Conf-9310276--1

EGG 11265-2030
UC-702

THE INFLUENCE OF ANNUAL SPECIES COMPOSITION AND DENSITY ON PERENNIAL SEEDLING DENSITY IN FOUR PLANT COMMUNITIES IN THE NORTHERN MOJAVE DESERT

by

P. F. Hall, B. W. Schultz,
J. P. Angerer, and W. K.Ostler

EG&G Energy Measurements
Environmental Sciences Department
P.O. Box 1912, Las Vegas, NV 89125
Second author is currently Terrestrial Ecologist,
Desert Research Institute, University of Nevada
System, Reno, NV.

Work supported by the U.S. Department of Energy, Nevada Operations Office under contract No. DE-AC08-93NV11265.

ABSTRACT

According to the Nuclear Waste Policy Act of 1982 (as amended in 1987), the U. S. Department of Energy (DOE) must study and characterize Yucca Mountain as a potential site for long-term underground storage of high-level nuclear waste. Part of the overall site characterization program is to monitor potential impacts on the biological resources at Yucca Mountain. A part of the biological monitoring program, assessed vegetation parameters included density of annual and perennial seedlings. This data was used to evaluate: 1) seed germination and seed survival; and 2) if annual plant species density and cover influence perennial seedling survival. Twelve permanent 200 x 200-m study plots were established in each of four vegetation associations present in the Yucca Mountain Project area. During the spring of 1992, 20 to 60, 1-m^2 randomly-located quadrats per study plot were measured for perennial seedling density, annual species density, and annual species composition. Perennial seedlings found in 1992 were relocated in the spring of 1993, and survival determined. Cover was measure in the spring of 1992. Annual plant density and cover was greatest in the *Larrea-Lycium-Grayia* vegetation asscoiation, and lowest in the *Larrea-Ambrosia* vegetation association. Annual seedling density had a negative exponential relationship with perennial seedling density in 1992. However, non-linear regression analysis indicated that 1992 annual seedling density had a greater impact on survival of pernnial seedlings from 1992 to 1993.

INTRODUCTION

- After several years of drought, the Yucca Mountain area of the northern Mojave Desert (Figure 1) received above-normal precipitation in 1992.

- Vegetation researchers observed an increase of both annual plants and perennial plant seedlings (Figure 2).

- Areas that appeared to have more annual plants also appeared to have fewer perennial plant seedlings.

- The two dominant annual plant species in these areas were *Bromus rubens* and *Amsinkia tessellata*.

- Areas having fewer annual plants appeared to have more perennial plant seedlings. *B. rubens* and *A. tessellata* were not frequently observed in these areas (Figure 3).

- These observations prompted researchers to investigate the relationship between the density and cover of annual plant species and perennial seedling density and survival.

OBJECTIVES

- To determine if a relationship exists between annual plant density and cover and perennial seedling density.

- To determine if a relationship exists between annual plant density and cover and the survival of perennial seedlings from one year to the next.

- To determine if a relationship exists between the density of *B. rubens* and *A. tessellata* and the density and survival of perennial seedlings.

STUDY AREA AND METHODS

- The Yucca Mountain Project area is characterized by four primary vegetation associations as described by Beatley (1976) and O'Farrell and Collins (1984): *Coleogyne* (COL), *Larrea-Ambrosia* (LA), *Lycium-Grayia*, and (LG) *Larrea-Lycium-Grayia* (LLG).

- Annual density and cover and perennial seedling density were measured on 48 200 x 200-m ecological study plots (ESPs) randomly located in the Yucca Mountain Project area. Twelve ESPs are located in each vegetation association.

- In 1992, annual plant density was measured in 20-60 1-m^2 quadrats in each ESP. The number of annual plants was counted and recorded, by species.

- In 1992, annual plant cover was measured using the point-intercept method. Species covers are expressed as percentages.

- Perennial seedling density was measured in 1992 and 1993 in 1-m^2 quadrats. In 1992, perennial plant seedlings were identified by species and mapped using and X-Y coordinate system.

- Perennial seedlings located in 1992 were relocated in the spring of 1993 and survival determined.

- Non-linear regressions were used to explore relationships between 1) annual plant density and perennial seedling density; 2) annual plant density and perennial seedling survival; 3) annual plant cover and perennial seedling density; and 4) annual plant cover and perennial seedling survival.

RESULTS AND DISCUSSION

Annual Plant Density

- The LLG vegetation association had the greatest total density of annual species, approximately 600 plants/m^2 (Figure 4).

- The total annual mean density in COL, LA, and LLG was comparable, with each having densities ranging from 300 and 400 plants/m^2.

- COL, LG, and LLG vegetation associations had high relative densities of *B. rubens*: 34%, 69%, and 67% respectively. The LA association has less than 3% *B. rubens* relative density.

- The relative density of *A. tessellata* is less than 4% in all vegetation associations (Figure 4).

Annual Plant Cover

- All four vegetation associations had less than 30% average annual plant cover (Figure 5).

- The LA association had the lowest cover and relatively low *B. rubens* and *A. tessellata* cover.

- Although *A. tessellata* density was generally low in comparison to *B. rubens* and the other annual species (Figure 4), this species made up a 24% of the LLG annual cover (Figure 3). This may be explained by *A. tessellata's* stature. This plant is commonly stands 50 cm and has a comparatively large canopy area.

