

**Analysis of the streamside vegetation within the Hubbell Trading Post
Historic Site, Apache County, Arizona**

**Marc Baker
November 1998**

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Abstract

Foliar height density of perennial vascular plants and percent cover of annual vascular plants were estimated for the riparian vegetation along Pueblo Colorado Wash within the boundaries of the Hubbell Trading Post National Historic Site, Apache County, Arizona. Data were recorded as a baseline for assessing changes in vegetation over time. Two sets of transects were established. One set was established along the south bank of the intermittent stream, where there had undergone efforts to eradicate the exotic shrubs, *Elaeagnus angustifolius* (Russian-olive) and *Tamarix ramosissima* (salt-cedar). The other set of transects was established along the north bank, where there had been no treatment. Both sets of transects were measured in mid-July and transects within the treated area were remeasured in late September. Foliar height density of woody vegetation, including that for seedlings, was very low within the treated area. There were no apparent differences in perennial vegetation between the summer and fall transects. Woody vegetation within transects of the untreated bank was dominated by *E. angustifolius* and *T. ramosissima*, while *Populus deltoides* (Eastern cottonwood) was common. *Eleocharis parishii* (Parish spikerush) and *Scirpus pungens* (common three-square) were the dominant herbaceous perennials and *Xanthium strumarium* (cocklebur) was the dominant annual. Along the dry banks within the treated area, percent cover of annuals increased dramatically from summer to fall.

Introduction

The primary purpose of the present study was to establish baseline data in order to monitor future changes in vascular vegetation within channel habitat where attempts were being made to eradicate the exotic shrubs, *Elaeagnus angustifolius* L. (Russian-olive) and *Tamarix ramosissima* Ledeb. (salt-cedar). The site occurs along Pueblo Colorado Wash within the Hubbell Trading Post National Historic Site, Apache County, Arizona. The south bank of the wash had been treated both mechanically and with herbicides during the spring of 1998. It is the long-term goal of the U. S. Park Service to reestablish the channel vegetation to that which preceded its invasion by exotic species.

In order to estimate composition and structure of the present channel vegetation, foliar height density by species of perennial vascular plants and percent cover by species of annual vascular plants were measured along bankside transects. Two sets of transects were established, one, along the south bank of the intermittent stream, in treated habitat and the other, along the north bank, in untreated habitat. Both sets of transects were measured mid-summer 1998 and transects within the treated area were remeasured early fall 1998. Thus, vegetation within the treated area was estimated before and after the period of highest average rainfall for central Arizona (Bulk 1985).

Methods

Vegetation sampling

Vegetation sampling along both sides of Pueblo Colorado Wash was conducted 16-17 July 1998 and the sampling for the treated area was repeated 28-29 September 1998. Thirteen 40m transects were established along the intermittent stream channel, seven along the treated bank and six along the untreated bank. Treated and untreated transects were paired except in one case, where the Park boundary was too close to the channel to allow room for the establishment of an untreated transect. The objectives of the transects were to estimate foliar-height density of perennial vegetation and cover of annuals. Foliar height distribution was recorded as "hits" along vertical poles. In addition to providing a measure of vegetation structure, this method estimates total vegetation volume (TVV) or the sum total of cubic decimeters within the transect's rectangular box ($40\text{m} \times 1\text{dm} \times \text{vegetation height} [\infty]$) that contain vegetation. The method is a modified version of the vertical-line intercept of MacArthur & Horn (1969) and vegetation volume of Mills et al. (1991). We chose foliar height distribution estimation over the line intercept method because the latter estimates vegetation cover only and does not account for vegetation height or structure within the canopy. Also TVV correlates closely with breeding bird densities (Mills et al. 1991), which is a primary management concern for the Park.

The present analysis was modified from Mills et al. (1991) by recording "hits" of perennial vegetation along the vertical axes by meters instead of by decimeters. From a practical perspective, this facilitated an increase in the number of transects thereby enhancing statistical significance.

Seven reference points were selected within the Park boundaries such that they were as evenly distributed as possible and easily relocated. At least one photograph was taken of each with a reference placard placed at the point.

Starting points (00m) of transects were established non-randomly at ca. 100m increments along the channel without bias with respect to the condition of the vegetation. The transects were situated at least 40m from the Park boundary in order to avoid boundary effects. Starting points were marked with 0.5in rebar at a point 20m bankside from the water's edge or the outer edge of obligate wetland graminoids, such as *Eleocharis parishii* Britton (Parish spikerush) and *Scirpus pungens* Vahl (common three-square). The transects were directed perpendicular toward the stream channel for 20m, then, to the right along the channel edge regardless of sinuosity for an additional 20m. The bearing from the starting point to the turn was recorded as degrees east of magnetic north.

Measurements were taken every two meters along the transect beginning with meter two. A nine meter collapsible pole was set vertically and living perennial vegetation within 1dm of the pole was recorded in height increments of 1m. This was done by recording the acronym of the plant species that fell within a particular meter mark on the pole. Thus for each 40m transect, vegetation volume, according to species, was sampled within twenty cylinders with a radius of 1dm.

At each 2m point along each transect a 20cm by 50cm (0.1m²) Daubenmire Grid was laid on top of the herbaceous layer and the cover of annuals was estimated by counting the number of squares occupied. The cover was recorded as cover classes one through seven (1= <1%, 2= 1-5%, 3= 5-25%, 4= 25-50%, 5= 50-75%, 6= 75-95%, 7= 95-100%).

Plant collections

At least one sample was collected for most plant taxa encountered along the transects. Species that were not sampled included those which occurred only as a few individuals or which were not fertile during the sampling periods. Samples were pressed on site in a standard 12in × 18in field press and later rearranged and repressed in a standard herbarium press. Presses were placed on an asphalt roof to dry or, in wet weather, within a dryer. Field notes included elevation, Universal Transverse Mercator [UTM] grid system coordinates, USGS quadrangle, distances from major landmarks, date, collection number, substrate type, community type, frequency, and plant associates. Also recorded were characteristics of the individuals or population that would not be apparent after the specimen was pressed and dried. Collection data were entered into a Word Perfect® 5.1 database and merged via a primary file into a text file for printing.

Results and discussion

Table 1 is a list of the vascular plant transects, along with the dominant perennial and the dominant annual. Table 2 is a summary of vegetation type, location, canopy height, and vegetation volume data for each transect.

The average TVV among all of the summer transects was $1.35\text{m}^3/\text{m}^2$, varying from $0.30\text{m}^3/\text{m}^2$ in treated habitat to $3.80\text{m}^3/\text{m}^2$ within the untreated habitat. The average TVV among the summer treated transects was $1.06\text{m}^3/\text{m}^2$ compared to $3.27\text{m}^3/\text{m}^2$ for the untreated transects. Almost all the difference being attributable to the eradication of *Elaeagnus angustifolius* and *Tamarix ramosissima* within the treated area. The average TVV for the fall treated transect was $1.43\text{m}^3/\text{m}^2$ or not much higher than the summer average. Figures 1-20 are graphs of the vegetation volume for each transect. Figures 1-13 represent summer transects and 14-20 represent fall transects. These graphs were designed to present a visualization of a cross-section of vegetation along the transects.

As expected, the dominant perennials along the banks of the untreated transects were *Elaeagnus angustifolius* and *Tamarix ramosissima* with the native *Populus deltoides* dominating only the two easternmost transects. The dominant streamside perennial of both the untreated and treated transects was *Scirpus pungens*. The perennial bank vegetation of the treated transects was dominated by *Chrysothamnus nauseosus* (rabbit-brush) and *Sporobolus cryptandrus* (sand drop-seed).

Summer annuals along the dry banks were few and sparse on all transects. Nearly all were weedy exotics, including *Carduus nutans* (musk-thistle), *Kochia scoparia* (summer-cypress), and *Salsola kali* (Russian-thistle). Annuals on the banks of the treated transects increased dramatically in fall, both in percent cover and diversity (Table 3). The average percent cover in the fall was 13.6% compared to a mere 0.9% in the summer. The dominant fall annuals along the treated banks were *Ambrosia acanthicarpa* (annual bursage), *Bromus rubens* (red brome), *Croton texensis* (Texas doveweed), *Erodium cicutarium* (filaree), *Hordeum marinum* (annual barley), and *Polygonum aviculare* (prostrate knotweed). In both summer and fall, the streamside annual flora was dominated by the cosmopolitan weed *Xanthium strumarium*. Figures 21-40 are graphs of the percent cover of annuals along the transects. Figures 21-33 represent summer transects and figures 34-40 represent fall transects.

Literature cited

Bulk, H. 1985. Useful climatic statistics for thirty-eight Arizona locations. Climatological Publications, Climate & Energy Series #6:98. Laboratory of Climatology, Arizona State University, Tempe, Arizona.

MacArther, R. and H. Horn. 1969. Foliage profile by vertical measurements. Ecology 50:802-804.

Mills, S., J. Dunning, and J. Bates. 1991. The relationship between breeding bird density and vegetation volume. Wilson Bulletin 103:468-479.

Table 1. Summary of dominant vegetation along transects.

Transect Number	dominant perennials		dominant annual, summer		dominant annuals, fall	
	bank	streamside	bank	streamside	bank	streamside
1	<i>Sporobolus cryptandrus</i>	<i>Scirpus pungens</i>	none	<i>Xanthium strumarium</i>	<i>Erodium cicutarium</i>	<i>Xanthium strumarium</i>
2	<i>Sporobolus cryptandrus</i>	<i>Scirpus pungens</i>	none	<i>Xanthium strumarium</i>	<i>Hordeum marinum</i>	<i>Xanthium strumarium</i>
3	none	<i>Populus deltoides</i>	none	<i>Xanthium strumarium</i>	<i>Hordeum marinum</i>	<i>Xanthium strumarium</i>
4	<i>Chrysothamnus nauseosus</i>	<i>Convolvulus arvensis</i>	<i>Carduus nutans</i>	<i>Xanthium strumarium</i>	<i>Ambrosia acanthicarpa</i>	<i>Xanthium strumarium</i>
5	<i>Chrysothamnus nauseosus</i>	<i>Convolvulus arvensis</i>	none	<i>Xanthium strumarium</i>	<i>Bromus rubens</i>	<i>Bromus rubens</i>
6	<i>Chrysothamnus nauseosus</i>	<i>Scirpus pungens</i>	<i>Salsola kali</i>	<i>Xanthium strumarium</i>	<i>Croton texensis</i>	<i>Xanthium strumarium</i>
7	<i>Chrysothamnus nauseosus</i>	<i>Scirpus pungens</i>	<i>Polygonum aviculare</i>	<i>Xanthium strumarium</i>	<i>Polygonum aviculare</i>	none
8	<i>Elaeagnus angustifolia</i>	<i>Scirpus pungens</i>	none	<i>Medicago lupulina</i>	n/a	n/a
9	<i>Elaeagnus angustifolia</i>	<i>Elaeagnus angustifolia</i>	none	<i>Xanthium strumarium</i>	n/a	n/a
10	<i>Tamarix ramosissima</i>	<i>Scirpus pungens</i>	<i>Kochia scoparia</i>	<i>Xanthium strumarium</i>	n/a	n/a
11	<i>Elaeagnus angustifolia</i>	<i>Scirpus pungens</i>	none	<i>Xanthium strumarium</i>	n/a	n/a
12	<i>Populus deltoides</i>	<i>Scirpus pungens</i>	none	<i>Xanthium strumarium</i>	n/a	n/a
13	<i>Populus deltoides</i>	<i>Scirpus pungens</i>	<i>Chenopodium glaucum</i>	<i>Xanthium strumarium</i>	n/a	n/a

Table 3. Summary of vegetation type, location, canopy height, and vegetation volume data for each transect.

transect	association	reference point	heading east of magnetic north	distance from reference point	maximum height of perennials	average height of perennials	TVV
summer transects							
1	<i>Eleocharis parishii</i>	1	26.5°	47m	1m	0.15m	0.30m³/m².
2	<i>Scirpus pungens</i>	2	297°	67m	2m	0.40m	1.00m³/m².
3	<i>Populus deltoides</i>	3	355°	27.6m	10m	0.95m	2.50m³/m².
4	<i>Pascopyrum smithii</i>	4	358°	68m	1m	0.20m	0.40m³/m².
5	<i>Pascopyrum smithii</i>	5	321°	21.8m	1m	0.30m	0.70m³/m².
6	<i>Scirpus pungens</i>	6	296°	46m	1m	0.35m	1.10m³/m².
7	<i>Chrysothamnus nauseosus</i>	7	259°	12.7m	2m	0.55m	1.40m³/m².
8	<i>Elaeagnus angustifolia</i>	8			7m	1.10m	2.70m³/m².
9	<i>Elaeagnus angustifolia</i>	9			6m	1.95m	3.80m³/m².
10	<i>Tamarix ramosissima</i>	10			7m	1.85m	2.50m³/m².
11	<i>Elaeagnus angustifolia</i>	11			5m	1.80m	3.40m³/m².
12	<i>Populus deltoides</i>	12			12m	2.25m	3.60m³/m².
13	<i>Populus deltoides</i>	13			12m	1.65m	3.60m³/m².
fall transects							
1	<i>Scirpus pungens</i>	1	26.5°	47m	1m	0.50m	1.20m³/m².
2	<i>Scirpus pungens</i>	2	297°	67m	1m	0.40m	0.80m³/m².
3	<i>Populus deltoides</i>	3	355°	27.6m	11m	1.40m	3.30m³/m².
4	<i>Chrysothamnus nauseosus</i>	4	358°	68m	1m	0.40m	1.20m³/m².
5	<i>Chrysothamnus nauseosus</i>	5	321°	21.8m	1m	0.35m	0.90m³/m².
6	<i>Scirpus pungens</i>	6	296°	46m	1m	0.45m	1.40m³/m².
7	<i>Chrysothamnus nauseosus</i>	7	259°	12.7m	2m	0.50m	1.20m³/m².

Table 3. Summary of percent cover for annuals.

transect number	average percent cover of annual per transect point, summer	average percent cover of annual per transect point, fall
1	1.05%	24.9%
2	1.13%	20.0%
3	1.38%	8.75%
4	0.15%	3.5%
5	0.28%	5.88%
6	1.55%	19.88%
7	0.95%	12.3%
8	0.03%	n/a
9	0.03%	n/a
10	0.88%	n/a
11	0.40%	n/a
12	0.25%	n/a
13	2.25%	n/a

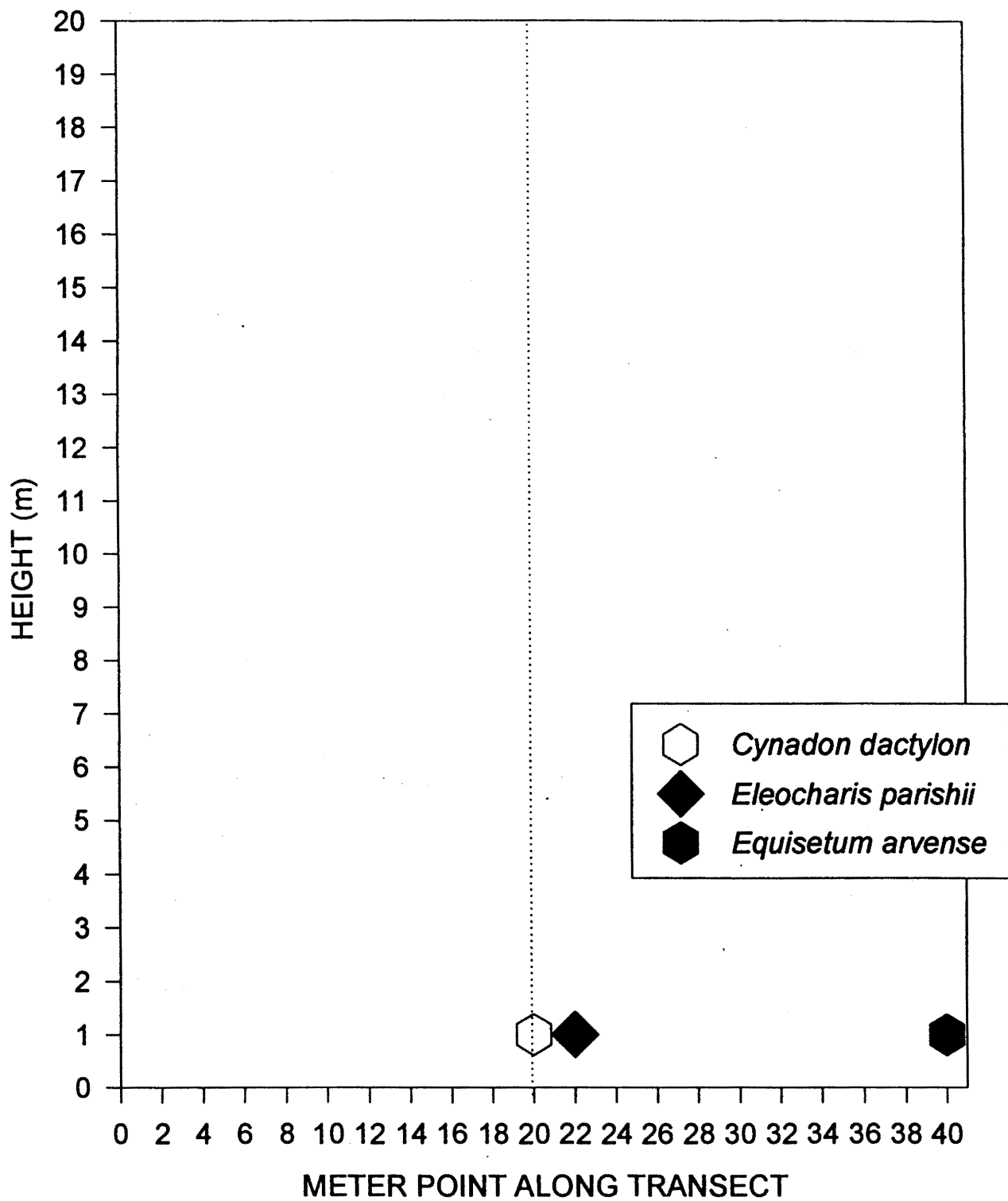


Figure 1. Transect 1 foliar height distribution, summer 1998.

