Vertical Distribution of the Lichen Genus PHYSCIA on Bigtooth Aspen, Northern Red Oak, and Red Maple at Douglas Lake, Michigan

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Patterns in the vertical distribution and directional aspect of the species of Physcia were investigated on trunks of Populus grandidentata (bigtooth aspen), Quercus rubra (northern red oak), and Acer rubrum (red maple). Previously studies of a similar type, mostly unpublished, were made by Schwerer (1962), Garren (1963), Hinds (1968), and Jones (1969).

The present study was carried out in sections 26 and 27 of Munro Township in Cheboygan County, in the vicinity of Douglas Lake, northern Michigan. The aspens were chosen from a dense aspen stand containing occasional red oaks and red maples. The red maples were selected from an open forest comprised largely of red maples and red oaks. The red oaks represented scattered individuals in a mixed aspen-red oak forest. Each sample consisted of 10 trees selected by a random pairs method. Trees were limited to those between 14 and 16 meters in height and were climbed by a ladder when no limbs were present to provide a handhold. As each tree was climbed, it was marked into two-meter bands. Within each band a cylindrical quadrat 10 centimeters in height was located by means of random numbers. Quadrats were placed only as high as 12 meters on the bole. All species of Physcia were recorded as to height and occurrence on the north or south sides of the trees. Specimens

of the P. stellaris-P. aipolia group were brought back to the laboratory for precise identification. (P. aipolia is usually almost identical to P. stellaris except for white spots on its upper cortex and some features of the rhizines. These characters are not diagnostically reliable, however, and a color test with KOH must be applied.) All the other species are easily recognized in the field.

If the rank of "stand" is assigned to a single tree, the term "constancy" can be used to indicate the number of times a species occurs at a given height throughout the sample. The constancy on each species of tree was determined for the three most common species (fig. 1). A total of seven species of Physcia occurred in the quadrats. Relative frequency and actual number of occurrences for all species are presented in Table 1. The species with the greatest number of occurrences are P. stellaris, P. adscendens, and P. aipolia, in that order. The other species were much less common in occurrence: P. millegrana, eight times; P. orbicularis, seven; P. pulverulenta, two; and P. ciliata, one. (The last two are not included in the discussion because of insufficient data.)

The distribution of P. stellaris is as follows: On aspen the highest constancy is reached in the vicinity of 10 meters. On red oak it is at approximately four meters and on red maple at six meters. A significant overlap in the vertical distribution of P. stellaris is evidenced on red oaks and red maples, as shown in figure 1. The distribution of P. aipolia differs from that of P. stellaris in that it has its greatest occurrence lower on all three species of tree, with peaks at no more than six meters (fig. 1). P. stellaris shows a preference for higher levels on aspen but no important differences in preference on oak or maple. P. adscendens has a broad

distribution on aspen with a slight peak at two meters and a relatively high constancy up to eight meters. On red maples P. adscendens peaks abruptly at two meters and is not present after eight meters. Only three specimens of P. adscendens were found on red oak, but they occurred at two-, four-, and eight-meter levels, suggesting a broad vertical distribution (fig. 1).

Schwerer (1962) reported that P. aipolia is highly directional in aspect. Her sample consisted of nine specimens from six aspens. Our larger sample of 36 specimens from 10 aspens indicates that the difference between the distribution on the north and south sides of the trees is less than 6% at any level, with the south side having two more specimens than the north. A similar pattern on aspen is shown by P. adscendens. P. stellaris also illustrates a lack of substantial difference between the north and south aspects, that difference being less than 8% (table 1).

