RETROSPECTIVE NOTE

When I began this work nearly a quarter century ago, mountain bald management was a new subject to me. My knowledge of fire and grasslands came from Atlantic coastal plain ecosystems, where fire had long been known to be a natural and essential component of management. Nevertheless, I instinctively resisted the idea of applying fire as a management tool across mountain landscapes when there were so many extremely rare plant species involved (as there were on Roan Mountain), without first testing it to (1) make sure that it did not harm unique resources that were not fire-adapted, and (2) determine if it was the best tool for accomplishing the stated objectives. Most of the rare species on the Roan Mountain balds were not known to be fire-dependent or even fire-tolerant, and it seemed to me that caution was the only logical course of action.

The U. S. Forest Service's stated objective for the Roan Mountain balds, at the time, was to return them to, and maintain them in, their historic "grassy" state. In retrospect, I realize that probably most of the land managers who formulated that goal, as well as most of the public concerned with the management of the balds, did not distinguish between dominance by native grasses such as *Danthonia compressa* and dominance by sedges (*Carex* spp.). My recommendations, however, were geared toward increasing dominance of grasses, and therefore, they included the use of fire in areas not occupied by fire-sensitive rare species. Many things have changed since then. I would caution any reader to note that fire was recommended only in combination with herbicide, and primarily because mowing at that time was not economically feasible, and grazing was not considered practical. Where the encroaching species are blackberry and firecherry, as they were on Round Bald at Roan Mountain, burning alone can greatly accelerate succession of the balds to woody species, as many other land managers have noted over the years. If herbicide cannot be used, then mowing (or grazing, under the right circumstances and with the right animals in appropriate numbers) is by far the most effective treatment against encroaching blackberry and other woody species that are favored by fire in these high-elevation grasslands.

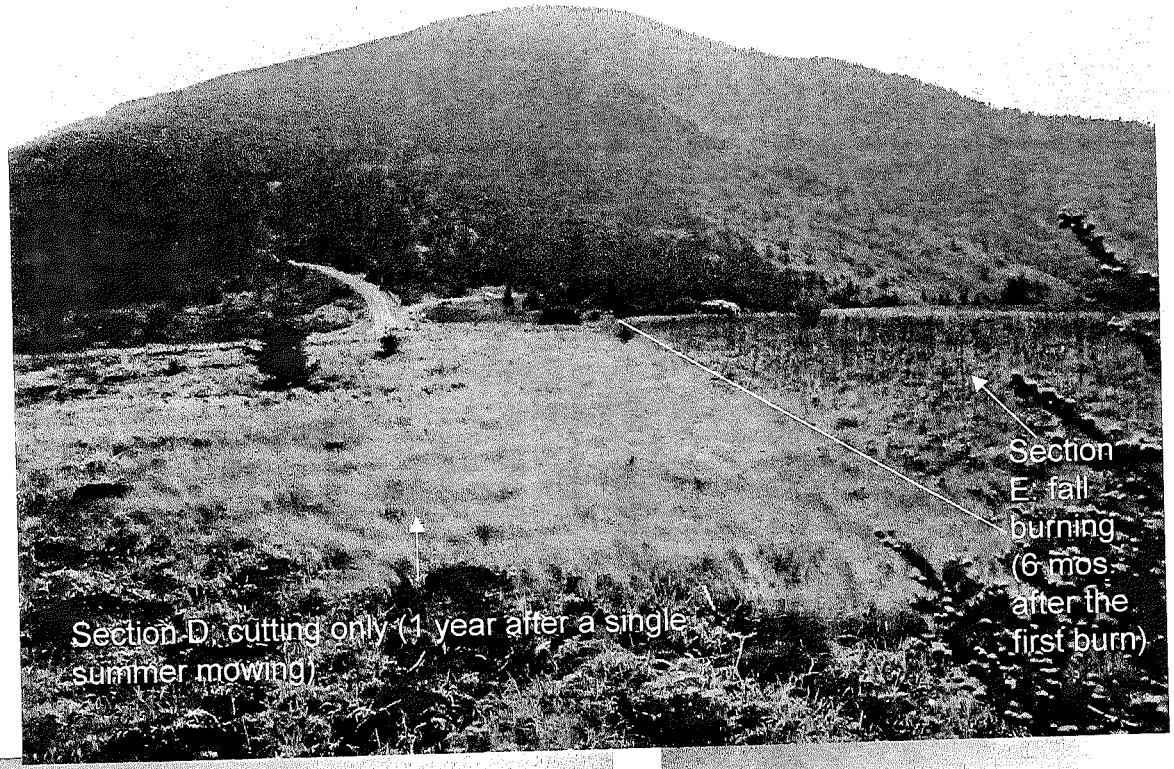
(See the accompanying photographs of the results of the burning and mowing conducted on Round Bald from 1982 – 1986.)

- Nora Murdock
June, 2006

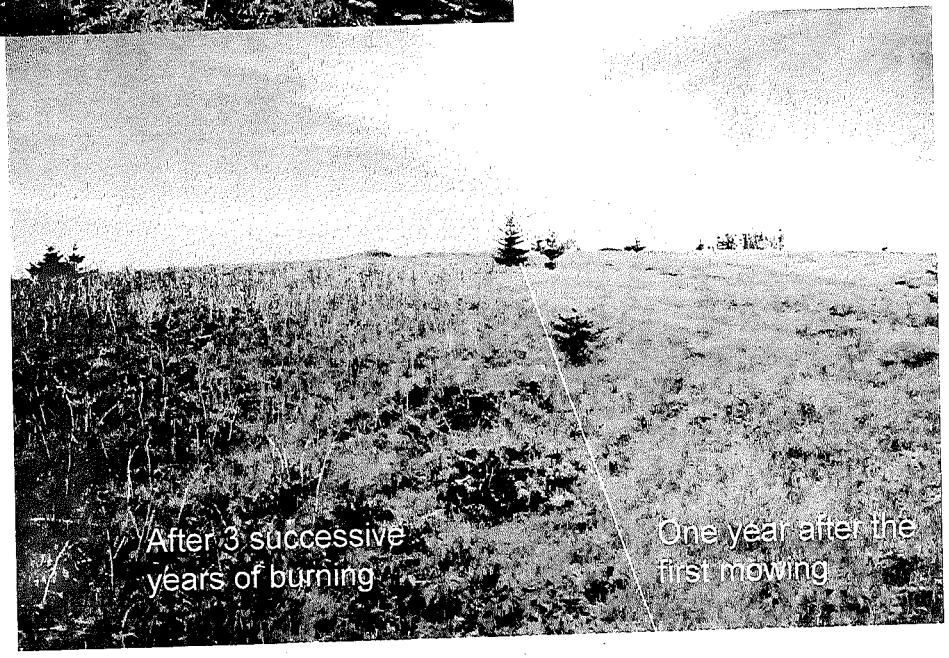
FIRST PRESCRIBED BURNING ON ROAN MOUNTAIN
MAY 11, 1982
(Round Bald, photographed from Carver's Gap)

ROAN MOUNTAIN BALDS MANAGE-MENT

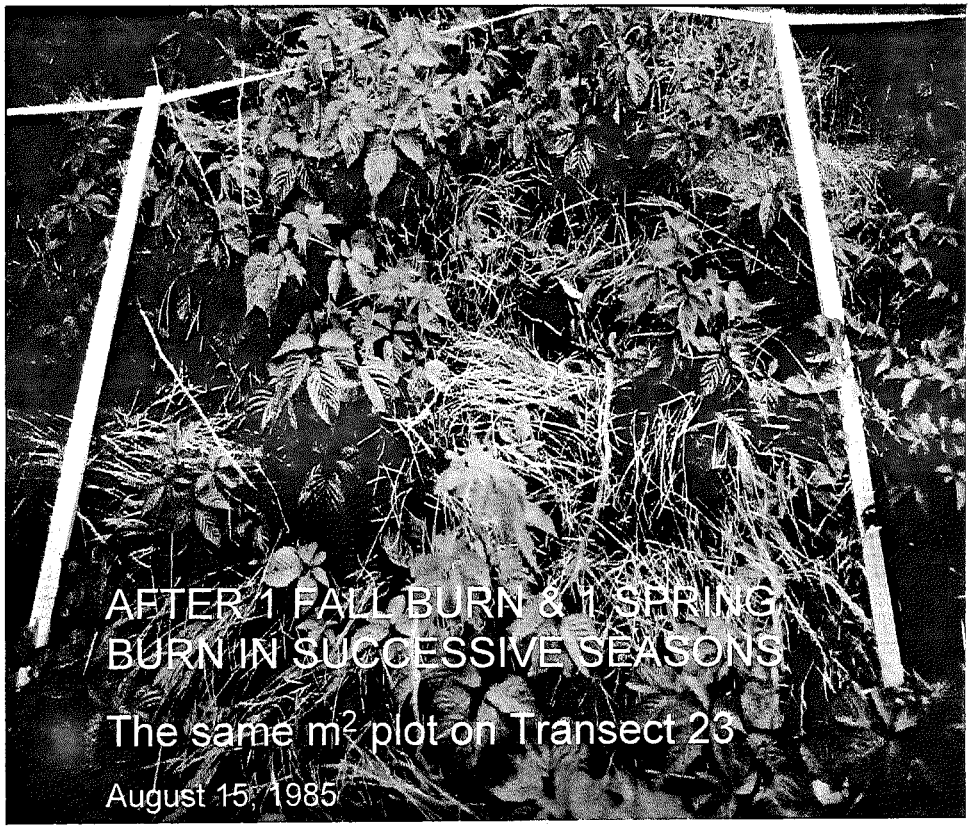
1982-1986



In these pictures, the lines between treated sections are clearly visible, contrasting the dense *Rubus* in the burned sections, and the dense sedge/grass with little *Rubus* in the mowed areas (Round Bald, looking west toward Carver's Gap, April 1985)



Roan Mountain Balds Management
1982-1986



EVALUATION OF MANAGEMENT TECHNIQUES ON A SOUTHERN APPALACHIAN BALD

By
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ABSTRACT

The "balds"--treeless meadows on mountaintops of the Southern Appalachians--have attracted and intrigued visitors for over two centuries. Some were apparently in existence when the first Europeans arrived, and the mystery of their origin has never been solved.

Because of their floristic diversity, high elevation, and commanding views of the surrounding landscape, balds are often spectacularly scenic and receive heavy public use. Consequently, there is strong public sentiment regarding management. Most of the larger balds are now in public ownership, with the National Park Service and the U.S. Forest Service being the major landholders. The majority of these areas were grazed by domestic stock before government acquisition. Now, after three to five decades without grazing or other habitat manipulation, the government-owned balds are vanishing, reverting to the climax forest of the region (spruce-fir and northern hardwood).

The question of whether or not to maintain the balds has been answered differently by each administering agency. The National Park Service (Great Smoky Mountains National Park), being severely restricted in its management options by Congressional wilderness designation in the mid-1970s, decided to allow natural succession to proceed, which would result in the eventual elimination of all the high open meadows in the park. When this decision was announced, strong public opposition to the policy was expressed. As a result, the policy

was altered to exclude a small part of the park from wilderness in order to allow for retention of two of the more spectacular balds in the Smokies--Andrews and Gregory Balds. A different Park Service decision was made for the Big Meadows area in Shenandoah National Park, Virginia, where attempts at managing the open areas are underway. The Blue Ridge Parkway in North Carolina has documented the gradual loss of balds at the Craggy Gardens area and determined that at least some of this area should be retained in its open meadow state. However, management actions to this end have not begun. The U.S. Forest Service, in North Carolina, Tennessee, and Virginia, has made a policy decision to maintain all balds in Forest Service ownership, "to optimize the mix of existing or potential National Forest resources involved" (U.S. Forest Service Manual, 1983).

The question now is how best to maintain these areas. There is no conclusive historic record to indicate exactly what maintained the balds before European influence arrived on the scene, although many theories have been proposed. Standard management methods used to maintain grasslands of the low-elevation Southeastern Coastal Plain (such as prescribed fire) have not been adequately tested and monitored in high mountain areas where climate and vegetation types are totally different. Also, each interest group has its own ideas as to what the balds should look like and what types of activities should be allowed on them. To further complicate the issue, many of these meadows support extremely rare species whose responses to potential management techniques are largely unknown. The U.S. Forest Service commitment to maintenance is no small one since several thousand acres of these mountain grasslands are in Forest Service ownership in North Carolina

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INTRODUCTION

Montane treeless areas exist throughout the world from the high meadows of the Alps and the Scottish Highlands to the "balds" of Australia's Bunya Mountains (Webb, 1964). North America has the "lawns" of New England and the "parks" of the Colorado Rockies, in addition to the mountain tundra which is found on the highest ranges of every continent. The highest mountains "extend to such rarified altitudes that they remain forever frozen, with no vegetation visible on the rocks and ice of their summits" (Gersmehl, 1970). Just below this frozen elevational zone, climatic conditions produce life forms resembling those of the Arctic tundra. Trees survive only at altitudes considerably below tundra level where the uppermost edges of the forest are represented by dwarfed and misshapen trees which are often no larger than shrubs. This edge of trees represents the "timberline" in most areas, above which trees are incapable of growing due to the severity of the habitat. However, human intervention has complicated this analysis of vegetative response considerably; on some Alpine meadows which have been grazed for centuries, the timberline has reportedly been lowered by as much as 2,000 feet (Ibid.).

