COMMUNITY DYNAMIC STUDY OF INSECT FORAGING GUILD AT CCK AIR FORCE BASE IN TAIWAN

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Abstract

Air insect-foraging birds are proficient air foraging creatures which are active among 0 to 200 feet above ground at the airport field. Since they share the sky with aircraft, they have been a safety hazard at the air force base in Taiwan. Current bird dispersal methods used in the field failed to exclude them out of the run ways at the airport. Therefore, it is important to use habitat management technologies to reduce their population around the airport for decreasing the risk of bird strike on aircraft.

In order to provide biological information regarding the habitat management, we studied the air insect-foraging bird guild at CCK air force base at Taichung in the center of Taiwan from February to November 2001. The main species components of the air insect-foraging bird guild at the study site were swift (*Apus affinis*), red-rump swallow (*Hirundo daurica*), pacific swallow (*Hirundo tahitica*), barn swallow (*Hirundo rustica*), sand martin (*Riparia paludicola*), drango(*Dicrurus macrocercus*) and pratincole(*Glareola maldivarum*). Among them, red-rump swallow, pacific swallow and barn swallow were the dominant species in numbers and frequencies occurred during the study period.

Principle component analysis was used to analyse the niche overlapping of each component species based on their morphologies. PCA 1 represents the foraging morphologies and PCA2 represents the morphologies specialised for air foraging. Both axes explained 96% of the total variation. Three distinct functional avian groups including drango, pratincole and swallows were identified. The morphology differences among various swallow species were rather close than those characteristics of drango and pratincole. Further studies including food analysis and feeding behaviour are necessary for differentiating the niches of various swallow species.

CCK air force base carried out an integrated wildlife habitat management program by cutting grasses at low, medium and high frequencies in different seasons. The grass cutting frequencies as well as avian species counted bases on a square meter sampling area were noted during the study period. One way ANOVA was used to analyse the effects of habitat treatment as well as seasonal factors on the avian species richness at the study area. Significant seasonal variation of species richness was found in the study area. Fall had the highest avian species richness index of all seasons. The highest avian species richness was found among the areas with medium frequency of grass cutting in the fall. No significant effect of habitat management was found in spring and summer. Significant habitat treatment effect was found for drango, house swallow and pratincole population sizes. This study result implies that a habitat management program based on each potential hazardous air insect foraging bird is necessary to reduce the risk of bird strike around the air force base areas.

Key words: bird strike, air insect-foraging bird, habitat management, avian guild, niche

1. Introduction

Bird strikes with aircraft has brought to public attention in Taiwan due to its high economic loss and the great threat to human life. The wildlife habitats have been modified dramatically as a consequence of rapid industrialisation for the past ten years in Taiwan. On the other hand, airfields have maintained a fairly stable environment and provide space, shelter and food for wildlife (SOLMAN, 1971). Therefore, it has become an ecological island among the urbanised area in Taiwan. Bird species including migratory and resident birds frequented the airfield and became a high risk to cause bird strike events.

Larger birds such as ring necked pheasant (*Phasianus colchicus*), pigeon (*Columba livia*) and common kestrel (*Falco tinnunculus*) were identified as the most vulnerable species causing the bird strike problems in Taiwan (YO, 2002). Air insect foraging birds such as barn swallow (*Hirundo rustica*) although the body size is fairly small (9-20 gm.), they formed a foraging group and active among 0 to 200 feet above ground at the airport field. Since they share the sky with aircraft, they have been a safety hazard at the air force base in Taiwan.

Bird dispersal methods such as visual stimuli, pyrotechnic devices and model airplane harassment (CONOVER, 2002) have been used in the field but failed to exclude them out of the skies above the runways of the airport. Therefore, it is important to establish habitat management technologies to reduce their populations around the airport in order to decrease the bird strike risk of air insect foraging birds on aircraft.

2. Material and Method

2.1 Study area

CCK airport locates in the central of Taiwan. The main vegetation includes shrubs, acacia trees, and ficus tree. The air force base maintains a high diversity of vegetation for wildlife habitat.

2.2 Study method

In order to identify the key hazardous species for bird strike on aircraft at the airfield, we have conducted an investigation of the quantity and distribution of birds on the area of and around the CCK air force base since November 2000. We divided the whole airfield into a grid of 84 (1 x 1 Km) sampling blocks for the purpose of applying GIS technology on habitat analysis. At least 5 bird observation points were established at each sampling block for avian population and community survey. We performed a monthly bird counting scheme to accommodate the avian activities around the clock including the observation periods from 0600 to 1000, 1000 to 1400, 1400 to 1800 and 1800 to 2200. Bird species as well as the total bird count were noted for every observation point in a specific sampling period.