Perennial Seedling Density

- The dominant perennial seedling species in the COL association were *Atriplex confertifolia* (36% relative density) and *Astragalus layneae* (27%). In the LA vegetation association, *Oryzopsis hymenoides* (58%) and *A. confertifolia* (26%) were the dominant species. *Eriogonum fasiculatum* (26%) and *Lycium andersonii* (15%) comprised the greater proportion of the perennials in the LG association. The LLG association had *Encelia virginensis* (19%) and *O. hymenoides* (5%) as the major perennial species.

- The LA perennial seedling density was (1.6/m^2) 4 to 8 times greater than the perennial seedling density in the other vegetation associations (Figure 6).

- The LG and COL associations had comparable seedling densities that ranged between 0.2/m^2 and 0.4/m^2.

- The LLG association had an average perennial seedling density less than 0.1/m^2.

Annual Seedling Density vs. Perennial Seedling Density

- The relationship between the mean density of annual plants and the mean density of perennial seedlings was a negative exponential relationship with a R^2 value of 0.30 (Figure 7).

- The LLG ESPs tended to have high annual species density, but low seedling density.

- The LA ESPs tended to have low annual species density, but high perennial seedling density.

Annual Plant Density vs. Perennial Seedling Survival

- The relationship between perennial seedling survival from 1992 to 1993 and annual species density in 1992 was a negative exponential with a R^2 value of 0.61 (Figure 8).

- This relationship suggests that the survival of perennial seedlings is related to the annual species cover from the previous year.

- Implications of this are that perennial seedlings received additional competition from annual plants during the height of the growing season which continued until summer dormancy.

Annual Plant Cover vs. Perennial Seedling Density.

- The relationships between annual species cover and perennial seedling density and survival are negatively exponential and similar to those seen in figures 7 and 8. These relationships had R^2 values of 0.49 and 0.39, respectively.

- Although the relationship between annual plant cover and perennial seedling survival from 1992 to 1993 was similar to that for annual plant density (Figure 7), the lower R^2 indicate that the relationship with cover was not quite as strong and that annual plant density may have a greater influence on perennial seedling survival.

CONCLUSIONS

- This study has provided information concerning the affect of annual plant density and cover on perennial seedling density and survival.

- High annual plant density and cover negatively affected perennial seedling density and survival.

- Regression analysis indicated that annual plant density during the year of perennial seedling germination has a strong negative impact on seedling survival in the following year.

- These analyses also indicated that annual plant density, rather than cover appeared to have a greater influence on perennial seedling survival.

- Although these relationships exist between annual plant density and cover with perennial seedling density and survival, these may not be a cause and effect relationship.

- The vegetation associations at Yucca Mountain may be inherently different with respect to soils, species composition and viable seed bank. These differences among vegetation associations may directly influence annual and perennial plant densities. For example, the LA vegetation associations generally had high perennial seedling densities and low annual plant cover. This could be caused by a lack of viable annual seeds in this vegetation associations seedbank or that the very sandy soils within this vegetation association do not promote growth of annual seedlings.

- Inherent differences in vegetation associations were not analyzed in this study, but may be required in future studies to fully explain the relationships between annual and perennial plants.