In the Southern Appalachian Mountains of North America, there are many treeless summits, locally known as balds. Two types of these naturally treeless areas have been recognized in this otherwise predominantly forested region (Gersmehl, 1970):

1. Heath balds - dominated by woody ericaceous species; studied and described by Cain (1930).

2. Grass balds - dominated by herbaceous vegetation, predominantly grasses and sedges.

(An intermediate form between the first two is recognized by some and referred to as "heath gardens" [Mark, 1959].)

These treeless areas are an enigma, since the theoretical thermal treeline for this area has been placed at 10,000 feet (Fink, 1931), 3,316 feet above the area's highest peak. Therefore, there is no true climatic timberline here. Trees survive on the tops of some of the highest mountains, even though the tops of adjacent peaks of similar or lower elevations are bald (Gersmehl, 1970). Moisture stress is not a causative factor; the higher elevations receive between 70 and 90 inches of annual precipitation and fall well into the "perhumid division of the Thornthwaite classification" (Shanks, 1954). Only slight soil differences between balds and adjacent forests have been noted, probably resulting from the vegetational differences rather than causing them. No obvious natural explanation for their treelessness presents itself (Gersmehl, 1970). The question of origin is separate from but important for effectively dealing with the problem of bald maintenance since, regardless of origin, the balds must be actively managed to prevent their succession to climax forest. Many theories have been proposed to explain the origin of the Southern Appalachian grassy balds, the earliest of which began to appear in the literature around 1808. The earliest suggestions attributed treelessness of balds to cold climate, ice damage, cold winds, and winter storms

(Harshberger, 1903). In the 1930s and 1940s, a wider variety of possible explanations was brought forth, including wind desication (Camp, 1931), Indian clearing (Wells, 1932, 1936, 1937), soil factors (Davis, 1930), insect deforestation (Gates, 1941), climatic changes (Billings and Mark, 1957), and fire (Clements, 1936). Cain (1930) believed the balds to be natural phenomena, since the black prairie-like soils were as deep as 12 inches in places which is "far too deep to have developed since the advent of the white man . . . ." Fink (1931) noted that balds are found over an altitude range of 3,000 feet, and that they were mentioned in the legends of the Cherokee Indians who attributed their origin to a supernatural force. Fink discounted the theories of Indian creation of the balds because of their existence in tribal legends and because of the level of energy and tools required for a primitive people to clear forests from such areas. Camp (1931) thought fire and grazing were used to enlarge existing grassy balds, but not to create them. Brown (1941) discounted the theory of Indian origin, sustaining the climatic change theory. In the 1950s, theories emphasizing microclimatic extremes in "bald susceptible zones" were posed (Gersmehl, 1970). It was not until the 1960s that the problems of bald origin and bald maintenance began to be separated, when studies were devoted to the factors which delayed the forest invasion of the balds (Ibid.).

In the late 1960s, Gersmehl (1970) undertook an extensive survey of the balds and related literature in an attempt to produce a final answer to the origin question. He noted that most places called balds

are above 4,000 feet in elevation; those accepted as true balds in ecological terms are all above 4,600 feet. His work uncovered 119 sites which were then, or had previously been, grass balds. Thirty-four of these were true balds (apparently existing before European settlement), 56 were historical balds (now forested), and 29 were apparent balds. The true balds occur only in the Southern Blue Ridge Physiographic Province (south of the New River Valley) and do not occur in the Ridge and Valley or Appalachian Plateau Provinces to the west.

Gersmehl's investigation into historical use of these areas revealed that permanent European settlers began moving with their livestock into the Southern Appalachians in the late 1700s, when a grazing/farming settlement pattern was established. In the mid-1800s selected logging began along streams and other transport routes. By 1880 most of the easily reached forest had been stripped of the valuable timber species. Logging expanded over the next 50 years until most of the accessible forests had been decimated, leaving behind "cut-over and burned wastelands." Traditional agriculture, including livestock grazing, continued until the early 1930s when economic conditions caused many mountain farms to be abandoned. About this time, governmental agencies at municipal, state, and federal levels began to purchase large acreages to be set aside as recreational areas, parks, National Forests, and protected watersheds. As grazing and intensive logging ceased on most of the publicly acquired lands, a large-scale reversion to forested wilderness began (Gersmehl, 1970).

Gersmehl echoed Ramseur (1960) in noting that grassy balds are one of the most variable high mountain communities; more species of trees, types of shrubs and more different vascular plants occur on grassy balds than any other high-elevation vegetation type in the Southern Appalachians. Nevertheless, balds can be characterized by a series of typical features (Gersmehl, 1970):

--Level to gently sloping topography (slopes rarely greater than 20 percent, and usually less than 10 percent).

--Usually dominated by mountain oat grass (Danthonia compressa), frequently interrupted by other vegetation types such as the heath species.

--Forest encroachment is usually evident on the margins.

--Gnarled old relict trees (especially hawthorn) are scattered in most open areas.

--Most are sheltered on at least two sides by taller forest growth; the margin of the bald often being an abrupt transition to mature forest. These abrupt borders are usually associated with a break in slope.

--Soil is usually 2 to 4 feet deep, with high organic matter and moisture content.

--At least one perennial spring is usually present on the margin.

This characterization of balds appears highly accurate based on historical literature and current observations. After extensively reviewing all hypotheses on origin and available evidence which supported or discounted them, Gersmehl rejected the earlier hypotheses based on climate, insects, Indians, and ice damage. His conclusion was that the grassy balds were cultural artifacts, originated and maintained by a combination of grazing and some deliberate burning. He stated further, however, that no type of fire, unaided, could result in a persistent grassy bald.

Jenkins and Ayres (1951) and Mark (1959) also noted that the dominant species on all the grass balds was Danthonia compressa (mountain oat grass). The former authors found this grass to be dominant only in areas which had been subjected to a prolonged and profound human disturbance, which effectively eliminated woody regeneration. They rejected fire as a possible cause of Danthonia dominated openings because the species occurs in trails and because of the absence of succession by firecherry. They agreed with earlier authors in believing that edaphic factors were not important in the determination of dominance by Danthonia, and that continued dominance by this species was suggested as being a result of intensive root competition without the aid of fire (Jenkins and Ayres, 1951). Mark (1959) studied 84 areas which were reported to be balds, collecting

453 different species from these grasslands. Like the other investigators, he found that the only consistently important species in the vegetation of all the treeless areas studied was Danthonia compressa.

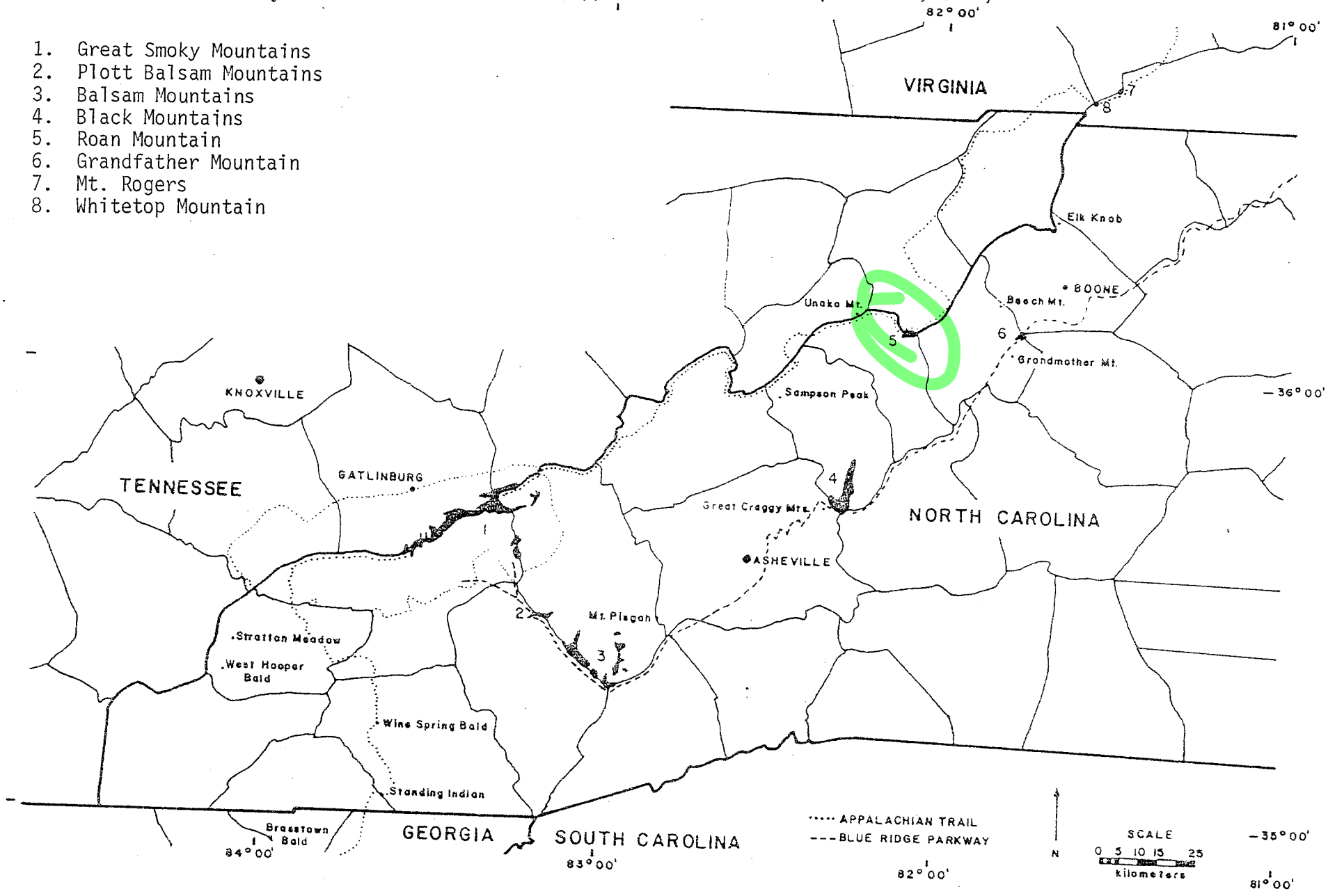
Lindsay (1976) stated that lightening fires which burn more than 2 acres are very rare in the Great Smoky Mountains, and did not believe that natural fires deforested large enough areas to result in bald creation. She documented the historic use of Smoky Mountain balds for grazing where they were gradually enlarged as herders cut firewood and poles for stock pens when the animals were rounded up in the fall. Trampling and browsing by stock prevented reproduction of trees. Mountain settlers of the 18th and 19th centuries apparently preferred the mountaintop pastures because of the cooler climate and the lack of insects at the higher altitudes, providing a healthier environment for stock. Also, milk sickness was thought to be less common at higher altitudes. Lindsay further reported that burning did not seem to have been a major factor in maintaining the balds of the Great Smokies. Although a few herders supposedly believed in spring burning as a means of range improvement, most evidently did not burn their pastures. In addition, fires that burned through logging slash in the mid-1920s cleared many acres, but these burned areas have not grown into grassy balds. Changes in the vegetation of the balds were reported as noticeable just five years after grazing stopped. Lindsay predicted that the balds of the Great Smoky Mountains will have vanished by the

end of the century if management is not undertaken to halt invasion by woody plants (Ibid.).

The distribution of the more important balds of the Southern Appalachians is shown in Figure 1 (Saunders, 1980). Most or all of these large bald areas are in public ownership, with the exception of Grandfather Mountain. Government agencies administering the areas include the National Park Service (Great Smoky Mountains National Park, Shenandoah National Park, and Blue Ridge Parkway), North Carolina Division of State Parks and Recreation (Mount Mitchell State Park), City of Asheville, North Carolina (Asheville Watershed), and U.S. Forest Service (Pisgah National Forest, Cherokee National Forest, and Jefferson National Forest). As mentioned earlier, the management policies with regard to balds differs from one agency to another; the U.S. Forest Service has made a commitment to retain all grassy balds, the Great Smoky Mountains National Park is committed to managing only two of the balds within park boundaries, and Shenandoah National Park as well as the Blue Ridge Parkway are planning to retain at least some of their balds.

Figure 1. Important Balds of the Southern Appalachian Mountains (Saunders, 1980)

1. Great Smoky Mountains
2. Plott Balsam Mountains
3. Balsam Mountains
4. Black Mountains
5. Roan Mountain
6. Grandfather Mountain
7. Mt. Rogers
8. Whitetop Mountain



STUDY AREA

Significance, Location, Climate, Geology, and Soils

Roan Mountain is the largest and probably the most famous of all the grass balds (Gersmehl, 1970). Brown (1941) stated, "For more than a century it has been considered by many people to be the most beautiful mountain east of the Rockies." The earliest known reference in the literature to any presently existing bald is a 1780 account of Roan Mountain, an area settled by Europeans before the Revolution. The earliest botanical description of the bald (1808) is also of Roan Mountain. Most of the earliest accounts of balds throughout the literature are descriptions of Roan Mountain, with most observers describing it as a level treeless prairie where very heavy grazing took place (Gersmehl, 1970). The beginning of forest encroachment onto the bald was noted as early as 1879 (Redfield, 1879). The entire Roan Massif, which includes Roan Mountain proper, Roan High Bluff, Roan High Knob, Eagle Cliff, Carver's Gap, Round Bald, Jane Bald, Grassy Ridge, Little Yellow Mountain, Big Yellow Mountain, Little Hump Mountain, and Hump Mountain, occupies approximately 50 square miles (Brown, 1941). The Massif as a whole is often referred to simply as Roan Mountain or, as local people call it, "the Roan." The Massif rises from a broad base at about 2,500 feet altitude to a rounded summit of 6,285 feet. The Tennessee side of the mountain is drained by the Doe River, while the North Carolina side drains into the Toe River, both of which eventually flow into the Tennessee River. Grassy balds occur on the

long broad ridges above 5,500 feet and cover an estimated area of over 1,000 acres. It is approximately 14 miles south of the town of Roan Mountain, Tennessee, on Tennessee Highway 143, and approximately 16 miles north of Bakersville, North Carolina, on North Carolina Highway 261. The Appalachian Trail, one of the most famous hiking routes in the National Trail System, follows the crest of the Massif for about 15 miles.

