Kontyû, 47(3): 291–297. September 25, 1979

Population Sizes and Resident Ratios of the Swallowtail Butterfly, *Papilio polytes* L., at a Secondary Bush Community in Dharan, Nepal*

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Synopsis Population sizes and resident ratios of the swallowtail butterfly, *Papilio polytes* L., were investigated by means of the mark-and-recapture method in Dharan, Nepal, 1977. The habitat of butterfly was a secondary bush community with a south-facing slope, where the host tree was one of the dominant species. The peak activities of males were observed during 8: 30–10: 30 a. m. in every sunny day. The strong wind which rose after 10: 30 every day seemed to inhibit the normal flight of adults. Number of females was smaller than that of males during the study period, and the changes of population sizes of both sexes were rather stable. Males stayed in the experimental plot for 3 to 4 days, while females did so for only 1 day. The mean life span of adult males was estimated as 12.74 days and that of females as 8.06 days. One of the factors affecting the population sizes and resident ratios of the swallowtail butterfly was discussed.

Although some parties for scientific expedition to the Himalayas had observed or collected a vast number of butterflies, their reports on such data have been confined mainly to the systematical and biogeographical studies (*e. g.* IGARASHI, 1966) or to the comparisons of butterfly fauna between Himalayas and Japan (*e. g.* NISHIMURA and HORI, 1975). These studies are helpful to clarify the historical origin of butterfly fauna of Japan. On the other hand, however, any intensive study of the population ecology in a specified area has not been carried out.

The author participated in the 4th Himalayan Expedition of Chiba University in 1977 and spent 17 days at Dharan in Nepal, and carried out population ecology research of a swallowtail butterfly, *Papilio polytes* L. This butterfly widely distributed in tropical and sub-tropical zones including Amami and Yaeyama islands of Japan (KAWAZOE and WAKABAYASHI, 1976), and its female mimics *Menelaides aristolochiae*, which occurs in the same localities (TALBOT, 1939).

In Dharan, the larvae feed chiefly on *Murraya koenigii*, (Rutaceae), which grew in the secondary plant community predominated by bush. The adults were usually found in this habitat where they also visited the flowers. Their flight was very swift and restless within the range of this habitat.

The purpose of this study is to describe preliminarily the changes in population sizes and resident ratios of adults in the secondary bush community.

* Results of Chiba University Scientific Expedition to the Nepal Himalaya (No. 34).

Study area and Methods

The experimental plot was a secondary bush community located at about 1 km eastward from Dharan city, east Nepal (500 m in altitude, at about 26°37′N and 87°35′E). It was 150 m wide and 50 m long with a south-facing slope. There were rice fields to a great extent to the south from the plot. The bamboo stand with ever-green trees formed the boundary between the experimental plot and Dharan city. On the east of the plot, the vegetation consisted of desert communities which went on toward a river flowing into Sapt Kasi River. To the north from the plot, there was a hamlet with a small pound surrounded by ever-green trees.

Although the vegetation at the experimental plot seemed to have been disturbed by mankind and livestocks long ago, it is possible to know the native vegetation by referring the reserved forest in the vicinity of Dharan (Terai's Forest) which is a sub-tropical monsoon forest.

Distribution of the host tree was surveyed at the plot on the slope by using the belt transect method.

Before the mark-and-recapture samplings were conducted, the change in number of adults seen during a day at the plot was observed for several days.

The number of adults was counted 11 times during the period from 8th to 20th April, 1977. At each time, all the adults found during two hours in a day were captured by a net, anesthetized by ether for about 10 second in a polyethylene bag, and then, marked individually on their hind wing with a white felt pen. The condition of the wings was also recorded in order to know the age and mimic forms of females. It was considered that such procedures of marking gave little effects to their flight activities because most butterflies began to fly normally when they recovered from the anesthesia. The butterflies wounded by marking were treated as dead individuals in calculations.

Although Jolly's stochastic model (JOLLY, 1965) has been considered as the most generalized one for estimating the population parameters (IWAO, 1971), the model contains several limitations to apply to the population study of butterflies as discussed by BRUSSARD and EHRLICH (1970). In this experiment, Jolly's model was used only to get supplementary information on the butterfly population, and most of the following analyses were based on the minimum number of butterflies known to be alive.

