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Diapause Potential in Tropical Papilionids (Lepidoptera: Papilionidae)^{1,2,3}

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It is an intriguing question whether or not tropical insects have an ability to enter diapause in response to environmental factor(s). Recently, the author obtained evidence for diapause potential in tropical papilionids at Sandakan in Sabah, Malaysia.

Females of papilionids, *Papilio demoleus libanius* FRUHSTORFER, *P. memnon memnon* L. and *P. polytes theseus* CRAMER were captured near the Forest Research Centre at Sepilok, in the suburbs of Sandakan (5.5°N) in mid July, 1983. They were kept in small cages (about 40 cm³) with fresh sprays of citrus tree for oviposition and fed on a 10% solution of sucrose. Eggs were put in 200 ml transparent plastic cups under quasi-natural laboratory conditions. Larvae were divided into 2 (in *memnon* and *polytes*) or 5 (in *demoleus*) groups, and reared in plastic cups under different photoperiodic conditions either in an air-conditioned laboratory at 25°C or in portable electric refrigerators at 20°C (see Table 1). At 25°C, both larvae and pupae were on a table illuminated by fluorescent lamps and/or the light through the window in photophases, and put in light-tight boxes in scotophases. At 20°C, photoperiods were manually controlled using a small lamp in the refrigerator. Fresh leaves

Table 1. Larval stages (mean±S.D. days) of the three Sabahan papilionids under different temperature and photoperiodic conditions

Conditions	<i>demoleus</i>	<i>polytes</i>	<i>memnon</i>
25°C 14L-10D	19.8±1.1 (N=10)	21.7±1.3 (N=7)	23.2±1.5 (N=6)
13L-11D	19.9±0.6 (N=8)	—	—
12L-12D	19.5±1.2 (N=13)	—	—
10L-14D	19.5±1.7 (N=14)	22.1±0.6 (N=8)	24.6±1.4 (N=7)
20°C 10L-14D	28.7±0.6 (N=3)	—	—

of the orange tree, *Citrus* sp. were daily given as larval food.

Larval stage. Larval development in the three Sabahan papilionids was not affected by photoperiod (Table 1). In *demoleus* the mean larval stages under different photoperiods were not significantly different ($P>0.05$, by *t*-test). The mean larval stage in 20°C-10L-14D was 90 days longer than that in 25°C-10L-14D. In both *polytes* and *memnon* also, the mean larval stage under 10L-14D did not differ from that under 14L-10D ($P>0.05$).

These results suggest that photoperiod does not influence the larval development in these papilionids and that, in *demoleus*, the larval growth was not particularly retarded under a short day combined with a low temperature of 20°C.

Pupal stage. Pupal development in these papilionids was not directly controlled by photoperiod (Table 2). In *demoleus* the mean pupal stages under 14-, 13-, 12-, and 10-hr photoperiods at 25°C were between 12.1 and 12.4 days with no

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Table 2. Pupal stages (mean $\pm$ S.D. days) of the three Sabahan papilionids under different temperature and photoperiodic conditions

Conditions	<i>demoleus</i>	<i>polytes</i>	<i>memnon</i>
25°C 14L-10D	12.4 $\pm$ 0.5 (N=9)	12.7 $\pm$ 0.6 (N=3)	15.0 $\pm$ 1.2 (N=4)
13L-11D	12.3 $\pm$ 0.6 (N=3)	—	—
12L-12D	12.1 $\pm$ 0.7 (N=10)	—	—
10L-14D	12.2 $\pm$ 0.8 (N=12)	12.1 $\pm$ 0.7 (N=7)	14.5 $\pm$ 0.8 (N=6)
20°C 10L-14D	120.0 $\pm$ 22.6 (N=2)	—	—

significant differences ($P > 0.05$). In *polytes* and *memnon* the mean pupal stage under a long day (14 hr) was not statistically different from that under a short day (10 hr) ($P > 0.05$).

The duration of pupal period at 25°C is thus not influenced by either larval or pupal photoperiod. However, two pupae of *demoleus* reared in 20°C-10L-14D as larvae and pupae persisted for 104 and 136 days, respectively. These extended stages could be explained not by non-diapause development but by induction of diapause. Temperate papilionids enter pupal diapause in response to a larval short day (e.g., OLIVER, 1969; HIDAKA and HIRAI, 1970; ICHINOSÉ, 1974; ISHII, 1977), and it is of evolutionary interest that a papilionid near the equator has the ability of diapause at the same stage.

In papilionids of Okinawa (Japan) and Philip-pines, including *demoleus*, *memnon* and *polytes*, the

larval short day induces the pupal diapause, though at a low rate, under a moderate temperature (AE, 1978; ICHINOSÉ and NEGISHI, 1979). Sandakan is located quite near the equator so that the variation of daylength is less than 40 min with the shortest day of about 12.5 hr (including civil twilights). Seasonal change in daylength may not serve as a cue for diapause near the equator (DENLINGER, 1986). In Sandakan, on the other hand, the temperature may decline at night or on rainy days though the mean monthly temperature is above 26°C throughout the year. The moderate rearing temperature (20°C) may be responsible for diapause in the two Sabahan pupae of *demoleus*.

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