The geology of this region is characterized by a complicated system of faulting, folding, and overthrusting. A great variety of surface rock types, primarily metamorphic, is present, with the most common type being a pre-Cambrian crystalline complex of granites and gneisses with inclusions of mica and hornblende schist. Extensive areas of graywacke conglomerate are found toward the southern end of the Unaka Mountains (Mark, 1958). Mark states, "It is apparent from the geological maps and also from field observation, that there is no correlation between distribution of balds and of certain rock types" (Ibid.).

Two main soil associations have been identified and described for the region. These are the Porters-ashe and the Stony Rough Land Associations (Ibid.). Distribution of soils and differences between the soils of balds and adjacent forests also fail to explain the existence of the grassy balds (Gersmehl, 1970).

The climate of the Southern Appalachians is generally characterized by lower temperatures, higher precipitation, and higher wind velocities than surrounding areas of lower altitude (Shanks, 1954). The mean annual precipitation on Roan Mountain is 55 inches, ranging from 36 to 73 inches (Brown, 1941). Clouds or fog are almost ever-present, with less than 10 percent of the days of summer having continuous sunshine (Ibid.). The mean annual temperature for Roan Mountain is estimated at 44°F. Based on weather records reported for Roan Mountain and nearby Banner Elk, North Carolina, there is a 116°F range in annual temperature extremes. Winter temperatures have reached as low as minus 30°F (Brown, 1941). Mark (1958) reported that fluctuations in air temperature of greater than 60° within a single month were not uncommon here. Summer temperatures can reach as high as 94°F (Ibid.). In general, it is obvious that the vegetation of this high mountain area is defined by climatic extremes, which explains the difference in flora and fauna from adjacent areas at lower elevations where climatic conditions are milder. However, climate cannot explain the presence of bald mountaintops immediately adjacent to forested peaks at the same or higher elevations.

Scribner (1889) described the Roan Mountain balds as being dominated by Danthonia compressa, in keeping with other earlier descriptions of grassy balds. Elisha Mitchell (1835) wrote that the "vast meadow" on Roan Mountain "is the pasture ground for the young horses of the whole country about it during the summer." Brown (1941) stated that very little land above 4,000 feet elevation had been

cleared for cultivation, however, the balds of Roan Mountain had been grazed in the summer for at least one and a half centuries, mostly by cattle and sheep. No evidence of overgrazing in the mid-1930s existed according to Brown. He further stated that no forest fires had been recorded above 4,000 feet, but, "The settlers have frequently burned the grassy balds in late fall or early spring to improve grazing." As it had been 50 years previously, Danthonia compressa was the only dominant species on the grassy balds, covering 50 to 75 percent of the total area, when studied by Brown in the late 1930s. No trees or shrubs were then present in typical grassy bald areas. On forested slopes, the climax forest was beech-maple at elevations from 3,500 feet to 5,000 feet. At 5,500 feet and above, the climax forest is spruce-fir (Brown, 1941).

The significance of Roan Mountain, in biological and geological terms, is indicated by its nomination as a National Natural Landmark (Gaddy, 1981; Harrington, 1981). The mountain harbors the largest and best developed heath bald to be found in the Southern Appalachians. Round Bald is considered by many to be the most outstanding grassy bald in existence. The alder balds found on Jane and Grassy Ridge Balds are unique to the Roan Massif. Over 300 species of plants exist on Roan Mountain, with 54 of these species currently recognized as rare on national or regional levels. More significant species of flora and fauna are found on the Roan Massif than are found at any other site in the high mountains of the Southern Appalachians (Gaddy, 1981). Harrington (1981) further stated that the "geologic/geomorphic

attributes of this site, when merged with the diversity of ecological characteristics of the Roan Massif make this a truly unique site of unparallelled significance in the Southern Appalachians." Encroachment of woody species onto the grassy balds was noted at Roan Mountain as early as 1879 (Redfield). Brown (1941) stated that areas described a century earlier by Mitchell and Gray as open meadow are now forested, and that in some places rhododendron is advancing into the grassy bald as much as a meter a year. Most recently, blackberries have invaded the grassy balds of Roan Mountain and appear to be accelerating the process of succession. It is apparent that if this significant area is to be preserved in its present form with all its unique elements intact, some sort of active management, such as fire, woody plant removal, grazing, etc., must be undertaken.

Tables 1 and 2 illustrate the wide variety of interest groups and administering agencies involved in the management of Roan Mountain. As can be seen from the tables, the conflicts between the various interests involved are readily apparent. Although the ultimate management decisions for Roan Mountain are made by the U.S. Forest Service, five separate offices of this agency are involved. The various private organizations, particularly the Southern Appalachian Highlands Conservancy and the Appalachian Trail Conference exert considerable influence over Forest Service policy on recreation areas. In short, a complicated management problem is made more difficult by the diversity of entities and the number of bureaucratic levels involved.

Table 1

FEDERAL AND STATE AGENCIES

INVOLVED WITH ROAN MOUNTAIN BALD MANAGEMENT

U.S. Forest Service (Department of Agriculture) - Manages 191 million acres of National Forest lands, including approximately 7,000 acres at Roan Mountain. The latter area is divided between two states and two National Forests--the Cherokee National Forest in Tennessee and the Pisgah National Forest in North Carolina. This results in five separate U.S. Forest Service offices having jurisdiction over the Roan Mountain lands.

U.S. Fish and Wildlife Service (Department of the Interior) - In addition to managing the 88-million-acre National Wildlife Refuge system, is responsible, among other things, for administering the Endangered Species Act of 1973, and for providing protection for all terrestrial endangered and threatened species. There are 2 federally listed endangered and threatened species on Roan Mountain (1 plant and 1 mammal), along with 11 rare species which are currently under consideration for federal listing. (See Appendix D.)

North Carolina Natural Heritage Program (North Carolina Department of Natural Resources and Community Development) - Officially designated Roan Mountain as a registered State Natural Area (indicating that

it contains significant outstanding elements of natural diversity); maintains computer data base for rare fauna and flora in North Carolina, including many of the species occurring on Roan Mountain.

Tennessee Heritage Program (Tennessee Department of Conservation) - Maintains the same kind of data base as above for Tennessee; has also registered Roan Mountain as a State Natural Area. Has submitted formal proposals to the U.S. Forest Service to designate portions of Roan Mountain as Research Natural Areas.

National Park Service (Department of the Interior) - Took over administration of National Natural Landmark Program from Heritage Conservation and Recreation Service when the latter agency was abolished. The Roan Massif has been evaluated and recommended for designation as a National Natural Landmark.

North Carolina Plant Protection Program (North Carolina Department of Agriculture) - Administers state activities for endangered and threatened plant conservation. Roan Mountain supports 23 plant species listed by North Carolina as endangered or threatened or of special concern.

Table 2

INTEREST GROUPS AND PRIVATE ORGANIZATIONS

INVOLVED WITH ROAN MOUNTAIN

BALD MANAGEMENT

Recreation

Cross-country skiers - Because of its large open areas, scenic vistas, and high snowfall, Roan Mountain is becoming an increasingly popular destination for skiers.

Hikers - The Appalachian Trail follows the crest of Roan Mountain for approximately 15 miles. The Appalachian Trail Conference and Carolina Mountain Club are organizations of hikers who contribute time to trail maintenance and planning.

Off-road vehicles - Operators of snowmobiles, four-wheel drive, and all-terrain vehicles desire greater access to the bald areas, where they are presently excluded.

Nature/wildflower photographers and enthusiasts - Roan Mountain's annual Rhododendron Festival attracts 50 to 60 thousand visitors each year. The Tennessee Native Plant Society is a private organization involved with inventory and conservation of native flora.

Blueberry pickers - Blueberry bushes are one of the encroaching species which will, if left unchecked, gradually take over the bald.

Preservation and Land Acquisition

The Nature Conservancy (North Carolina and Tennessee offices) - Private, non-profit national organization dedicated to preservation of natural diversity (responsible for preservation of 2,481,000 acres since its inception in 1951); owns and manages Yellow Mountain tract and is actively pursuing acquisition of other tracts on Roan Massif. Currently experimenting with cooperative grazing to maintain their balds.

Southern Appalachian Highlands Conservancy - A 1,200-member private conservation organization currently dedicated to the protection (and acquisition where necessary) of the 23,000-acre Roan Mountain Highlands (areas above 3,200 feet in elevation). Organizational policy: "To maintain grass balds in open condition, leave the forests undisturbed, encourage continued farming and rural activities on lower slopes, and assure that the area remains available to the visitor on foot."

Academic

Roan Mountain has been used for decades as a field laboratory for universities in North Carolina, Tennessee, and neighboring states. Some scientists have expressed a desire to see the balds left unmanaged to facilitate the study of unimpeded natural succession.

Management and Coordination

Southern Appalachian Research/Resource Management Cooperative - Composed of Federal agency and university representatives and dedicated to cooperative research and problem identification on natural resource management issues. Organized and sponsored ~~by~~ the First Workshop on Mountain Balds Status and Management in 1981.

The current Forest Service objectives in managing balds are as follows (U.S.D.A. Forest Service Manual, 1984):

1. To maintain all areas of the Southern Region National Forests defined as Appalachian Mountain balds at a desired successional stage.

2. Ensure the reestablishment and/or perpetuation of the often unique vegetative character of these areas for a variety of National Forest uses and purposes.

3. Provide a significant visual resource for recreationists to enjoy as well as special habitat requirements for unusual plant and animal life.

4. Provide the necessary survival needs for the protection of endangered, threatened, and sensitive species occurring on certain balds.

In order for these objectives to be met at Roan Mountain, the chief encroaching species (blackberry [Rubus sp.]) must be eliminated or reduced in the grassy bald area, without eliminating rare species or other elements of ecological/recreational/aesthetic value. Danthonia compressa (mountain oat grass) was the historically dominant species of the grassy balds; effective management should result in an increase of Danthonia to its former preeminence. Woody species with showy

flowering displays (such as rhododendron and azalea) should not be eliminated entirely from the balds, but they should be prevented from completely covering the sward. Unlike blackberry, these latter species are not aggressive encroachers since they expand very slowly in the absence of disturbance, such as logging or intense fires (McGee and Smith, 1967). Firecherry, on the other hand, can become a problem; as the name implies, it is encouraged and proliferated by fire. At present, this species has not played a major role in bald succession at Roan Mountain since it is present only in relatively small clumps. However, it should be eliminated if possible. This study sought to evaluate some of the management techniques which were available to the Forest Service for use in accomplishing the above objectives on Roan Mountain.

METHODS

Site Selection

The site chosen for this study was a bald area of approximately 50 acres on the western side of Round Bald, which is part of the Roan Massif. The study area is bisected by the North Carolina and Tennessee state line and by the Appalachian Trail. This area was selected from the Forest Service-owned balds because of its accessibility to fire fighting and mowing equipment, its heavy public use (as a test of public opinion on management activities), and because it was not known

to harbor any rare species that might be negatively affected by the experimental treatments. The elevation of the study site varies from 5,512 feet at Carver's Gap to 5,800 feet at the crest of Round Bald. The aspect varies approximately 21^{0} from the northernmost margin of the study area to the southernmost margin.

Sampling Procedures

Vegetation

In the spring of 1983, ~~16~~ 6 permanent 20-meter line transects were placed across the study area. The one-dimensional line intercept technique of vegetation sampling was chosen because, as stated in Smith (1974), "This method is rapid, objective, and relatively accurate. The area may be determined directly from recorded observations. The lines can be randomly placed and replicated to obtain the desired precision. The method is well adapted for measuring changes in vegetation if the ends of the lines are well marked. Generally it is more accurate in mixed plant communities than quadrat sampling and is especially well suited for measuring low vegetation." The lines were placed in a stratified random manner by dividing the study area into four subcommunity types. These four types were, from the lowest elevation to the highest, as follows:

1. Diverse herbaceous community dominated by *Carex* sp., principally *C. brunnescens*. Other abundant species include

Solidago sp., *Rumex acetosella*, *Rubus allegheniensis*, and *Lycopodium obscurum*.

2. *Rhododendron catawbiense* thicket with scattered patches of *Polytrichum* sp. and individuals of *Solidago* sp. as well as large patches of bare, rocky ground.

3. Area of very low species diversity dominated by *Rubus allegheniensis*, *Carex brunnescens*, and *Rumex acetosella*.

4. Mountain crest subcommunity, dominated by *Angelica triquinata*, *Polytrichum* sp., *Prenanthes roanensis*, and *Potentilla tridentata*.