LITERATURE CITED

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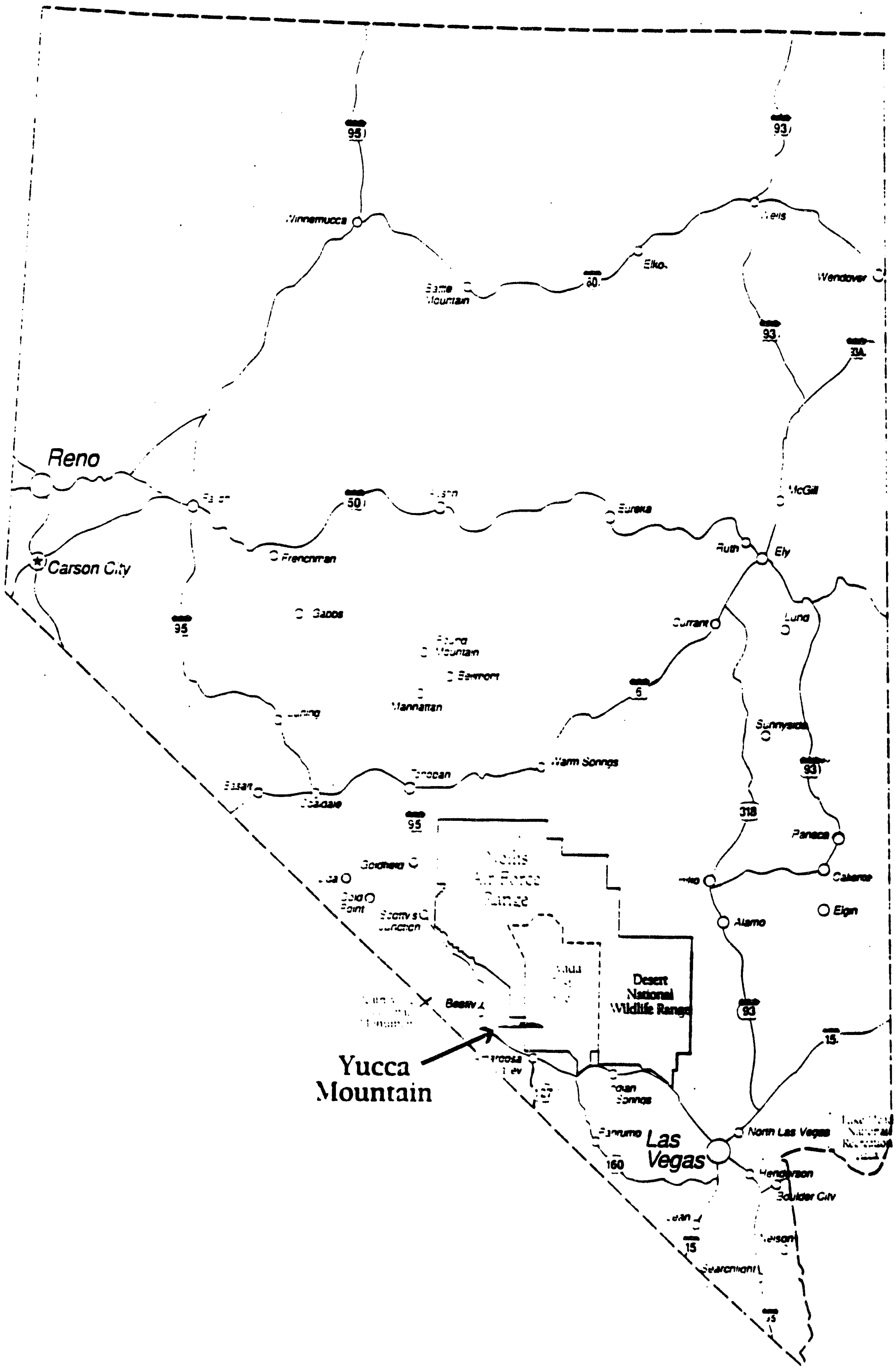
O'Farrell, T.P. and E. Collins. 1984. 1983 Biotic Studies of Yucca Mountain, Nevada Test Site, Nye County, Nevada. EGG 10282-2031-S-764-R. (Sandia National Laboratories through the U.S. DOE, Nevada Operations office). EG&G Energy Measurements, Santa Barbara Operations, Goleta, CA. 38 p.

LIST OF FIGURES

Figure 7. The relationship between the mean density of annual plant species in 1992 and the mean density of perennial seedlings for four vegetation associations in the northern Mojave Desert. The four vegetation associations include *Coleogyne* (COL), *Larrea-Ambrosia* (LA), *Lycium - Grayia* (LG), and *Larrea - Lycium - Grayia* (LLG).

Figure 8. The relationship between the mean density of annual plant species in 1992 and the mean density of perennial seedlings that survived from 1992 to 1993 for four vegetation associations in the northern Mojave Desert. The four vegetation associations include *Coleogyne* (COL), *Larrea-Ambrosia* (LA), *Lycium - Grayia* (LG), and *Larrea - Lycium - Grayia* (LLG).



