Geographic variation in parasitism rates of two sympatric cuckoo hosts in China

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Abstract: Rates of brood parasitism vary extensively among host species and populations of a single host species. In this study, we documented and compared parasitism rates of two sympatric hosts, the Oriental Reed Warbler (*Acrocephalus orientalis*) and the Reed Parrotbill (*Paradoxornis heudei*), in three populations in China. We found that the Common Cuckoo (*Cuculus canorus*) is the only parasite using both the Oriental Reed Warbler and Reed Parrotbill as hosts, with a parasitism rate of 22.4%−34.3% and 0%−4.6%, respectively. The multiple parasitism rates were positively correlated with local parasitism rates across three geographic populations of Oriental Reed Warbler, which implies that higher pressure of parasitism lead to higher multiple parasitism rate. Furthermore, only one phenotype of cuckoo eggs was found in the nests of these two host species. Our results lead to two conclusions: (1) The Oriental Reed Warbler should be considered the major host of Common Cuckoo in our study sites; and (2) obligate parasitism on Oriental Reed Warbler by Common Cuckoo is specialized but flexible to some extent, *i.e.*, using Reed Parrotbill as a secondary host. Further studies focusing on egg recognition and rejection behaviour of these two host species should be conducted to test our predictions.

Keywords: *Acrocephalus orientalis*; Brood parasitism; Host shift; Egg phenotype before host shift; *Paradoxornis heudei*.

The interaction between the common cuckoo (*Cuculus canorus*) and its hosts is a classic case of coevolution. Cuckoo parasitism exerts intensive costs on the hosts, which evolve anti-parasite behaviour to increase their own reproductive success (Davies, 2000). Parasitism rates of common cuckoo hosts vary extensively among species (Antonov et al, 2006, 2007; Moksnes & Røskaft, 1988; Yang et al, 2010, 2011, 2012) and among different populations within a single host species (Moskát & Honza, 2002; Stokke et al, 2007; Polačiková et al, 2009). Parasitism rate reflects the interaction between cuckoos and their hosts, including the population size of cuckoo and host, host rejection and coevolutionary stage (Davies, 2000).

Here, we investigated the rate of parasitism and multiple parasitisms in two host species of the common cuckoo across three populations in China in an attempt to understand the factors that contribute to differences in parasitism rate. Both the Oriental Reed Warbler (*Acrocephalus orientalis*) and Reed Parrotbill (*Paradoxornis heudei*) breed in reed habitat and have similar open cup nests. The Oriental Reed Warbler is a summer breeder that was formerly classified as a subspecies of the great reed warbler (*A. arundinaceus*) of western Eurasia (Dyrcz & Nagata, 2002). The Reed Parrotbill is a resident species found in eastern China, Mongolia, and Russia (Robson, 2002). Data about the interaction of these two host species with the common

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cuckoo have only rarely been reported before. In this paper we documented and compared parasitism rates of these two species across a large geographic scale among three populations in China.

MATERIALS AND METHODS

Study areas

Cuckoo parasitism rates of Oriental Reed Warbler and Reed Parrotbill were quantified in three study sites, namely Chongming Dongtan (CM), Yellow River Delta (YRD) and Zalong (ZL) National Nature Reserves (Figure 1). CM (N31°25′−38′, E121°50′−122°05′) is located on Chongming Island, an island at the mouth of the Yangtze Estuary in eastern China. It has a northern sub-tropical monsoon climate with an average annual temperature of 15.3°C. Average annual precipitation is approximately 1.022 mm, with 60% of rainfall occurring between May and September. The wetland types include tidal marshes, tidal flats and shallow open waters, and birds breeding in CM reed habitats are mainly Oriental Reed Warbler and Reed Parrotbill (Tian et al, 2010). YRD (N37°35′−38°12′, E118°33′−119°20′) is located on the estuary of the Yellow River in Shandong, eastern China. The mouth of the Yellow River is characterized by huge sediment deposits forming extensive new delta wetland habitats and large areas of reed habitat and birds breeding here are mainly Oriental Reed Warbler and Reed Parrotbill (Li et al, 2011). YRD is characterized by a temperate, semi-humid continental monsoon climate with a mean annual temperature of 12.1 °C. Mean annual rainfall is 551.6 mm, occurring mainly in summer (Cui et al, 2009). ZL (N46°48′−47°31′, E123°51′−124°37′) lies in the north of Songnen Plain in Heilongjiang, northeast China. This area includes reed swamps, open water and degenerative grasslands. The mean annual temperature and precipitation are 3.2 °C and 426 mm, respectively and birds breeding in ZL include Oriental Reed Warbler, Reed Parrotbill and Black-browed Reed Warbler (*Acrocephalus bistrigiceps*) (Wang et al, 2006).

