Flowering of *Aeschynanthus* 'Koral'

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Abstract. *Aeschynanthus* 'Koral' plants were grown in photoperiods of 8 to 14 hours (8 hours of natural daylight plus 0 to 6 hours of incandescent light of 3 $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$) beginning January, March, or June. The number of weeks to anthesis and the number of leaves on flowering shoots were not affected by photoperiod but differed based on when treatments commenced. Flowering was inhibited, regardless of photoperiod, when the daily temperature differential was larger than 10C. To study the interaction of photoperiod and temperature, *Aeschynanthus* 'Koral' plants were grown under photoperiods of 12 or 24 hours (daylight fluorescent lamps at 4.3 $\text{mol}\cdot\text{m}^{-2}\cdot\text{day}^{-1}$) at 18 or 24C. After 8 weeks, plants grown at 18C had fewer nodes before the first flower bud than plants grown at 24C. *Aeschynanthus* 'Koral' was day-neutral at 18C, but responded as a long-day plant at 24C.

Aeschynanthus, epiphytic gesneriads valued for their tubular orange or red flowers, have potential as a commercial potted floral crop (Christensen, 1988; Lentjes, 1985). However, the response to photoperiod and temperature is inconsistent; making crop timing and quality unpredictable (Gertsson, 1987; Welander, 1984; Zimmer, 1972).

Zimmer (1972) grew *A. speciosus* at minima of 20, 23, or 26C and photoperiods of 8 or 16 h. The number of flowering plants increased as temperature and photoperiod increased. To separate the photoperiod response from the fluence effect, a study was performed where cool-white fluorescent lamps supplied different peak irradiances for 9, 12, 15, or 18-h photoperiods, resulting in 12 photoperiod-irradiance treatment combinations providing total fluence of 18, 36, or 54 Klux/h (0.9, 1.8, or 2.6 $\text{mol}\cdot\text{m}^{-2}\cdot\text{day}^{-1}$) at 23C. Increasing the total fluence was more effective in promoting early flowering and increased percentage of flowering than photoperiod. Zimmer concluded that high irradiance and temperature were required for *A. speciosus* to flower, remarking that any photoperiod response was not obvious. However, the total fluence Zimmer used was low and the increased flowering observed was most likely a photosynthetic response. Poole (1985), working with *A. pulcher*, found a

similar response of increased flowering as total fluence increased.

Welander (1984) tested photoperiods of 8 or 20 h with night temperatures of 12, 15, 18, or 21C (days were maximally 4C higher). The 20-h photoperiod hastened flowering in two of four seasonal replications, while an 8-h photoperiod hastened flowering in the other two seasons.

Recent work with *Aeschynanthus* 'Koral' showed that floral induction was promoted when plants were grown under 12-h photoperiods and a constant 18C (Whitton and Healy, 1990). When plants were exposed to daily temperature differentials of more than 6C, flowering was inhibited.

The following studies were conducted to determine the critical photoperiod for flower induction and whether photoperiod and temperature interacted to induce flower formation.

Photoperiod study. Photoperiods of 8, 9, 10, 11, 12, 13, or 14 h were used to simulate the range of photoperiods *Aeschynanthus* would perceive in native habitats (Burrt and Woods, 1975). Photoperiod treatments were applied in a glasshouse within compartments separated by black cloth partitions that were rolled up during daylight hours and lowered nightly. Black cloth was pulled over compartments daily at 1600 HR and removed at 0800 HR. Supplementary irradiance within each compartment was supplied by two incandescent lamps (3 $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$) 0.6 m apart and $\approx$ 0.8 m above plants. The air minimum was set at 21C. Ventilation was provided automatically when the air exceeded 24C. From May to Sept., white shading compound was applied to the glasshouse to reduce irradiance by 50%. Air temperatures were recorded daily at 0300 and 1500 HR and are presented graphically for those months when temperatures exceeded set points (Fig. 1).

Plants of *Aeschynanthus* 'Koral', propagated from leaf cuttings (Whitton and Healy, 1989), were placed in photoperiod treatments on 21 Jan. or 21 June 1988 or 12 Mar. 1989 with 20, 15, and 15 replicates, respectively. Vegetative plants were pruned to one shoot per plant at the start of treatment and potted in 0.5-liter containers. At anthesis of the first flower in the terminal cluster, the number of nodes subtending the whorl and the shoot length were recorded. The total number of shoots that reached anthesis on each plant was recorded on 21 Jan. and 19 June 1989 and on 12 Sept. 1989; i.e., after 12, 12, or 6 months of photoperiod treatment. Data were analyzed using SAS GLM (SAS Institute, Cary, N.C.) using a split-plot design with start date as the main plot and photoperiod as the subplot.

Photoperiod and temperature study. Photoperiods of 12 or 24 h with a total fluence of 4.3 $\text{mol}\cdot\text{m}^{-2}\cdot\text{day}^{-1}$ (100 or 50 $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ respectively) were applied at 18 or 24C ($\pm$ 2C) in growth chambers. Irradiance was supplied with daylight fluorescent lamps. Nine vegetative plants of *Aeschynanthus* 'Koral' were pruned to three shoots and placed into treatments on 18 July 1989. A replicate experiment began 1 Aug. Plants were fertilized weekly with 16N-6.9P-13.3K at 200 mg N/liter. The number of leaves >1.5 cm (from leaf tip to petiole) was recorded at the start of treatment, with the top leaf notched to indicate subsequent growth. The following data were collected 10 Sept. or 26 Sept. for replicates 1 or 2, respectively: number of new leaves unfolded >1.5 cm and shoot length and nodal position

Table 1. Effect of time of year when photoperiod treatments were applied to *Aeschynanthus* 'Koral' shoots on weeks to anthesis and number of leaves unfolding after imposition of treatments.

