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SIMULTANEOUS TERRITORY MAPPING OF MALE FAN-TAILED WARBLERS (*CISTICOLA JUNCIDIS*)

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Territoriality is widespread among birds. Since Howard's (1920) pioneering work there have been many intensive field studies on some bird species (e.g., Kluver and Tinbergen 1953, Nice 1941, Yamagishi 1978) and comprehensive review works (e.g., Brown 1964, 1975, Hinde 1956) on avian territoriality. Fretwell and Lucas (1969), Jennrich and Turner (1969), Brown and Orians (1970), and Davies (1978) have contributed to the theoretical consideration of avian spacing patterns. However, there have been few improvements in the techniques for mapping and analyzing spacing patterns, except that of Odum and Kuenzler (1955) and Yamagishi (1971) who introduced the "observation area curve" based on a time mapping method and a method for exactly determining territorial boundaries, both excellent methods for increasing the confidence of sampling data and for analyzing home range structure.

Implicitly, territorial boundaries are considered to be fixed for a long time. However, in many studies territorial boundaries have been shown to shift from one day to the next, probably due to the stage of the breeding cycle (Odum and Kuenzler 1955, Stefanski 1967, Stenger and Falls 1959, Weeden 1965) and time of day (Weeden 1965); furthermore, it may vary with changes in dominance relations and/or the physiological conditions of territory owners. If single observers map their territories chronologically, apparent overlaps between neighboring territories are recorded. It is an unavoidable bias when mapping bird territories sequentially over several days.

Ideally, territories should be mapped by multiple observers simultaneously. However, almost all territory mapping has been done by single, or small groups of observers even in detailed studies (e.g., Weeden 1965, Yamagishi 1971, 1978). The use of amateurs and/or untrained students in the field should not be disregarded; in a situation where an easily observed and unmistakable species is being studied it can easily be studied by untrained observers. In this paper, we present the data on simultaneous territory mapping by untrained observers and discuss its application to field ornithology.

STUDY AREA AND METHODS

We chose the Fan-tailed Warbler *Cisticola juncidis* as the subject of simultaneous mapping of territories because it is widespread and common in dry grasslands in Japan. It is a highly territorial, polygynous species (Motai 1973, Ueda 1984, 1985). As male Fan-tailed Warblers frequently give loud and unique territorial calls in flight and while perched (Ueda 1985), it is possible for untrained observers to easily record territorial behavior and to map their flight paths and perching positions exactly.

This study was carried out on Shinoda-yama (34°29'N, 135°28'E), 15 km south of Osaka City, Japan, on a flat terrace of about 50 ha including some shallow valleys. Dry grassland covers the terrace, on which barren areas and several small ponds are scattered. Pampas grass (*Themada triandra*) and an alang grass (*Imperata cylindrica*) with patches of eulalia (*Miscanthus sinensis*) comprise the grassland. Along both sides of the road and around the barren areas, a tall goldenrod (*Solidago altissima*) bush has invaded. This vegetation is maintained by occasional burning in winter.

The study was conducted as an exercise for the students of a biological course at Osaka City University during late May or early June from 1978 to 1985, 1981 excepted. A total of 116 students followed male Fan-tailed Warblers and mapped their territories. Most of the students had no experience at observing birds. The general habits of the Fan-tailed Warbler were explained on the previous day. Immediately before the exercise the students were given binoculars, detailed maps of the area, and an introduction to the observations. Observation groups were composed of 1–3 students.

Male warblers were observed for periods of 2–4 h per student(s) between 1300 and 1900, during which time the paths of their song flights and their perching positions were recorded on maps. These exercises were conducted on clear or partly cloudy days. Therefore, observations were made under similar conditions. For checking the accuracy of students' observations, we inspected students during the exercise and helped their observations.

RESULTS AND DISCUSSION

During the 7 yr study the number of territorial males in the study area varied from 5 to 19. Of 85 males with territories on the day when territories were mapped, the territories of 72 males (84.7%) were mapped (see Figs. 1 and 2).