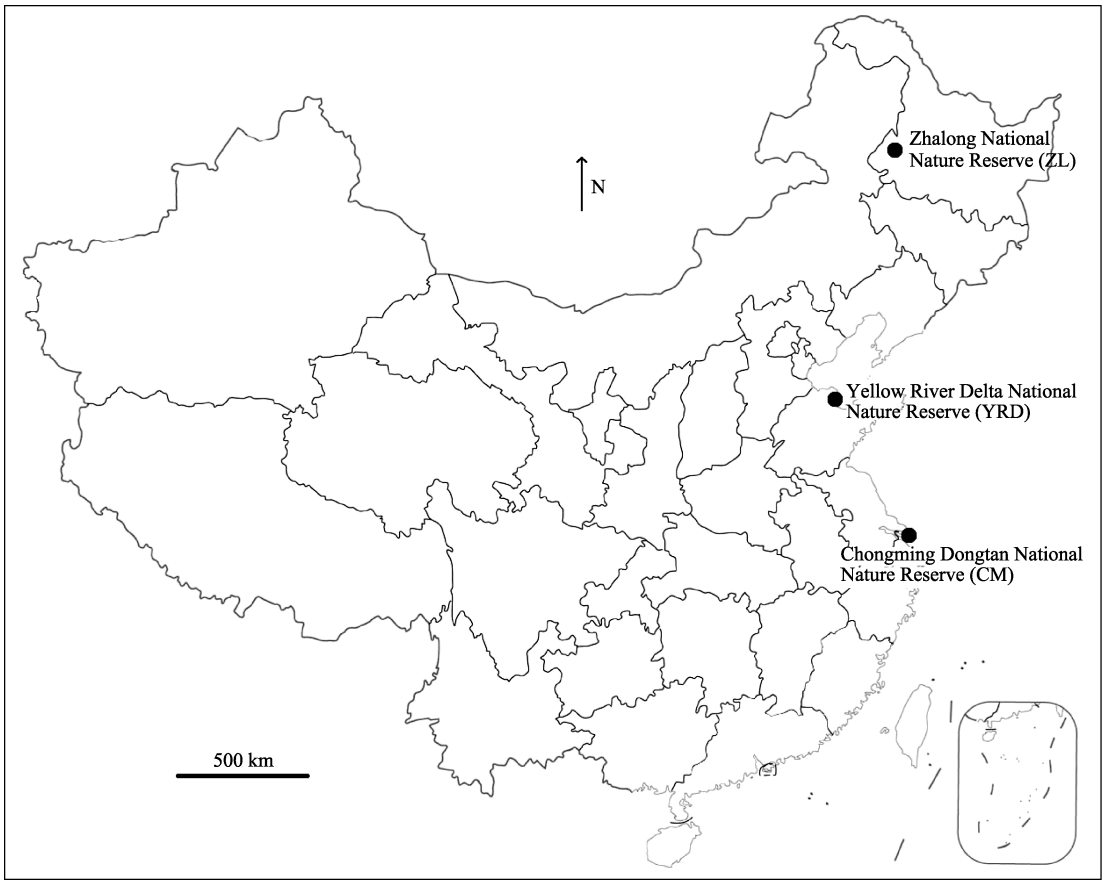

Figure 1 Location of the study sites in China

Methods

This study was conducted during the breeding season of 2012. We systematically searched for nests of the Oriental Reed Warbler and Reed Parrotbill, which were breeding in sympatric reed habitat at these three study sites. Nests were checked every day in the egg-laying period and every 2−3 days during incubation. For each nest egg-laying date, clutch size, egg colour, egg size and the occurrence of brood parasitism were recorded. Statistical analysis was done using IBM SPSS Statistics 20.0 (IBM Corp.).

