberian stonechats.

In spring, onset, mean, and end dates were earliest for Irish stonechats, followed by Austrian stonechats. Kenyan and Siberian populations showed *Zugunruhe* periods that were later than those of the other two populations but not significantly different from one another. The duration of the spring *Zugunruhe* period was longest in Irish birds, significantly shorter in Austrian stonechats, and significantly shorter still in Siberian stonechats. For Kenyan stonechats, duration did not significantly differ from Austrian or Siberian birds, possibly because the sample size for Kenyan stonechats was small ($n \geq 6$). Within populations, the dates of *Zugunruhe* onset were generally more synchronous than the dates of *Zugunruhe* completion. Compared to autumn, duration of spring *Zugunruhe* was significantly longer for Irish (effect = 51.06 d, $t = 12.03$, $p < 0.0001$) and Austrian stonechats (effect = 27.51 d, $t = 7.66$, $p < 0.0001$), but shorter for Siberian birds (effect = –49.62 d, $t = -10.63$, $p < 0.0001$). Thus, in autumn, Siberian long-distance migrants started *Zugunruhe* earliest and showed the longest durations, while in spring, Siberian birds started among the latest and showed the shortest durations.

Hybrids

Austrian × Siberian hybrids generally showed intermediate timing relative to parental birds. In autumn, onset dates, mean dates, and durations of Austrian × Siberian stonechats were intermediate and significantly different from parental values, but end dates were all similar. In spring, timing of onset and mean *Zugunruhe* were intermediate and significantly different from parental values; the end date for hybrids was not significantly different from Siberian birds and duration was not significantly different from Austrian birds. Austrian × Kenyan stonechats showed autumn timing characteristics that were similar to those of both parental groups; spring timing was not significantly different from Austrian birds but significantly earlier than Kenyan birds. *Zugunruhe* profiles of hybrids are shown in Fig. 5C–F.

Effects of age and sex

Young stonechats showed high levels of juvenile nocturnal restlessness before they finished postjuvenile moult (Fig. 2). Nocturnal activity beginning after moult start was interpreted as *Zugunruhe*. In autumn (Supplementary material Appendix 2, Fig. A2), the onset, mean, and end dates of *Zugunruhe* of young birds occurred 2–3 weeks later than those of older birds (onset: effect = –14.08 d, 240.72 DF, $t = -5.05$, $p < 0.0001$; mean: effect = –19.19 d, 195.11 DF, $t = -8.11$, $p < 0.0001$; end: effect = –22.25 d, 355 DF, $t = -8.35$, $p < 0.0001$). There was no significant main effect of age on autumn duration (189.78 DF, $t = -0.02$, $p = 0.9872$), but there was a significant interaction for Siberian birds, which showed shorter *Zugunruhe* periods in older birds (effect = –25.44 d, 162.96 DF, $t = -2.6$, $p = 0.0101$). In spring, older birds of all groups had slightly later *Zugunruhe* start dates (effect = 4.98 d, 283.8 DF, $t = 4.73$, $p < 0.0001$), earlier end dates (non-significant; effect = –7.12 d, 105.9 DF, $t = -1.72$, $p = 0.0875$), and shorter durations (effect = –15.29 d, 113.2 DF, $t = -3.01$, $p = 0.0032$). Mean