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Nesting Ecology of the Eastern Curlew, *Numenius madagascariensis* (Linnaeus, 1766) in the South of the Species Range

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The eastern curlew is far behind other waders with respect to the number of references in the recent ornithological literature (Thomas et al., 2003), remaining among the least studied species of the genus. Before the start of our research, only nine findings of nests were known from the southern part of the recent species range (the Amur River Basin), and specific biological features of this bird were fragmentarily described in 24 publications (for review, see Antonov, 2009). Being listed in the Red Data Book of the Russian Federation since 1997, *N. madagascarensis* was unexpectedly excluded from the IUCN Red Data List, which is evidence that the study of the species biology is an acute problem. The responses of *N. madagascarensis* populations to anthropogenic transformations of landscapes remain unknown.

This study was performed in different areas of the left-bank Amur region, from the Zeya River basin in the west to the Lake Bolon' basin in the east (1997–2008). Brief excursions were made to the right-bank Amur region in the territory of China, but no eastern curlew habitats were found there; neither were any findings of nesting birds reported by the personnel of wetland reserves in Heilongjiang Province.

The bulk of material used in the study was collected at two permanent stations in the Bureya–Khingan lowland: the Borzinskii station in the Khinganskii Nature Reserve (slightly affected by economic activities) and the Arkharinskii station in the zone adjoining a populated area and exposed to moderate anthropogenic pressure (hay harvesting, livestock grazing, periodic fires, etc.). The former is characterized by the prevalence of swamped open larch forests (known under the local name *mari*) with degraded tree stands and sphagnum mosses dominating in the ground vegetation layer and of sedge–reed grass (*Carex–Calamagrostis*) meadows alternating with elevations occupied by aspen–birch (*Populus tremula–Betula plathyphylla*) and oak–birch (*Quercus mongolica–Betula davurica*) forests. Numerous lakes occur in swamped areas. Most characteristic of the Arkharinskii station are mixed meadows with sparse willows (*Salix caprea*) and sedge–moss bogs in depressions.

The numbers of birds in two test areas (15 km^2 at each station) were determined by taking absolute counts of territorial pairs, nests, and broods. Their relative abundance was estimated by means of route censuses without limitations on census strip width (Caughley, 1979). Color marking of adult and juvenile was used to study their territoriality. Adult bird trapping (licensed by federal authorities) was performed on nests in the second half of the incubation period, using a hide and a manual snare. Long-term monitoring of individual home ranges was used as an alternative method of studying breeding site fidelity. An advantage of this method is that it is less disturbing for birds. Nesting (breeding) success was calculated by the Mayfield–Payevsky method (Mayfield, 1975; Payevsky, 1985). Empirical data were processed by conventional, mainly nonparametric statistical methods (chi-square test, Spearman correlation analysis, Mann–Whitney *U* test, and comparison of means) in the Statistica 6.0 program package. The results are presented as mean values with standard deviations.

The modal date of arrival of eastern curlews to nesting sites in the Khinganskii reserve over 10 years is April 10. No distinct dependence of this date on temperature transition through 0°C was revealed (R = 0.24, $p > 0.05$). The choice of nesting sites by these birds in the south of the species range was described in detail previously (Ueta and Antonov, 2000). Here, it is relevant to note that the numbers of birds recorded during the nesting season in human-exploited meadow habitats at the Arkharinskii station (5.6 ± 1.04 ind./km^2) and in protected bog areas at the Borzinskii station (4.3 ± 1.37 ind./km^2) did not differ statistically ($p > 0.05$), but the proportion of successfully breeding pairs was significantly higher in the latter

($\chi^2 = 3.90$, $p < 0.05$). A positive correlation was revealed between the patterns of long-term dynamics of bird abundance at the two stations ($R = 0.8$, $p < 0.05$), which is evidence that the factors determining them are probably the same. However, it remains unknown what exactly these factors are; apparently, their source lies beyond the nesting range. This parameter at both stations showed a weak positive correlation with local amounts of precipitation accumulated either in spring or since the last autumn ($R = -0.1$ to -0.3, $p > 0.05$).

Eastern curlews nest either in groups of two to three pairs or separately. The smallest recorded distance between any two nests is about 300 m. The nests are made in the ground, in shallow depressions sparsely lined with herbaceous plant stems (the lining is no more than 0.9 cm thick) A complete clutch consists of two to four eggs (on average, 3.81 ± 0.14, $n = 22$). The average egg dimensions ($n = 33$) are $70.1 \pm 0.34 \times 47.2 \pm 0.23$ mm (variation ranges 74.5–66.2 mm for egg length and 49.6–42.2 mm for egg diameter.). They do not differ from those recorded by Gerasimov et al. (1977) in southern Kamchatka: $70.3 \pm 0.62 \times 47.6 \pm 0.23$ mm ($p = 0.77$ for egg length and $p = 0.51$ for egg diameter), which is evidence for a low level of intraspecific variation.

Live nests ($n = 24$) were recorded on May 7 to June 9. The first hatchlings appeared on May 23–25. Nesting success ($n = 22$ nests) averaged 0.69 ± 0.01, and the overall breeding success at the end of the season was 0.2 ± 0.07 fledglings per nesting pair (more precisely, per territorial pair assumed to be nesting). Egg loss resulted mainly from predation by foxes (*Vulpes vulpes*), badgers (*Meles meles*), or raccoon dogs (*Nyctereutes procyonoides*) (41%) or from seasonal prescribed fires (28 %). Mortality among chicks is largely accounted for by adverse weather conditions, in addition to predation, but an accurate analysis of its causes is difficult because of high mobility of broods. Adult birds die mainly as a result of human activities. According to my data, for example, one bird was hit by a car and two were killed by poachers. Records were also made of adult birds killed by hail (Shibnev, 1976).

Data on *N. madagascariensis* site fidelity in the study area are contradictory. Seven adult birds of different sexes and ten juvenile birds were color-tagged on the nests, but none of them was recorded again in subsequent seasons. On the other hand, long-term observations on home ranges of several pairs showed that some of them were repeatedly used for nesting over 3–5 or even 8 years. It should be noted that birds failed to return to their nesting site in the next season if least one pair partner was trapped and tagged.

Thus, breeding site fidelity typical for the majority of well-studied *Numenius* species (Berg, 1992; Redmond and Jenni, 1986; McCaffery, 1996) is apparently not obligatory in *N. madagascariensis*, since these birds are fairly easily stimulated to abandon their home range This behavioral feature of the eastern curlew makes it similar to the whimbrel, *Numenius phaeopus* L. (McCaffery, 1996).

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