Vertical distribution of the several species of Physcia follows patterns, as clearly shown by our data and also suggested in earlier studies by Garren (1963), Hinds (1968), Jones (1969), and Schwerer (1962). The reasons for the patterns and why they differ according to species of tree are difficult to assess. Some factors that could be correlated with vertical distribution are bark pH and water-holding capacity, nutrient leaching by stem flow, light intensity, and rate of evaporation, all varying at different levels. Hale (1967) suggested that bark pH may have a primary effect on germination of spores of lichen fungi and on growth of free-living algae suitable for lichenization. Bark porosity, hardness, and water-holding capacity are related to evaporation rate. Hale found that the order of magnitude of the rate of evaporation from different species of hardwoods is not sufficient to explain differences in lichen communities. Light gradients and humidity gradients would seem to be important factors affecting vertical distribution. Certain correlations

can be made with vertical distribution, but the lack of a gradual transition from one species to another from the base upward and the presence of some species along the entire length of the trunk indicate that none of these factors is likely to be the sole influencing agent.

It has been demonstrated, especially by Garren's work on windthrown trees in Minnesota, that on Populus grandidentata, Physcia aipolia is more typically found at lower levels, whereas P. stellaris is more abundant upward. This would seem to provide a biological basis for recognizing two species which differ more in chemistry than in structure. It is an interesting result of our study, based on a larger and more random sample, that such a difference does indeed exist on Populus, but not on other trees under investigation. Populus is a pioneer in the succession leading toward the local hardwood climax, and Physcia stellaris plays a pioneering role on that tree, showing a distinct preference for the younger, more exposed, upper levels. It is surprising to find that on red maple, equally a pioneer species, it favors older, more protected, lower levels, as it does also on red oak which may be somewhat higher in the successional series and presumably offering somewhat more shade and greater humidity. We do not have the physical measurements to show what the differences are at various levels on different trees, but it appears that there is no correlation with the changes in light intensity and humidity associated with succession . It is true that Physcia aipolia shows a preference for lower levels in all the trees investigated, and this has some chemotaxonomic significance, but unless other bark factors can be correlated with vertical distributions, the support for chemotaxonomy supposedly provided by vertical distributions alone must be de-emphasized.

Acknowledgments

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References

Garren, F. R. 1963. The vertical distribution of lichens on aspen. Unpublished report, Itasca Biological Station.

Hale, M. E., Jr. 1967. The Biology of Lichens. Edward Arnold Ltd., London. 176 pp.

Hinds, H. R. 1968. A vertical survey of lichen species on the bark of bigtooth aspen in the Douglas Lake area of Pellston, Michigan. Unpublished report, University of Michigan Biological Station.