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Carson City
Winnemucca
Elko
Wendover
Eureka
Frenchman
Gabbs
Manhattan
Ruth
Ely
McGill
Currant
Lund
Sunnyside
Warm Springs
Tonopah
Panaca
Caliente
Alamo
Elgin
Desert National Wildlife Range
Yucca Mountain
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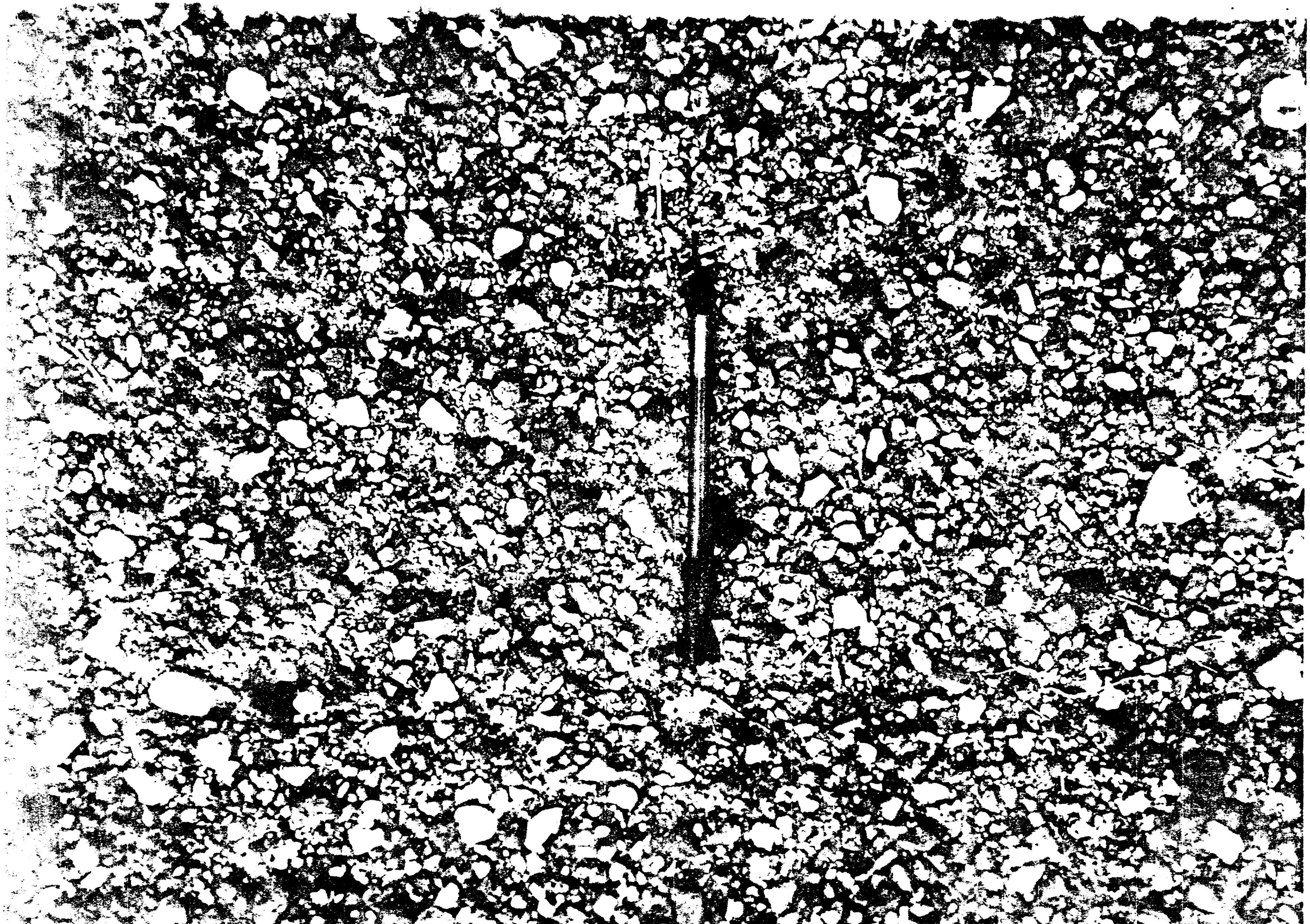
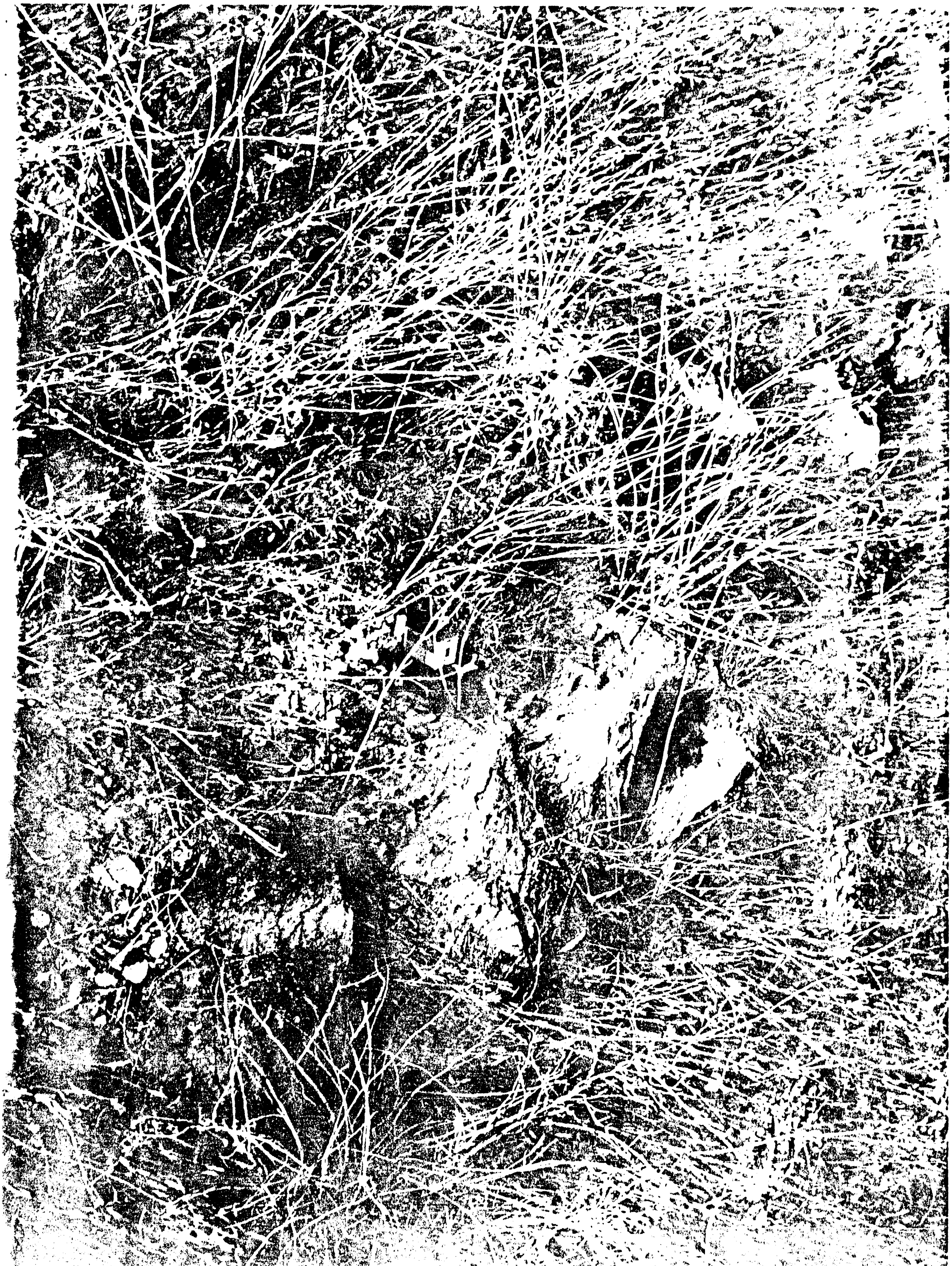