Results

General observation

The vegetation survey by using the belt transect method showed that the host tree of the swallowtail butterfly was the third dominant species (SDR_2=65.0) or the first dominant species (SDR_3=76.7), where SDR_2 means summed dominance ratio calculated by the height and the coverage and SDR_3 means that calculated by the height, the coverage and the frequency of the respective species (NUMATA and SUZUKI, 1958). The average height of host tree was 52.4 cm (20–118 cm), while the average height of vegetation was 68.4 cm. There were various stages of the host trees, such as a seedling or a bush type with arising coppices, sprouting, forming the flower buds, flowering and bearing fruits.

On the other hand, all stages of *P. polytes* were also found. The adult butterflies seldom rose far from the vegetation, preferring the shelter of bushes. They did not show the puddling behaviors, which was reported by TALBOT (1939).

The typical change of diurnal activities in sunny days is shown in Figure 1. It is clear that the mean half-hourly counts on the males show the most active range to

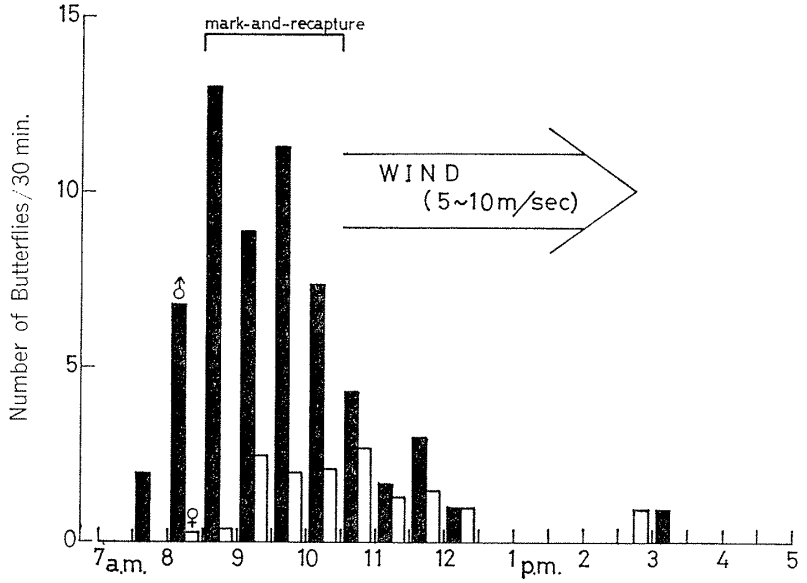

Fig. 1. Diurnal changes on the activities of the adult swallowtail butterfly, *P. polytes*, in Dharan, Nepal. The number of adults fluttering at the area per 30 minutes are averaged in 8 sunny days without 1 dull and 2 rainy days. The wind rose after about 10: 30 a. m. every day.

be during 8: 30–10: 30 a. m., though those of females somewhat delayed. The wind began to blow from east or east southeast after 10: 30 a.m. every sunny day. The wind velocity of 5–10 m/sec seemed to inhibit the normal flight of butterfly, because the butterfly was observed to be driven away by the wind above the vegetation. The diurnal change did not show any peak on dull or rainy days.

There are three principal forms of females: one resembling the males (8.6% of total females captured), one with red discal patches on the hind wing and with white band on the fore wing (2.9%), and one with white discal patches on the hind wing (88.5%). Although it was considered that the last form mimics *Menelaides aristolochiae* which appeared near the experimental plot, flight behavior of the latter was significantly different from all forms of *P. polytes*.

Population sizes and resident ratios

Since the activitiy of butterflies was high between 8: 30 and 10: 30 a.m. in a day, the procedures of the capture-mark-release were conducted during this period. Figure 2 shows the changes in minimum number of adults known to be alive in comparison with those in numbers of males estimated by Jolly's model. Although the estimated population size was fluctuated widely, the minimum number of adults known to be alive is rather stable. Number of females was smaller than that of males at each sampling, probably due to differences in their flight behavior as in the case of the black-veined white, *Aporia crataegi* (WATANABE, 1978). In addition, only two females were recaptured once and others were disappeared. So, the resident ratios were calculated for males only.