Each of these subcommunity types was treated as a separate area for the purposes of establishing the permanent transects. Each area was measured and gridded, and positions for the permanent line transects were selected using a random number table. Lines were placed parallel to the contour with the use of a hand level, and the line ends were marked by 12-inch-long aluminum pipes 1 inch in diameter. The pipes were driven into the ground to a depth of approximately 10 inches. Following the method described in Smith (1974) and Brewer and McCann (1982), the adequacy of sampling within each of these subcommunities was determined by drawing species:area curves.

In 1984 negotiations within the U.S. Forest Service were completed, which determined the final experimental treatment scheme. The study area was then further divided as shown in Figure 2, and additional transects were placed in each of the treatment areas to assure adequate coverage. This resulted in a total of 24 permanent 20-meter line transects, placed as shown in the figure.

In 1983 the vegetation along the first 16 transects was measured at intervals of approximately 30 days. A 50-meter fiberglass tape was stretched between the aluminum posts marking the ends of each transect. The coverage of all plant species, occurring either directly above or directly below the line, was then measured to the nearest decimeter. This first year's monthly sampling was designed to establish the best time for taking vegetation measurements. This is particularly important in a study such as this one where measurements of changes in vegetation and response to experimental treatments form the basis of future management recommendations. Also the time of year when the sampling is done can cause the community configuration to appear radically and artificially different. For instance, in April, when buds have burst and leaves are out on the vegetation in the adjacent valleys, the appearance of the plants on top of the Roan is still that of mid-winter. Similarly, if the coverage of a common species such as Rubus allegheniensis is measured before the leaves are completely developed, the relative importance of that species in the community will be underestimated. Therefore, using the measurements taken

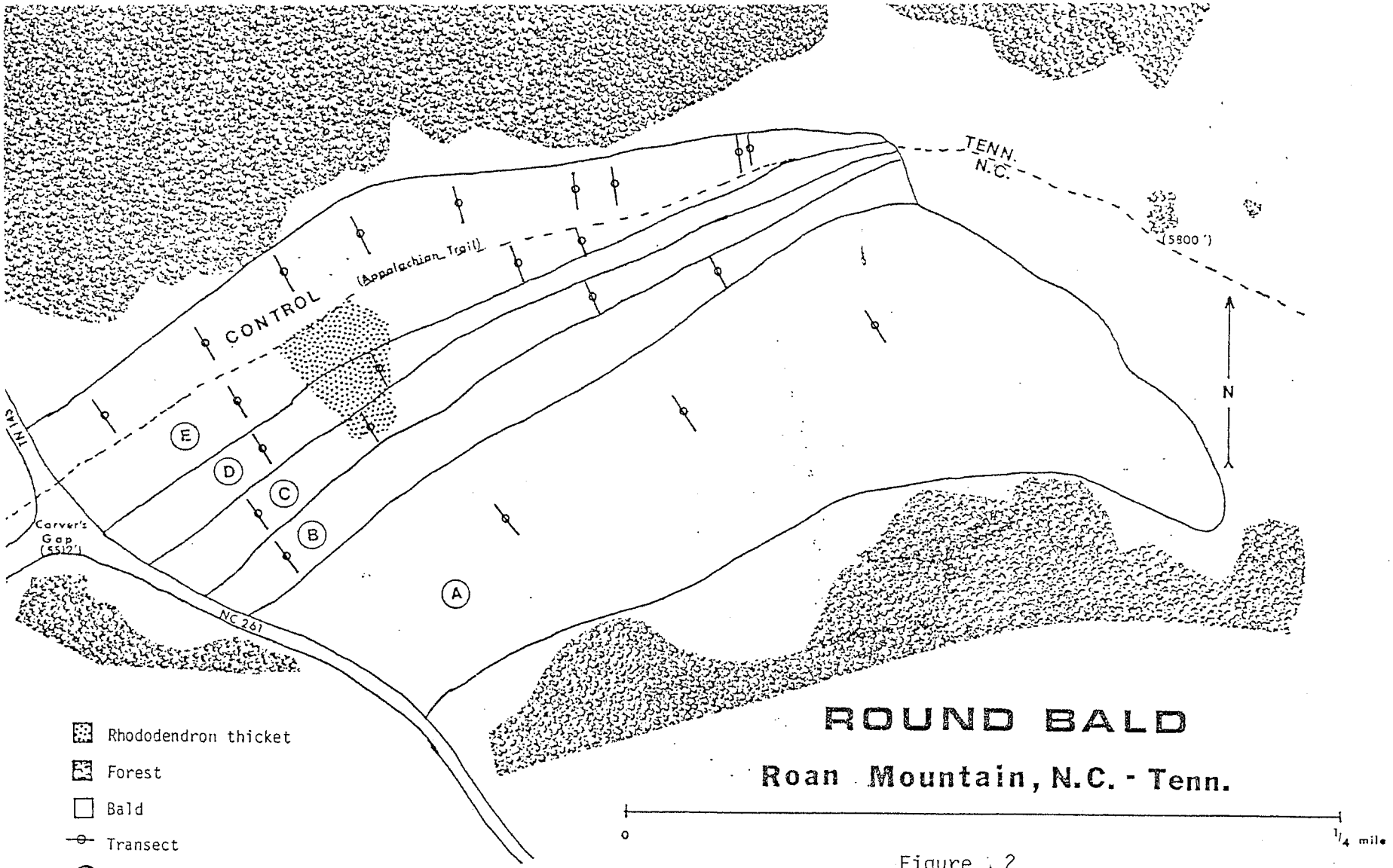

TENN.
N.C.
(5800')
CONTROL
(Appalachian Trail)
N
E
D
C
B
A
TN 143
Carver's Gap (5512')
NC 261
Rhododendron thicket
Forest
Bald
Transect
Treatment area
ROUND BALD
Roan Mountain, N.C. - Tenn.
0
1/4 mile

Figure 2

throughout the seasons in 1983, it was determined that the time when most species coverage and frequency curves are at their peak, and therefore the best time for accurate vegetation sampling, is July and August. This time was used for the sampling of the permanent transects in the years following the initial setup.

Where vegetation was low enough to permit, photographs were taken of a square meter along each permanent transect and also of the entire transect in a north to south direction. In the first year's sampling, these photographs were taken in the spring, summer, and fall. In years thereafter, when sampling was done at the peak of vegetation growth, the photographs were taken in the July-August sampling period.

Soil

Soil data were collected in 1983 along each transect prior to treatment, using an 18-inch tube sampler. Samples were taken from at least six sites along each transect, with the shallow, rocky nature of the soil sometimes necessitating as many as 25 different sampling sites on a transect. Soils were analyzed following standard procedures for pH, phosphorous, potassium, calcium, manganese, zinc, copper, magnesium, and cation exchange capacity, by the North Carolina Department of Agriculture, Soil Testing Laboratory, Raleigh, North Carolina. Samples from treatment Area A, which had burned during the three years preceding soil sampling, were compared with the pretreatment analysis data from the other areas to determine the

effects of burning upon the soils here. (The composition of the soils in areas treated with methods other than fire remains unaltered.)

Treatments

In 1984 experimental treatment of the plots began.

Area A. Burned (by prescription) in the springs of 1982 and 1983 before baseline vegetation data was taken. Spring burning of this area has continued through 1985, and the area will be burned for the fifth consecutive spring in 1986. Because no baseline vegetation data was taken before the treatment, data from the post-burn transects placed in Area A was treated separately (see Results Section).

Area B. Prescribed spring burning, beginning in 1984.

Area C. Prescribed spring burning, as well as summer cutting or mowing, beginning in 1984.

Area D. Cutting or mowing only, starting in 1984.

Area E. Prescribed fall burning, starting in 1984.

Control Area. This area, to the north of the Appalachian Trail in the study site, was selected for the control area as a comparison to the adjacent experimentally treated areas. It was selected because of the value of the wide, bare foot trail separating it from the adjacent areas to be burned. It was believed that this trail would serve as an effective fire break in the event that the controlled burns on areas A, B, C, and E should escape. In April 1984, the prescribed fire ignited by the U.S. Forest Service escaped and was effectively stopped by the trail, which prevented the accidental burning of the control area.

The schedule of treatments and the areas treated are shown in Figure 2. As indicated, the 1984 spring burn, ignited in Area A, escaped control and burned across approximately the lower two-thirds of all the treatment areas. Two transects were placed in the upper part of the control area in an attempt to compensate for this and to measure the effects of cutting without fire. This irregular burning pattern made data analysis more difficult. The remainder of the treatments through the fall of 1985 were carried out as prescribed.

Data Analysis

For each species along the 24 permanent transects, the following values were calculated as shown:

$$\text{dominance (cover)} = \frac{\text{Species A}}{\text{total transect length}} \times 100$$

$$\text{relative dominance} = \frac{\text{total intercept length, Species A}}{\text{total intercept length, all species}} \times 100$$

$$\text{frequency} = \frac{\text{intervals in which species occurs}}{\text{total number of transect intervals}} \times 100$$

$$\text{relative frequency} = \frac{\text{frequency value, Species A}}{\text{total frequency value, all species}} \times 100$$

The most useful and accurate measure of species reaction was dominance. The changes in dominance in response to the treatments and in comparison to the control plots, can be seen in Appendix A. These data were analyzed using analysis of variance by species, with arcsine transformations on percentages where appropriate. The responses of individual species, as well as classes of species (i.e., woody species versus herbaceous, grasses versus other herbs, etc.), were similarly compared for each treatment.

RESULTS

Vegetation

As can be seen in Appendix A, the following results were measured from the management techniques used:

Burning and cutting - Significant increases in Danthonia compressa, and significant decreases in Rumex acetosella; slight but insignificant changes noted in other species.

Fall burning - Significant increases in Danthonia compressa and Rumex acetosella; slight but insignificant changes noted in other species.

Cutting - Significant decrease in Rubus and significant increase in Rumex acetosella; slight changes in other species.

Spring burning - Significant decrease in Carex, significant increase in Rumex acetosella, slight changes in other species.

The graph showing mean species dominance after two spring burns was constructed from measurements taken in an area burned before this monitoring project began. The same measurements taken after three spring burns show significant increases in Carex, Rumex acetosella, slight increases in Rubus, and significant decreases in Danthonia and Polytrichum. The species dominance means after four consecutive years of spring burns show a continued increase in Rubus from the first year as well as significant increases in Carex and Rumex acetosella. Little change is seen from the third to the

fourth year with the exception of an increase in Danthonia compressa. The shifting directions of species dominance in these plots is thought to be related to variations in fire intensity in different years. The remaining graphs are constructed from plots which were accidentally missed during treatments and do not represent a large enough sample size to have any statistical significance. However, it is interesting to note that the increase in Danthonia in response to fire persists for at least two years after the last burn. The control plot decreases from 1984 to 1985 in Rubus, Carex, Danthonia compressa, Rumex acetosella, Polytrichum, and Angelica, although not statistically significant, may be a reflection of the unusually cold temperatures recorded in the winter of 1984-85. (Nearby Banner Elk, North Carolina, recorded an all-time record low of minus 31^{o}F on January 21, 1985.) This factor may also be slightly masking the effects of the treatments in the other plots.

It would appear from these results that the only one of the treatments which significantly decreases Rubus is the cutting. The burned plots exhibit an almost invariable increase in Danthonia compressa, along with an accompanying increase in Rumex acetosella, except when cutting was combined with burning and Rumex acetosella declined. Fall burning differs from spring burning in having an apparent overall lesser effect on vegetation change. The Carex, which declines in response to spring burning, is apparently unaffected by the fall burning.

Soil

The results of soil analysis from burned and unburned plots are given in Table 3. The plots which have undergone three consecutive years of spring burns exhibit significant increases in humic matter, base saturation, pH (making the soil more basic), potassium, magnesium, manganese, and zinc. This is in keeping with results reported from other studies of the effects of fire on soil as will be discussed in the next section.

Cost Analysis

Figures presented in this section obviously do not represent an exhaustive cost comparison, but rather a record of expenditures during this particular project. Additional cost estimates from other studies and comparisons for these methods and others are given below in the discussion section.

