

Notes on the appearance date of pupal diapause butterfly species in Yamaguchi City during spring in 2006

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(Received September 28, 2007)

Abstract

We investigated the appearance date of pupal diapause butterfly species in Yamaguchi City during spring from March to May, 2006. This survey recorded the appearance date of 16 pupal diapause butterfly species in Yamaguchi City, and identified 9 papilionids, 3 pierids, 2 satyrids, 1 nymphalid and 1 lycaenid. In the spring of 2006, *Pieris rapae* (Pieridae) was first to appear from March 7 around urban districts of Yamaguchi City, and then *Papilio machaon* and *Pa. xuthus* (Papilionidae) appeared within similar areas from late March. *Anthocharis scolymus* (Pieridae), *Arachunia burejana* (Nymphalidae) and *Rapala arata* (Lycaenidae) appeared from the middle of April around upland areas, and another 6 papilionids and 2 satyrids were observed from May in hill areas around Yamaguchi City. These data provide a benchmark of the appearance date of pupal diapause butterfly species in Yamaguchi City, Japan.

Key words: pupal diapause butterfly, appearance date, Yamaguchi City, climatic warming

Introduction

The appearance of adult butterflies after the winter season is traditionally one of the indicators for the coming of spring in Japan. The white cabbage butterfly *Pieris rapae* is a butterfly representing the early spring season in Japan, and adults of this species usually appear from February in warm areas of southern regions of Japan, and from April to May in northern regions (Shirozu, 2006).

Recently, Goto (2007) reported the appearance of adult butterflies of *Lampides boeticus* and *P. rapae* at the earlier dates of February 4 and 6, respectively, at Ube City, Yamaguchi Prefecture. Additionally, *Byasa alcinous* larvae and *Graphium sarpeden* adults were

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observed within Yamaguchi Prefecture in the off-season of early winter at Ube and Shimonoseki City, respectively (Goto, 2006; Taketsugu, 2007). These observations suggest that the appearance and survival of butterflies in the off-season may have been influenced by the climatic warming in recent years.

Information concerning the appearance date of butterflies after the winter season and for butterflies in the off-season in the Yamaguchi Prefecture is based on personal observations of limited survey areas, and until now there was no information that could be regarded as benchmark data of the appearance date of butterflies in Yamaguchi City.

The winter stage of diapause butterflies is generally classified into the types of egg, larva, pupa or adult, and the types of the winter stage differ among butterfly species. Hence, we focused on the earliest appearance of pupal diapause butterfly species because it is known that some adult diapause butterfly species (e.g. *Polygonia c-aureum*) occasionally fly when it is a sunny and warm day during the winter season, and that the growing stage of some larval diapause species (e.g. *Lycaena phlaeas*) differs among the same species during the winter season.

In this survey, we investigated the appearance date of pupal diapause butterfly species after the winter season to collect benchmark data of such species in Yamaguchi City, Yamaguchi Prefecture.

Materials and Methods

Survey

Seven survey sites (Fig. 1) were selected within Yamaguchi City: Aio (seaside area of Setouchi Sea), Asada (riverbank area of Yoshiki River), Hirai (riverbank area of Fushino River), Kurokawa (forested area near residential zone), Niho (valley area in the hills), Namera (mountain area) and Yoshida (Yoshida Campus of Yamaguchi University including agricultural farms). These selected areas were the collecting sites of butterfly species targeted in our personal experiences. Field surveys were conducted during the spring season from March to May 2006 every day or every other day. The appearance date is defined as a date on which a butterfly species was observed in the field or collected using an insect net for the first time during this season.

Observation and identification

Adult butterflies observed or collected in the field were identified with respect to species and gender.

Climatic data

Mean yearly and monthly data for temperature (Figs. 2 and 3) were taken from Yamaguchi weather station at Yamaguchi City.