The territory of the Fan-tailed Warbler consists of a "song-flight area" and a "perching area" (Ueda 1985). The flying ranges of territorial males, "song-flight areas," overlap each other when they are mapped from combined data for several consecutive days because of daily shifts of territorial boundaries. Overlapping flying ranges are attributed in part to invasions by neighboring territory owners. The ranges in which males

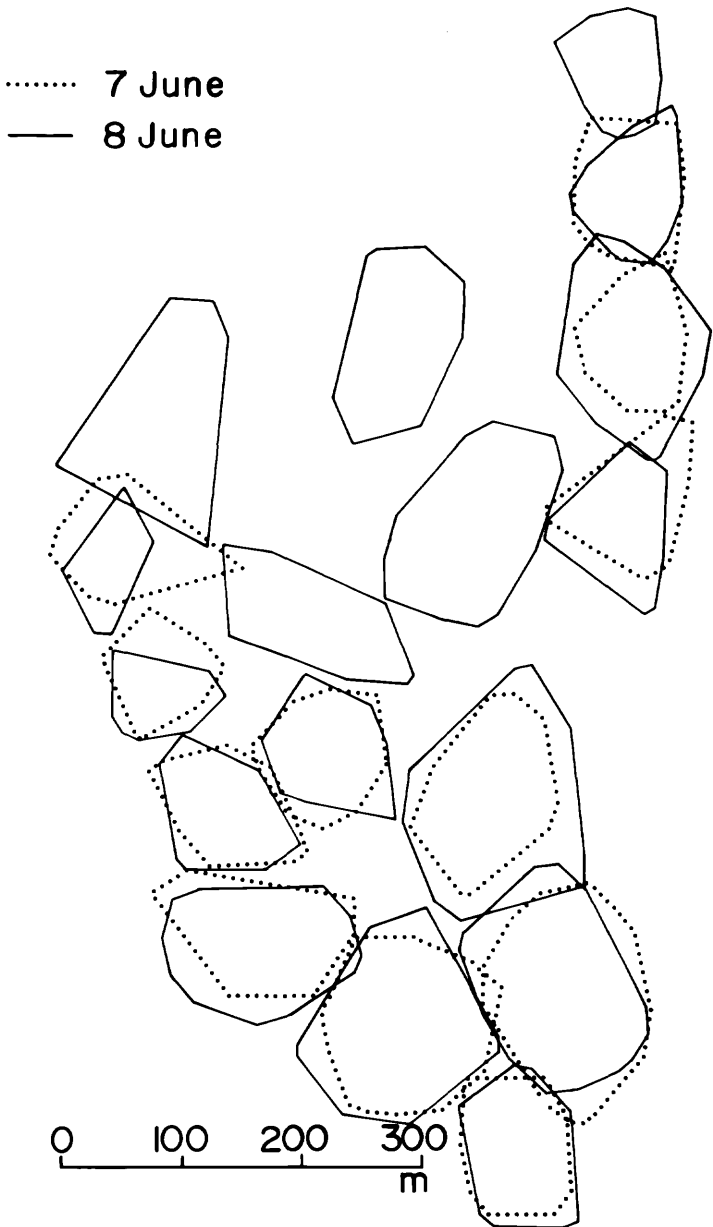


FIGURE 1. Simultaneous mapping of territories of male Fan-tailed Warblers on 7 (dotted lines) and 8 (solid lines) June 1978. Upper 5 males were not observed on 7 June.