Spring burning

Mean = 1.5 man-days per acre

Range = .12 to 1 man-day per acre

Handcutting

Mean = 1.9 man-days per acre

Range = 1.2 to 2.5 man-days per acre

Fall burning

Mean = .3 man-days per acre (figured from one treatment)

Table 3
SOIL ANALYSIS
(Soil Samples Taken August 4, 1984 - September 9, 1984)

	Soil Class	HM-%	W/V	CEC	BS-%	Ac	pH	P-1	K-1	Ca-%	Mg-%	Mn-1	Zn-1	Cu-1
Control Plots (Untreated)	MIN	2.7	.72	5.2	8	4.8	3.9	013	18	3.9	1.9	59	037	36
	MIN	2.8	.74	4.8	8	4.4	3.9	012	16	4.2	1.7	58	037	34
	MIN	2.8	.78	5.2	7	4.8	3.9	010	16	3.9	1.9	58	038	34
Means:		2.8	.75	5.1	7.7	4.7	3.9	11.6	16.7	4	1.8	58.3	37.3	34.7
Burned Plots (After three consecutive years of spring burns)	M-O	4.0	.72	5.0	12	4.4	5.2	009	38	6.0	2.4	74	046	30
	M-O	4.1	.68	4.5	12	4.0	5.1	013	36	4.4	3.1	80	047	32
Means:		4.1	.70	4.8	12	4.2	5.2	011	37	5.2	2.8	77	46.5	31

MIN = Mineral

M-O = Mineral-Organic

HM-% = Humic Matter, percent by volume

W/V = Weight per volume, g/cm^3

CEC = Cation Exchange Capacity, meg/100 cm^3

BS-% = Base Saturation, % of CEC

Ac = Acidity, meg/100 cm^3

pH = Hydrogen-ion activity

P-1 = Phosphorus index

K-1 = Potassium index

Ca-% = Calcium, % of CEC

Mg-% = Magnesium, % of CEC

Mn-1 = Manganese index

Zn-1 = Zinc index

Cu-1 = Copper index

The labor expenditures shown above were the only figures kept by the Forest Service for their treatment of the experimental area. The cost of fuel for the drip torches and gasoline for the weed-eaters is relatively negligible for such small areas. However, hidden costs that are not reflected in the figures above are the salary costs for the workers when they were taken to the bald in expectation of having appropriate burning conditions, only to find that the higher elevations were experiencing rain, heavy fog, or high winds. According to the District Ranger this was a fairly frequent occurrence, and the distance which had to be traveled from the work center to the experimental area resulted in loss of an entire day, with no work accomplished. In addition, in 1984 as well as 1985, when burning was being attempted with less than the necessary number of people in attendance due to manpower shortage, the fire escaped control. In 1984 a fire fighter helicopter had to be called in to assist in extinguishing what had become a potentially dangerous wildfire. No cost or labor figures were kept for these additional expenditures, however, helicopter time for such purposes currently ranges around $500 an hour. Therefore, although the figures above indicate that burning is the least expensive management technique, the actual total cost of accomplishing the objectives is not reflected.

Summary, Discussion, and Recommendations

Based upon the three years of data obtained from this study of four management methods (spring burning, fall burning, cutting, and burning and cutting combined), it appears that the only treatment which significantly reduces the major encroaching species is cutting. Burning (both spring and fall) has the positive effect of increasing the dominance of *Danthonia compressa*, the historically dominant species of the balds. Therefore, it would appear that, of these methods, a combination of the two would have to be employed to accomplish the objectives of returning the balds to their original aspect and maintaining them at an arrested stage of succession.

However, cutting in this area has its disadvantages. Handcutting a thousand acres of bald every year for many years in order to set back woody growth is hardly a feasible form of management. Tractors are difficult and dangerous to use in this terrain because the slopes of Roan Mountain are steep and rocky, in addition to being quite fragile. Burning, although relatively cheap and practical for this type of terrain, has not thus far accomplished the objectives of reducing encroaching woody species. Because of the erratic climate of this high-elevation area and high spring humidity, controlled fires vary tremendously in intensity, and therefore in their effect on the vegetation.

Management attempts in similar habitats have produced results which, although sometimes conflicting, must be taken into account when designing a management plan for an area such as Roan Mountain. From earliest records to the present, balds have been likened to prairies. Although they are not true prairies, the striking similarities make it worthwhile to look into the extensive management literature which exists on the midwestern grasslands. Although some balds researchers (Lindsay, 1977; Lindsay and Bratton, 1979) maintain that fire was not a historically important contributor to bald maintenance, fire is considered a natural and essential component of prairie ecosystems because of its tendency to stimulate the growth and flowering of the native vegetation, and because of the fire adaptation demonstrated by prairie plants (Henderson, 1982). Prescribed fire in prairies has been found to reduce nonnative invading species, which tend to be adapted to the cooler moister meadows of northern Europe. The root growth of cool-season exotic grasses (such as bluegrass, timothy, redtop, and orchard grass) ceases at high summer soil temperatures (26^{o}C); such a rise in soil temperatures can result from burning off dead material, thereby exposing the dark soil to solar radiation (Ibid.). However, several factors have been found to be extremely important in achieving the desired vegetation changes with fire, including time and frequency of burning and character of the fire (completeness of surface litter combustion). Also, post-fire moisture conditions on the site have a profound effect on recovery of the vegetation. In drier conditions, biomass reductions, rather than the expected increases, are seen. Litter accumulation also seems to be an important factor; in general,

the greater the litter cover at the time of the burn, the more positive the prairie's response to fire. More mesic sites tend to accumulate more litter than dry ones, and therefore respond more favorably to fire. Mesic stands require one to three years to reach pre-burn litter levels, while dry prairies require four to six years. These results led Henderson to speculate that (at least for grasses) the benefit derived by a species from burning is directly related to the amount of litter produced by that species. Evans (1983) found that heavy grazing reduced the competitive ability of grasses in prairies, resulting in an increase in undesirable woody species. Spring burning combined with mid-summer mowing controlled some encroaching species (particularly sumac), while spring burning alone caused prolific resprouting. Repeated cutting and burning had the additional advantage of restoring prairie plants under sumac clones, and these helped shade out woody sprouts and provided a better fuel base for subsequent burns. However, because of the intensity of labor involved in repeated cutting and burning, Evans concluded that herbicides (such as Picloram, Triclopyr, and Tebuthiuron) were the best means of controlling succession.

In a different habitat type, DeSelm et al. (1973) found an increase in Rubus in response to prescribed burning of upland hardwoods in the Highland Rim area of Tennessee. Mobley et al. (1978) reported that prescribed fire had been used in the Southeastern Coastal Plain pine forests as early as 1907 to reduce fuels and therefore wildfire hazard. In this habitat, burning has been found to be most effective at eliminating hardwoods 3 inches and less in ground

diameter. Generally, spring and summer backfires result in more root kill than winter burns. Fire usually causes small increases in soil pH, organic matter, nitrogen, phosphorous, calcium, and magnesium (consistent with results in Roan Mountain data), and sometimes results in nitrogen fixation. Very hot fires, such as wildfires, can cause damaging changes to soils, including losses of soil organic matter and changes in structure of soil clays. Because of the danger of erosion, these authors stated, "Burning should not be done on highly erosive soils" (Ibid.). Stransky and Harlow (1981), studying fire in the same type of habitat as Mobley, found that winter burns increased the abundance of forbs, grasses, and legumes for up to three years after the burn. Infrequent summer burning was found to slightly decrease the number of woody plants and increase the abundance in kinds of herbaceous vegetation. Frequent summer burns eventually eliminated woody plants, many forb species, and some grasses, and led to site domination by certain fire-tolerant grasses and forbs. Studies of controlled burning in the mountains are virtually nonexistent, and these authors recommended that more site specific studies be done in such areas before their conclusions were applied to different habitat types.

In 1973 the U.S. Forest Service control-burned a grassy area between Tennent Mountain and Black Balsam Knob, on the Pisgah National Forest in Haywood County, North Carolina, to open the area up and improve it as habitat for golden eagles and ravens (Sanders, 1975). This area is not a true bald, as defined by Gersmehl (1970), since it

is known to be the direct result of 20th century clearcutting and slash burning, and is dominated by blueberry, firecherry and various grasses. No pretreatment data was recorded for this series of burns. Sanders estimated that only about 77 percent of the treated area actually burned. Barden (1978) studied the results of these fires on the vegetation. He found that the woody shrubs, which were unpalatable to browsing animals such as deer, regained their original coverage within one to two seasons after burning. The other shrubs' recovery was delayed by browsing, but they recovered within five to eight years. Barden estimated that a five-year fire rotation (burning once every five years) would be required for sites dominated by unpalatable shrubs in order to maintain an open herb-shrub community; communities dominated by rhododendron would require fire less frequently once a complete topkill had been achieved. He further stated that fire alone could not eliminate shrubs entirely, forming meadows of herbaceous species such as those found in the Great Smokies and at Roan Mountain in the 1930s. Barden postulated that heavy grazing by cattle in the 19th century had removed the shrubs, and he further stated his support for Gersmehl's (1970) fire-grazing hypothesis that the high grassy meadows are "cultural artifacts maintained by cattle grazing and occasional deliberate firing . . ." (Ibid.).

On Mount Rogers in the Jefferson National Forest, Virginia, the U.S. Forest Service manages a series of recently-acquired balds with cattle grazing and occasional controlled burning (U.S.D.A. Forest Service, 1976 and 1977). Grazing of this area in summer had been

taking place up until Forest Service acquisition in 1974. Therefore, fences are still largely intact and livestock interests are still present in the area. In 1982 a controlled burn of three areas totalling 506 acres was conducted at an average cost of $6.53 per acre. Cattle were used to supplement the effects of the burn by grazing the area during the season following the fire. Conclusions from that work were that burning did not control encroaching vegetation by itself, and had to be combined with livestock grazing and/or brush control by cutting woody stems larger than one-half inch in diameter. Repeated difficulty was experienced in getting proper burning conditions at higher elevations, consistent with results of the Roan Mountain work. Managers on the Jefferson National Forest concluded that the objective of brush control could be attained with the combined use of prescribed fire, grazing, brushcutting, and limited chemical use (Ibid.).

Big Meadows, on the Shenandoah National Park in Virginia, had been maintained for ten years prior to 1976 by annual fall mowing. As this effort became increasingly expensive and as the area appeared to be stabilizing at a shrub-briar stage rather than the desired grassland-shrub stage of succession, Park Service managers sought a less expensive and more effective means of maintaining the open area (Cocking et al., 1979). A limited experiment was begun in the fall of 1974 to determine the feasibility of using prescribed fire as an alternative management practice to mowing. The major encroaching species in this grassland were Robinia (black locust) and Rubus (blackberry). It was determined from the study of burns in this area

that controlled burning increased the coverage by both these encroaching species. Because fire was found to stimulate the sprouting and spreading of Robinia and Rubus, they concluded that it was beneficial in a grass-dominated plant community where only an occasional Robinia was found. In such situations, the authors believed that a strong healthy growth of grasses might successfully compete with young locust sprouts and retard their growth to the point where periodic fires could maintain the grassland. The conclusion and recommended management was for repeated mowing of the area during the summer season for one to three years (Ibid.).

Weakley (1980), in his study of the Yellow Mountain balds of North Carolina, stated that several rare plant communities or associations there were "almost certainly dependent on active grazing for continuance," and recommended continued cattle grazing at the present intensity. He noted that overgrazing on the adjacent balds of Big Hump and Little Hump Mountains had fostered colonization by non-indigenous species. He believed that burning had been used in this area only rarely and would cause "great change in herbaceous vegetation and would ultimately encourage invasion by such plants as blackberry and firecherry." He recognized that handcutting might be required to supplement the grazing. Carex, the graminoid which has overtaken most of the balds in this area, is less adapted to grazing than Danthonia and other grasses. Evidence of this was seen from the sparse growth of Carex on the grazed portions of Big Yellow Mountain. (Grasses, such as Danthonia, have an intercalary meristem; growth

occurs at the base of the leaf rather than the tip, making them well suited to repeated cropping by grazing animals.)

Lindsay and Bratton (1979), in their study of the grassy balds of the Great Smoky Mountains, stated that burning did not seem to have been a major factor in maintaining the balds of the Smokies. Grass was kept so short by grazing animals that there was not enough fuel to support a grass fire, much less one that would kill woody shrubs or seedlings. Historically, open areas were maintained primarily by grazing but cutting was also important. Fire may have been used to clear areas but was not commonly employed to keep them open. They further stated their belief that "generally, fire is more effective for preventing invasion than for causing retrogression of already established shrubs." The major experimental part of the work done by Lindsay and Bratton consisted of comparing various grazing techniques to maintain balds. They found that grazing appeared to be effective in controlling blueberries and blackberries, however, many years of frequent handcutting or grazing by goats or other animals that prefer woody browse would be required to control sprouts without herbicides. In their testing of different grazing animals for the purpose of bald maintenance, these authors found goats to be the best because they preferred woody plants (oaks, hawthorn, and blueberries) and only grazed grass lightly. However, they were difficult to confine and expensive to purchase in large numbers. Sheep were the next best and would readily eat oak, hawthorn, and blueberry sprouts but would not eat mature blueberry bushes until the grass had been eaten to the

ground level (sheep were the animals that historically grazed the balds of the Smokies before park establishment). Cattle would not eat blueberries and grazed grass down faster than all other animals combined. They seldom ate hawthorn, which is a major encroaching species on the balds of the Smokies, and were the only animals that ate azaleas (for which they seemed to display a preference). Cattle needed a lot of water, making a large herd difficult to manage. Donkeys, on the other hand, were the easiest animals to manage, but ate mostly grass, only eating hawthorn and oak when the grass had run short. These animals therefore could not be used to set back succession but would be effective in retarding its advance. In addition, they were thought to be probably the best able to fight off predators. They summarized that "grazing would undoubtedly be effective in setting back succession and maintaining the balds." Grazing by anything other than cattle would discriminate in favor of azaleas (and possibly rhododendron) as could no other method short of cutting every other kind of woody plant by hand (and repeating the treatment to control sprouts). The cost to graze approximately 20 to 30 hectares on two balds in the Smokies was estimated at approximately $12,000 (1975 prices, not including fencing and other site preparation costs or herders' salaries). Lindsay and Bratton believed that the park would have to purchase the grazing animals, since the areas involved were too small and too remote for farmers to be interested in grazing stock there as a commercial venture. The potential drawbacks to this form of management were that some animals might be lost to predators, and disease exchange might occur between stocked artiodactyls and native

deer. They conceded that whereas grazing is probably the most effective method for maintaining balds, in the long run, it has the most problems associated with it in the Great Smoky Mountains National Park environment.