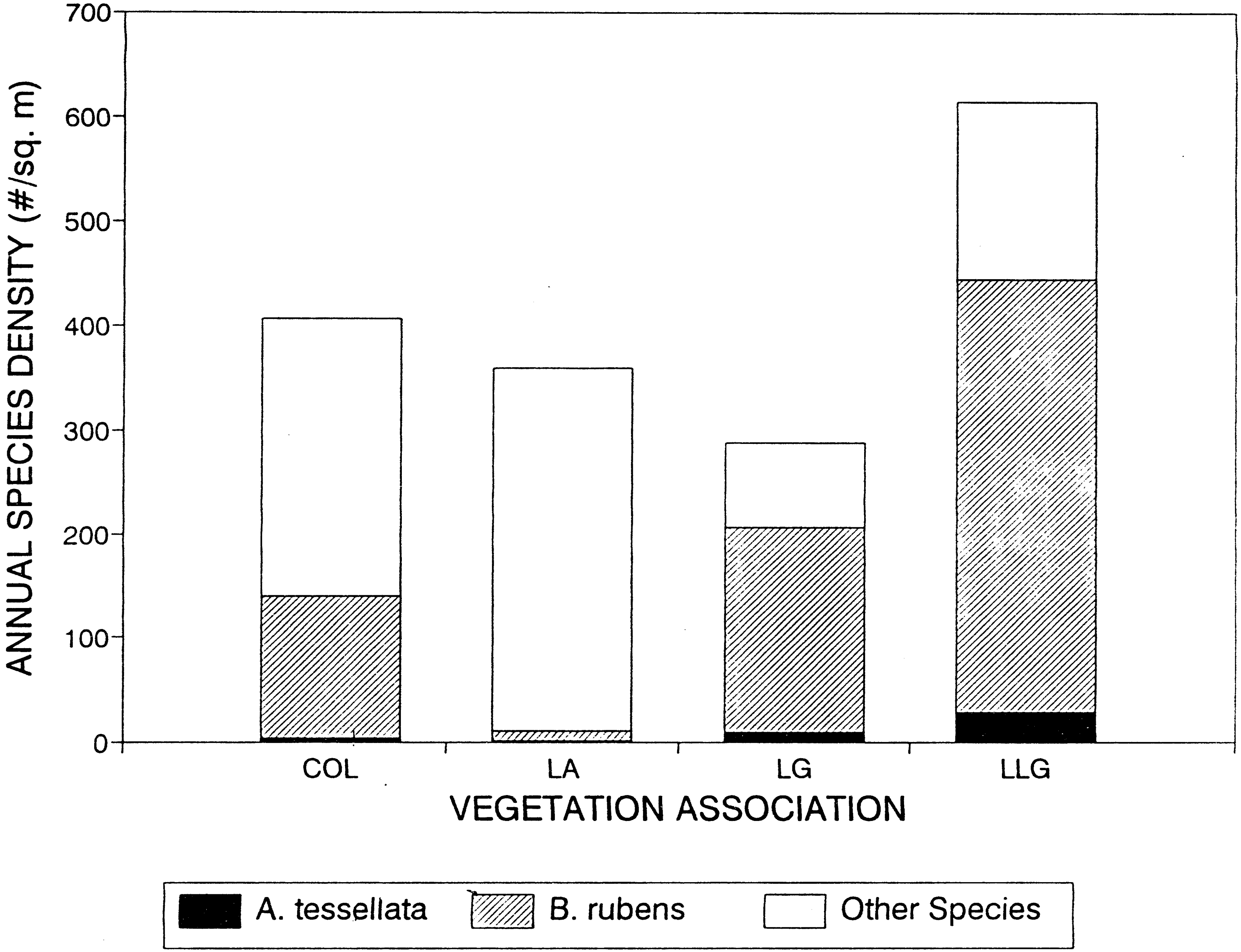

700
600
500
400
300
200
100
0
ANNUAL SPECIES DENSITY (#/sq. m)
COL
LA
LG
LLG
VEGETATION ASSOCIATION
A. tessellata
B. rubens
Other Species

Figure 4.