Start of photoperiod treatment	Date of anthesis	Weeks to anthesis	No. nodes
Jan. 1988	18 Nov.	43 a ²	62 a
June 1988	20 Dec.	26 b	40 b
Mar. 1989	27 Aug.	24 c	16 c

¹Mean separation within columns by LSD, *P* = 0.05.

Table 2. Vegetative growth and flowering of *Aeschynanthus* 'Koral' shoots on plants grown at 18 or 24C with a 12- or 24-h photoperiod (4.3 $\text{mol}\cdot\text{m}^{-2}\cdot\text{day}^{-1}$) after 8 weeks.

Growth response	18C		24C	
	Photoperiod (h)			
	12	24	12	24
Shoot length	2.0 a ^z	2.9 a	6.8 b	7.4 b
No. unfolded leaves	5.9 a	6.9 a	12.3 b	11.5 b
No. nodes subtending whorl	2.6 a	3.0 a	9.3 c	6.4 b
Percent flowering (± SE)	88±8	86±6	40±14	67±22

¹Mean separation within row by LSD, *P* = 0.05.

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Fig. 1. Glasshouse temperatures at 0300 HR (+) and 1500 HR (Δ) for July through Nov. 1988; night temperature = $0.090x + 70.58$ ($R = 0.68$); day temperature = $-0.22x + 103.73$ ($R = 0.65$). Mar. through Sept. 1989: night temperature = $0.038x + 69.26$ ($R = 0.43$); day temperature = $0.046x + 75.38$ ($R = 0.46$).

of first flower bud acropetal to the notched leaf. Previous work (Whitton, 1989) showed that the nodal position where the first flower developed was a good indicator of time of floral induction. Data were analyzed using SAS GLM.

Photoperiod response. The number of weeks to anthesis and the number of leaves on flowering shoots were not affected by photoperiod (data not presented), but differed based on when plants were placed into treatment (Table 1). Plant groups placed into treatment 6 months apart in 1988 (January vs. June), flowered within 3.5 weeks of each other. During 1988, plants placed into photoperiod treatments in June developed 35% fewer nodes than plants placed into treatment in January. Plants placed in treatment in Mar. 1989 developed 74% fewer nodes than plants placed in treatment in Jan. 1988. The number of leaves on flowering shoots increased as experiment duration increased. Plants with as few as 16 or as many as 64 leaves flowered, indicating that shoot age was not the main factor limiting flowering. Our inconsistent response to photoperiod, also observed by others (Poole, 1985; Welander, 1984), suggested that another factor may be interacting with photoperiod to modify flowering response.

In 1988, temperatures averaged 5.3C (day) and 0.3C (night) higher than in 1989 during the time when temperatures were above the set points (Fig. 1). The 1989 day/night differentials and maxima were less than in 1988, with mean afternoon temperatures during July and Aug. 1989 up to 10C lower than in 1988 (Fig. 1). Before anthesis in 1988, the temperatures gradually decreased until the difference between day and night was reduced to ≈ 4 C, which was similar to the differential observed during all of 1989. The reduction in absolute or differential temperature may have triggered flowering. Recent work by Whitton et al. (1990) demonstrated that con-

stant 18 or 24C, or 24C day/18C night treatment promoted floral induction. Therefore, the temperature at which the photoperiod treatment occurred appeared to be critical.

Previous research with *A. speciosus* showed that high temperature promoted rapid flowering (Welander, 1984; Zimmer, 1972). The discrepancy between our data and these reports may relate to differences in rates of development and not floral induction. The research by Poole (1985) and Zimmer (1972), in which high light intensity was essential for flowering, did not account for a potentially higher plant temperature at the elevated light levels. The cuttings that Welander (1984) used in his study may have been reproductive, since the stock plants were all flowering at the time of cutting harvest. Recent work has shown that postinduction floral development is accelerated at 24C vs. 18C (Whitton and Healy, 1990).

Photoperiod and temperature study. After 8 weeks, shoot length was greater at 24C than at 18C and when plants were grown under 24- vs. 12-h photoperiods (Table 2). The number of unfolded leaves was not affected by photoperiod, but was greater at 24 than at 18C.

Plants grown at 24C produced more nodes before the first flower bud than those grown at 18C (Table 2). Flowering of plants grown at 18C was not affected by photoperiod, while those grown at 24C flowered at an earlier nodal position when grown in photoperiods of 24 vs. 12 h.

At 18C, photoperiod did not influence flowering, suggesting that *Aeschynanthus* 'Koral' is day-neutral at 18C, while at 24C, it is a facultative long-day plant with flowering promoted at 24 h relative to 12 h. Plants grown under 24-h photoperiods formed fewer nodes before the first flower bud than those at 12 h when equal total irradiance was supplied, indicating a delay in floral induction under short photoperiods.

Aeschynanthus 'Koral' appears to be a facultative long-day plant at 24C, which supports Welander's (1984) observation with postinduction development of *A. speciosus*. Under glasshouse conditions, low or constant temperatures may override the photoperiod response. At 18C, the plant appears to be day-neutral and rapid flowering is promoted. Some inconsistencies in past research involving *Aeschynanthus* may be explained by the interaction of temperature and photoperiod.

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