Based on limited collection of fire data, Lindsay and Bratton (Ibid.) expressed the belief that fire would have to be either very frequent or very intense to suppress woody plant succession. On most burns of light to moderate intensity, a shrub succession (especially of Ericads) would be expected. They hypothesized that fire might be effective in suppressing shrub succession if repeated burns were used, and stated that fire does not encourage exotic plant species to the extent that grazing and trampling do. They suggested that mowing could be used to supplement management, if fire fails to retard sprouts. Based upon their own experimental observations and reports of others, Lindsay and Bratton concluded that cutting and grazing were the most historically accurate management techniques for grassy balds and would probably best maintain their character. However, the most practical methods are probably cutting followed by mowing or cutting followed by burning and mowing. They emphasized an extremely important point in the following statement: "The need for long-term management commitment and the expenses of the various techniques are important elements in the decision to take action" (Ibid.).

Based upon all of the preceding information, this writer has concluded the following:

1. Management requirements are not the same for every bald. Important factors to be considered in selecting a management technique are identity of encroaching species (since different species respond differently to the same management techniques), climate and elevation at a particular bald, accessibility, and the size of the area to be treated.

2. "Historically authentic" means of maintaining balds may no longer be the most practical or the most economical methods.

3. Chosen techniques should be carefully monitored to ensure that they are accomplishing the desired objectives.

4. Public opposition to management of these areas, regardless of the technique employed, can be minimized by explaining to people and local visitors the purposes for the action and demonstrating desired effects. (Personal experience at Roan Mountain supported this idea, where the writer had many opportunities to successfully allay peoples' fears and concerns with a few minutes of explanation and several well-placed explanatory signs.)

5. As concluded by Lindsay and Bratton (1979), the commitment to maintain the balds must be more than lip service; where succession has progressed to an advanced stage, a sizeable investment of resources may be required initially to restore the balds to their original appearance. After this is done, a continuous commitment of funds to maintain them at this stage is required, or the original work will have been wasted. In addition, shortages of funds and particularly manpower can create potentially dangerous situations. This was seen on Roan Mountain during this study when, in three out of five years, prescribed burns escaped control, primarily because of lack of manpower.

The recommended management for the Roan Mountain balds, based on existing literature and data generated from this work, is as follows (before wide-scale treatment of the Roan Mountain balds is undertaken, all rare plant species should be located and inventoried):

Blackberries, firecherry, and other aggressive invaders should be treated in the first year with a systemic herbicide such as Roundup. This should be hand-applied, not sprayed, with a wick applicator such as those commonly used to eliminate weeds. Such an herbicide is nonpersistent, killing the plants it touches by penetrating to the root collar, without translocating through the soil to unintended targets. If applied at the right time of year, it generally achieves a near 100 percent kill with one application. This technique should be the

least expensive and most effective way of eliminating unwanted woody species. In addition, with hand-application, extreme selectivity can be used in its application, thus avoiding accidental damage to rare species and flowering shrubs which are to be retained. Although mowing or handcutting, particularly repeated cuts during successive growing seasons, might accomplish the same objective, it would probably take several years and be considerably more expensive. On the Roan Massif, as stated earlier, mowing is a particularly hazardous proposition owing to the steepness and rocky nature of the terrain.

The herbicide application in the first year of treatment would be followed the next year by a spring burn and a second year of herbicide treatment to eradicate any stems that might have been missed the first year.

Following these first two years of treatment, spring burning should be undertaken once every three years and herbicide treatment of individual areas undertaken as necessary. Monitoring with permanent plots such as those used in the current study should be continued to determine the effectiveness of and the need for alterations in the prescribed management. Rare plants should initially be isolated from any treatment. Once it is determined that the prescribed management is working to maintain the bald and will be continued in the long run, small portions of large populations of the rare plant species should be subjected to the spring burning and their responses measured and recorded. It is expected that at least some may respond favorably to

fire. Once this is determined, then the entire areas occupied by these species can be treated in the same manner as the rest of the bald (except, of course, with the herbicide). A public education program should be undertaken and signs erected to interpret ongoing management to visitors. Publicity in local newspapers and radio stations would also be helpful. A workshop should be sponsored once every five years or so for all those persons and agencies involved in bald management for the purpose of information exchange and resolution of problems.

Implementation of these recommendations into Forest Service policy has already begun, partially as a result of the Roan Mountain study. In 1981 the Forest Service initiative to manage balds was delegated to field level managers (District Rangers) in North Carolina. Internal Forest Service correspondence (January 15, 1981) from the Deputy Forest Supervisor to the District Ranger (Toecane Ranger District) stated that a multi-disciplinary review team had been convened to review bald management options and had concluded that prescribed burning alone probably would not effectively maintain the area. Cattle grazing along with periodic bush-hog clearing was recommended. The District Ranger was directed to prepare a "specific action plan" for management of the area, combining grazing, bush-hogging, and burning for the purpose of maintaining balds in an open grassy condition. The result of this direction was an environmental assessment prepared in 1982 by a Forest Service staff officer who, under increasing budgetary restrictions, selected what appeared to be the least expensive and easiest method of managing the balds (prescribed fire) and proceeded to selectively

present data which would justify this choice, rather than objectively reviewing options and selecting the optimum solution to the problem. As March and Simon (1958) noted, "Most human decision-making, whether individual or organizational, is concerned with the discovery and selection of satisfactory alternatives; only in exceptional cases is it concerned with the discovery and selection of optimal alternatives." The recommended management for Forest Service-owned balds in North Carolina at that point in time was prescribed burning on a three-year rotation. There were no provisions for pretreatment or post-treatment monitoring to assess effectiveness of the effort. At that point, largely because of the many extremely rare plants occurring on the Roan Mountain balds in particular, objections from various agencies and individuals were raised. Under pressure, the Forest Service agreed to permit a limited test of management techniques to be undertaken before treatment was applied to the balds in their entirety. Volunteer effort had to be used to accomplish the three years of vegetation monitoring necessary to produce results. During the course of this project, the writer (directly and indirectly through other interested agencies and citizens' groups) continued to encourage Forest Service decision-makers to pursue a more objective course of action. As a result, a new chapter on bald management, promoting unbiased management decisions, was issued for the Forest Service Policy Manual in 1984 (Appendix G). The recommendation with regard to sponsoring a gathering of people and agencies involved in bald management from different states will be implemented in June 1986, when the Forest Service will sponsor a workshop on bald management at Crossnore, North Carolina (the results

of this study, as well as several others, will be presented there). The reason for this unusually successful influence on Forest Service policy-making is probably tied to timing and the legal requirements of the National Forest Management Act of 1976. This act provides for long-range resource planning, focusing on the periodic development of two documents. The first of these documents, the Assessment, presents long-term demands and supplies of renewable resources on the nation's 1.6 billion acres of forest and range land, under all ownerships, and recognizes how these resources may best be used. The second document, which is based on the Assessment, is the long-range Program for all Forest Service activities, including management of the National Forest system, state and private forestry programs, and forestry research. A new Assessment is prepared every ten years, and a new program document is prepared every five years. The Forest Service is required to integrate extensive public involvement in the preparation of both. To implement the long-range plans for multiple use management, a Land and Resource Management Plan is prepared in turn for each National Forest unit. Here, too, public involvement, particularly on a local scale, plays a key role in the development of Forest Service policy as expressed in these Plans. During the time the bald management work at Roan Mountain was going on, the National Forests in North Carolina were undergoing their five-year revision of the Land Management Plan. An accelerated timber harvest schedule, presented in the new draft Plan, received widespread public criticism, sensitizing the agency to public input and in turn arousing more public attention through media coverage which was focused on the Forest Service. As a result of the heightened

public awareness, increased membership and participation in special interest groups such as those in Table 2 strengthened the influence of such groups on policy decisions being made by the Forest Service. As a result, a more objective policy on bald management was written into the Forest Service Manual which directs all managerial activities within the agency, and the new Land Management Plan was altered to comply. Currently, a new and more objective management plan for the spectacular balds of Roan Mountain is being drafted and should serve as a basis for management decisions on the remainder of the Forest Service-owned balds in the area.

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APPENDIX A

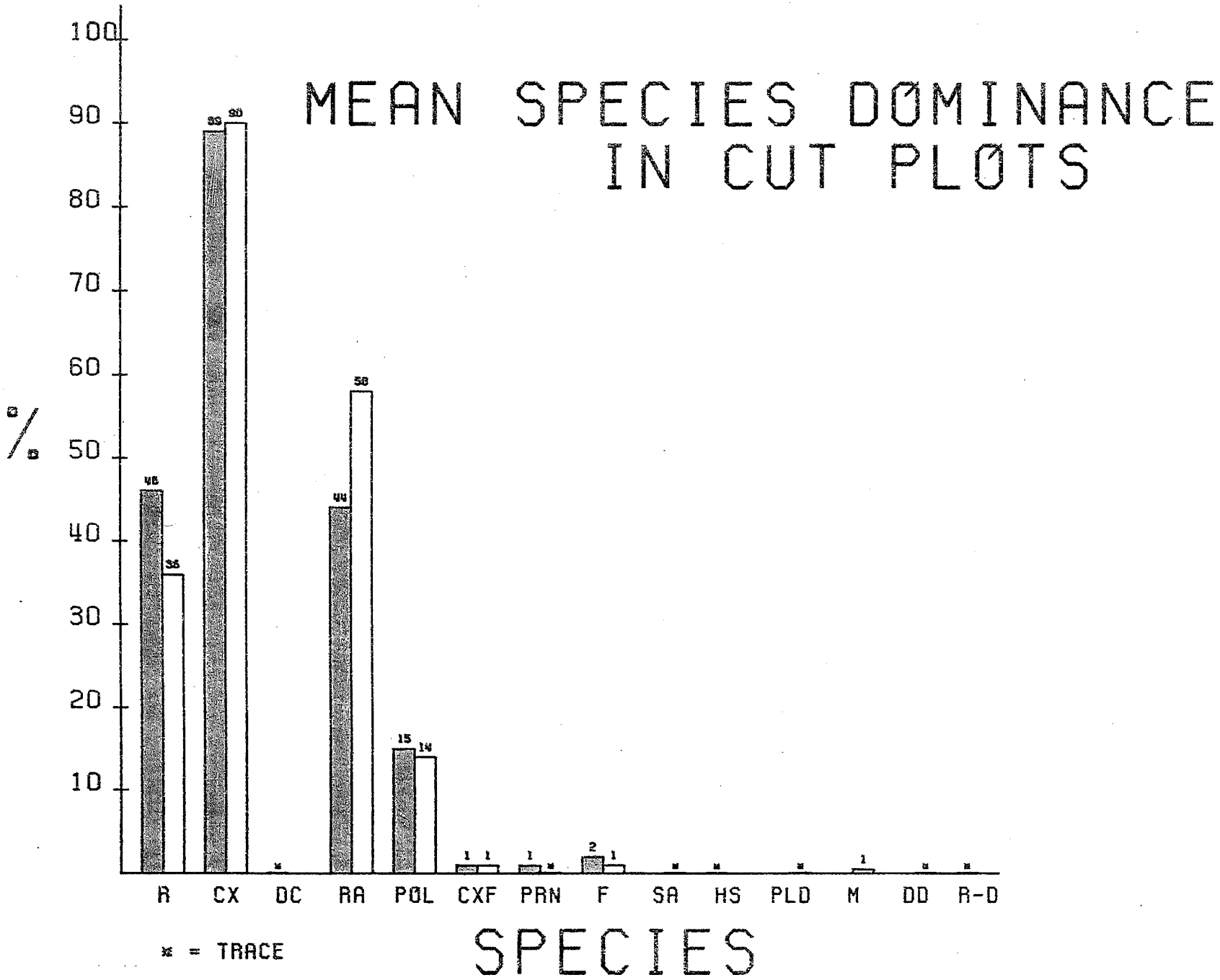
MEAN SPECIES DOMINANCE
IN CONTROL AND TREATMENT AREAS

(Key)