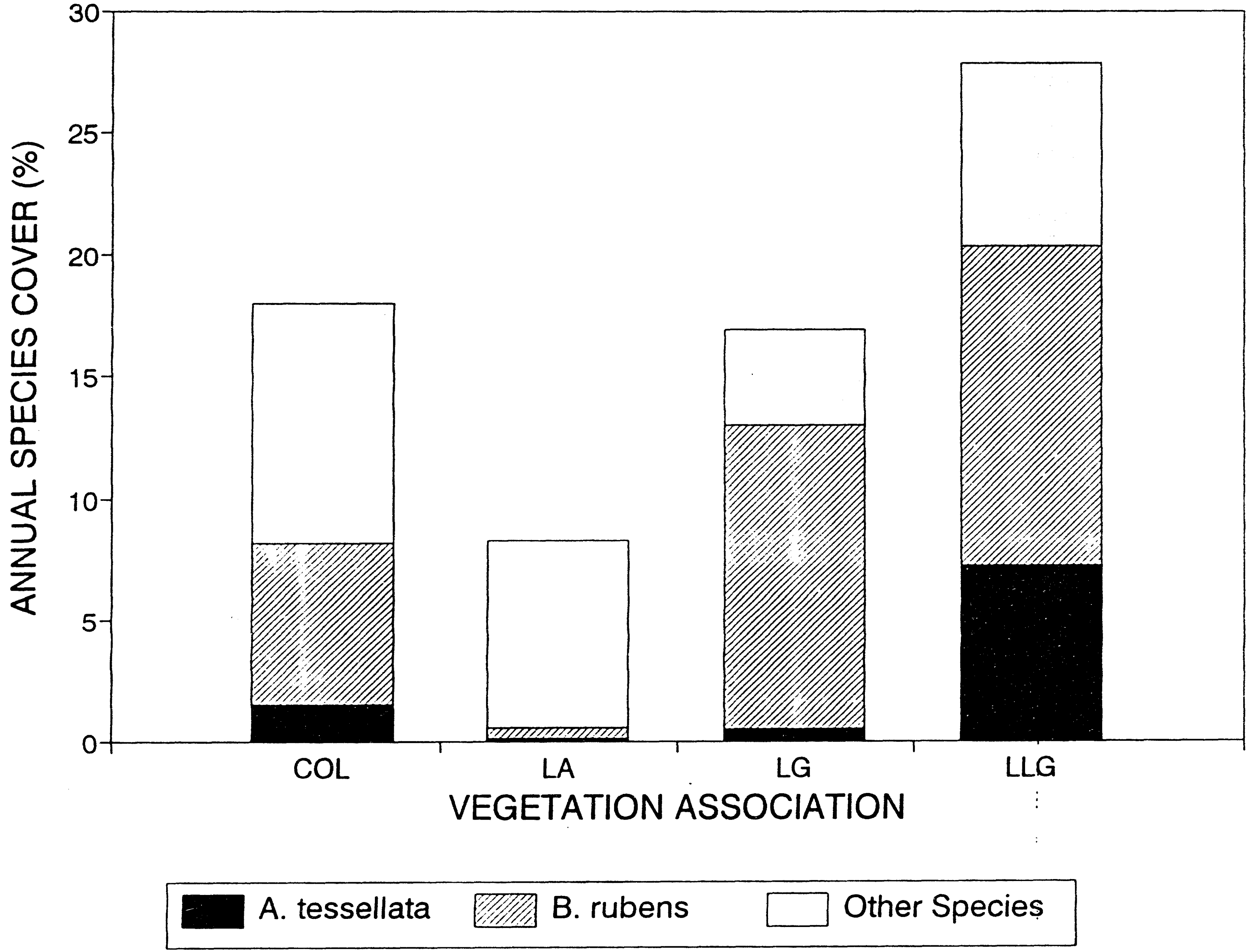
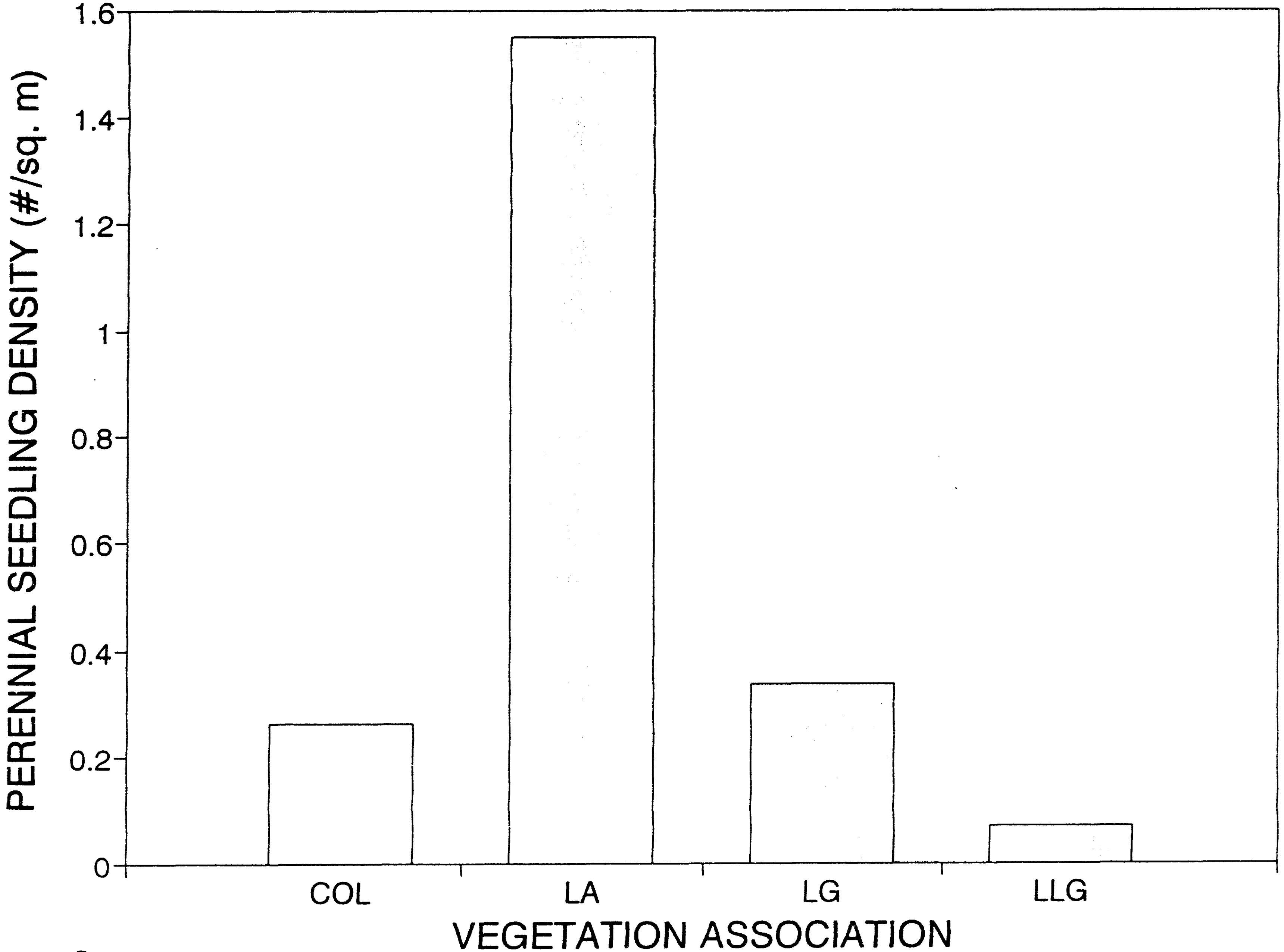
