The Light-vented Bulbul *Pycnonotus sinensis* is distributed in the southern part of China and its surrounding regions and exists in the form of two subspecies: *P. s. formosae* in Taiwan and *P. s. hainanus* on Hainan Island, China, and in northern Vietnam (Yamasaki 2006). This species inhabits in gardens and scrubby hillsides (Brown 1984) and breeds in the period from March to August in China (Zheng 1995). In Taiwan, *P. s. formosae* is common in city parks, scrubby forests and farmlands (Yan 2001). After breeding they form large flocks and migrate to lowland regions (Yan 2001).

*P. sinensis* was first found in the southernmost part of Okinawa Island in 1976 (Higa 1976), thereafter its distribution spread until by 1998 it covered the entire island and several associated offshore islands (Kinjo 1998). The increasing population density of this frugivorous species resulted in increased damage to vegetable crops from the early 1980s onwards, including to the fruits of tomatoes and to the leaves of lettuce and potato in the southern and central regions of Okinawa Island (Kinjo et al. 1994; Suzuki 1999; Kasahara 2000).

I have conducted line censuses of *P. sinensis* in different habitats (farmland, forest and residential areas) in southern Okinawa Island for three years. In this paper, I describe seasonal fluctuations in numbers of individuals and in flock size. Based on this data, I compare the seasonal fluctuation and movements of the introduced population on Okinawa Island with those of the populations in Taiwan and China.

**METHODS**

Five census routes were established in farmland and forest in Tomigusuku City, Okinawa Island (26°11′N, 127°42′E) (Fig. 1). Route 1, 150 m long, passed through farmland on the slope of a hill where *Strelizia reginae* was planted. Route 2 (365 m long) was along a road around the foot of a hill. Route 3 (380 m long) was along a path at the foot of a hill where there were greenhouses along the way and fields of potatoes, sugarcane, and other vegetables. Route 4 (480 m long) was along a path running along the slope of a 70 m hill from the foot to the top, through evergreen broad-leaved forest. Route 5 (1,590 m long) was along a hill top plateau through a residential area and between uncultivated fields with shrubs and weeds.

I walked at a speed of ca. 1.5 km/hr along each of the five routes and recorded the number of individuals in each flock of *P. sinensis* along with all other birds observed within ca. 50 m on both sides of the routes. I identified young birds based on their brown
wings and recorded their number separately.

The census was conducted from May 1998 to April 2001 on a biweekly basis, starting from 20–30 minutes after sunrise. It took about 120 minutes to cover all five routes. In this paper, the period from May one year to the following April has been referred to as a year. I conducted 24 censuses in 1988/1999, 21 in 1999/2000 and 19 in 2000/2001.

To compare population densities of *P. sinensis* among different habitats, I converted the number of individuals observed into the number of individuals per 100 m of the route. For this comparison, data from Routes 1 and 3 were combined because they presented the same habitat of farmland at the foot of a hill, and Route 2 was deleted because very few birds were observed. I was able to compare, therefore, three different habitats: farmland (Route 1+3), forest (Route 4) and residential areas and uncultivated fields on a hill top (Route 5).

To obtain the seasonal fluctuation pattern in population densities in the three different habitats, the mean densities over three years for each habitat were calculated in the following way. Each year was divided into 36 10-days periods and censuses were assigned to a corresponding period according to the date on which the census was conducted. The mean densities during each period were calculated from three years of census results. As the censuses were conducted fewer than 24 times a year, the number of censuses during an interval ranged from one to three.

In order to understand the seasonal pattern of flocking, the mean number of individuals per flock was calculated for all flocks observed at each census. The maximum number of individuals in a flock for all flocks observed during a 10-day period was used to compare the seasonal flocking pattern in each habitat.

**RESULTS**

The number of individuals of *P. sinensis* per 100 m differed greatly among the three habitats. The median values of these densities for the three years censused were highest (2.64) in farmland (Route 1+3), followed by forest (1.04) (Route 4) and lowest (0.28) in the residential area and uncultivated fields (Route 5).

The number of individuals attained a peak in May or June and increased again from August until it showed a high peak in November and December (see Fig. 2), although the peak in November/December was not as high in 2000/2001 as in the two previous years. From late December to early January numbers decreased to their lowest levels, but the fluctuation thereafter differed among years: that is, the number was still small until March in 1999/2000, but it increased again from late January in 1998/1999 and in 2000/2001.

As the general pattern in the seasonal fluctuation of individuals was similar in each year (Fig. 2), fluctuations in the numbers of young birds and in flock sizes in the first year alone are shown in Fig. 3. Young birds were observed only from June to August (Fig. 3a).