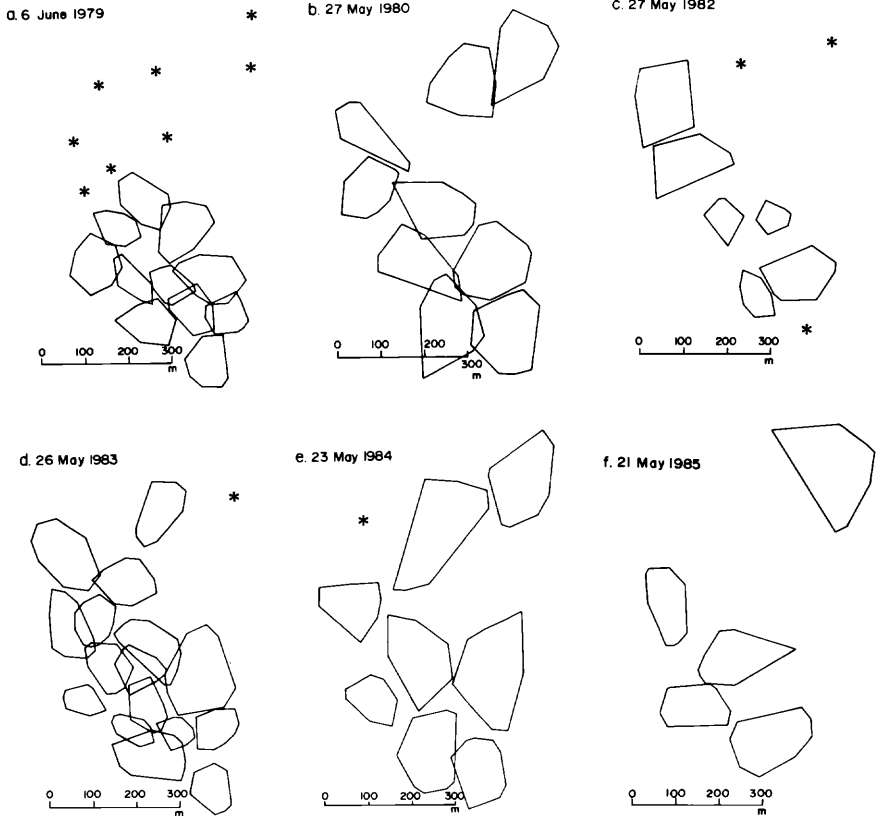


FIGURE 2. Simultaneous mapping of territories of male Fan-tailed Warblers for 6 yrs: 1979 (a), 1980 (b), 1982 (c), 1983 (d), 1984 (e), and 1985 (f). Asterisks are territories that were not mapped.

perched (“perching area”) overlap little even over long periods much like the “core areas” reported on the Tree Sparrow (*Spizella arborea*) by Weeden (1965).

In 1978, maps were drawn on consecutive days. Since song-flight areas of male Fan-tailed Warblers did not overlap on any one day, but shifted and overlapped on consecutive days (Fig. 1), one-day mapping was done in 1979, 1980, 1982, 1983, 1984, and 1985 (Figs. 2a-f). There was little overlap between neighboring song-flight areas mapped on the same day (Figs. 2a-f). Therefore, the song-flight area is regarded as the territory of the Fan-tailed Warbler within any 1 d, rather like the “song area” in the Meadow Bunting (*Emberiza cioides*; Yamagishi 1971).

Only in 1983, a year of high density, was considerable overlap recorded in the central area. Although some overlap was ascribed to the invasion flights of territory owners beyond their own territories, most was ascribed

