A Convenient Method for Estimating the Breeding Density of a Threatened Passerine Bird *Apalopteron familiare*, Endemic to the Ogasawara (Bonin) Islands, Japan

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Abstract. We investigated a convenient method for estimating the absolute density of breeding populations of a threatened subtropical passerine, *Apalopteron familiare*, which is endemic to the Ogasawara (Bonin) Islands. In order to estimate the number of breeding males or pairs, the method takes advantage of the brief dawn chorus period of the species. The number of vocalising males detected, using the method, was very stable during each census period. The detectability of resident males was nearly 90% of the total number of resident males known to be occupying the study area, based on territory mapping of marked birds. Only about 10% of resident, paired males did not sing, thus the method registered almost all males singing in the study site. As few unpaired, singing males were present, the number of males estimated by the method was approximately the same as that of paired males.

Key words: *Apalopteron familiare*, Ogasawara, Bonin Islands, Threatened bird, Monitoring, Estimation method of breeding density.

Introduction

*Apalopteron* is a genus endemic to the Ogasawara (Bonin) Islands, the Pacific Ocean, which lie at about 1,000 km south of Tokyo between mainland Japan and the Mariana Islands. This genus consists of only a single species *A. familiare* (Ornithol. Soc. Japn. 1974, Monroe & Sibley 1993). The species has been considered a honeyeater (Meliphagidae) and normally called the Bonin Islands Honeyeater or simply the Bonin Honeyeater. Recently, Springer et al. (1995) sequenced the mitochondrial DNA of the species and concluded that *A. familiare* belongs to Zosteropidae, calling it the Bonin Islands White-eye. We take their view, although the Ornithological Society of Japan (1997) still places this species in Meliphagidae. However, to avoid this taxonomic problem, we used the scientific name but not the English name in this paper.

*A. familiare* is divided into two subspecies, *A. familiare familiare* and *A. familiare hahasima*. The subspecies *familiare* is distributed on the Mukojima and Chichijima groups of the Ogasawara Islands but considered already extinct, and the subspecies *hahasima* is on the Hahajima group and still extant (Ornithol. Soc. Japn. 1974, Morioka & Sakane

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The species is still common on three islands, Hahajima, Mukojima and Imotojima, of the Hahajima group (Suzuki 1991). However, the sizes of these islands are very small, that is, 20.2 km², 1.4 km² and 1.2 km², respectively, and accordingly the population size of the species is considered to be small. Thus, *A. familiare* is listed as one of threatened birds in Japan, which is categorized as VU (IUCN 1996). General ecologies of *A. familiare* are given in Morioka & Sakane (1978), Higuchi et al. (1984, 1993), Brazil (1991) and so on.

In order to continuously monitor the status of the threatened birds such as *A. familiare* whose habitat is inconveniently situated, it is vital to explore the suitable technique to investigate the absolute density of breeding populations with ease. After the Ogasawara Islands were returned to Japan by USA in 1968, many surveys on the distribution and abundance of *A. familiare* have been undertaken (for early references, Higuchi 1984). Line transects were usually employed to survey the abundance, because it can be conveniently undertaken to examine the relative and, in some conditions, the absolute density of birds along the transect line (Gibbon et al. 1996). However, in the past, line transects for *A. familiare* were undertaken once or at most only a few times per survey, generally owing to insufficient working time because of the remote, oceanic islands. As a result, very rough estimates of relative abundance have been made. Even when censuses are undertaken in repetition, ordinary line transects employed in the previous surveys do not give an estimate of absolute density. Line transects by distance sampling (Buckland et al. 1993) which can give an estimate of absolute density under some prerequisites may be useful. But, to determine the precise distance of all detected birds from the transect line seems virtually impractical for *A. familiare* because not only the Ogasawara Islands have normally dense vegetation and/or intricate topography but also resident adults are rather inconspicuous.

Territory mapping is a popular technique to estimate the absolute density of breeding populations (Gibbon et al. 1996). Higuchi et al. (1993) conducted territory mapping using marked individuals of *A. familiare* and clarified a breeding density in their study area. But the ordinary territory mapping without individual marking appears not to be appropriate to estimate the breeding density of *A. familiare*. Males of this species rarely sing in the daytime even in the morning (Suzuki 1993), and, in addition, their density is relatively high and home ranges of pairs sometimes overlap greatly (Higuchi et al. 1993). These make generally difficult to employ the method. Furthermore, territory mapping needs time-consuming works in the field; it is not always practical for the time-limited investigation.