Corpus samples of air insect foraging birds including 10 large Indian pratincoles, 7 black drongos, 1 house swift, 10 barn swallows, 2 red-rumped swallows and 6 brown-throated sand martins were collected by shooting around the airfield for studying the stomach contents. We also measured the eco-morphological parameters including the beak width, beak length, total head length, wing length, the maximum wing length, total body length, tail length, tarsus length, body weight and the wing cover area for further Principal Component Analysis to demonstrate the potential niche overlapping among them.

To maintain the length of the grass in the airfield is a common practice for habitat management to reduce the risk of bird strikes in the airfield (CLEARY & DOLBEER 1999). The CCK air force base keeps a grass mowing schedule to keep the grass in check. We used the grass mowing schedule to classify the airfield into three habitat management categories including frequent, medium and rare mowing practices based on the duration between two mowing dates. The total number of bird species recorded on each sampling block was entered to its corresponding mowing practices for further statistical analysis. We used ANOVA to test if the grass mowing has an impact on the species richness of a typical grass land airfield habitat.

3. Results

The monthly population count of each air insect foraging bird species noted in CCK field is presented in *Figure 1*. The main species components of the air insect-foraging bird guild at the study site were swift (*Apus affinis*), red-rump swallow (*Hirundo daurica*), pacific swallow (*Hirundo tahitica*), barn swallow (*Hirundo rustica*), sand martin (*Riparia paludicola*), drango (*Dicrurus macrocercus*) and pratincole (*Glareola maldivarum*). Among them, red-rump swallow, pacific swallow and barn swallow were the dominant species in numbers and frequencies occurred during the study period. The peak numbers of barn swallow, red-rump swallow and sand martin population occurred in summer. We found only one type of food item, male ant, in their stomach contents. The results indicate that the aggregation of air insect foraging species around the airfield may have some connection to the outbreak of ant population in the worm and humid summer season.

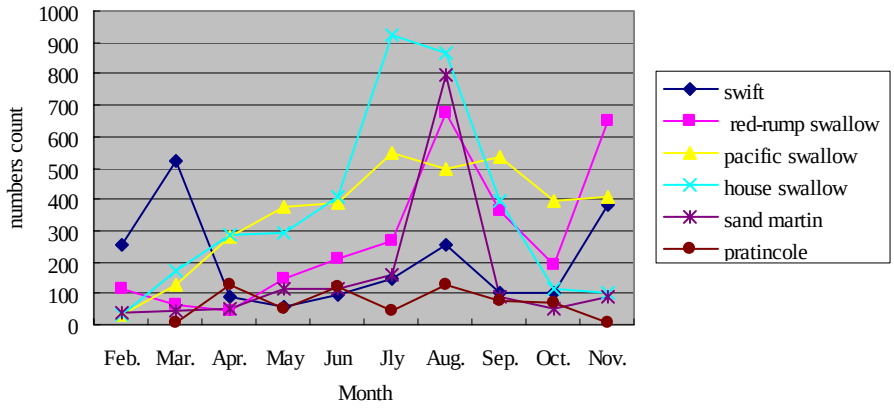

Figure 1. *Monthly population numbers of air-insect foraging bird species.*

Do the air insect foraging birds have developed certain strategies to avoid competition among different species for sharing the same type of food? If the answer is positive, character displacement related to their morphologies may be identified (PIANKA, 1978). In order to study the potential feeding character displacement, we measured the eco-morphological parameters including the beak width, beak length, total head length, wing length, the maximum wing length, total body length, tail length, tarsus length, body weight and the wing cover area of each specimen for analysing the potential niche segregation among them.

Principle component analysis was used to analyse the niche characteristics of each component species based on their morphologies. *Table 1* is the summary result of PCA analysis. Two axes were extracted to explain the 96% of the total variation. PCA 1 which highly correlates with beak width, wing length, maximum wing length, tarsus length and body weight represents the most characteristics of foraging morphology. PCA2 which highly correlates with total head length, beak length, tail length, total body length and wing cover area represents the morphologies specialised for food manoeuvre in the air foraging environment.

Figure 2 demonstrates the niche segregation among the species of the air insect foraging guild based on the PCA scores of each species. Distinct three functional avian groups including drango, pratincole and swallows were identified. The morphology differences among various swallow species were rather close than those characteristics of drango and pratincole. Further studies including food analysis and feeding behaviour are necessary for differentiating the niches of various swallow species.