_____. 1970. Vertical distribution of lichens on aspens in Michigan. Bryologist 73:626-628.

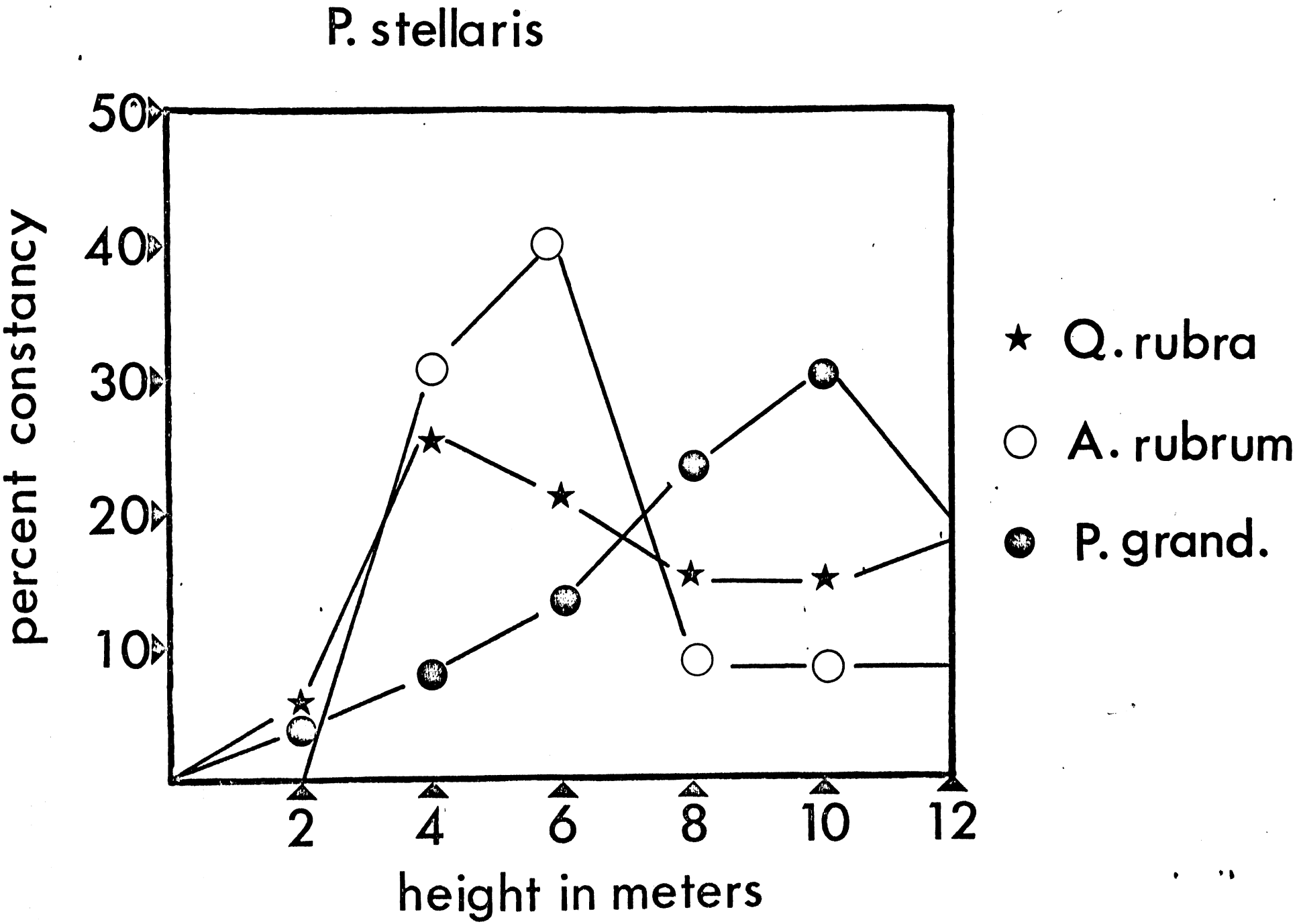
Jones, R. E. 1969. Vertical distribution of Physcia stellaris (L.) Nyl. and Physcia aipolia (Ehrh.) Hampe on bigtooth aspen and northern red oak in the vicinity of Douglas Lake, Michigan. Unpublished report, University of Michigan Biological Station.

TABLE 1. Summary of relative frequency and aspect occurrence of species of *Physcia* on bigtooth aspen, northern red oak, and red maple.

	Total Occurrence	Relative Frequency	Aspect	
			North	South
P. stellaris	60	40%	43	42
P. aipolia	31	21%	19	24
P. adscendens	41	27%	22	23
P. orbicularis	7	5%	4	6
P. millegrana	8	5%	3	4
P. ciliata	1	less than 1%	1	0
P. pulverulenta	2	1%	0	2

Fig. 1. Graphs showing the constancy of three species of *Physcia* at different levels on the trunks of *Quercus rubra*, *Acer rubrum*, and *Populus grandidentata*.