We examined a convenient method to evaluate the absolute density of a local breeding population of *A. familiare*. The present paper reports the results.

**Material and Methods**

**Methodology**

*A. familiare* breeds in woody areas between March and July and is territorial during the breeding season (Higuchi et al. 1993). Males begin singing in the early morning about
half an hour before sunrise in the breeding season and concentrate singing bouts for approximately 20 min after the start of song (this was here called the song-burst) (Suzuki 1993). Excepting for unpaired males, the birds rarely sing in the daytime, even during the breeding season (Higuchi et al. 1984, Higuchi et al. 1993, Suzuki 1993).

When most or all of the males in an area engage concentratedly in singing activity at dawn (dawn chorus), it is possible to obtain the reliable number of resident males by counts of singing males. As *A. familiare* is monogamous (Higuchi et al. 1993), the number of males approximates the number of pairs when the proportion of unpaired singing males is low.

**Study site**

The study was conducted in a woody area surrounding a small local shrine (Ontake-Jinjya) in Hyōgidaira, Hahajima (33°8’N, 142°10’E), in the breeding season. The area consisted mainly of secondary woods and gardens. The woods were occupied by native tree species such as the Alexandrian Laurel *Calophyllum inophyllum* (Guttiferae), *Ochnosia nakaiana* (Apocynaceae), *Ardisia sieboldii* (Myrsinaceae) and *Rhaphiolepis wrightana* (Rosaceae), and introduced ones such as the White Popinac *Leucaena leucocephala* (Leguminosae), the Chinese Banyan *Ficus microcarpa* (Moraceae) and the Coast She-Oak *Casuarina equisetifolia* (Casuarinaceae) (a vegetation map around Ontake-Jinjya is shown in Higuchi et al. 1993).

The study plot consisted of woods, roads and gardens, and was about 30,000 m² in area. The census route was set up using the existing road and newly opened paths so that all points in the study plot were within 30 m from the census route. A part of the census route was used both for going and back because of topography. We can easily detect males’ song within a range of 30 m, and even from a distance of 50 m or longer. As the set-up census route was not straight and the land was uneven, the shape of the study plot was irregular (Fig. 1).

**Censusing**

We arrived at the census starting point before 0400 h when males did not sing, and waited there until the dawn chorus began. We started censusing three to five min after the first song from nearby males. We moved along the census route while stopping occasionally to search carefully for the singing birds. We registered the positions of males singing within 30 m from the census route. Censuses were completed as a rule within 20 min, with a walking speed of approximately 4 km per hour. Census data were taken on days as calm as possible. In the following the technique mentioned above is called the song-burst technique for convenience.

Censuses using the song-burst technique were undertaken twice to four times (days) per census session in the breeding season of *A. familiare*, that is, in middle May (1996), middle June (1995), and early July (1996). As stated previously, the breeding season of *A. familiare* is between March and July, although it seems to vary slightly among years (Yamashina 1934, Morioka & Sakane 1978, Higuchi et al. 1984, 1993). Singing activity of the species appears to continue during the breeding season (Higuchi et al. 1984, this

To know detectability of the song-burst technique, we also conducted territory mapping using marked individuals to determine the number of males or pairs inhabiting the study plot. *A. familiare* in the area around Ontake-Jinjya was caught and individually marked with colour rings with official permission. Their presence and distribution were determined by observing them in or close to the census session using the song-burst technique. Few individuals which were not caught but lived at the study plot during the study period were recognized from the distribution of marked and non-marked birds. These were also included for analyses.

Censuses using the song-burst technique and those by territory mapping were undertaken by Suzuki and by Kawakami and Higuchi, respectively. We compared the numbers and distributions of birds detected by the two studies after each census session using the song-burst technique had been completed. For the comparative purpose, each male detected in the study plot was counted as one.

Both studies were made independent of each other up until the time we finished each census session using the song-burst technique. Therefore, data obtained using the song-burst technique were collected without prior knowledge of the actual numbers of males at that time.