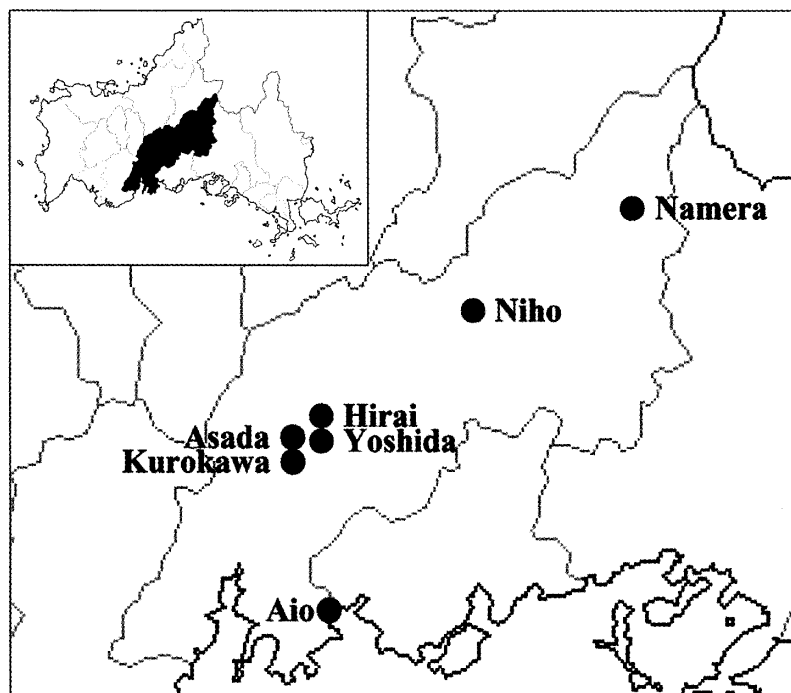


Fig. 1. Location of survey areas. Inset map: Yamaguchi Prefecture. Black area shows Yamaguchi City. Main map: Field survey sites selected in this survey within Yamaguchi City—Aio, Asada, Hirai, Kurokawa, Namera, Niho and Yoshida (Yoshida campus of Yamaguchi University).

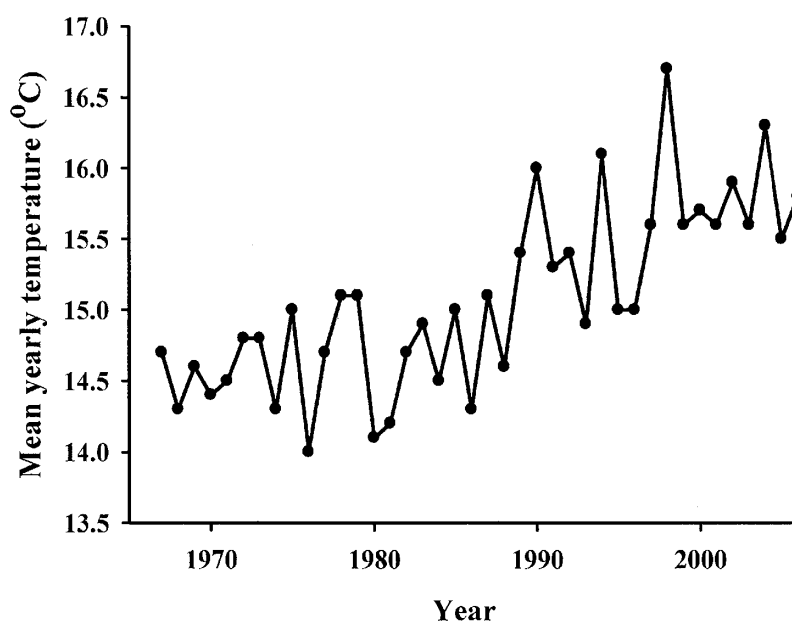


Fig. 2. Mean yearly temperature in Yamaguchi City, Yamaguchi Prefecture. Data shown for the period 1967-2006.

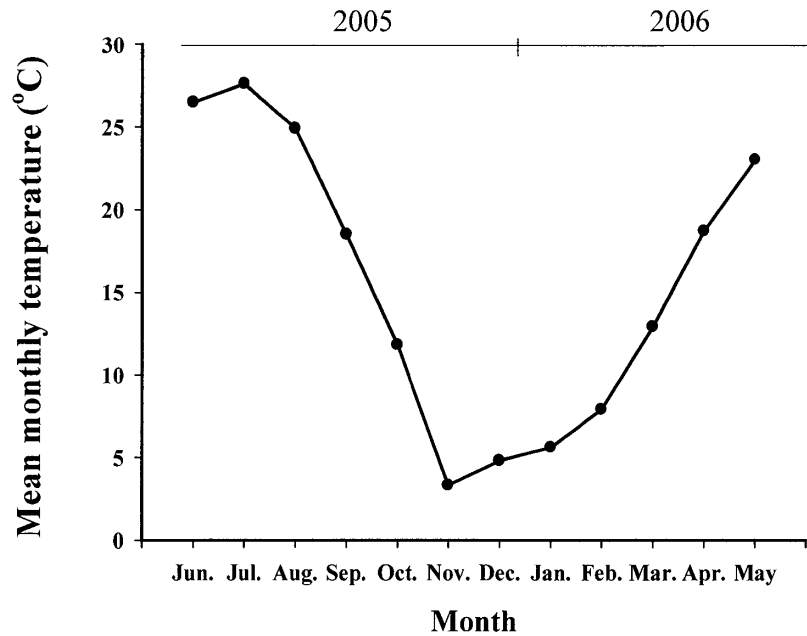


Fig. 3. Mean monthly temperature in Yamaguchi City, Yamaguchi Prefecture. Data shown for the period June 2005 to May 2006.