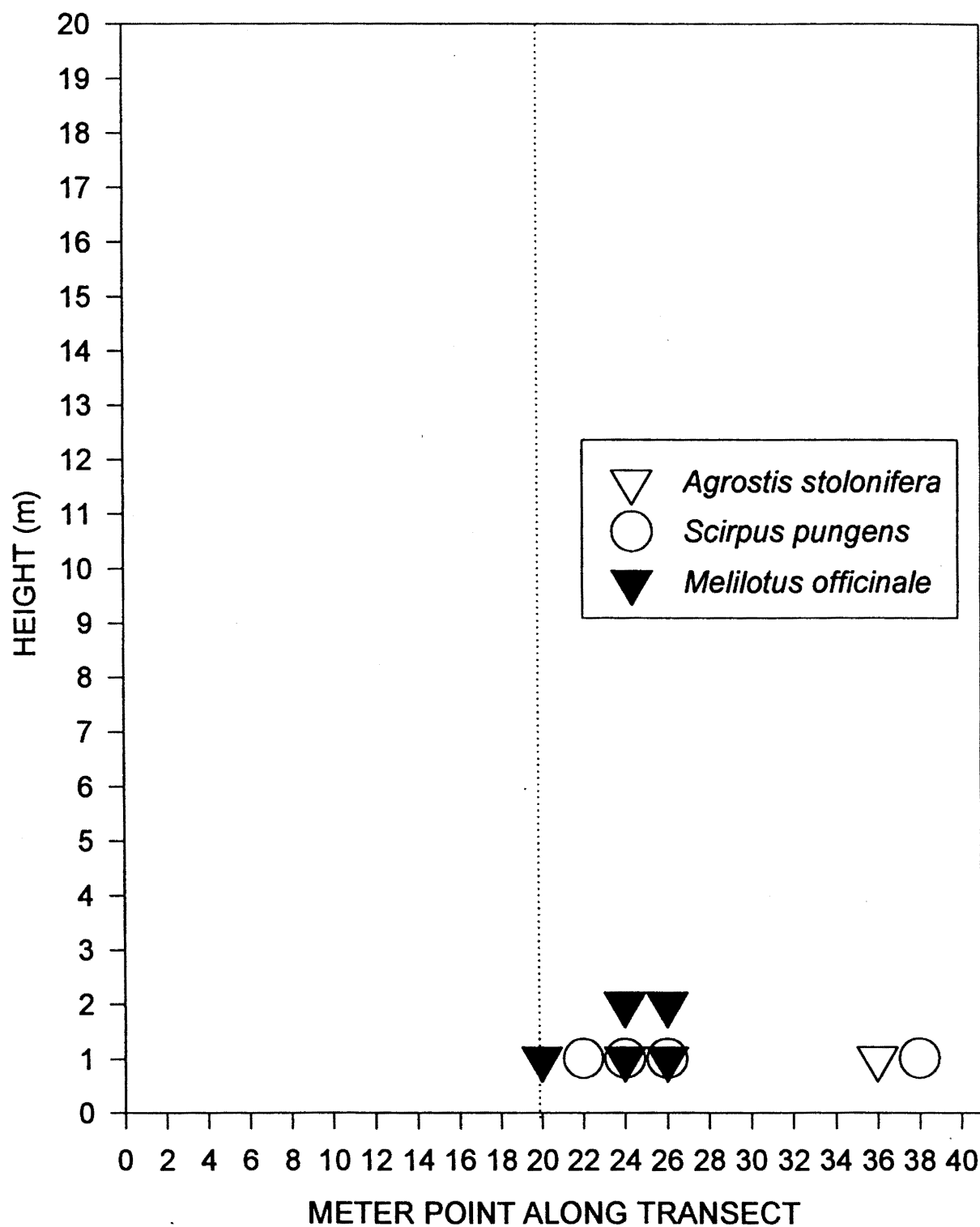


Figure 2. Transect 2 foliar height distribution, summer 1998.

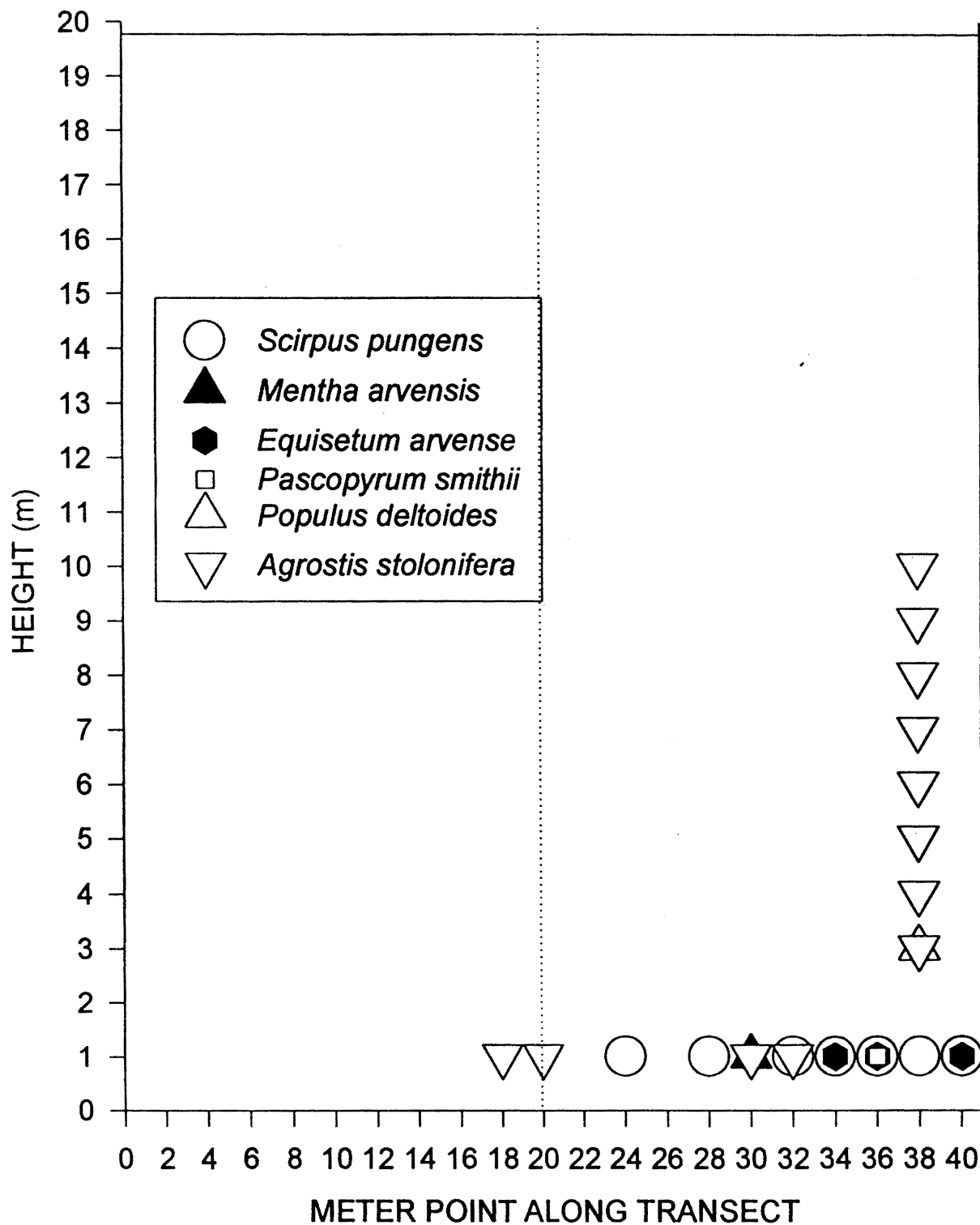


Figure 3. Transect 3 foliar height distribution, summer 1998.

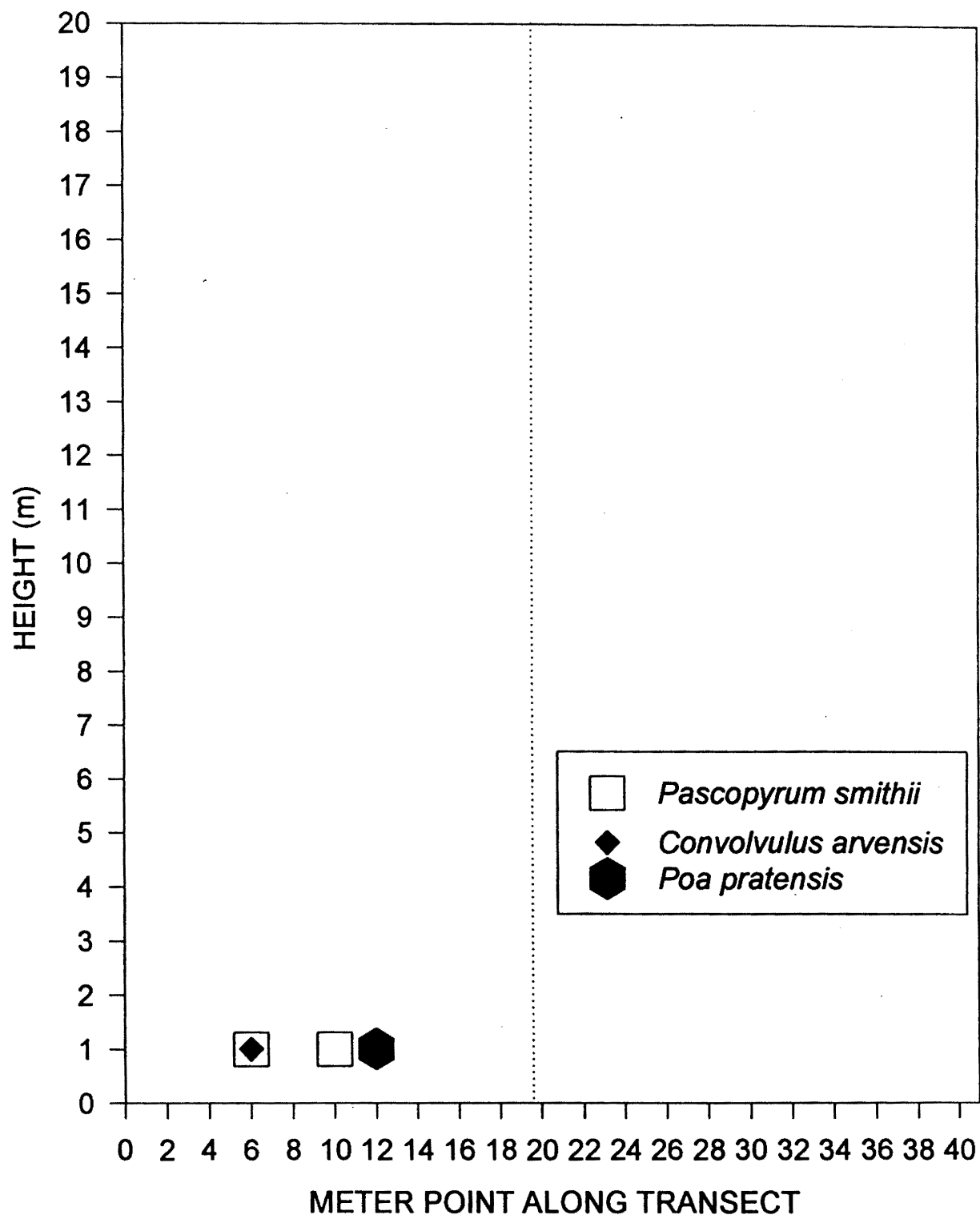


Figure 4. Transect 4 foliar height distribution, summer 1998.

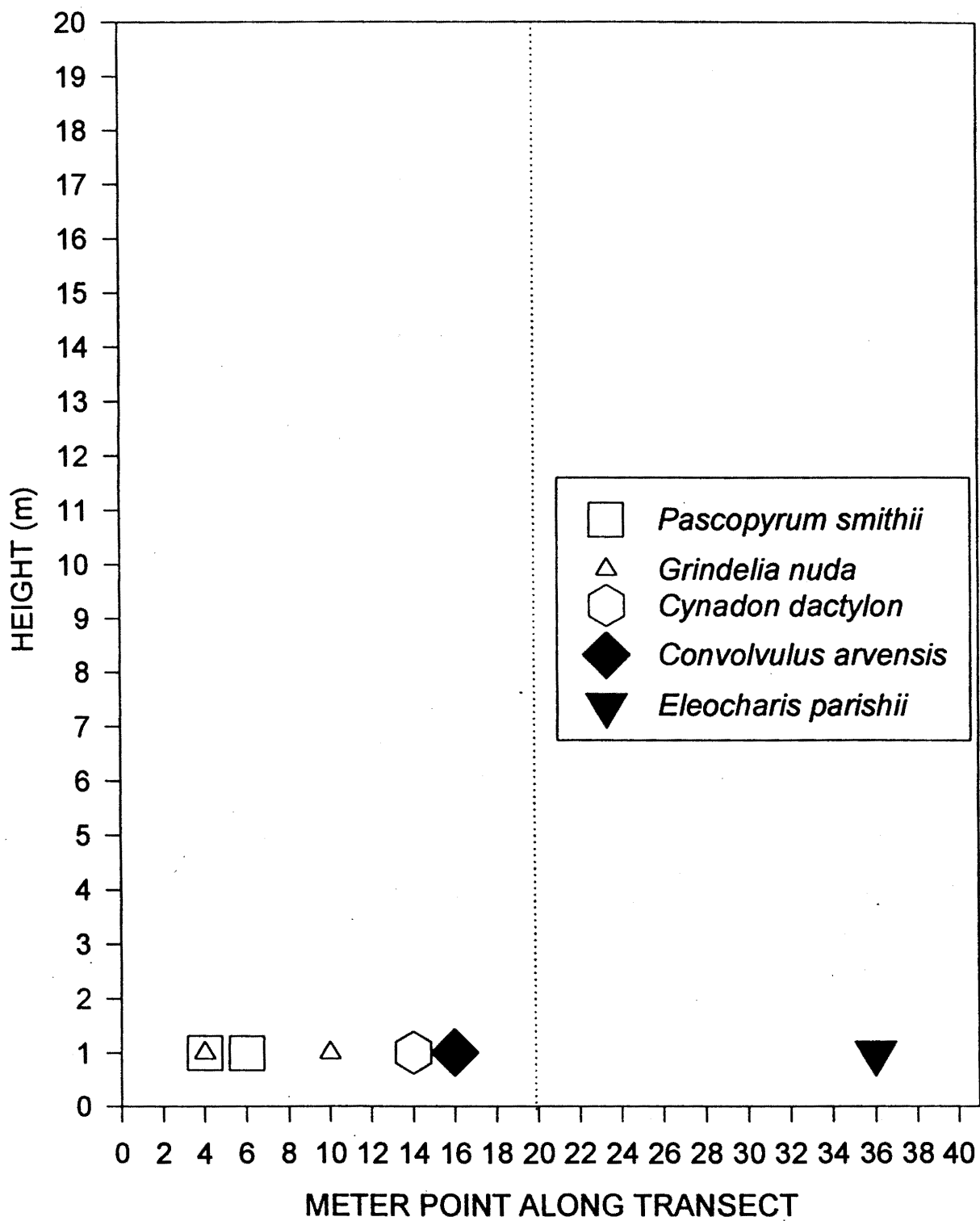


Figure 5. Transect 5 foliar height distribution, summer 1998.