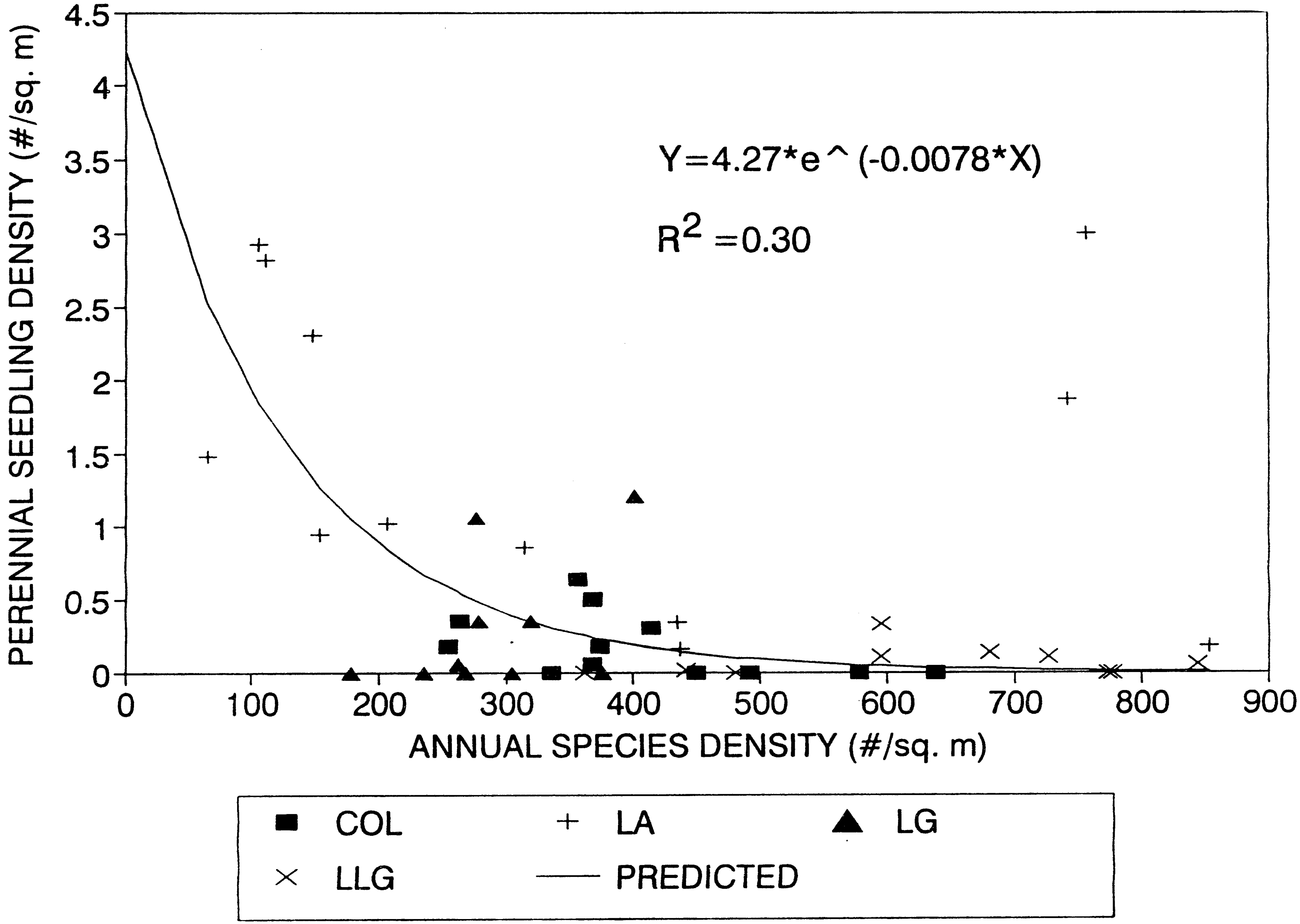