Results

Table 1 summarizes the appearance date, site, and sex of pupal diapause butterfly species observed or collected within Yamaguchi City during the spring season from March to May, 2006. Nine papilionid, 3 pierid, 2 satyrid, 1 nymphalid and 1 lycaenid butterfly species were observed in this survey. The earliest appearance involved a male *P. rapae* observed at Yoshida on February 7, 2006. Following the appearance of *P. rapae*, *Papilio machaon* and *Pa. xuthus* appeared from late March around the urban district of Yamaguchi City. *Anthocharis scolymus*, *Arachunia burejana* and *Rapala arata* appeared from the middle of April around upland areas, and another 6 papilionids and 2 satyrids were observed from May in hill areas around Yamaguchi City. The last butterfly observed during this season was a male *Neope niphonica* observed at Namera on May 24, 2006.

Discussion

This survey provides benchmark data concerning the appearance date of pupal diapause butterfly species in Yamaguchi City (Table 1).

The first butterfly observed in this survey was a male *P. rapae* recorded at Yoshida on March 7, 2006. Recently, this species was observed at Ube City on February 6, 2007 and this observation is considered the earliest appearance of this species in Yamaguchi Prefecture (Goto, 2007). As shown in Fig. 3, mean monthly temperature during the winter season from December 2005 to January 2006 in Yamaguchi was below 5°C, and it was considered a cold winter. However, mean monthly temperature during the same season at Ube, Ube City in 2007 was above 6.5°C, and this period was considered a warm winter (data not

Table 1. Species list with appearance date and site of first observation of pupal diapause butterflies in Yamaguchi City during the spring season of 2006

Families and Species	Date of Observation (Site)	Date of Collection (Site)	
		Male	Female
PAPILIONIDAE			
<i>Papilio maackii</i>	12.V. (Ni)	12.V. (Ni)	ND
<i>Papilio helenus</i>	12.V. (Y)	12.V. (Y)	14.V. (Ai)
<i>Papilio macilentus</i>	21.V. (Na)	21.V. (Na)	ND
<i>Papilio protenor</i>	27.IV.(As)	28.IV.(Ni)	12.V. (Ni)
<i>Byasa alcinous</i>	19.IV.(H)	19.IV.(H)	27.IV.(As)
<i>Papilio xuthus</i>	31.III.(Y)	31.III.(Y)	18.IV.(As)
<i>Papilio machaon</i>	26.III.(Y)	26.III.(Y)	7.IV.(Y)
<i>Papilio memnon</i>	8.V. (K)	8.V. (K)	14.V. (Ai)
<i>Graphium sarpedon</i>	30.IV.(Ai)	8.V. (Ai)	4.V. (Y)
PIERIDAE			
<i>Pieris rapae</i>	7.III.(Y)	7.III.(Y)	8.III.(Y)
<i>Pieris melete</i>	25.III.(Y)	25.III.(Y)	18.IV.(Ni)
<i>Anthocharis scolymus</i>	7.IV.(Y)	7.IV.(Y)	8.IV.(Ai)
SATYRIDAE			
<i>Neope goschkevitschii</i>	8.V. (Y)	8.V. (Y)	8.V. (Y)
<i>Neope nipponica</i>	24.V. (Na)	24.V. (Na)	ND
NYMPHALIDAE			
<i>Araschnia burejana</i>	18.IV.(Ni)	18.IV.(Ni)	21.IV.(Ni)
LYCAENIDAE			
<i>Rapala arata</i>	16.IV.(Ni and Y)	16.IV.(Ni)	16.IV.(Y)

ND indicates no data for a collection of this butterfly species in this survey.

Ai: Aio; As: Asada; H: Hirai; K: Kurokawa; Na: Namera; Ni: Niho; Y: Yoshida.

shown). These observations suggest that the earliest appearance date of *P. rapae* may be strongly dependent on the increasing temperature from December to January.

On the other hand, it is known that the Great Mormon butterfly *Pa. memnon* is a butterfly whose range is expanding northwards following climatic warming in Japan, and is now observed in the Kanto district (Yoshio, 1997; Kitahara *et al.*, 2001). Interestingly, the mean yearly temperature of Yamaguchi since 1967 gradually increased amid fluctuations, and the mean yearly temperature of 2006 was over 1°C higher than that recorded for 1967 (Fig. 2). This suggests that some southern butterflies (e.g. *Precis almama*) expanding into central regions of Kyushu may appear in the Yamaguchi Prefecture beyond the Kanmon Canal, the line separating Fukuoka and Yamaguchi

Prefectures. Some butterfly species that inhabit hill and mountain areas (e.g. *A. burejana*) may move to more northern regions, and some butterflies may increase the number of broods per year in the future.

Further investigation of ecological signs regarding the life cycle of butterflies as affected by climatic warming is necessary in Yamaguchi Prefecture, such as changes of the appearance date of butterflies in the spring or winter, variation in broods per year, and observation of invasion species.

Acknowledgements

We are grateful to Yuki Tsujimura, Miwako Kometani and Yuuki Nomura (Faculty of Science, Yamaguchi University) for their assistance.

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