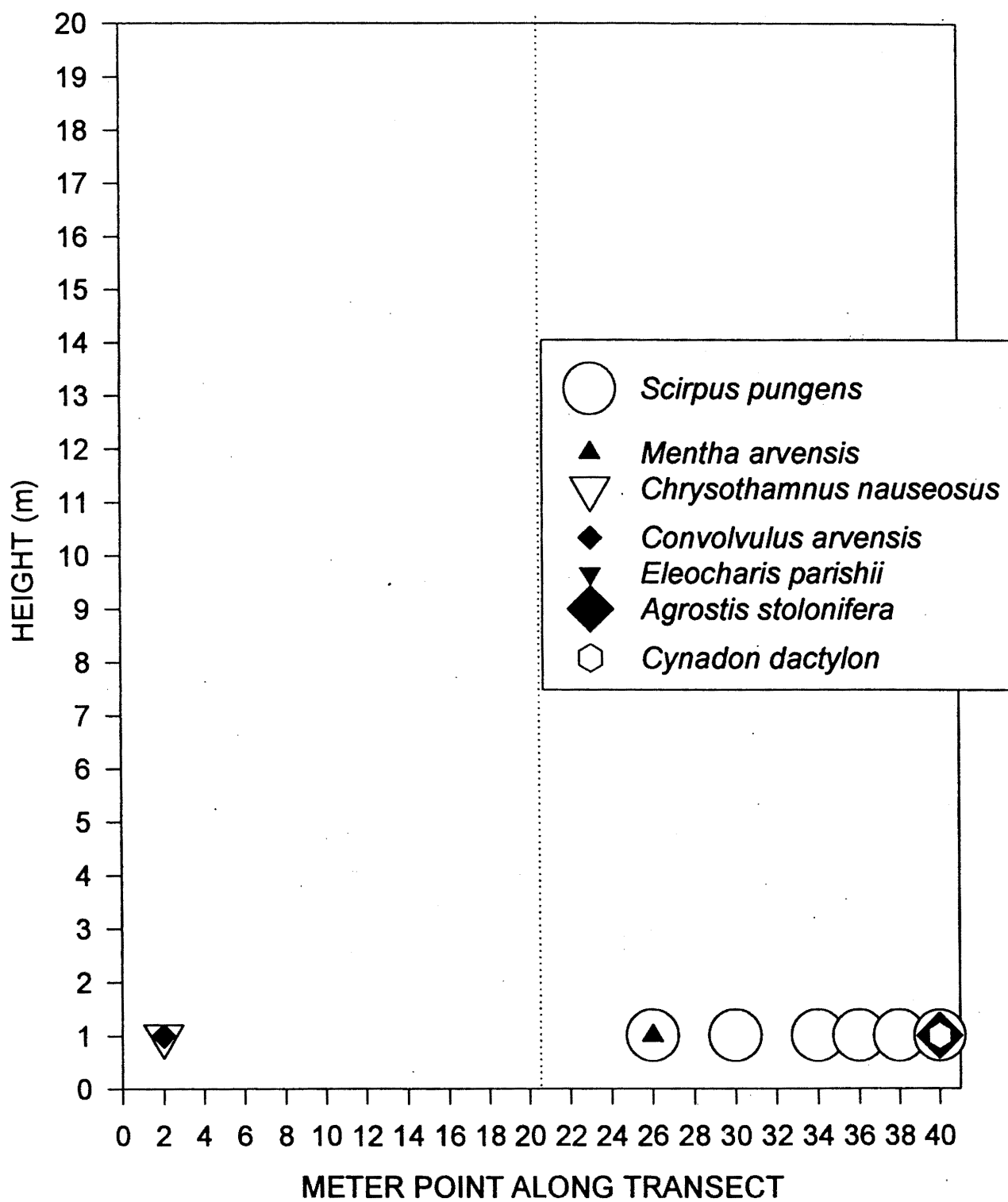


Figure 6. Transect 6 foliar height distribution, summer 1998.

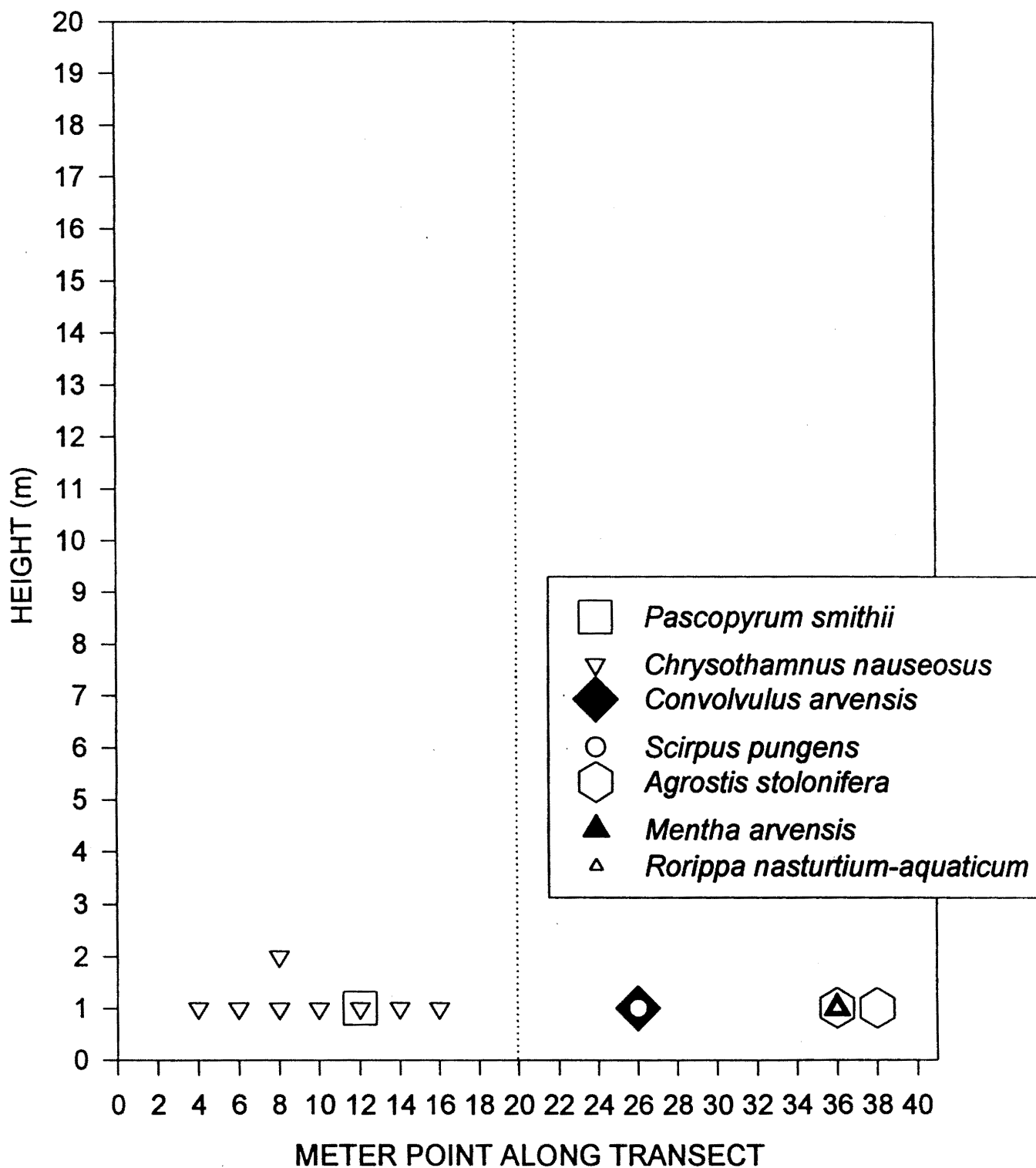


Figure 7. Transect 7 foliar height distribution, summer 1998.

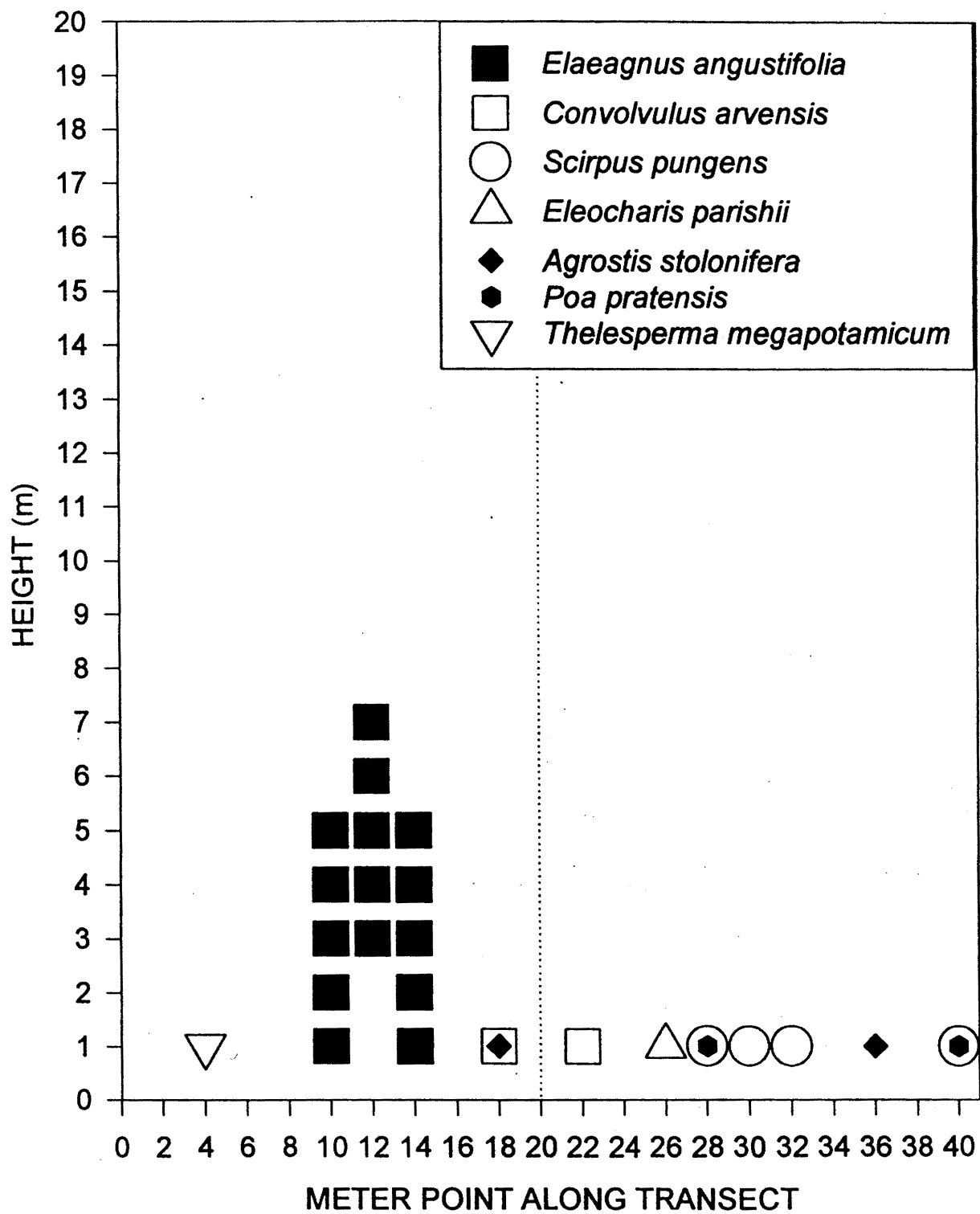


Figure 8. Transect 8 foliar height distribution, summer 1998.

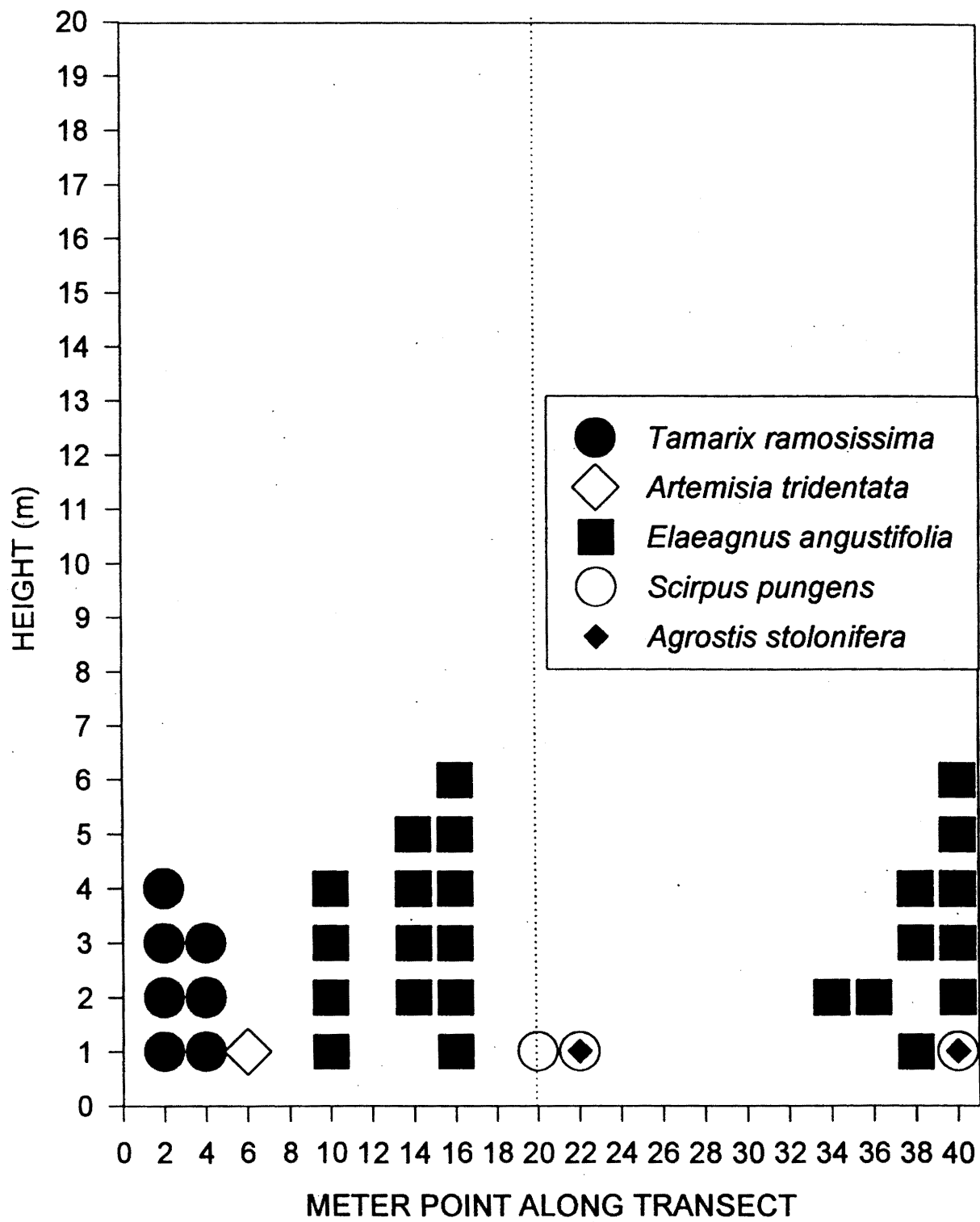


Figure 9. Transect 9 foliar height distribution, summer 1998.

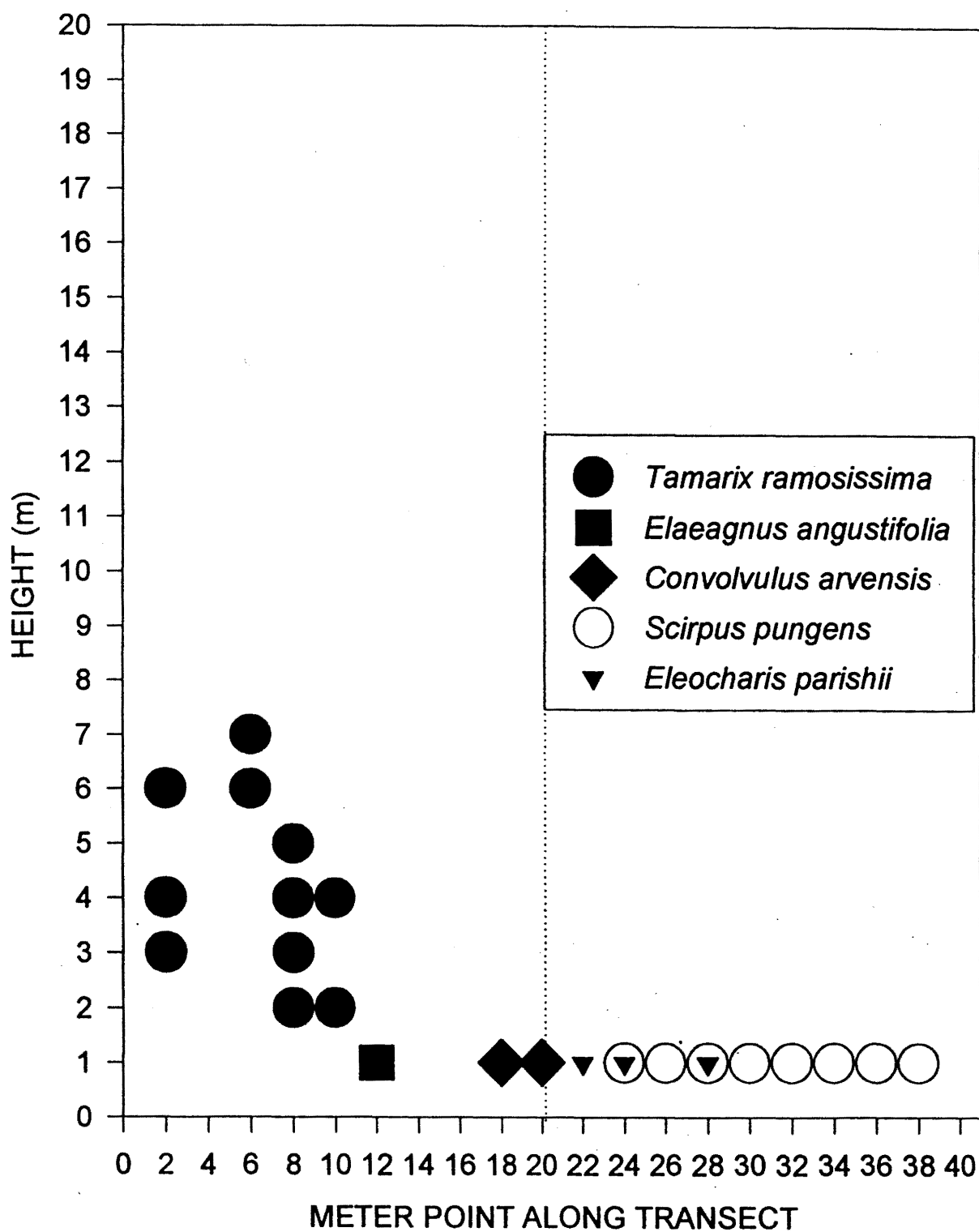


Figure 10. Transect 10 foliar height distribution, summer 1998.

