Response to Photoperiod of Reported Long-day and Intermediate Varieties of Rice

ALTHOUGH *Oryza sativa* L. is generally considered to be a short-day plant, a delay in flowering by short-day treatment has been reported[1-7]. Varieties with such a response would have a potential use in studies of physiology and breeding, and would be most interesting ecologically. The data reported on such varieties do not present a clear picture of their reaction, however, and are insufficient to warrant their classification as intermediate, much less long-day, types. To clarify this point, we have carried out detailed tests on several varieties of rice previously reported to be long-day or intermediate. '*BPI*-76', a variety known to be sensitive to photoperiod, was included as a control.

The plants were grown in the greenhouse during the day and transferred to different photoperiods in the evening. Table 1 shows the response of the varieties to photoperiod. All showed responses similar to short-day varieties. None could be regarded as a long-day or intermediate plant.

Table 1. NUMBER OF DAYS FROM SOWING TO FLOWERING OF THIRTEEN VARIETIES OF RICE GROWN AT DIFFERENT PHOTOPERIODS

Variety	Photoperiod (h) 8	10	12	13	14	16
'*T*-3 *W*356'	88	82	90	98	127	137
'*B* 76'	76	69	72	79	86	91
'Baok'	136	126	122	125	147	163
'*GEB* 24'	73	63	90	*	†	†
'*CH*-10'	78	76	78	78	80	85
'*T*.21'	91	77	82	88	103	98
'*T*.136'	72	66	69	76	88	92
'Heenati 8963'	81	75	77	77	91	112
'Heenati 8976'	83	73	86	112	165	†
'Heenati 8965'	67	51	63	77	90	125
'Karang Serang'	127	115	111	111	114	121
'Karang Serang Sel.'	147	139	123	129	132	153
'*BPI*-76' (sensitive)	64	65	100	145	†	†

* Panicle formation but no emergence after 200 days of growth.
† No panicle initiation after 200 days of growth.

The seeds of '*T*-3 *W*356', '*B* 76', 'Baok', '*GEB* 24', '*CH*-10', '*T*.21' and '*T*.136' were obtained from the Central Rice Research Institute, Cuttack, India.

The conclusion of previous workers that these varieties were long-day plants, or that short-day treatment delayed flowering, was probably reached because only two photoperiods were tested, one of which was natural day length. For example, if 'Baok' is compared at photoperiods of 8 and 12 h, the 8 h treatment delays flowering by 14 days which leads to the conclusion that it is a long-day plant. The extra photoperiods of 10, 13, 14 and 16 h used in our tests, however, show definitely that it is a quantitative short-day plant. The delay in flowering with an 8 h photoperiod, which is sub-optimum, is a common phenomenon with the short-day rice varieties[8,9]. Other factors such as temperature may have greatly modified the response of these varieties in previous tests. Varieties like '*BPI*-76', '*GEB* 24' and 'Heenati 8976' are qualitative, whereas the other varieties are quantitative, short-day plants.

More than a hundred varieties have been critically tested at the International Rice Research Institute and not one, so far, has shown a long-day response.

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Received July 25, 1967.

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Relationships among Functional Properties of Californian Grassland

ECOLOGISTS have become increasingly interested in general properties of communities and the relationships among species diversity, biomass, productivity, dominance and stability. Both verbal[1] and mathematical[2] models have been proposed to relate these properties. These models are important as initial generalizations in a developing predictive theory of ecology. The available data, however, are largely from planktonic systems and these data are contradictory. For example, Margalef[3] has concluded from his extensive studies of marine systems that productivity and dominance are inversely related to stability and diversity. Increasing species diversity in the community leads to decreased dominance and productivity but increased stability. Patten[4], however, has concluded that "high productive capacity is associated with high diversity" in summer plankton communities of Virginia's York River. Studies of grasslands on California's San Francisco peninsula, reported here, provide the first rigorous development of the relationships among diversity, dominance, productivity and stability of terrestrial communities. This report extends Margalef's general model to terrestrial systems and provides strong support for it as a valid description of general properties of communities.

From January 1 to July 1, 1966, standing crop was harvested in three 0·5 m² rectangular quadrats arranged linearly perpendicular to the slope and randomly placed at monthly intervals on north-east, north-west, south-east and south-west slopes on sandstone and serpentine soil types[5] on Stanford University's Jasper Ridge Biological Experimental Area. The area studied had been free of grazing and fire for more than 5 years previously, undoubtedly long enough for the vegetation to come to equilibrium considering the rapidity with which this vegetation type responds after disturbance[6]. Oven dried material from monthly samplings provided data on biomass and productivity of the grasslands during the principal productive period[7]. During May, the month of peak standing crop, diversity data were collected by canopy interception[8] along two 5 m transects on each sampling site with sampling points fixed at intervals according to fifty random numbers between 0 and 500 (ref. 9). One transect was perpendicular to the slope and one was parallel to the slope. Dominance was assessed as a "dominance index" equal to the percentage of the total standing crop contributed by the two most important species. I am concerned here with the general properties of the grasslands as a model system and a more detailed treatment of their ecology will appear elsewhere.

Dominance in the grasslands was related to diversity according to $Y = 138 - 6{\cdot}6\,X$, where Y is the percentage of the peak standing crop contributed by the two most

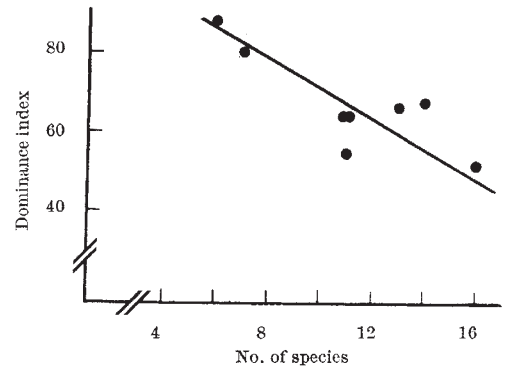

Fig. 1. Relationship between dominance (as percentage of total standing crop contributed by two most important species) and species diversity of grasslands on Stanford University's Jasper Ridge.