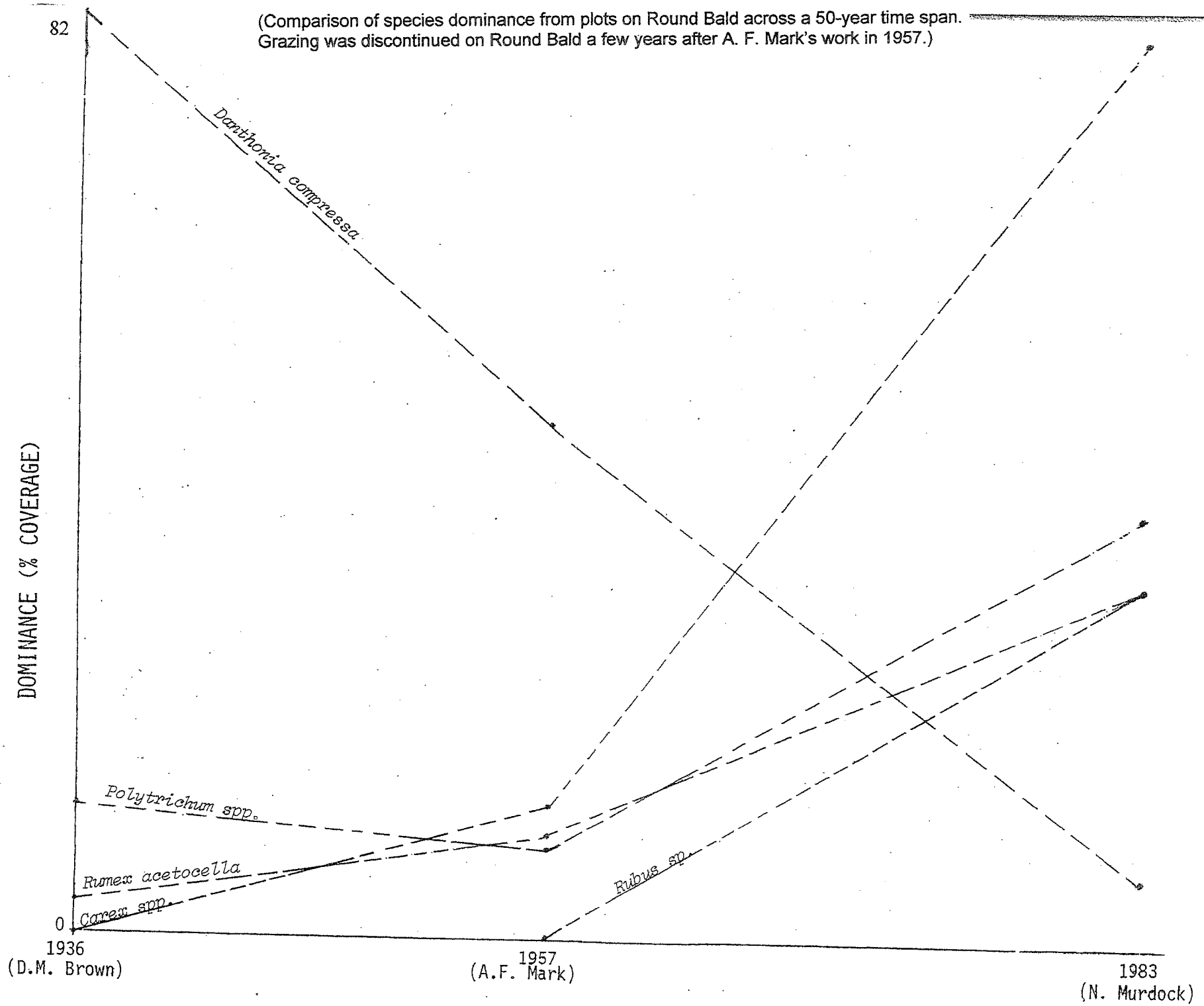
Before treatment

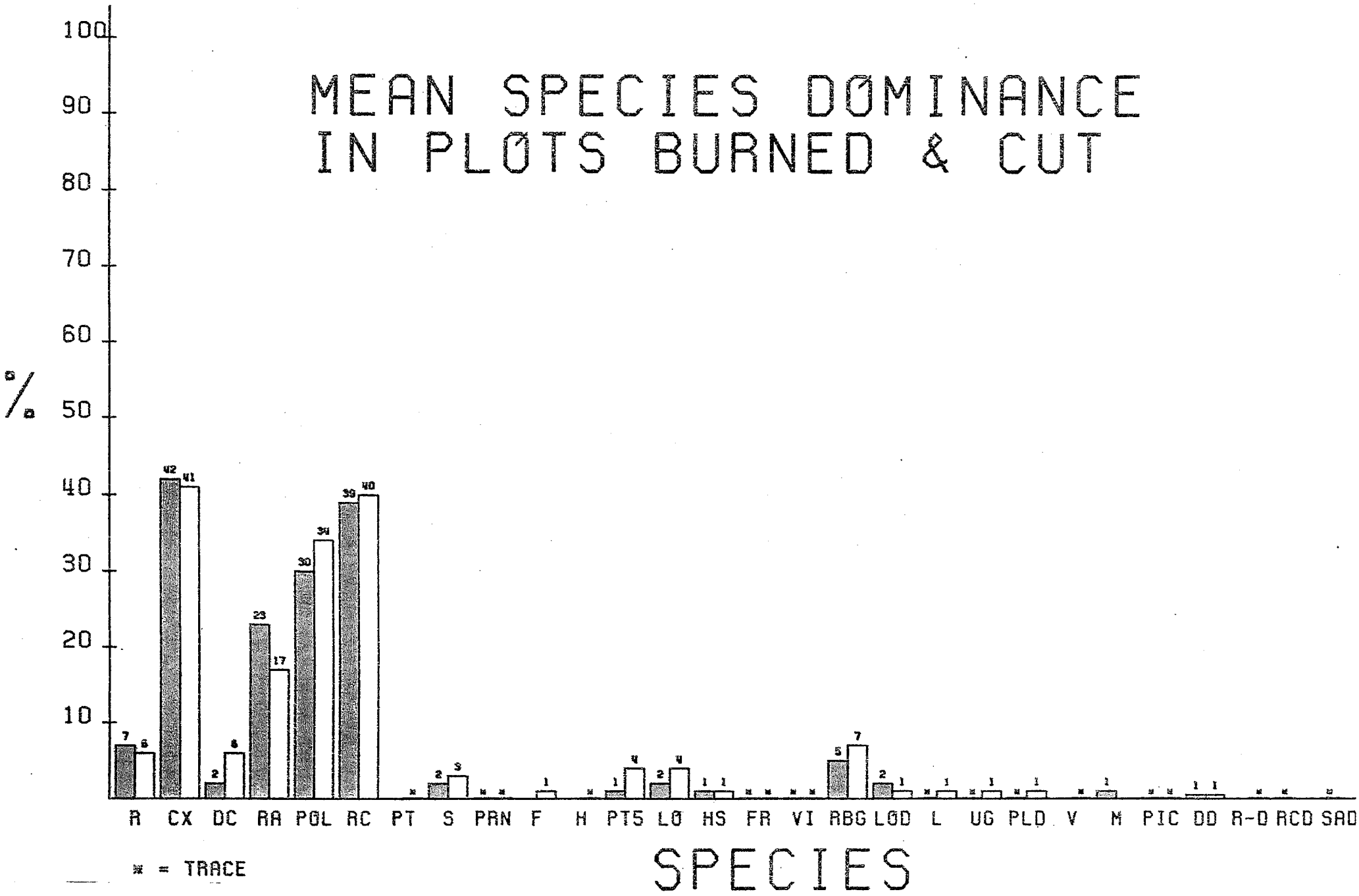
After treatment

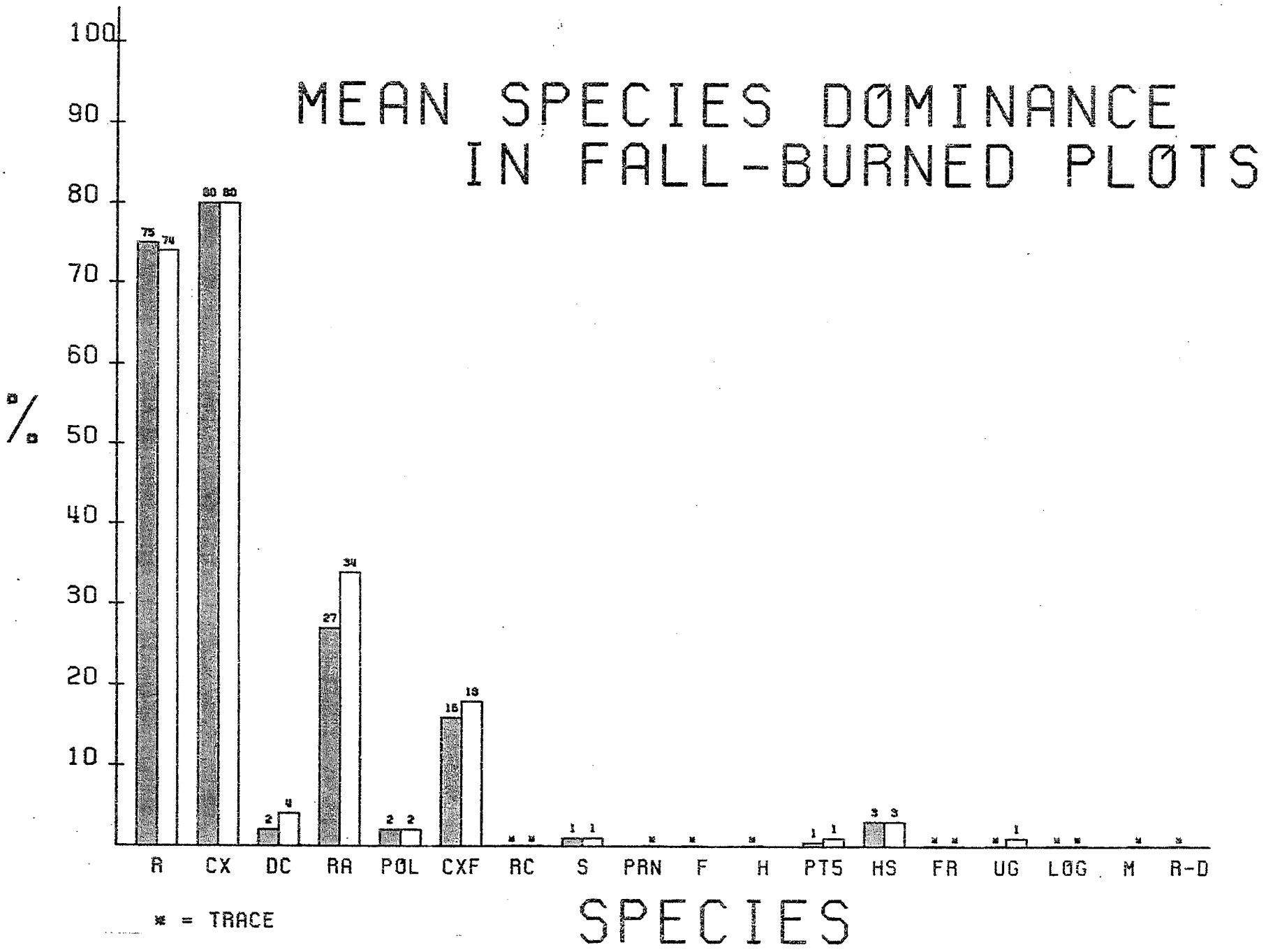
Yard, R.S. 1942. The Great Smoky Wilderness. Living Wilderness 7:13-16.

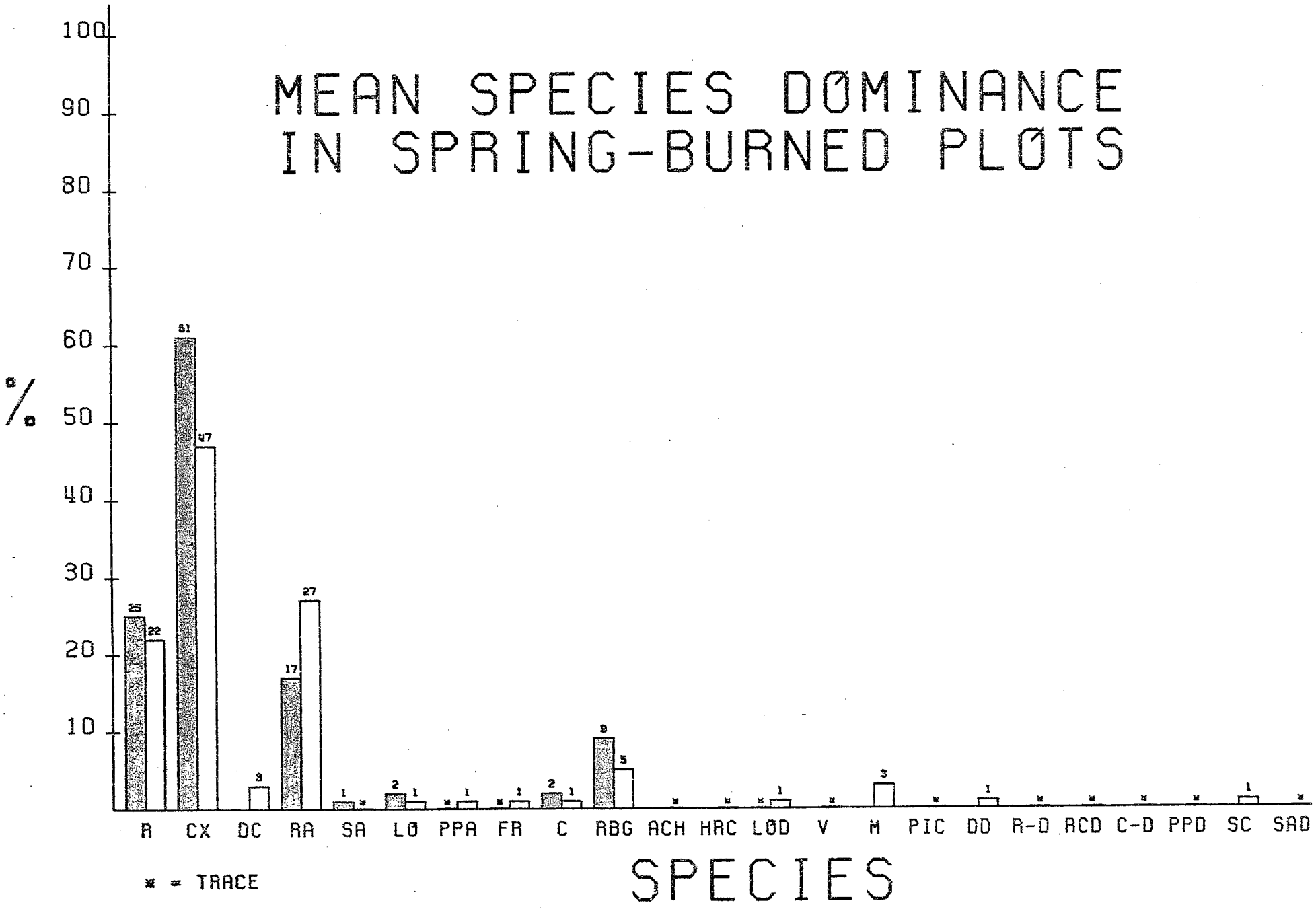

MEAN SPECIES DØMINANCE
IN CUT PLØTS
100
90
80
70
60
50
40
30
20
10
%
46
36
89
90
44
58
15
14
1
1
1
x
2
1
x
x
x
1
x
x
R
CX
DC
RA
PØL
CXF
PRN
F
SA
HS
PLD
M
DD
R-D
x = TRACE
SPECIES

(Comparison of species dominance from plots on Round Bald across a 50-year time span. Grazing was discontinued on Round Bald a few years after A. F. Mark's work in 1957.)