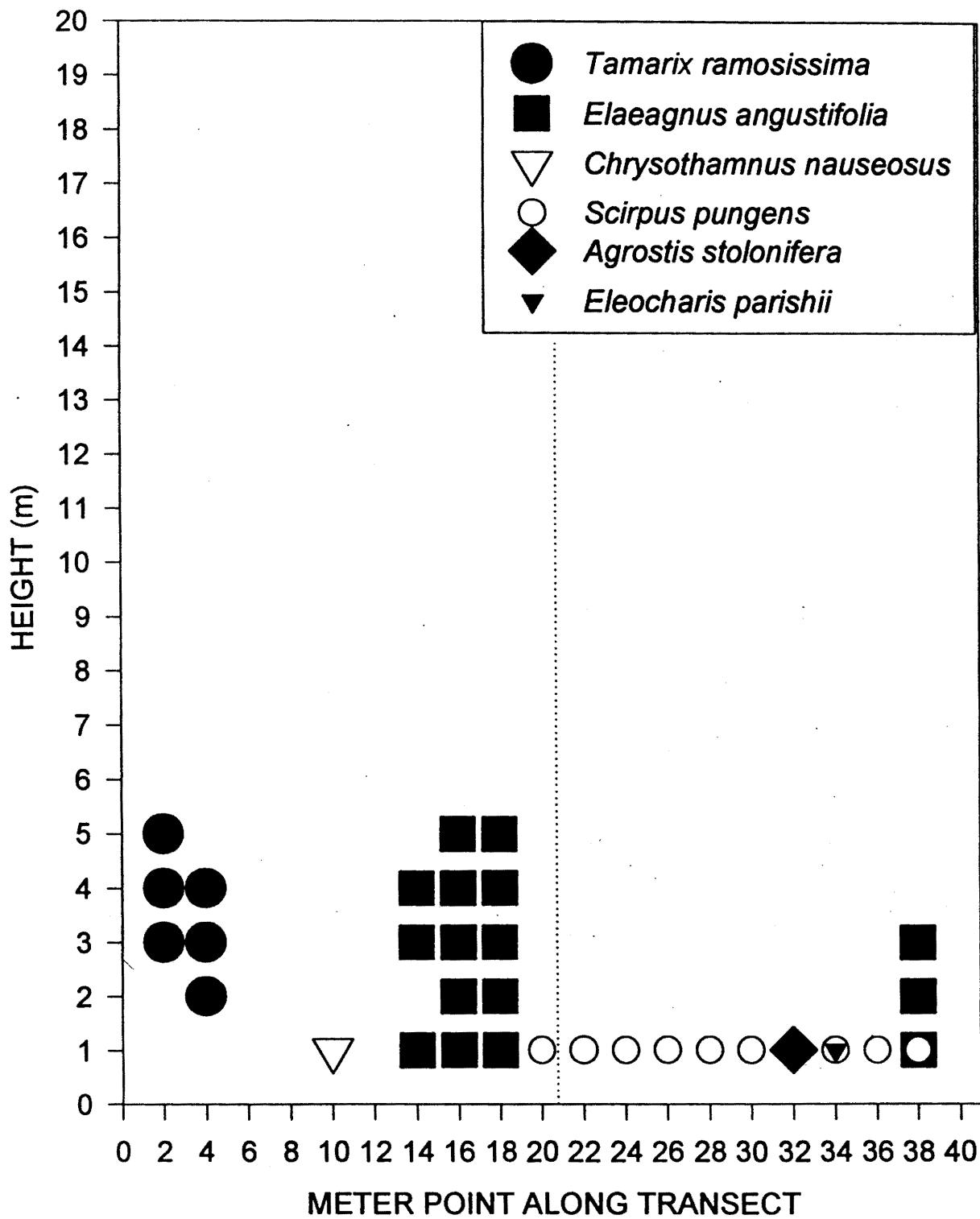


Figure 11. Transect 11 foliar height distribution, summer 1998.

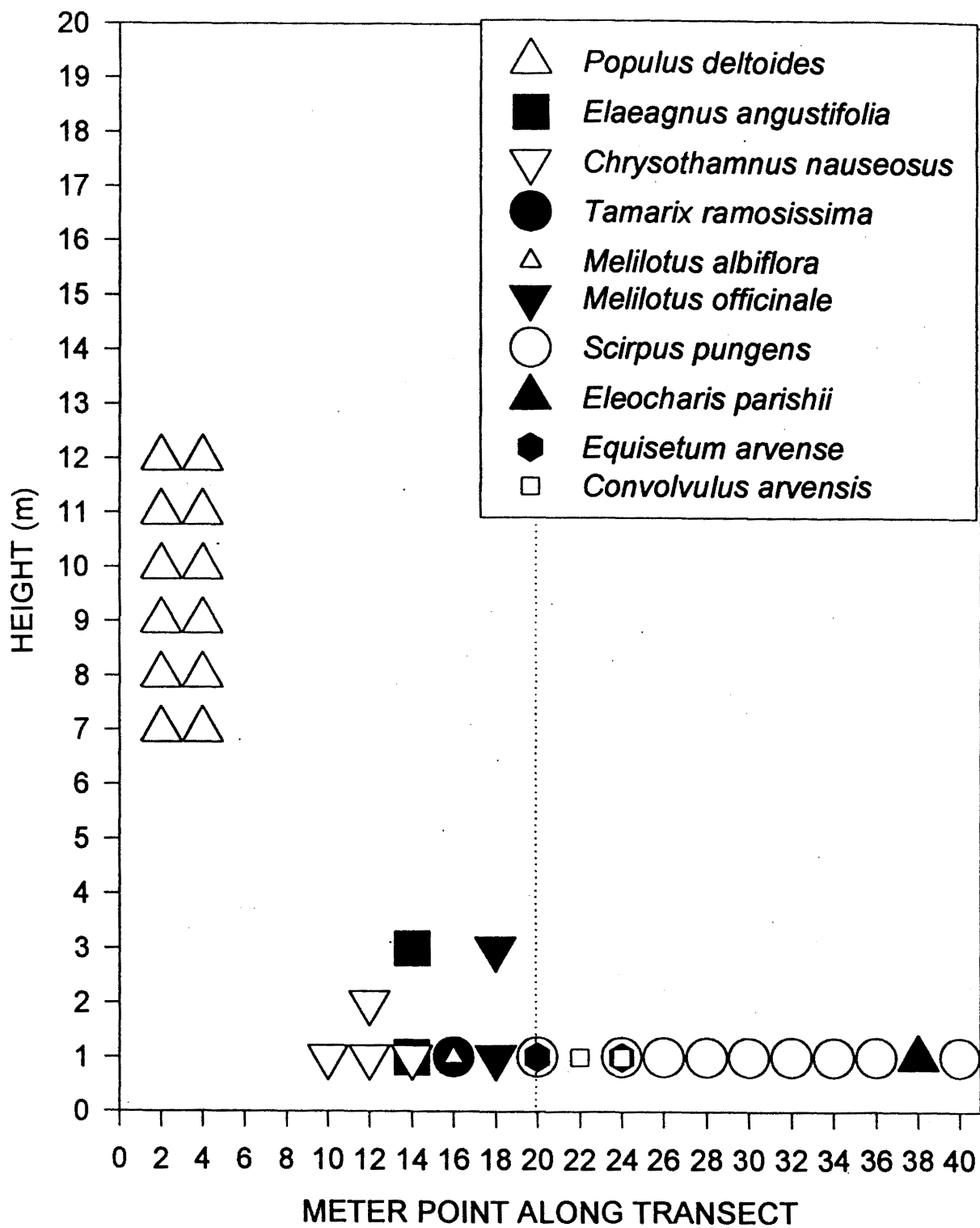


Figure 12. Transect 12 foliar height distribution, summer 1998.

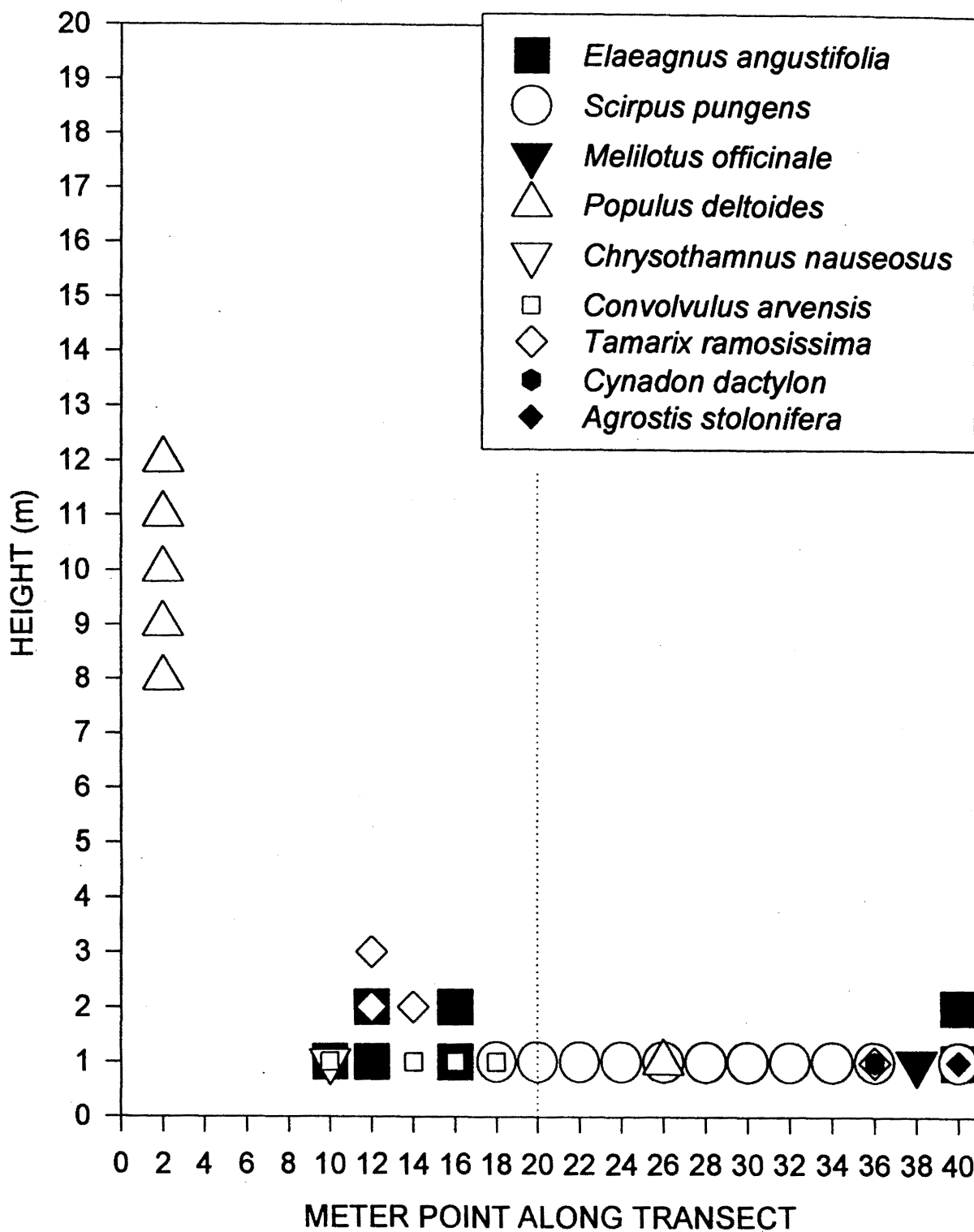


Figure 13. Transect 13 foliar height distribution, summer 1998.

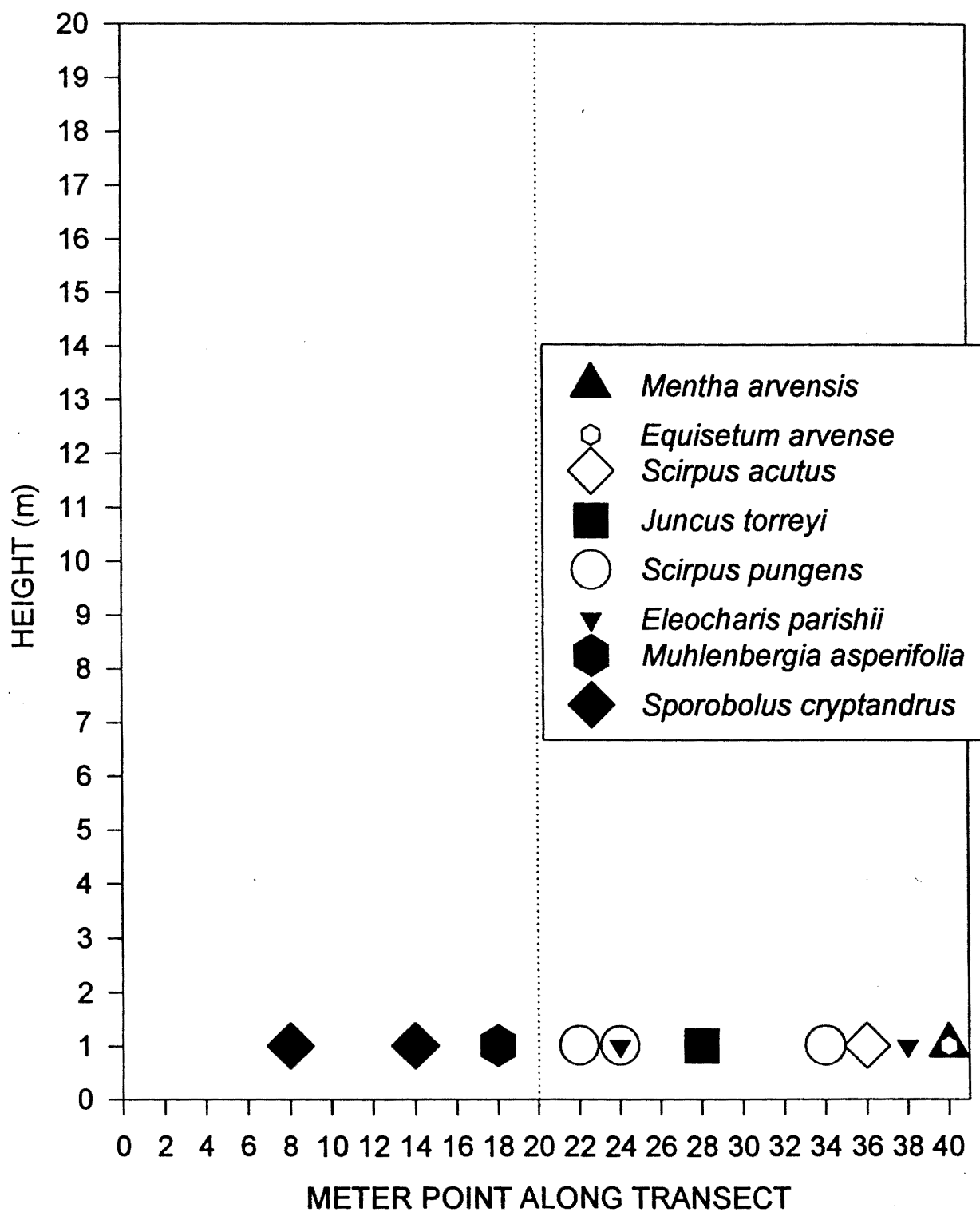


Figure 14. Transect 1 foliar height distribution, fall 1998.