**Results and Discussion**

Fig. 1 shows examples of the distribution of singing males detected using the song-burst technique in the study plot. The males of *A. familiare* usually sang in the higher section of trees at dawn while they were either relatively stationary or faced the neighbor singing near the territory boundary. Due to the twilight and the high position of the singing males, most males were not individually identified. But several neighbors were simultaneously recognized by hearing their songs.

Fig. 1. Distribution of singing males of *Apalopteron familiare* registered by the song-burst technique in the study plot on 19 (left) and 20 (right) June, 1995.
S: Ontake-Jinjya (shrine), ●: positions of singing males.
Table 1. The number of males of *Apalopteron familiare* registered by the song-burst technique and by territory mapping using marked individuals in the study plot of ca. 30,000 m$^2$.

<table>
<thead>
<tr>
<th>Session</th>
<th>By song-burst technique</th>
<th>By territory mapping</th>
<th>Detectability (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Date</td>
<td>No. males (A)</td>
<td>Period</td>
</tr>
<tr>
<td>I (1995)</td>
<td>June 19</td>
<td>10</td>
<td>June</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>10</td>
<td></td>
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<tr>
<td></td>
<td>21</td>
<td>10</td>
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</tr>
<tr>
<td></td>
<td>22</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>II (1996)</td>
<td>May 16</td>
<td>10</td>
<td>May</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>III (1996)</td>
<td>July 3</td>
<td>11</td>
<td>June-July</td>
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<td></td>
<td>4</td>
<td>11</td>
<td></td>
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<tr>
<td></td>
<td>5</td>
<td>11</td>
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</table>

The results of censuses using the song-burst technique are shown in Table 1. The number of singing males did not vary among days in one session. The average number of singing males was also stable among study sessions. As a result, the estimated density of males was 3.3 to 3.7 per 10,000 m$^2$, depending on the year.

Table 1 also shows the number of males resident at the study plot, which was determined by territory mapping for marked individuals. Of these, one marked male in 1995 was a territory-holding unpaired individual which sang intensively both at dawn and during the daytime. In 1996, one marked male was probably also unpaired at the time of census using the song-burst technique. Higuchi *et al.* (1993) also found that one of 10 males in their study site was unpaired during the breeding season of 1984. From these observations, unpaired males appear to account for approximately 10% of males in the breeding area.

The detectability of the song-burst technique, as shown in Table 1, was high and near to 90% (83.3 to 91.7%, mean ± SD = 88.6 ± 4.6). Thus, the song-burst technique was undoubtedly useful in estimating the absolute breeding density of *A. familiare*. Although multiple censuses are desired, of course, Table 1 indicates one or two censuses are sufficient under good weather conditions. This enabled us to readily estimate the absolute number of breeding pairs in the study area even when we can stay for only a few days on the islands.

The detectability, on the other hand, indicates that approximately 10% of resident males were not detected by the song-burst technique. Immediately after estimating the presence of undetected males at the end of the census session in May and July of 1996, we checked home ranges of putatively undetected males. We did not record any singing males there again despite the reconfirmation of the presence of marked, putatively undetected males. One putatively undetected male was confirmed to be a territory-holding paired male. We were also unable to detect song-bursts in the home ranges of two marked males during the census session in June 1995. Therefore, a small portion of males was considered not to join the dawn chorus at least in the study periods.
Counts by the song-burst technique were undertaken on a roughly roundish plot in the woody area in the present study. Therefore the method above shown is a kind of territory mapping in which we need not census many times on the contrary to ordinary territory mapping. We can also employ this technique for line transects in which case we get reliable estimates of males (pairs) of *Apalopteron familiare* along the census routes by one or few censuses. When the recording distance from the census route is within the audible range for song, we can calculate the absolute density of breeding populations.

We conducted the preliminary survey along a section of 500 m of the mountain path covered with secondary forests on Chibusya-yama (Mt. Chibusya) in June 1996. The number of males singing within 30 m from the path was nearly constant, i.e. 13 and 14 (average 13.5), for two days. This equal to approximately 4.5 males per 10,000 m² [i.e., 13.5 males/(2 x 30 m x 500 m)]. This value tended to be slightly higher than the values (3.3 to 3.7 males per 10,000 m²) for the study plot around Ontake-Jinjya. But the latter involves some unsuitable places such as a paved road and the difference was not unexpected.