Fig. 1


P. stellaris
50
40
30
20
10
percent constancy
2
4
6
8
10
12
height in meters
★ Q. rubra
○ A. rubrum
● P. grand.

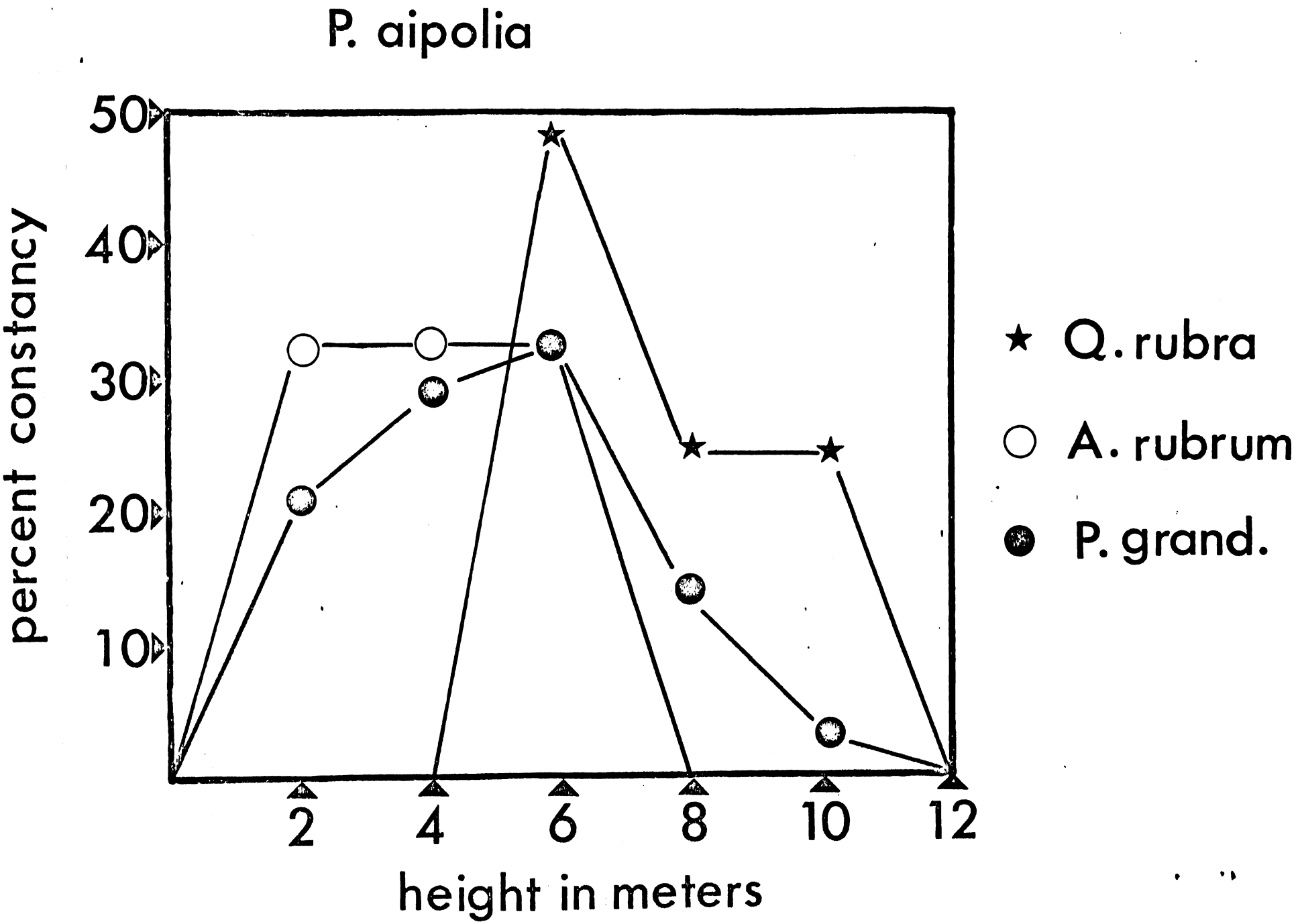
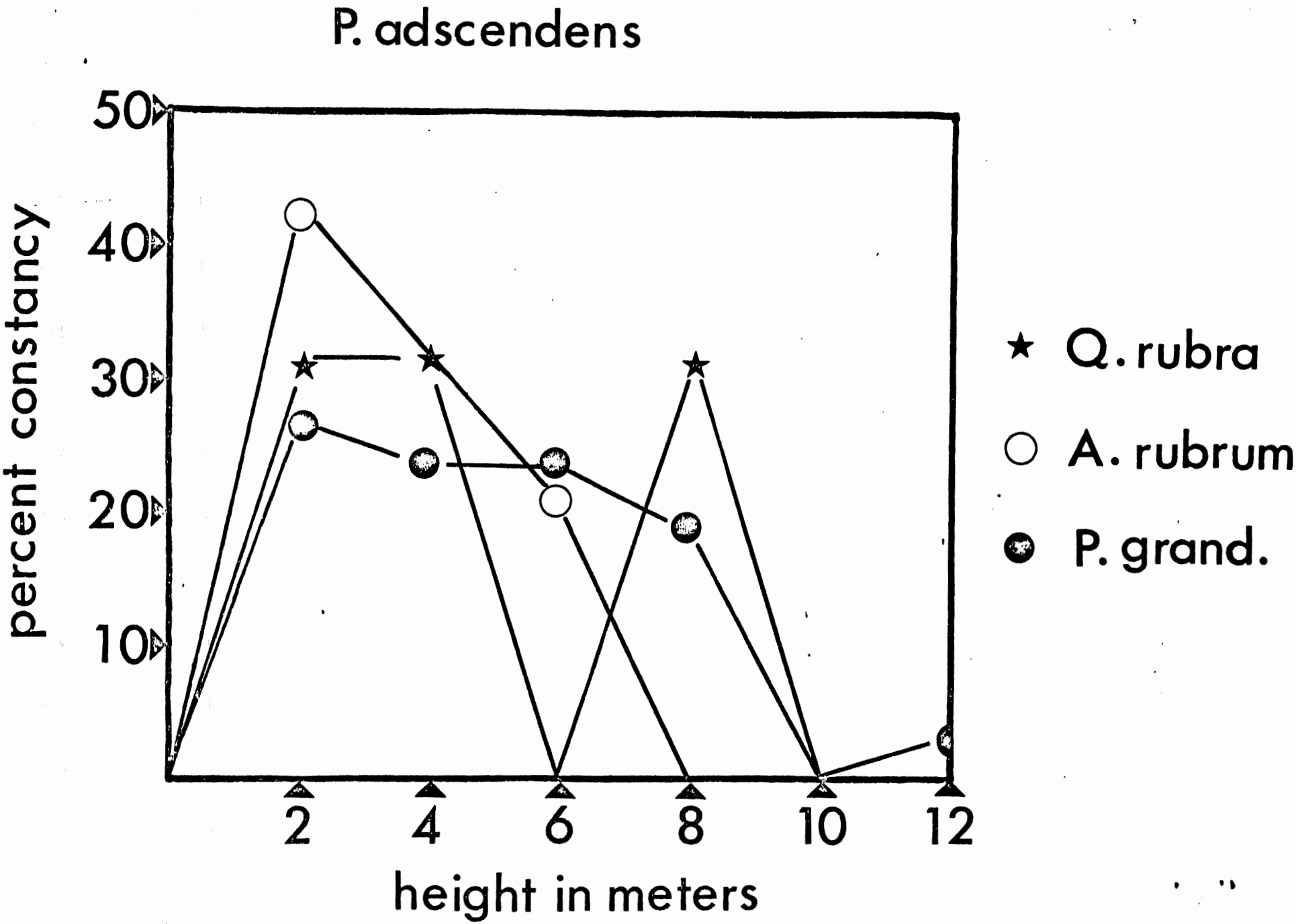

P. aipolia
50
40
30
20
10
percent constancy
2
4
6
8
10
12
height in meters
Q. rubra
A. rubrum
P. grand.

Fig. 3.


P. adscendens
50
40
30
20
10
percent constancy
2
4
6
8
10
12
height in meters
Q. rubra
A. rubrum
P. grand.