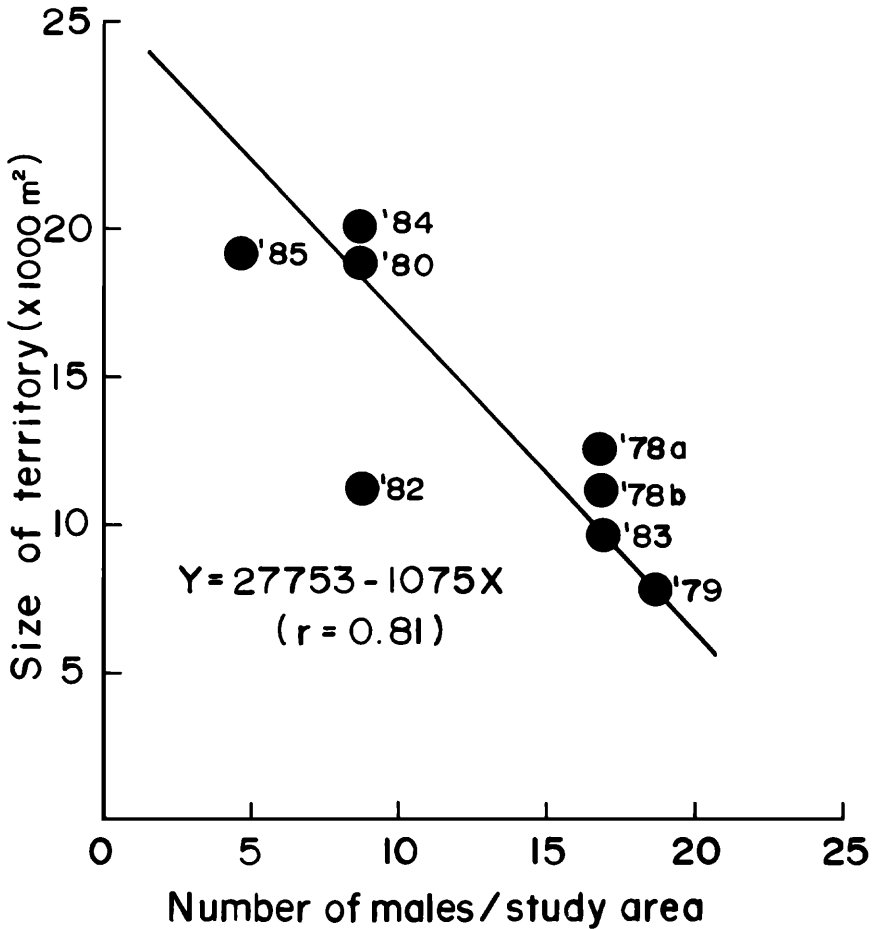


FIGURE 3. Correlation between the territory sizes and the density of males with territories.

to the misidentification of neighboring territorial males and territory boundaries by untrained observers. In 1982 and 1985, years of extremely low density, there were some vacant areas between neighboring territories (Figs. 2c and f). The vacant areas might have resulted from overlooking territorial birds near territorial boundaries, due to the large area of each territory.

The territory size of the Fan-tailed Warbler was first measured by Motai (1970) who concluded that an average territory was 250 m in diameter, the largest being 600 × 400 m. That average is considerably larger than the average found in this study. Territory size decreased as the density of territorial males increased (Fig. 3). When the density of territorial males was high, small territories with clear boundaries tightly

filled the study area (1978, 1979, and 1983). Conversely when territorial males were few the boundaries became vague (1980, 1982, 1984, and 1985). This was probably due to a decrease in the detectability of invasion by neighboring males as territory sizes expanded. We conclude that the territory size is not fixed in the Fan-tailed Warbler, but varies with population density.

There is a possibility that the nesting stage affects territorial activity of male warblers, as has been shown in many other species (e.g., Tree Sparrows, Weeden 1965; Black-capped Chickadee [*Parus atricapilla*], Stefanski 1967). In fact, males varied in the number of breeding nests attended by females in their territories and in the nesting stages of these nests. However, since male Fan-tailed Warblers provide no parental care (Ueda 1984), the difference in nesting stages seemed not to affect male territorial activity.

Another problem lies in observing males in the nest building stage. Males with a complete courtship nest give loud, long calls in flight. They were, therefore, easily detected and mapped even by untrained observers. By contrast, males in the nest building stage gave few calls and were less conspicuous. Such males were more difficult for untrained observers to follow. At such time detectability and accuracy of observing territorial males seemed to decrease. However, continuous mapping over 2 h minimized the problems of detectability and accuracy and enabled untrained observers to accurately map the Fan-tailed Warblers' territories. Thus, despite the inexperience of the observers, the simultaneous mapping method is useful for mapping the territories of birds, especially those inhabiting open habitats or those with shifting boundaries such as the Fan-tailed Warbler. It is superior to successive territory mapping by the single observer.

SUMMARY

Territories of male Fan-tailed Warblers were simultaneously mapped by untrained students for 7 yr between 1978 and 1985. Seventy-two males with territories were mapped successfully. The territory size varied with the population density. There was little overlap of neighboring territories within any 1 d. This method of mapping is useful for analyzing space use of birds, especially those inhabiting open habitats and showing conspicuous territoriality.

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