We need to take into consideration the following points when we use the song-burst technique for *A. familiare*. Firstly, the proportion of singing males and the frequency of singing may change with a breeding season or depending on the social status and/or reproductive conditions of males. These might affect the probability of detecting birds (Bibby et al. 1992, Gibbs & Wenny 1993, Welling et al. 1995). Regarding to the seasonal changes of singing activity in *A. familiare*, however, we think it is unlikely a serious problem within the breeding season as observed in this study, although there have not been any in-depth studies on these for this species. On the other hand, unpaired singing and “silent” paired males were present in the *A. familiare* population. The presence of the former results in an overestimation of the number of paired males, and that of the latter does in an underestimation. But, the percentages of both types of males appeared to be similar (approximately 10% of all males), and probably offset each other in *A. familiare*. Secondly, each researcher is able to work only for a limited time in terms of both year and day. We can work, of course, only in the breeding season when males actively sing. Furthermore our experience showed that it was better to complete the census within 20 min after the first song, resulting in that the distance or the size of the area surveyed by each person in one day was very restricted. Finally, the song-burst technique or the census result is likely to be more affected by bad weather conditions than other census techniques because only males’ songs were used for the detection of birds. Therefore we must carry out surveys on calm mornings as possible. This limits the number of days we can work. In our study, censusing were unable to be made between 17 and 19 May 1996 (see Table 1) owing to bad weather.

The latter two disadvantages are, however, not unavoidable. These are ultimately the problems of time, manpower and budget as with many other methods of bird censuses, and are solvable when necessary. Even if we are unable to invest much time and/or labor, we can use the song-burst technique to investigate the accurate density and distribution of males or pairs in the small-scale study areas. This will enable us to study more accurately the habitat-specific density and/or long-term fluctuations of the breeding population in
given areas for the threatened bird *A. familiare*.

The present work showed, although sample size is yet small, that we can estimate not only conveniently but also accurately the absolute density of a local breeding population of *A. familiare* in a short period by using the song-burst technique. The present work examined the song-burst technique specific to *A. familiare* in the breeding season, but the technique would be useful to estimate population density of some other bird species which have the song-burst but do not almost sing in other time in a day, e.g. the Seven Island Thrush *Turdus cefaenops* (Higuchi 1995). By employing the basically same technique, the Amani Ornithologists’ Club (1997) was able to estimate the population density of the threatened bird Amami Thrush *Zoothera dauma amami* (or *Z. amami*) along the road, although detectability was not examined; otherwise the population estimate was not possible because the species is a cryptic bird inhabiting deep-forests.

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References


小笠原孤有絶滅危惧種メグロ *Apalopteron familiare* の
繁殖密度推定のための簡便法

メグロ *Apalopteron familiare* は小笠原固有種（属）で絶滅危惧種とされている。本種の繁殖密度を推定するための簡便法を検討した。この方法は、通常あまり暮らないメグロが、早朝、日の出前の短時間だけ活発に鳴るということを利用してある。メグロの繁殖期の天気の良い早朝に、母島の鳥類学園の調査地（車道なども含み、合計約3 ha）内を、メグロの初鳴記録後3-5分経ってから約20分間かけて移動・探索し、調査地内で鳴るすべての個体を記録した。3シーズン延べ9日の調査で得られた記録数は非常に安定していた（10-11羽）。これとは独立に個体識別とテリトリーマッピングに基づいて生息数を調べたところ、調査地内には調査シーズンにより11羽から12羽のオスが認められた。したがって調査地に生息するオスの検出率は約90%（mean ± SD = 88.6 ± 4.6%，n = 3）であった。ところで、鳴りにより記録されたオスの中には独身で、一方つかいテリトリを持って繁殖生活しているにもかかわらず鳴りの認められないオスがあった。しかし本調査地（全域テリトリーベを埋まる）では、それぞれの個体は共に生息オスの10%程度であり、それゆえ、早朝の一斉鳴りによって記録される個体数は概ね繁殖つかい数を表すものと見なせた。本報で述べた方法でメグロの繁殖個体群密度調査を行う際の利点は、比較的正確な繁殖つかい数推定値が得られる、簡便である。短期調査が可能、などである。欠点としては、調査時期が繁殖期に限られる、1日の中でも調査可能時間帯が限られる上、非常に短い（したがって一人が調査できる範囲が狭い）、鳴りだけを個体発見の手段とするので調査は好天の日に限られる、などである。

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