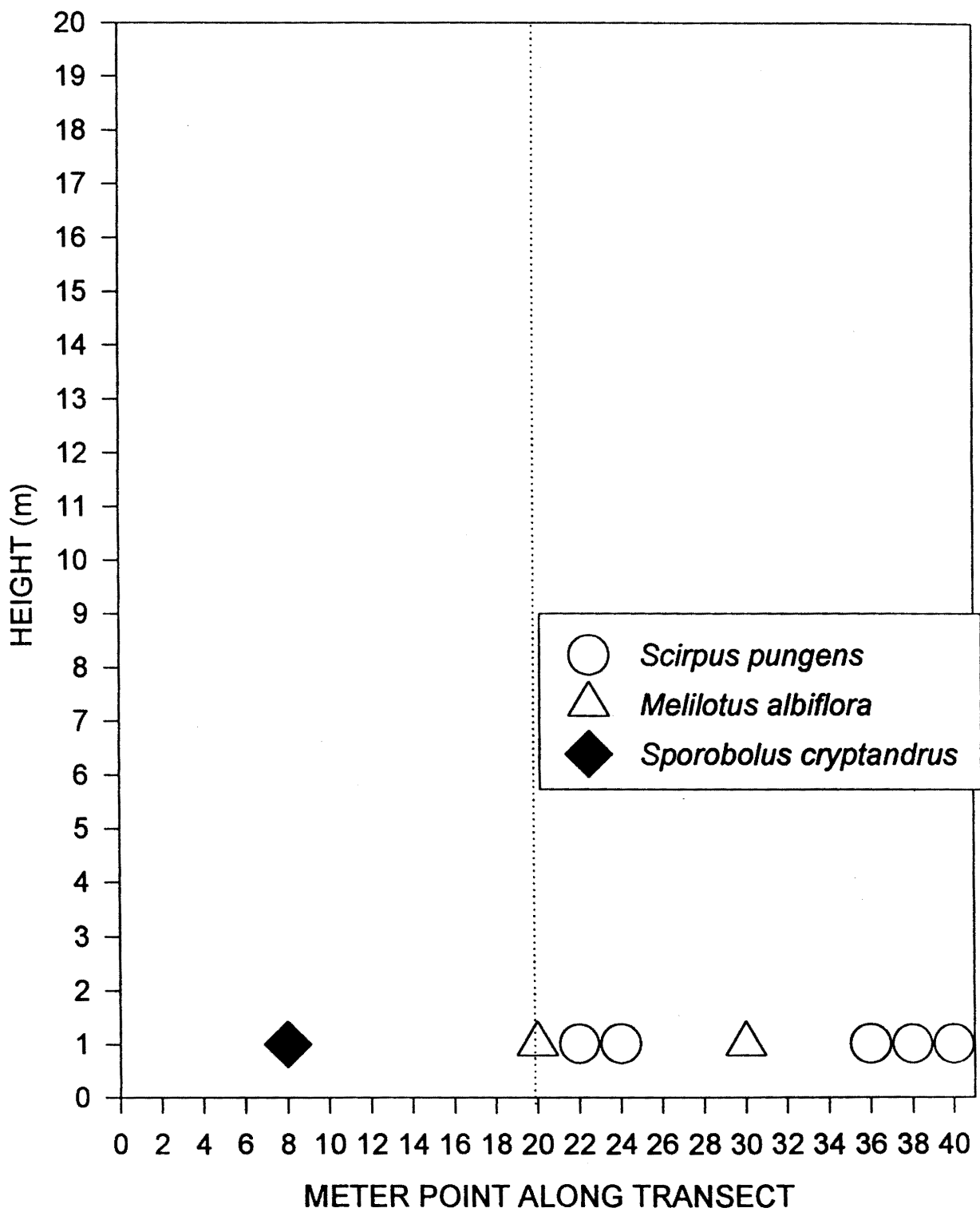


Figure 15. Transect 2 foliar height distribution, fall 1998.

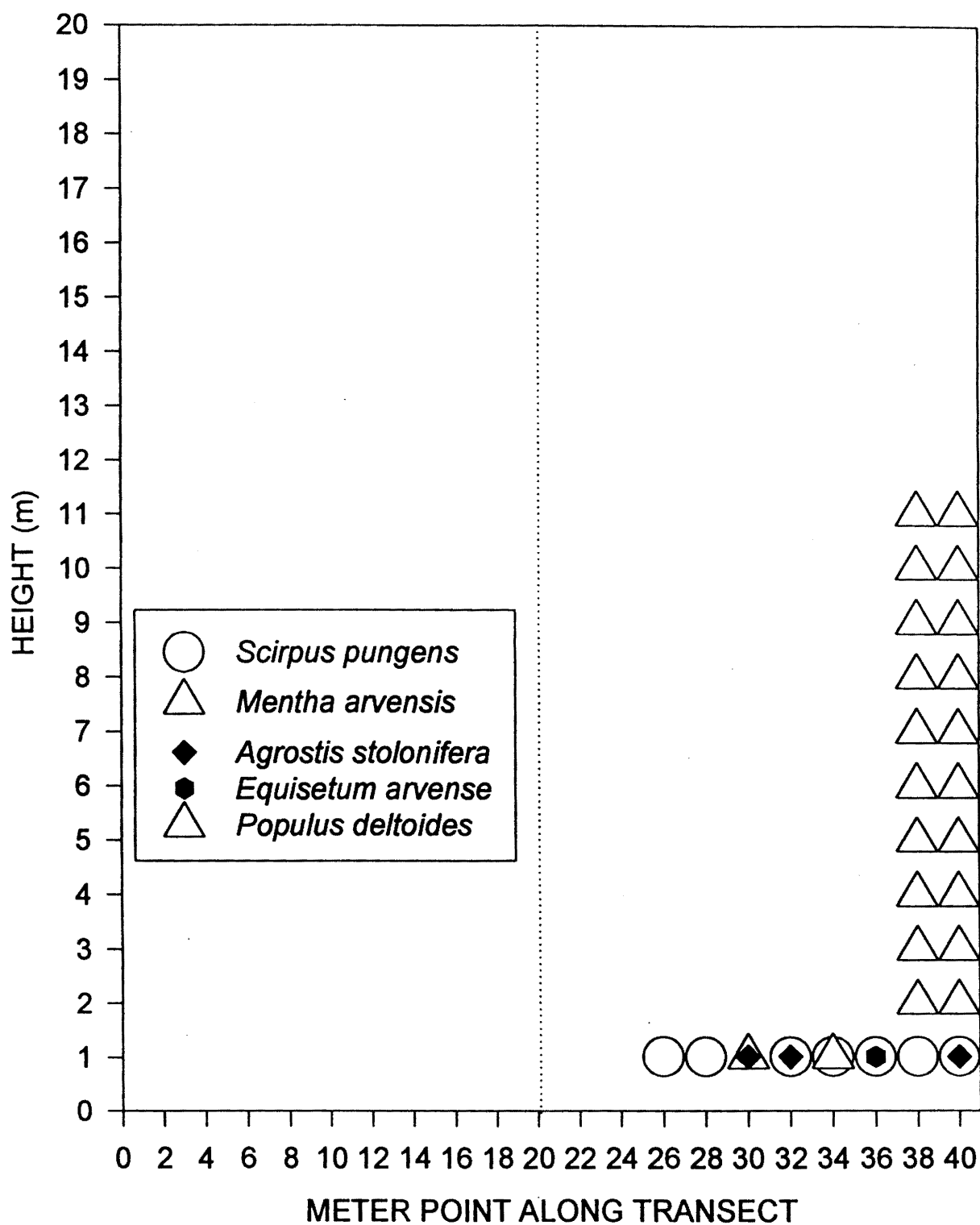


Figure 16. Transect 3 foliar height distribution, fall 1998.

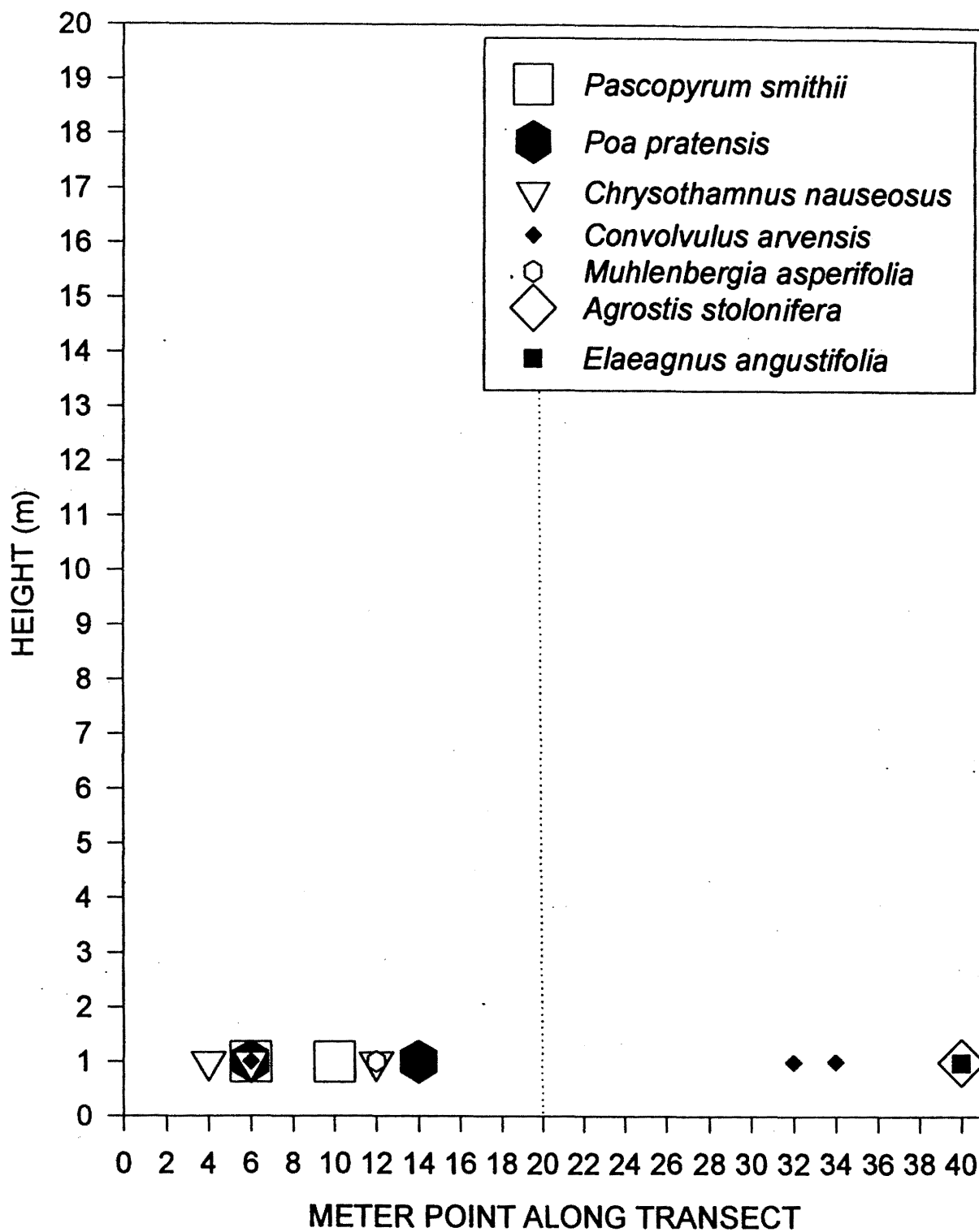


Figure 17. Transect 4 foliar height distribution, fall 1998.

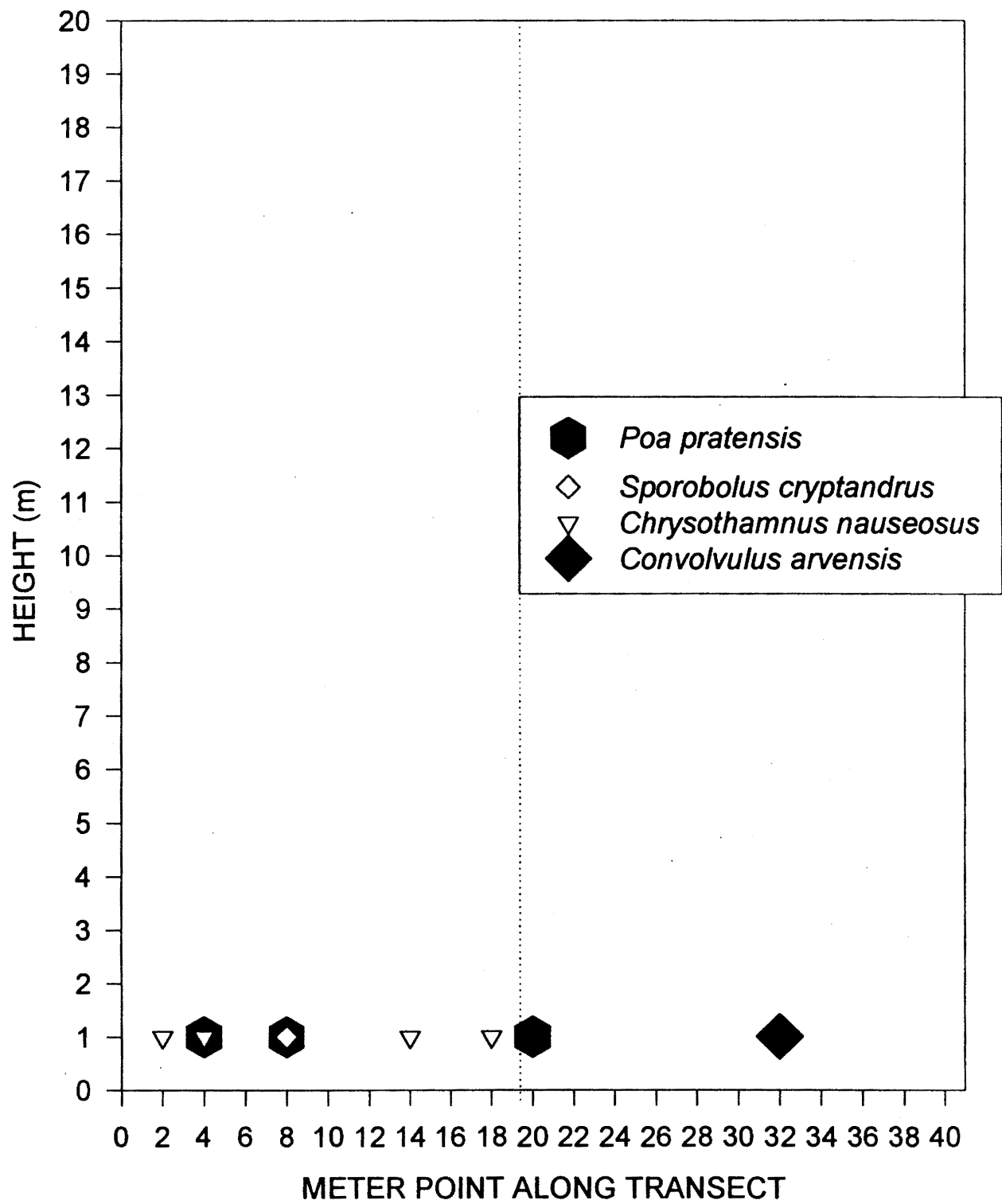


Figure 18. Transect 5 foliar height distribution, fall 1998.

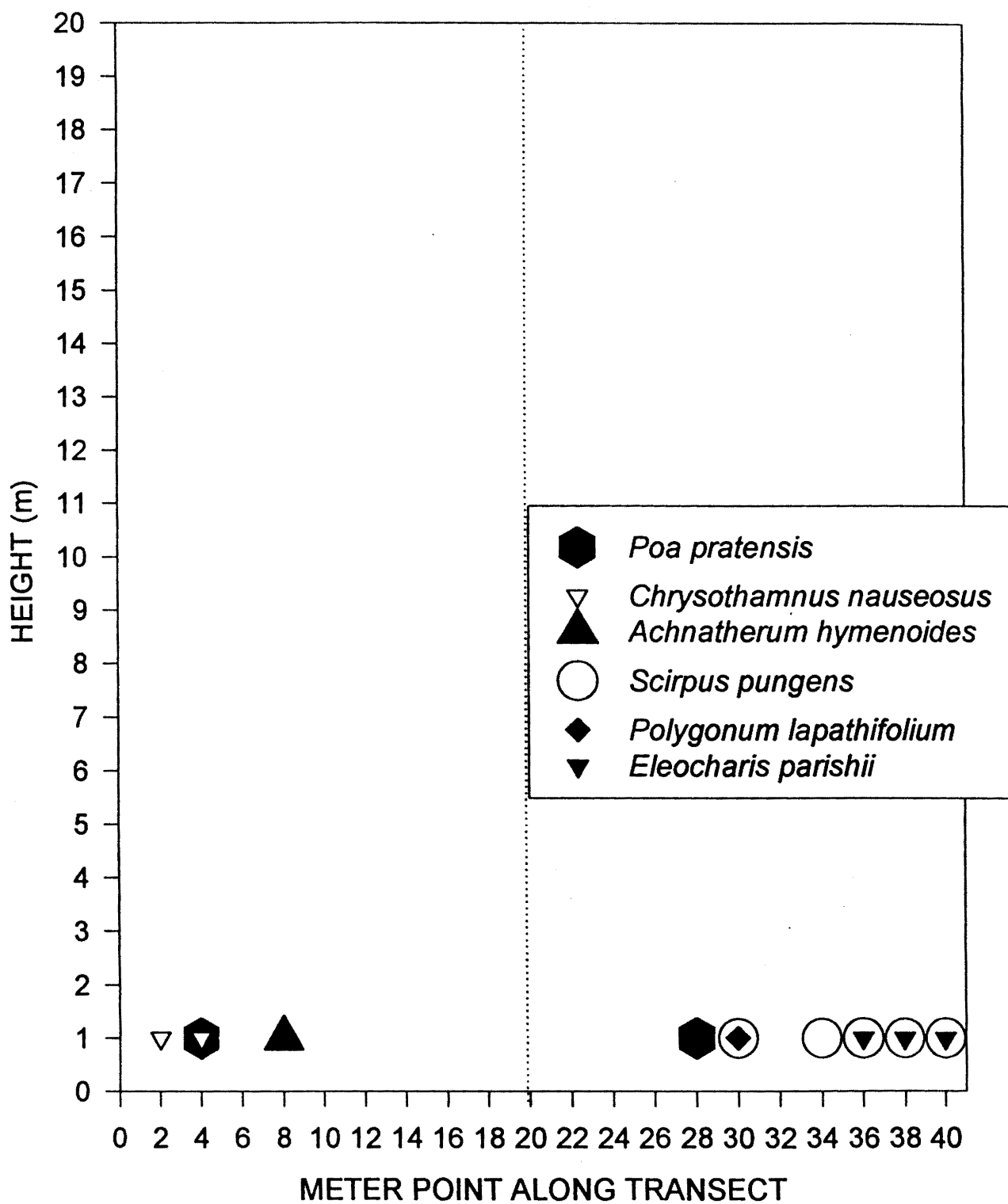


Figure 19. Transect 6 foliar height distribution, fall 1998.