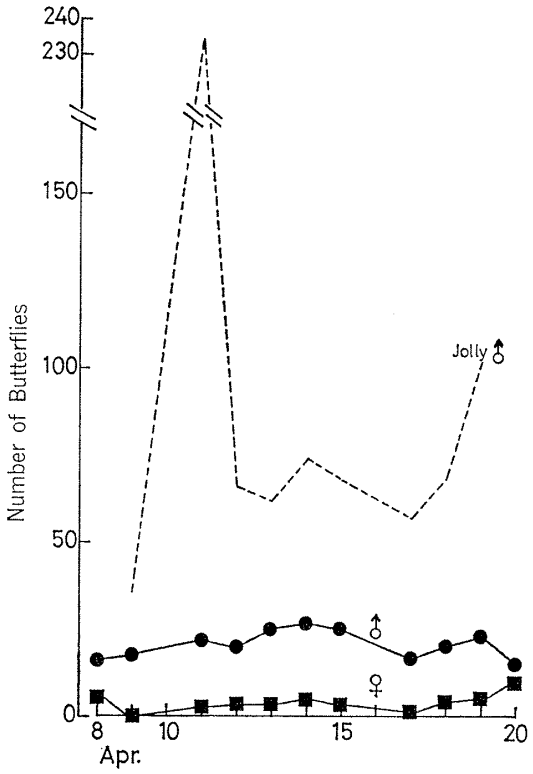

Fig. 2. Population sizes of the swallowtail butterfly, *P. polytes*. Solid lines show the minimum numbers of adults known to be alive in the plot: Broken line shows the number of males estimated by Jolly's model.

Figure 3 shows the survival curve of the minimum number of males compared with those estimated by Jolly's model. Here, the survival ratio means the resident ratio within the experimental plot, because the disappeared adults would emigrate from the plot but were not necessarily killed.

Figure 4 shows the expected resident period calculated from the survival curve in Figure 3. The mean resident period was 2.17 days based on the minimum number of males and 2.62 days on the estimated number of males by Jolly's model. Thus, it was considered that males stayed at the experimental plot for 3 or 4 days while females for only 1 day.

In order to estimate the age of adult butterfly, it is assumed, as a very simple and handy method, that the condition of wings is almost coincident with the age as suggested by WATT *et al.* (1977). Here, the conditions of wings were classified into 4 degrees: "0" type with the fresh wings, "I" type with a bit broken wings, "II" type with wings of outer margins broken and "III" type with wings of limbal or discal areas broken. Table 1 shows the life tables calculated by the mean age distribution at each sampling. The mean duration in each class of age is also shown in Table 1. They were calculated under caged conditions with 1 mm mesh net in the experimental plot (5 to 13 butterflies on each class of age). Thus, the mean longevity of males was

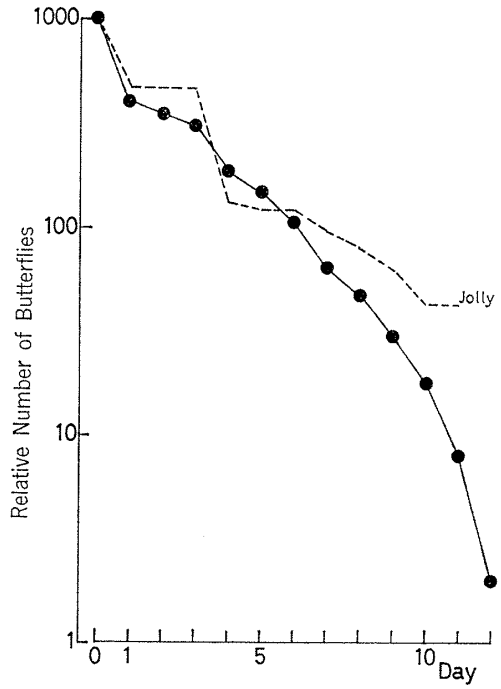

Fig. 3. Survival curve based on the minimum number of males in comparison with that of Jolly's estimates.

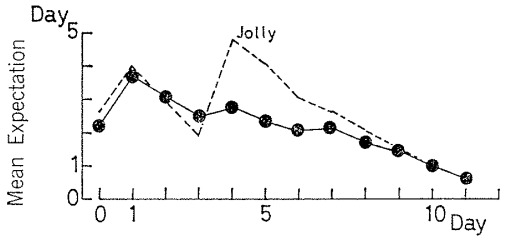

Fig. 4. Mean expectations of further period of residence in males at the start of each day calculated from the survival curves in Figure 3.