RESULTS

In total 101, 100, and 107 nests were found in reed habitats of ZL, YRD, and CM, respectively. Nest densities of Oriental Reed Warbler were higher than those of the Reed Parrotbill in all three study sites (Table 1). Only one cuckoo species (the common cuckoo) was recorded in our study sites, and the phenotypes of cuckoo eggs in both Oriental Reed Warbler and Reed Parrotbill nests looked similar (Figure 2), which indicated that parasitism of these two sympatric hosts was caused by the same cuckoo host race. The highest parasitism rate (34.3%) of Oriental Reed Warbler was recorded in ZL, with 4.1% of multiple parasitism. By contrast, the lowest value was found in CM, with 22.4% of parasitism rate and no cases of multiple parasitism. The multiple parasitism rates were positively correlated with the local parasitism rates across three geographic populations of Oriental Reed Warbler (Spearman's rho; r_{sp}=1.00, n=3, P<0.01). Parasitism rates were much lower in Reed Parrotbill, with 3.6%, 0% and 4.6% in ZL, YRD and CM, respectively. No multiple parasitism was found in Reed Parrotbill nests at the three sites.

Figure 2 Nests of Oriental Reed Warbler (left) and Reed Parrotbill (right) parasitized by common cuckoo eggs (the larger egg in each nest) (Photograph by Guo-Xian LIANG)

DISCUSSION

The present study showed that three Oriental Reed Warbler populations in China suffered a parasitism rate from 22.4% to 34.3%, which was similar to previous studies in Japan in Oriental Reed Warbler (where it varied from 8% to 39%, see Takasu & Moskát 2011; Moskát et al 2012) and in Europe in Great Reed Warbler *A. arundinaceus* (where it varied from 0% to 31.9%, see Stokke et al 2007; Polačiková et al 2009), with some exception of an extremely high rate (64%) in Hungary (Moskát & Honza 2002). Our results also showed that cuckoo parasitism rates in Reed Parrotbill populations were much lower than that of the Oriental Reed Warbler. Multiple parasitism rates were positively correlated with the local parasitism rates across three geographic populations of Oriental Reed Warbler, which implies that higher pressure of parasitism lead to higher multiple parasitism rate. If we calculated the expected multiple parasitism rates by simply squaring the parasitism rates, the results showed that they were 11.7, 7.4, 5.0 and 0.13, 0.00, 0.20 for Oriental Reed Warbler and Reed Parrotbill, respectively. Obviously the multiple parasitism rates of Oriental Reed Warbler are higher than the observed rates (Table 1). In contrast, the values for Reed Parrotbill are close to observed rates. This suggests that Oriental Reed Warbler might be better than Reed Parrotbill at defending its nests. Furthermore, only one phenotype of cuckoo eggs was found in the nests of these two host species. Apparently, this cuckoo egg phenotype mimics the eggs of Oriental Reed Warbler. In summary, our results yield two pieces of information: (1) The Oriental Reed Warbler should be the major host of Common Cuckoo in our study areas; and (2) obligate parasitism on Oriental Reed Warbler by Common Cuckoo is specialized but flexible to some extent, i.e. using Reed Parrotbill as a secondary host. We have reported that the Chinese Babax (*Babax lanceolatus*) is exploited as a secondary host by the Large Hawk-cuckoo (*Hierococcyx sparverioides*) (Yang et al 2012). New and naive host populations might be short of egg recognition ability and thus favour the success of cuckoo parasitism. Therefore, it is reasonable to speculate that some individuals of Common Cuckoo shift their host selection to Reed Parrotbill under high pressure of parasitism, or the pressure of egg rejection by Oriental Reed Warbler. Further studies focusing on egg recognition of these two host species should be conducted to test these ideas.

Table 1 Cuckoo parasitism rates of Oriental Reed Warbler and Reed Parrotbill in three study sites

Site	Number of host nests	Number of parasitized nests	Parasitism rate (%)	Multiple parasitism rate (%)
Oriental Reed Warbler (*Acrocephalus orientalis*)				
ZL	73	25	34.3	4.1
YRD	66	18	27.3	3.0
CM	85	19	22.4	0
Reed Parrotbill (*Paradoxornis heudei*)				
ZL	28	1	3.6	0
YRD	34	0	0	0
CM	22	1	4.6	0

In the present study, we did not estimate the densities of these two hosts at these three sites. Previous work showed that host breeding densities or population sizes positively correlated with parasitism rates (Adamík et al, 2009; Stokke et al, 2007). Then nest densities could be one of the key aspects explaining the parasitism rates in our system, and this might be worth considering in future studies.

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