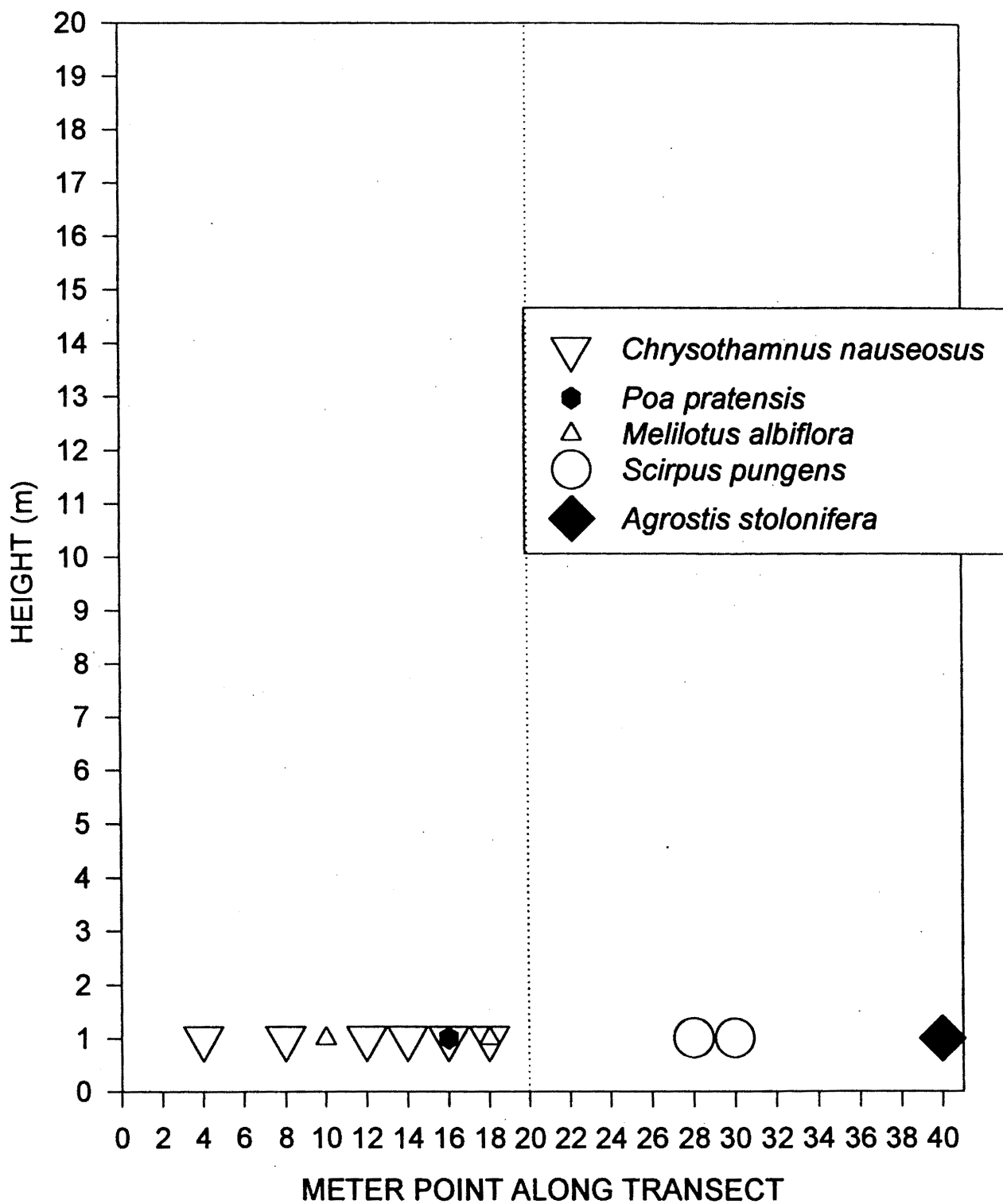


Figure 20. Transect 7 foliar height distribution, fall 1998.

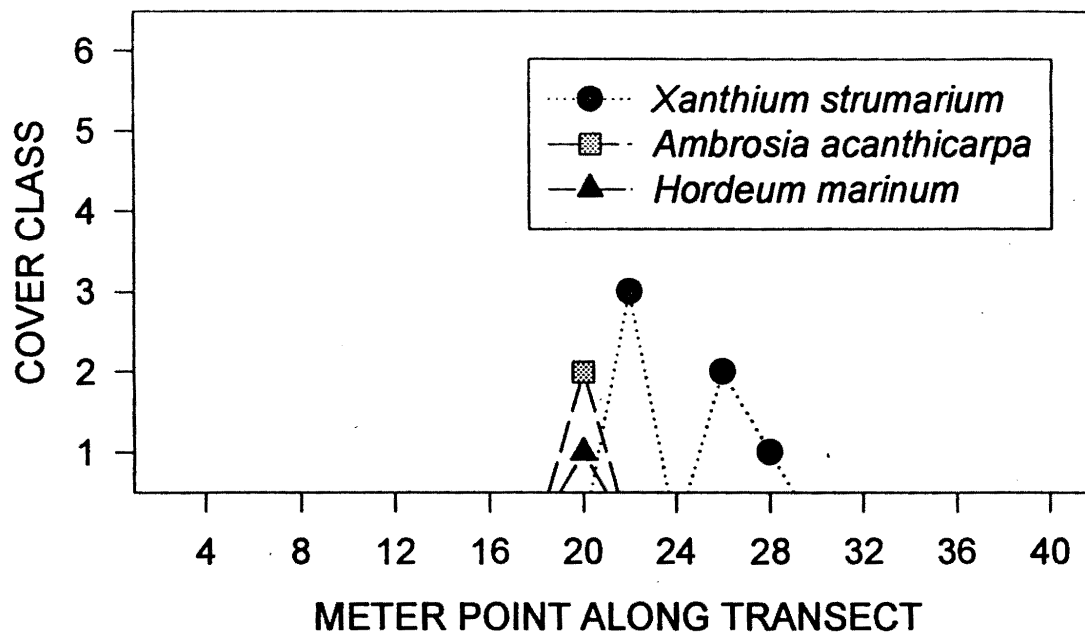


Figure 21. Transect 1 annual cover, summer 1998.

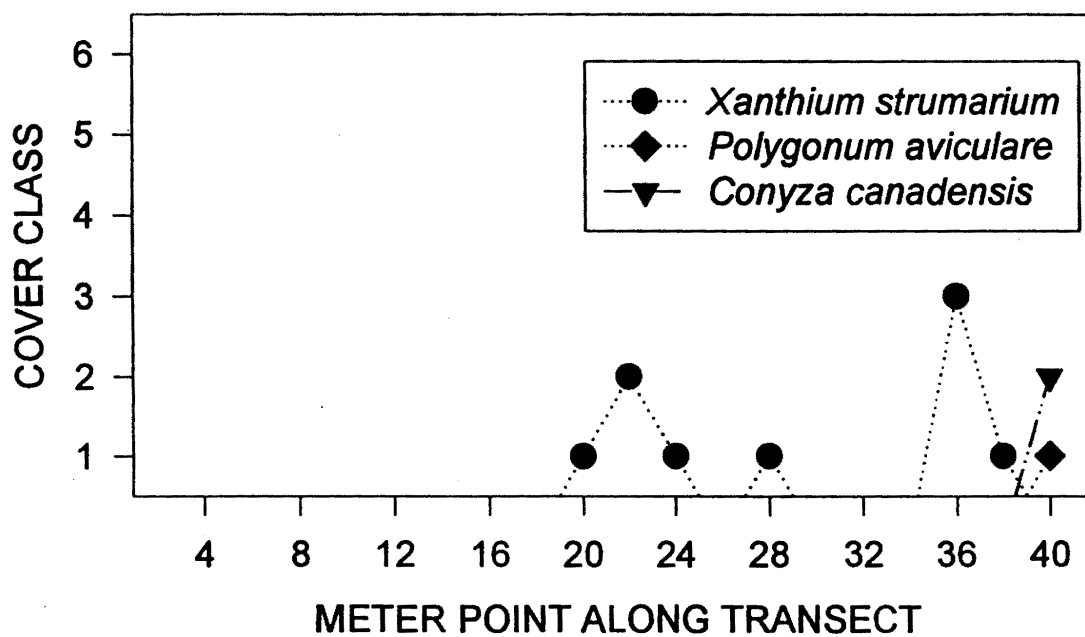


Figure 22. Transect 2 annual cover, summer 1998.

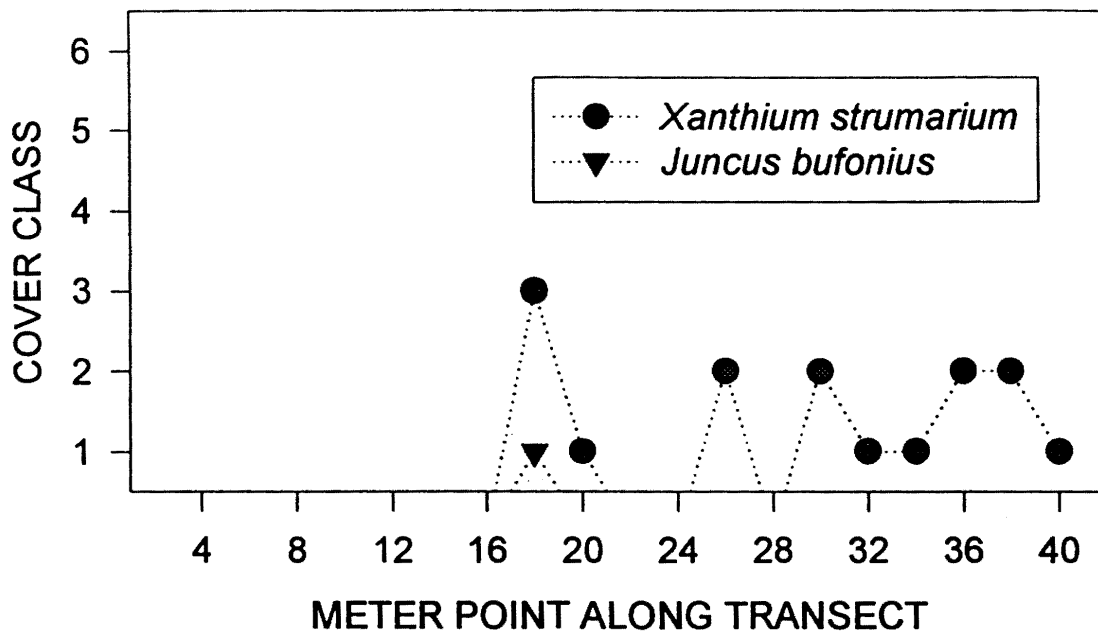


Figure 23. Transect 3 annual cover, summer 1998.

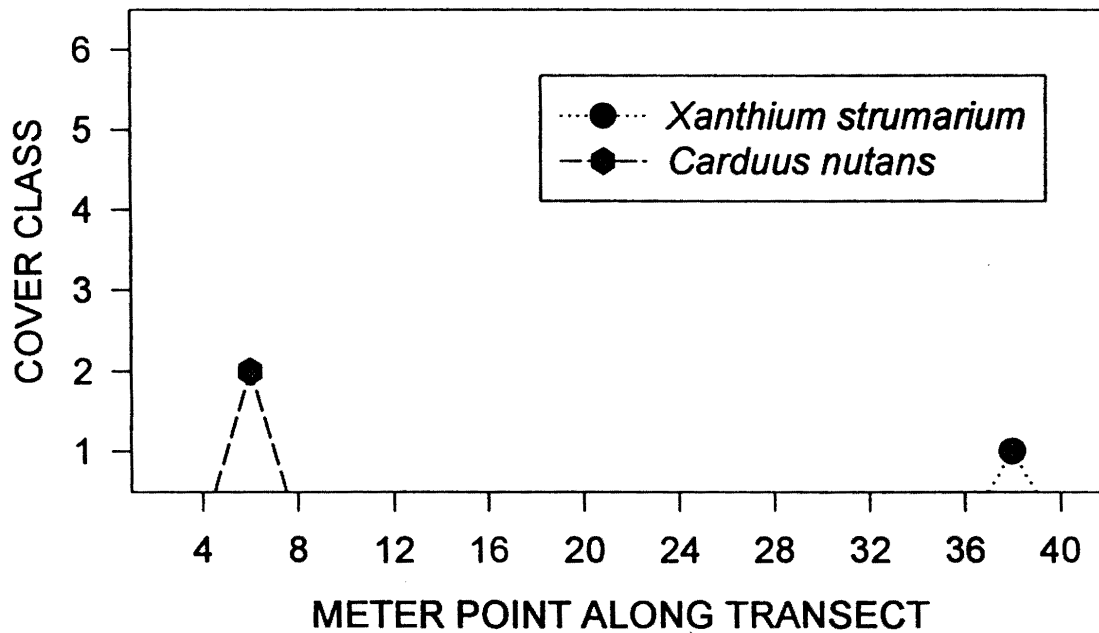


Figure 24. Transect 4 annual cover, summer 1998.

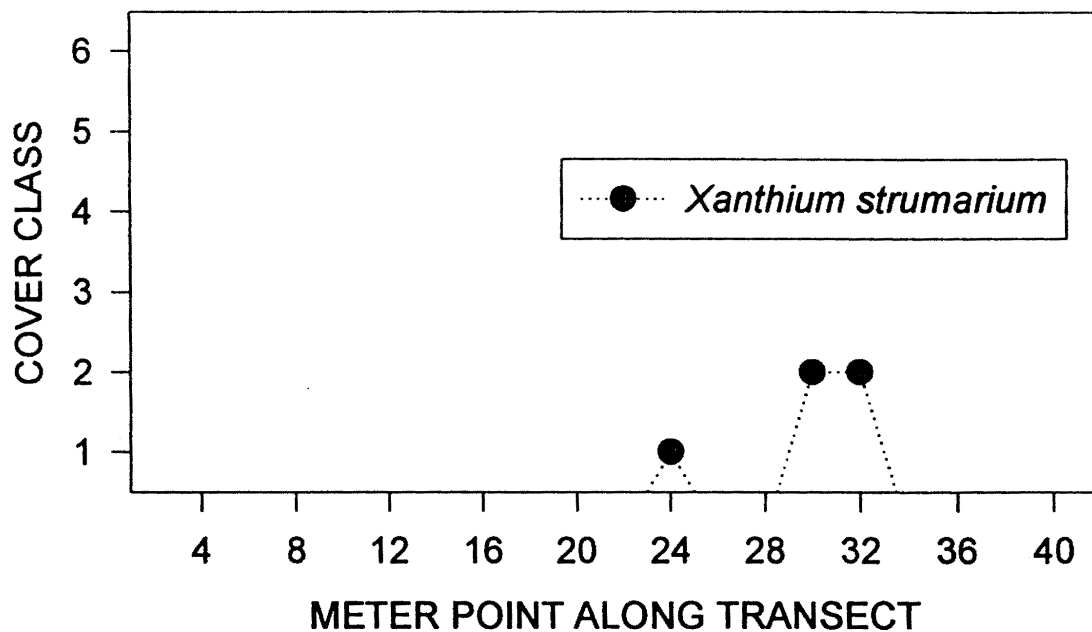


Figure 25. Transect 5 annual cover, summer 1998.