Table 1. Life tables for the adult swallowtail butterfly, *P. polytes*, in Dharan, Nepal. (Mean duration with the 90% confidence limit.)

Age class	Mean duration (days)	male		female	
		lx	*ex*	*lx*	*ex*
0	4.40±1.09	1000	3.10	1000	1.78
I	4.69±1.33	978	2.16	533	1.90
II	3.20±1.24	889	1.32	533	0.90
III	4.50±1.62	733	0.50	213	0.50
—	—	0	—	0	—

lx: number surviving at start of each class of age.
ex: mean expectation of further life for adults alive at start of each age class.

calculated as 12.74 days and that of females as 8.06 days. This length seemed to be roughly similar to that of *P. xuthus* in Kyushu (TSUBAKI, 1973).

Discussion

NUMATA (1966) pointed out that the vegetation in Nepal had been considerably influenced by mankind including livestock from very early ages. In Dharan, it was seen that the native vegetation had been transformed to the extensive rice fields except the reserved natural forest or the slopes which could not be ploughed. The vegetation of the slopes, however, consisted of not native plant communities but the secondary ones.

The habitat for *P. polytes* seemed to be such a secondary plant communities, where one of pioneer trees, *M. koenigii* was considerably dominant. OWEN (1971) said that the great part of the area shown as tropical forest on vegetation maps was now secondary forest or secondary bush, and that the wild Rutaceae were presumably the original food-plants for the swallowtail butterflies. In Dharan, the life history of the swallowtail butterfly could be completed within the experimental plot, because all stages (from egg to adult) were observed through the experimental period. Thus, one might think that the adults were restricted within the plot in stable population sizes (Figure 2). The mean resident period at the plot calculated from the survival curve (3 or 4 days in males and only 1 day in females) was, however, considerably shorter than the mean life span calculated from the life tables on age class. Therefore, it is considered that the population interchanges with the habitat of range more than 1 km from the experimental plot.

In order to determine the process of interchange on the population with the plot, the population sizes at a given time is plotted against that at a previous time. Table 2 shows that the regression coefficient, b, and the coefficient of determination, r^2, calculated by the least square method on males are lower than unity. Thus, it was suggested that the males did not interchange constantly at any time with the plot: that is, the males disorderly wander or disappear.

Table 2. Regression coefficient (b) and the coefficient of determination (r^2) in the relation of the population size of males at a given time i to that a subsequent time $i+1$, $i+2$, $i+3$, $i+4$, $i+5$ or $i+6$, respectively.

Relation with i	$i+1$	$i+2$	$i+3$	$i+4$	$i+5$	$i+6$
		N.S.	N.S.	N.S.	N.S.	N.S.
b	1.1004*	0.3168	−0.3916	1.1494	1.9783	2.0283
r^2	0.47	0.04	0.02	0.44	0.25	0.36

The coefficients are calculated by the least squares method.
* : $0.05>P>0.01$
N.S.: $P>0.10$

Since the adults flying above the vegetation were seldom observed, it seemed to be impossible that the adults flew away from the experimental plot along the flyway. However, there might be one chance for flying above the vegetation and away from the plot. Cattles in Nepal wander everywhere, and, at the experimental plot, cattles were free from man and wandered to feed or to rest. When a cattle walked in the bush, the adult butterfly in the bush was disturbed for resting and flew up from the vegetation, where the strong wind which blew after 10: 30 a.m. every day inhibit the normal flight of butterflies. The wind carried away the butterfly from the experimental plot. Thus, it can be seen that the cattle-wind relation is one of the factors to affect on the population sizes and resident ratios of the swallowtail butterfly.

Acknowledgement The author is indebted to Dr. A. KOKUBO of Tokyo University for helpful suggestions and a critical reading of the manuscript. Thanks are due to Mr. N. OSAKI of Nagoya University for his help in the computation using Jolly's model and to Dr. H. KANAI of National Science Museum for his kind identification of the host tree of the swallowtail butterfly.

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