30
25
20
15
10
5
0
ANNUAL SPECIES COVER (%)
COL
LA
LG
LLG
VEGETATION ASSOCIATION
A. tessellata
B. rubens
Other Species

Figure 5.



PERENNIAL SEEDLING DENSITY (#/sq. m)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
COL
LA
LG
LLG
VEGETATION ASSOCIATION

Figure 6.



PERENNIAL SEEDLING DENSITY (#/sq. m)
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
100
200
300
400
500
600
700
800
900
ANNUAL SPECIES DENSITY (#/sq. m)
Y=4.27*e^ (-0.0078*X)
R2 =0.30
COL
LA
LG
LLG
PREDICTED

Figure 7.

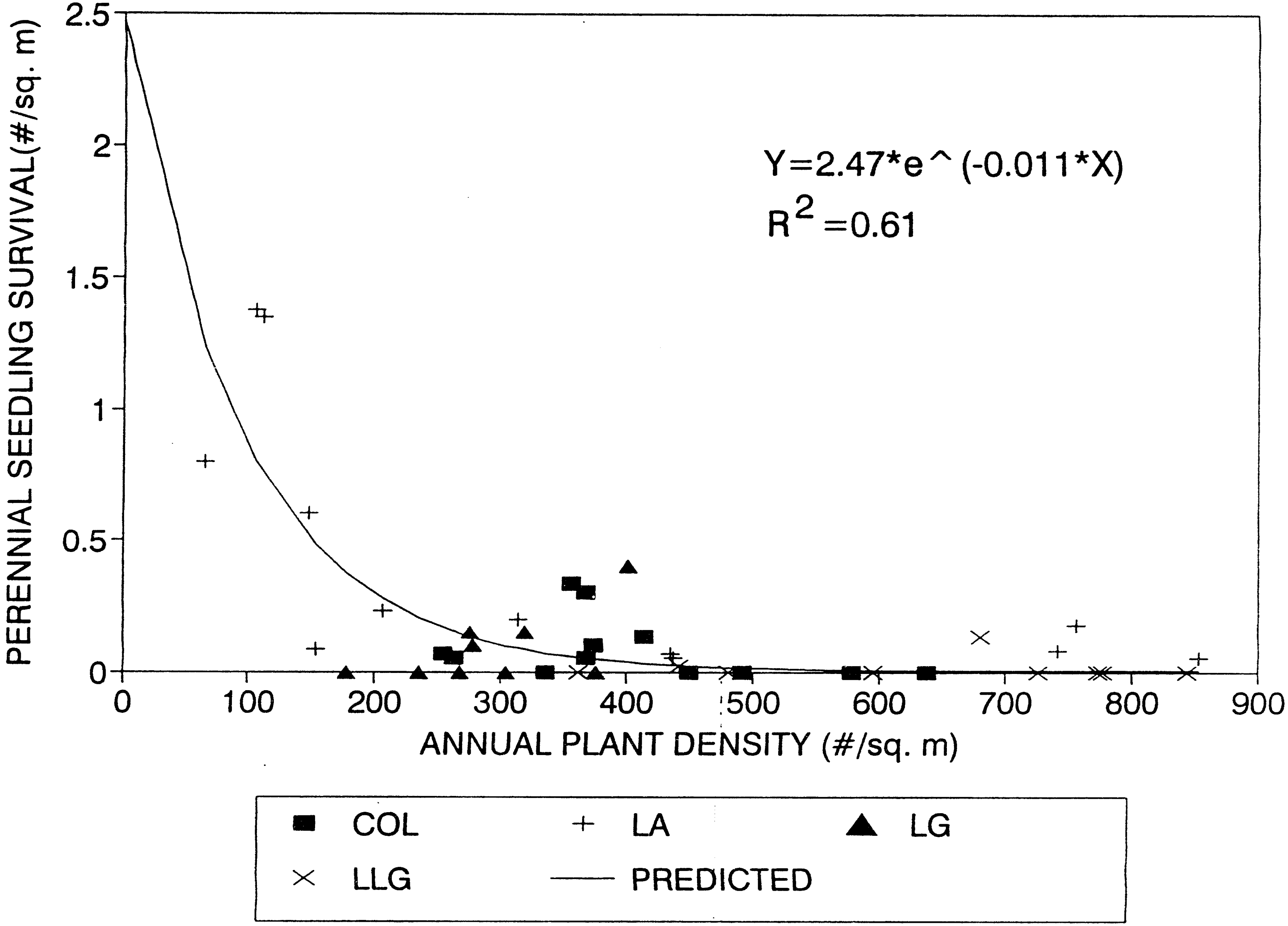

PERENNIAL SEEDLING SURVIVAL(#/sq. m)
2.5
2
1.5
1
0.5
0
Y=2.47*e^(-0.011*X)
R2 =0.61
0
100
200
300
400
500
600
700
800
900
ANNUAL PLANT DENSITY (#/sq. m)
COL
LA
LG
LLG
PREDICTED

Figure 8.

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