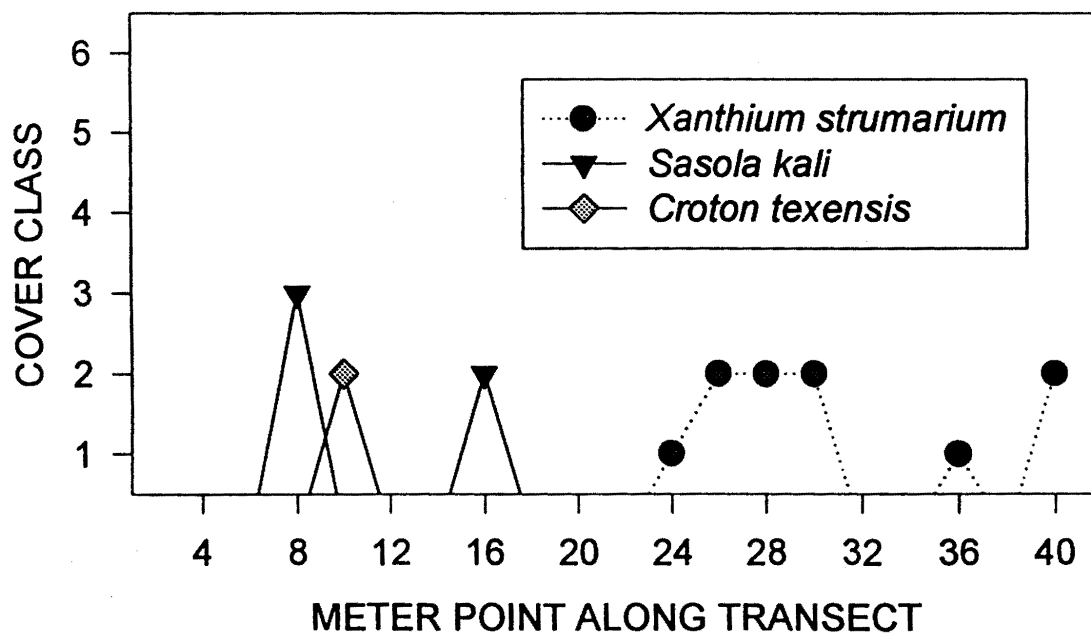


Figure 26. Transect 6 annual cover, summer 1998.

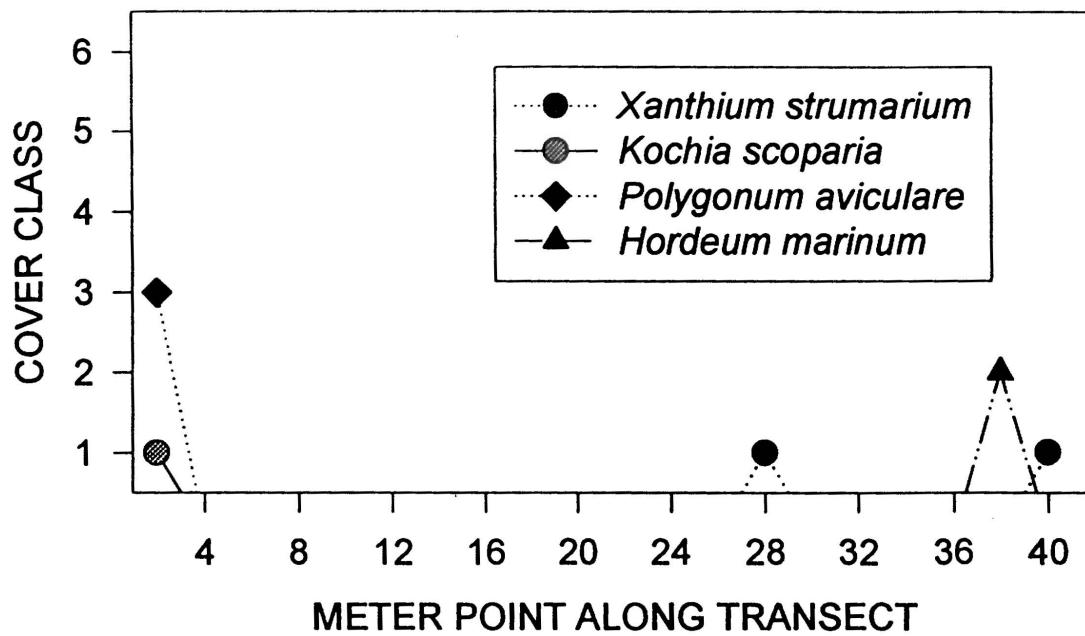


Figure 27. Transect 7 annual cover, summer 1998.

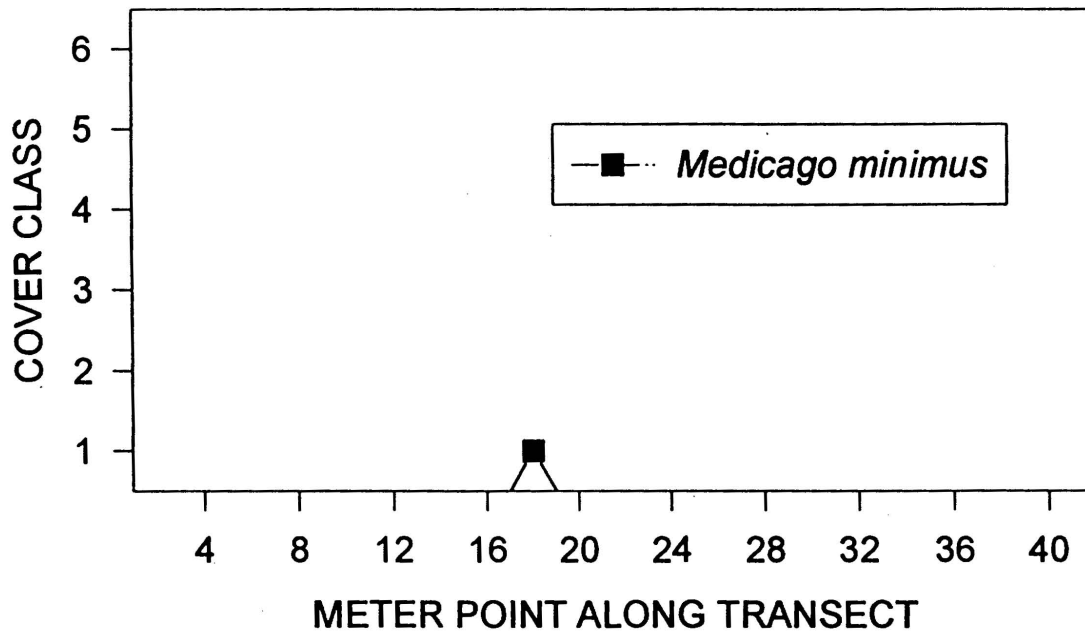


Figure 28. Transect 8 annual cover, summer 1998.

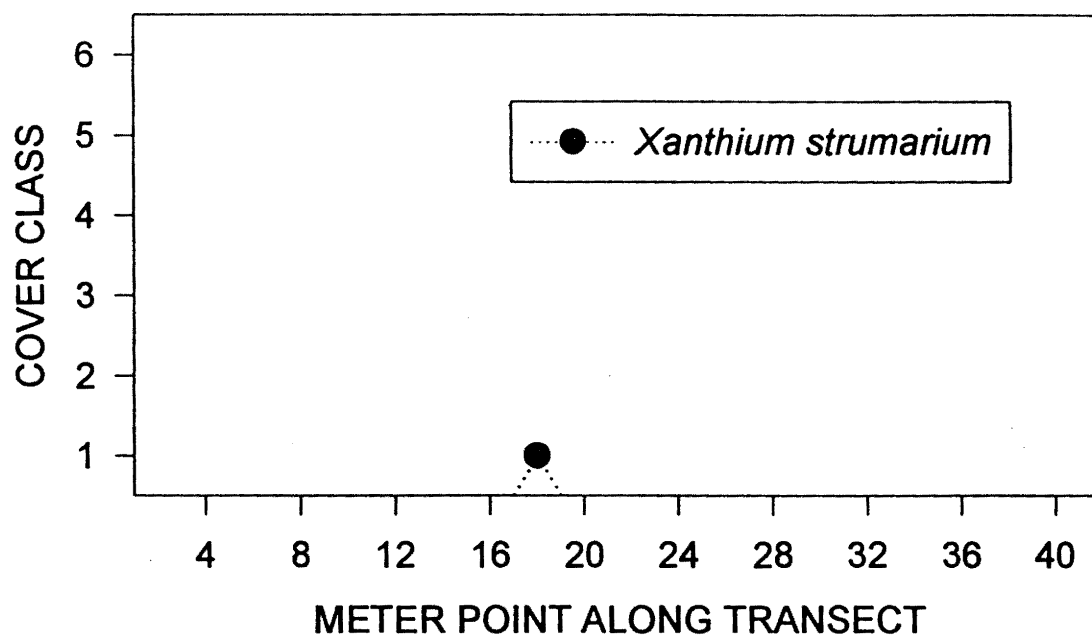


Figure 29. Transect 9 annual cover, summer 1998.

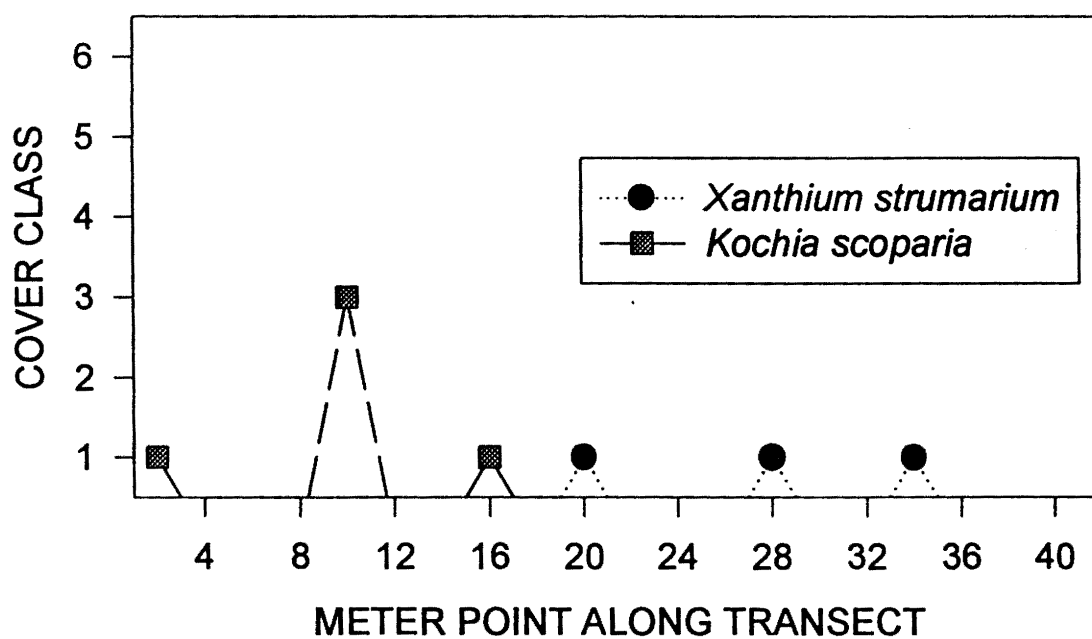


Figure 30. Transect 10 annual cover, summer 1998.

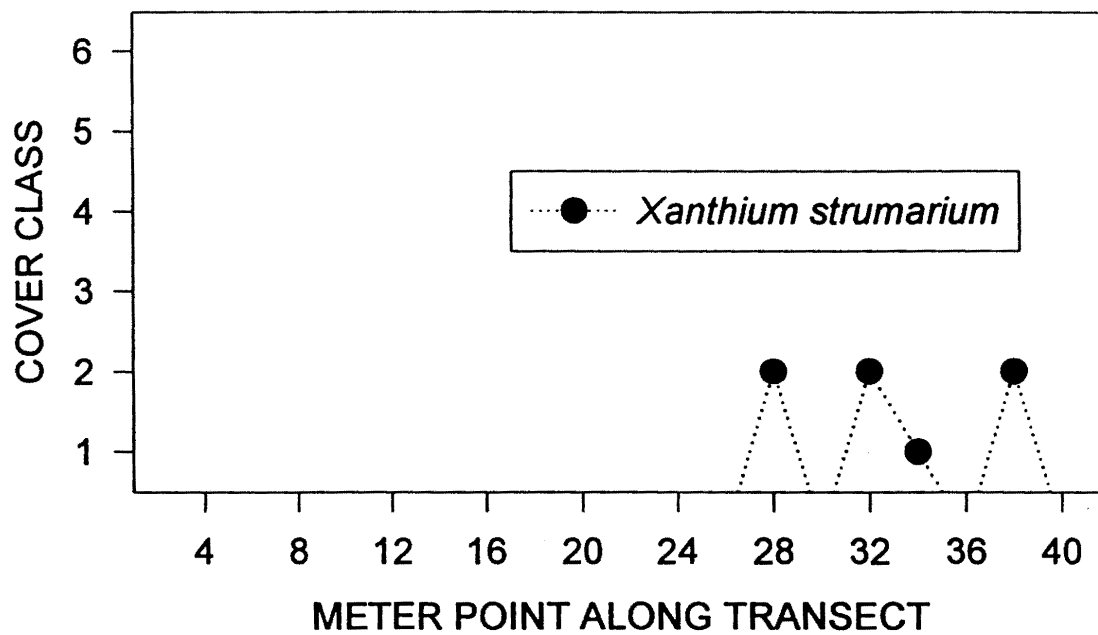


Figure 31. Transect 11 annual cover, summer 1998.

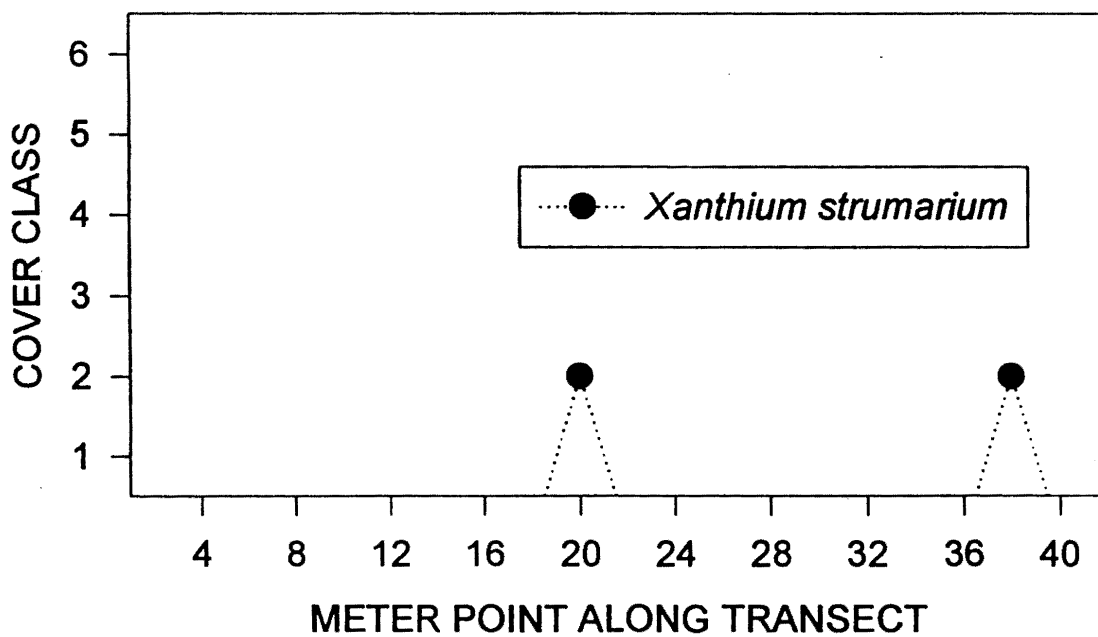


Figure 32. Transect 12 annual cover, summer 1998.

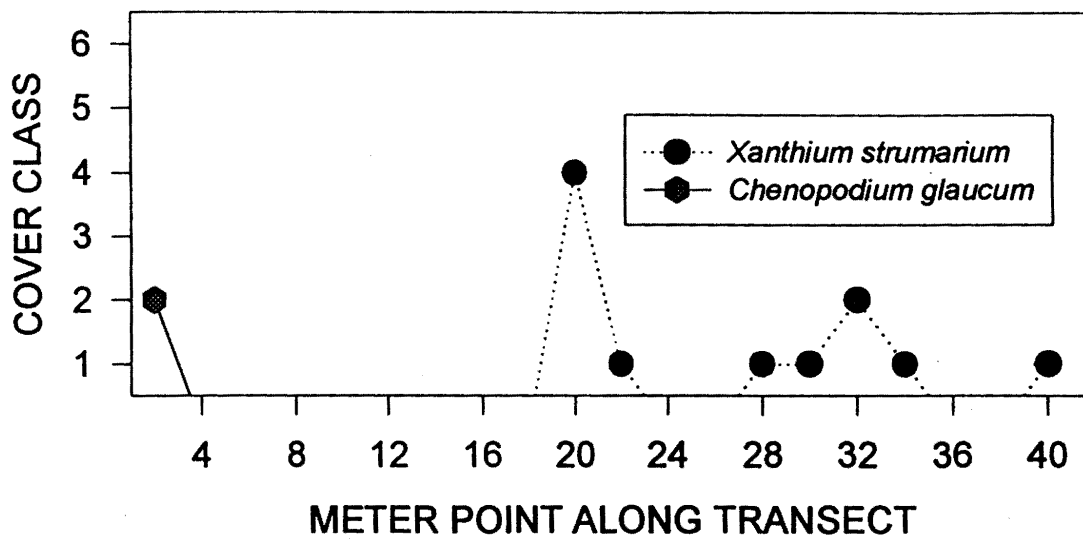


Figure 33. Transect 13 annual cover, summer 1998.