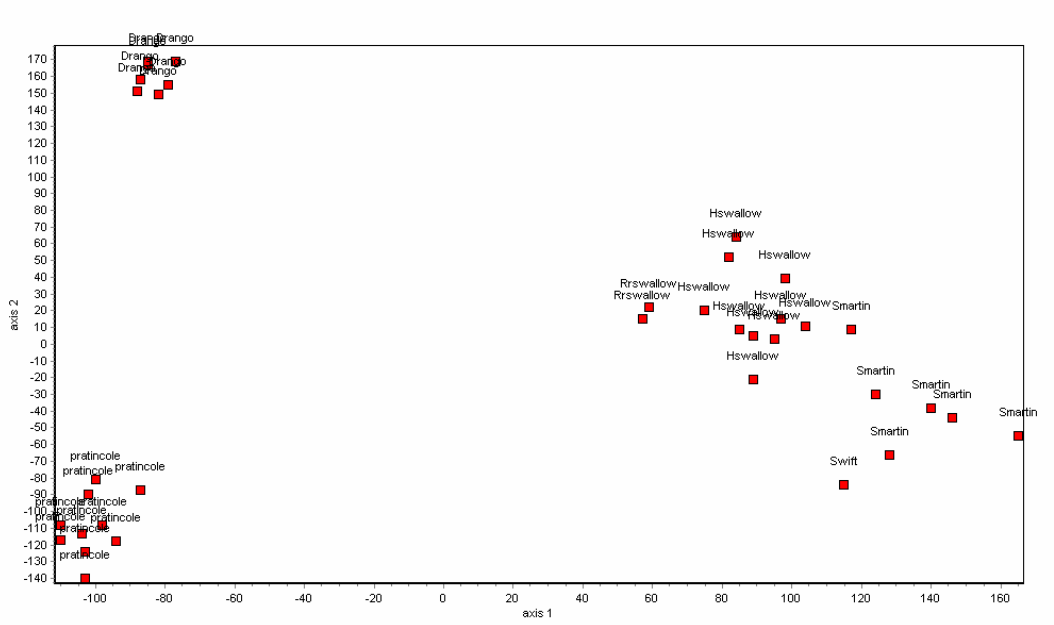

Figure 2. *The distribution of species samples on the PCA1 and PCA2 space*

CCK air force based carried out an integrated wildlife habitat management program by mowing grasses at low, medium and high frequencies in different seasons. The grass cutting frequencies as well as avian species counted on the sampling point were noted during the study period. The average species numbers (richness) noted under different grass mowing intensities in spring, summer and fall are listed in Table 2. One way ANOVA was used to analyze the effects of habitat treatment (grass mowing intensity) as well as seasonal factors on the avian species richness at the study area. In general, the specie richness found in the medium intensity of grass mowing is higher than those found with intense and scarce grass mowing intensities. Significant seasonal variation of species richness was found in the study area. Fall had the highest avian species richness index than the other seasons. The highest avian species richness was found among the areas where medium frequency of grass cutting in the fall ($p<0.01$). No significant effect of habitat management was found in spring and summer. Significant habitat treatment effect was found for drango, house swallow and pratincole population sizes.

Table 1. Summary result of Principle Component Analysis. Marked loadings are > .700000.

	Factor 1	Factor 2
total head length	.681657	.724306
beak length	.401999	.901070
beak width	.832337	.432777
wing length	.939060	.314073
maximum wing length	.948862	.293416
tarsus length	.922384	.268554
tail length	.110061	.981844
total body length	.407363	.899368
body weight	.911517	.369997
wing cover area	.570602	.808087
Expl.Var	5.286516	4.343483
Prp.Totl	.528652	.434348

Table 2. The average bird species richness noted under different grass mowing frequency in spring, fall and summer from 2000 to 2001

		Intense	Medium	Scarce	p-value
Seasons	Spring	8.9	10.67	10	0.12
	Summer	6.56	7.46	7.3	0.31
	Fall	6.77	9.27	6.5	**< 0.01**

4. Discussion and conclusion

Taiwan locates on the Western Pacific bird migration flyway. In addition, the wetlands along the coastal area have provided nutrient and energy for those migratory birds. However, some migratory birds choose to rest at the dry grass land such as airfield near the coastal area during the high tide period. Therefore, the risk of bird strike increases during the migratory seasons of the year. In this study, we identified that birds of the air insect foraging guild have the hazard to cause bird strike due to their long hours foraging in the sky. The eco-morphological studies indicated that the niche of drango and pratincole were separated away from the swallows. In addition, the risk of bird strike for drango and pratincole is higher than the swallows due to their larger body weight. As a consequence, the habitat management for both species is critical for managing the risk of both bird species on bird strike at CCK air force base. The result of grass mowing analysis indicated that the hazards of drango, house swallow and pratincole are manageable by applying proper habitat management strategies.

We need to carry out a more detail niche separation study for the swallow species in order to determine the hazard status of every species. A well designed habitat management program based on the niche characteristic of each air insect foraging bird species is necessary to reduce the risk of bird strike around the air force base areas.

5. References

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