The mean number of individuals per flock during each census increased during July and August and
reached high peaks in November and December (see Fig. 3b). During the period from January to June flock size remained at a constant value of around 2, suggesting that this was a period of pair bonding, pair maintenance and breeding.

The seasonal fluctuations in the mean densities in each habitat (Fig. 4a) show that fluctuations in farm-land and forest were similar to the overall pattern of fluctuation (Fig. 2), although the densities in forest were always lower than in farmland. Densities in the residential area were very low throughout the year, but showed slight increases in November, January and early April.

Seasonal fluctuation in the maximum number of individuals per flock in each habitat during three years (Fig. 4b) shows that large flocks (more than 30 individuals) were observed from late October to December in both farmland and forest. Even in the residential area, a flock of 10 individuals was observed in late October (Fig. 4b). All these flocks were seen in flight, and corresponded to high peaks in densities during these seasons (Fig. 2). A large flock (15 birds) observed in January in the residential area (Fig. 4b) was feeding on fruits in a Ficus microcarpa tree.

**DISCUSSION**

The total number of individuals of *P. sinensis* observed during this study peaked in May or June, increased again after July or August until reaching a high peak in November or December. Numbers decreased suddenly thereafter to their lowest levels in January (Fig. 2). This pattern of population fluctuation is largely dependent on fluctuations in both farmland and forest, because the population density in the residential area was generally low throughout the year (Fig. 4a).

As bird density increased from June to August, flock size also increased (Fig. 3b), this is thought to be the result of the young birds joining flocks (Fig. 3a). Kasahara (2000) studied population fluctuation of this species in agricultural fields and shrubbery on the campus of the University of the Ryukyus and in farmland, used for growing taro, situated 5 km away from the campus. According to Kasahara (2000), on the campus, the population density reached a peak in August, that is, immediately after the breeding season, and remained high until November, but then decreased to a low level in winter (December to February). In contrast, in farmland, the density remained constant even after the breeding season and increased in winter when large flocks were often seen feeding on remnants of taro. Kasahara (2000) concluded that there was sufficient food on campus to support increasing population densities after the breeding, but
food became scarce in winter.

The pattern of population fluctuation in farmland and forest in this study was similar to that found on the campus reported by Kasahara (2000). This suggests that birds in this study were breeding in or around farmland and forest and that there was sufficient food to support a high population density. Conversely, the population density in the residential area and among uncultivated fields was low throughout the year (Fig. 4b), suggesting that they did not breed there and that there was little food there even in winter.

The high population peaks noted in November and December were attributable to the presence of large flying flocks. As reported by Kasahara (2000), this species gradually forms large flocks after breeding and moves to available feeding sites. The large flocks observed during this study may have been moving in search of suitable feeding areas.

Kinjo (1993) supplied bananas at a bird feeder on the verandah of a house in a residential area in Okinawa and counted the number of *P. sinensis* individuals visiting in a year. Kinjo (1993) found that a large number of individuals visited the feeder from October to March, but very few visited from April to September, suggesting that this species experiences food scarcity during autumn and winter, forcing it to turn to vegetables in crop fields, as reported by Kinjo et al. (1987) and Hokama and Murakami (1999).

Based on these results, we can conclude that *P. sinensis* in Okinawa Island remains around its breeding sites after the March to August breeding season, then gradually forms flocks from August to October and moves in large flocks during late October to December to feed on vegetable crops in winter. At the end of winter, they return to their breeding sites.

This seasonal pattern of flocking has also been examined in a population of *P. s. formosae* in Taiwan. Liu (1991) examined the biology of this species in Tailugu National Park, Hualien, in northeastern Taiwan and found that the flock sizes increased after the breeding season and attained more than 20 individuals in December and January. In Taiwan, large flocks migrate to lowland areas returning to the breeding areas before the beginning of the breeding season (Yan 2001). In China, *P. s. sinensis* also breeds during the period from March to August and forms large flocks during autumn and winter when it mainly feeds on plant material including vegetable crops (Zheng 1985).

We conclude, therefore, that the life patterns and seasonal population trends of introduced *P. sinensis* on Okinawa Island shows the same basic pattern as *P. s. sinensis* in China and *P. s. formosae* in Taiwan. In this species movement, or migrations away from breeding areas may result from local food scarcities.

**ACKNOWLEDGMENTS**

I am thankful to Mr. T. Kinjo and Ms. M. Kasahara for their useful advice while I was conducting this work, and express my gratitude to Dr. T. Yamasaki, who acquainted me with research papers on this species in China.

**REFERENCES**


Suzuki Y (1999) Seasonal changes in numbers of *Pyc-