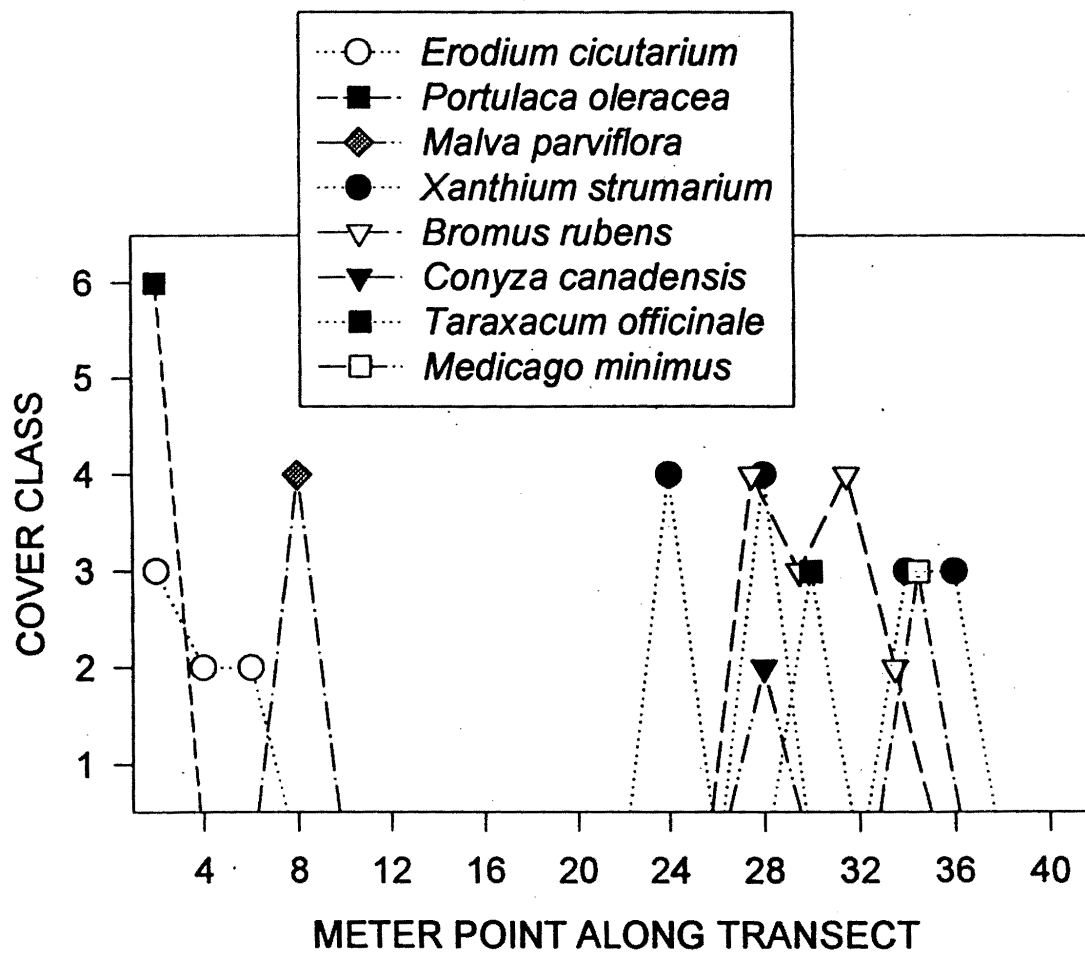


Figure 34. Transect 1 annual cover, fall 1998.

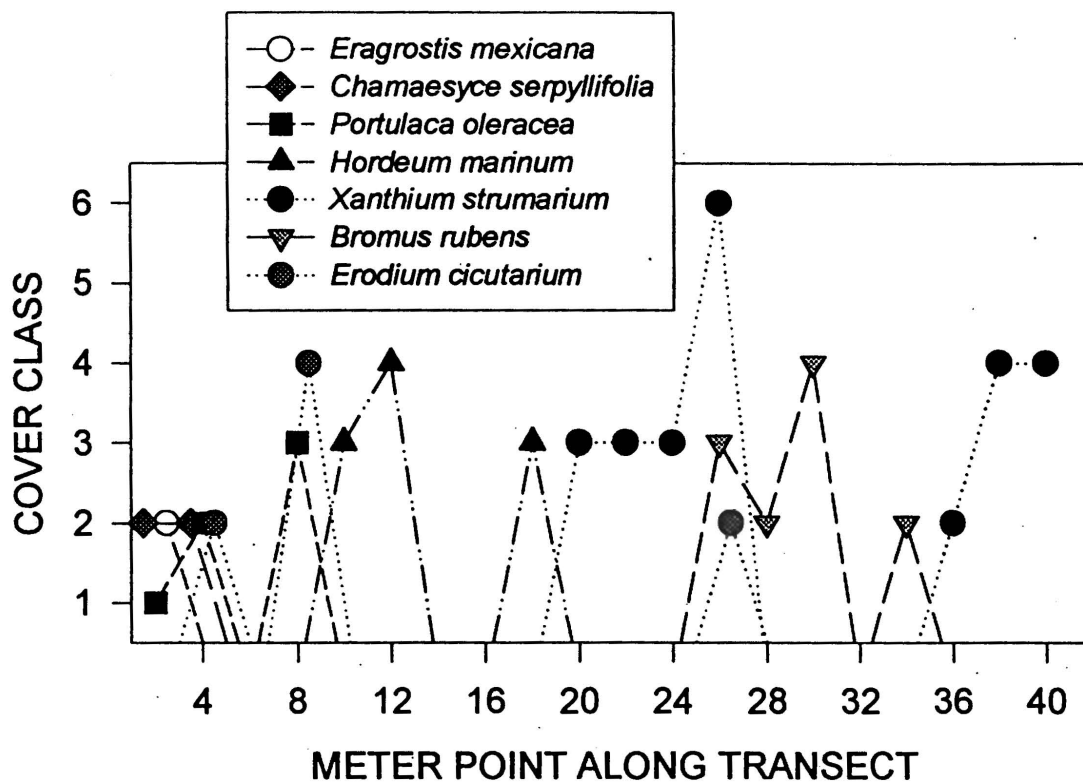


Figure 35. Transect 2 annual cover, fall 1998.

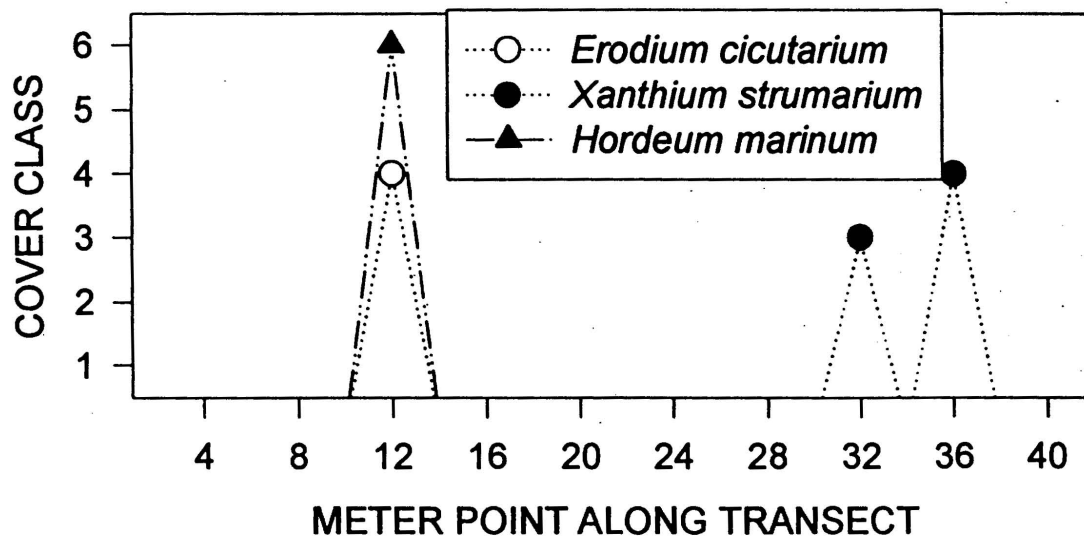


Figure 36. Transect 3 annual cover, fall 1998.

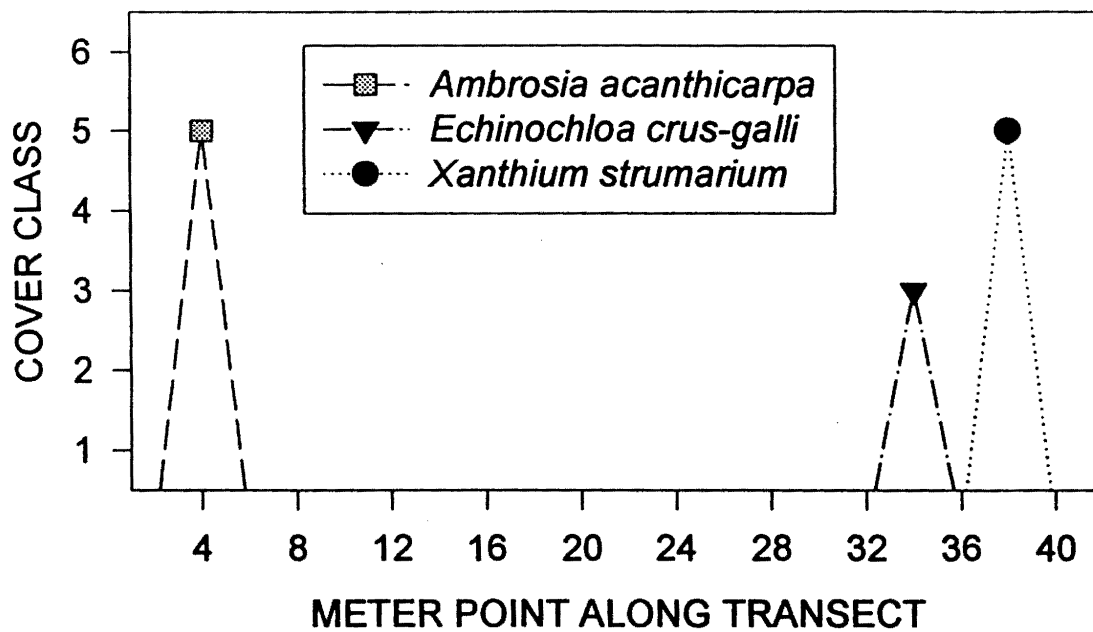


Figure 37. Transect 4 annual cover, fall 1998.

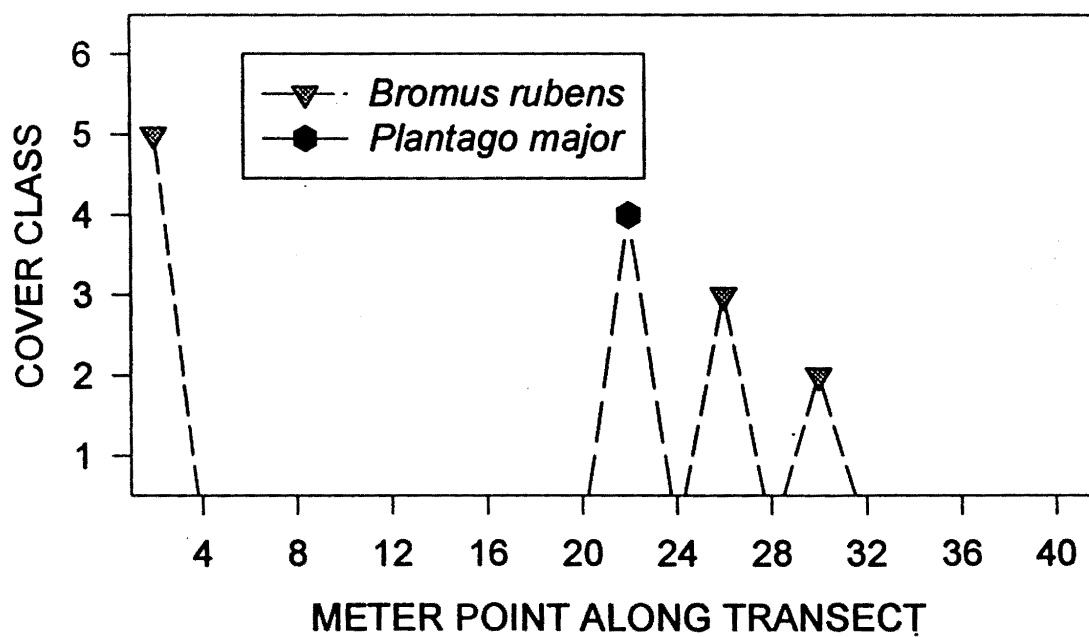


Figure 38. Transect 5 annual cover, fall 1998.

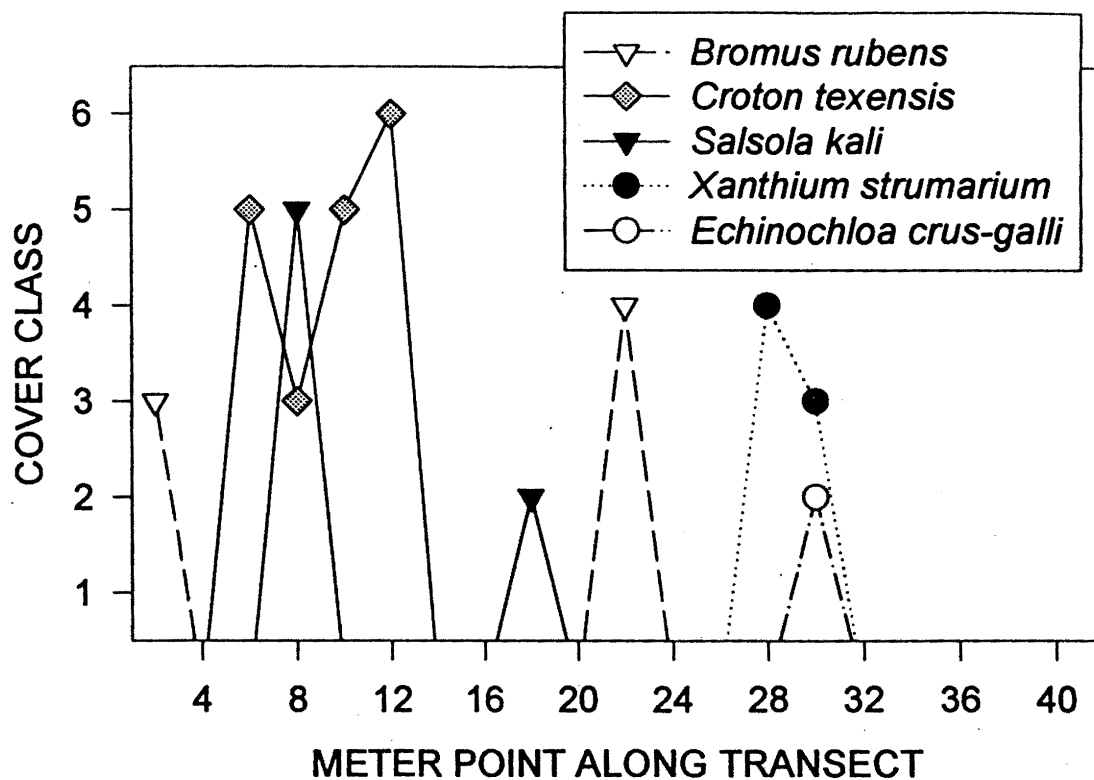


Figure 39. Transect 6 annual cover, fall 1998.

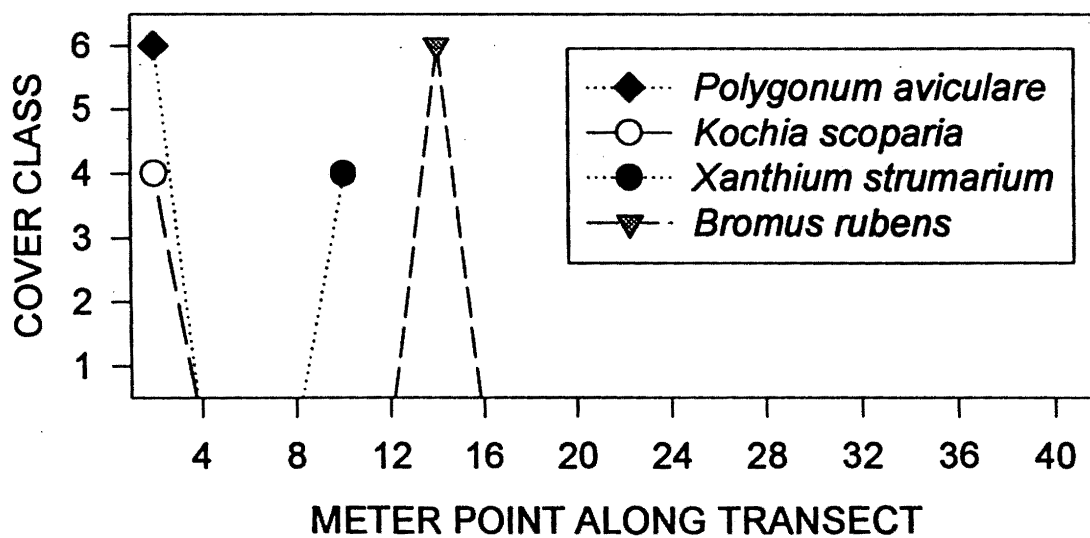


Figure 40. Transect 7 annual cover, fall 1998.