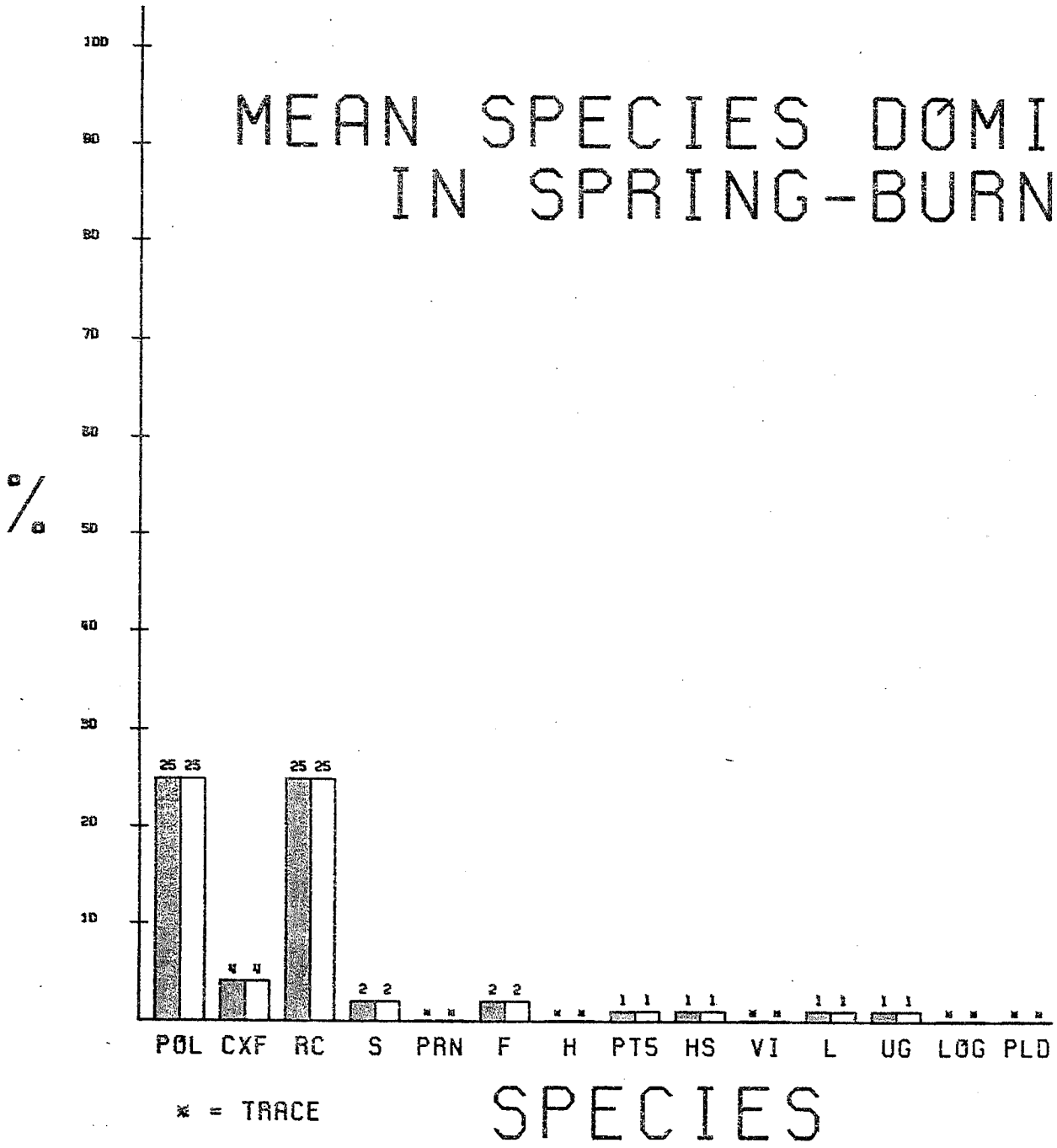


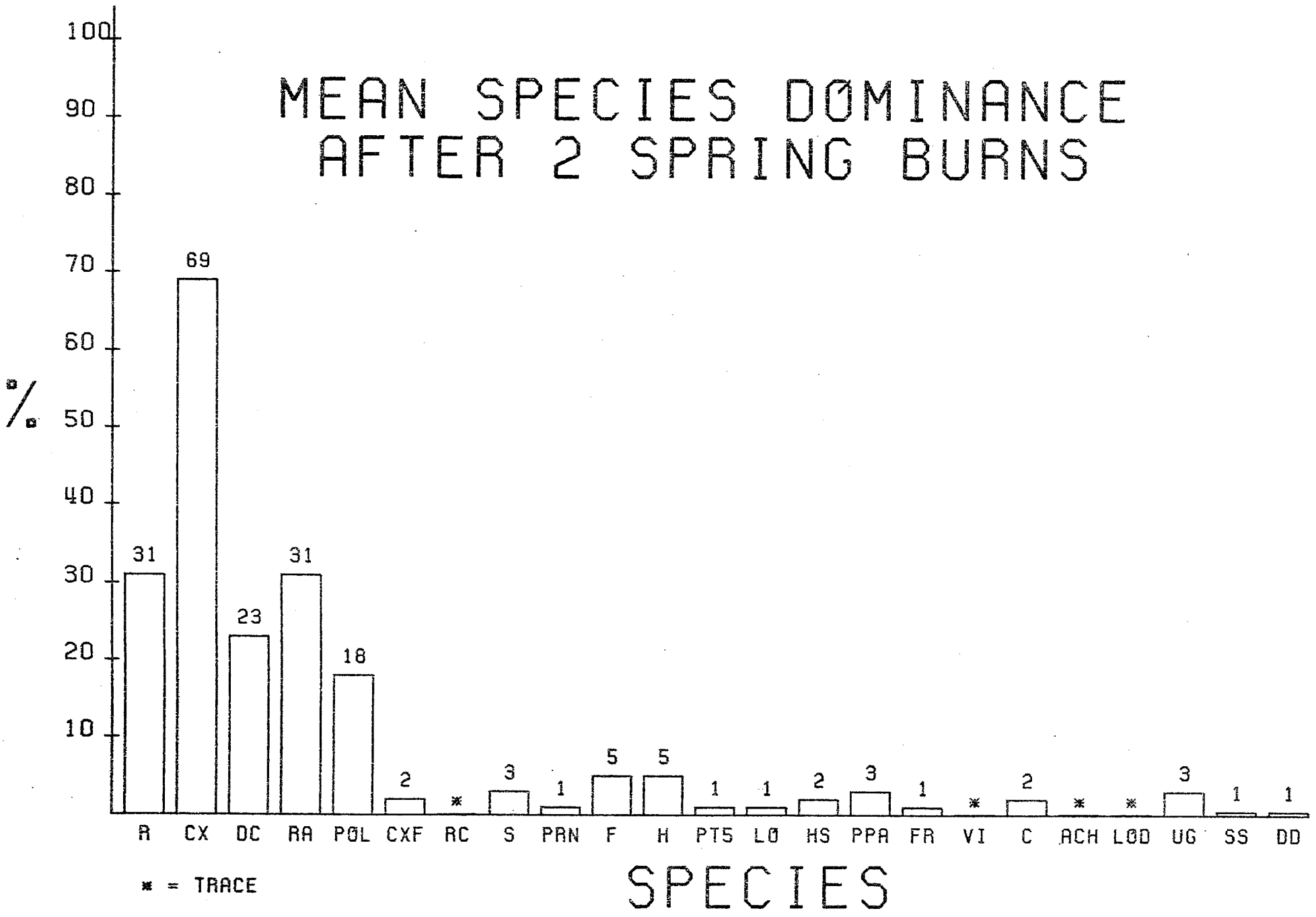

MEAN SPECIES DOMINANCE
IN PLOTS BURNED & CUT
%
100
90
80
70
60
50
40
30
20
10
7
6
42
41
2
6
23
17
30
34
39
40
2
3
1
1
4
2
4
1
1
5
7
2
1
1
1
1
1
R
CX
DC
RA
POL
RC
PT
S
PRN
F
H
PT5
LO
HS
FR
VI
RBG
LOD
L
UG
PLD
V
M
PIC
DD
R-D
RCD
SAD
* = TRACE
SPECIES

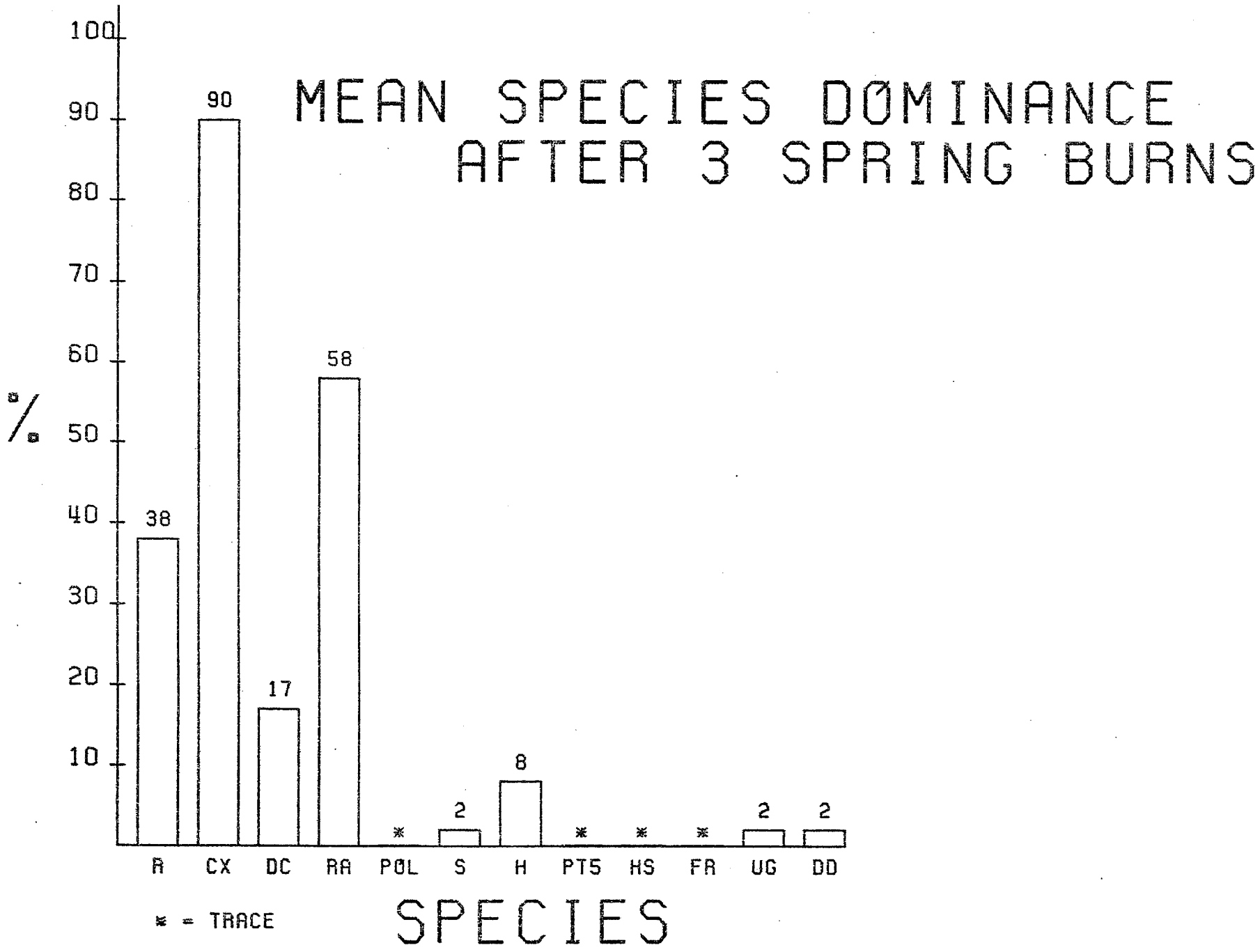

MEAN SPECIES DOMINANCE
IN FALL-BURNED PLOTS
100
90
80
70
60
50
40
30
20
10
%
75 74
80 80
2 4
27 34
2 2
15 18
* *
1 1
* *
* *
1 1
3 3
* *
* 1
* *
* *
R CX DC RA POL CXF RC S PRN F H PTS HS FR UG LOG M R-D
* = TRACE
SPECIES

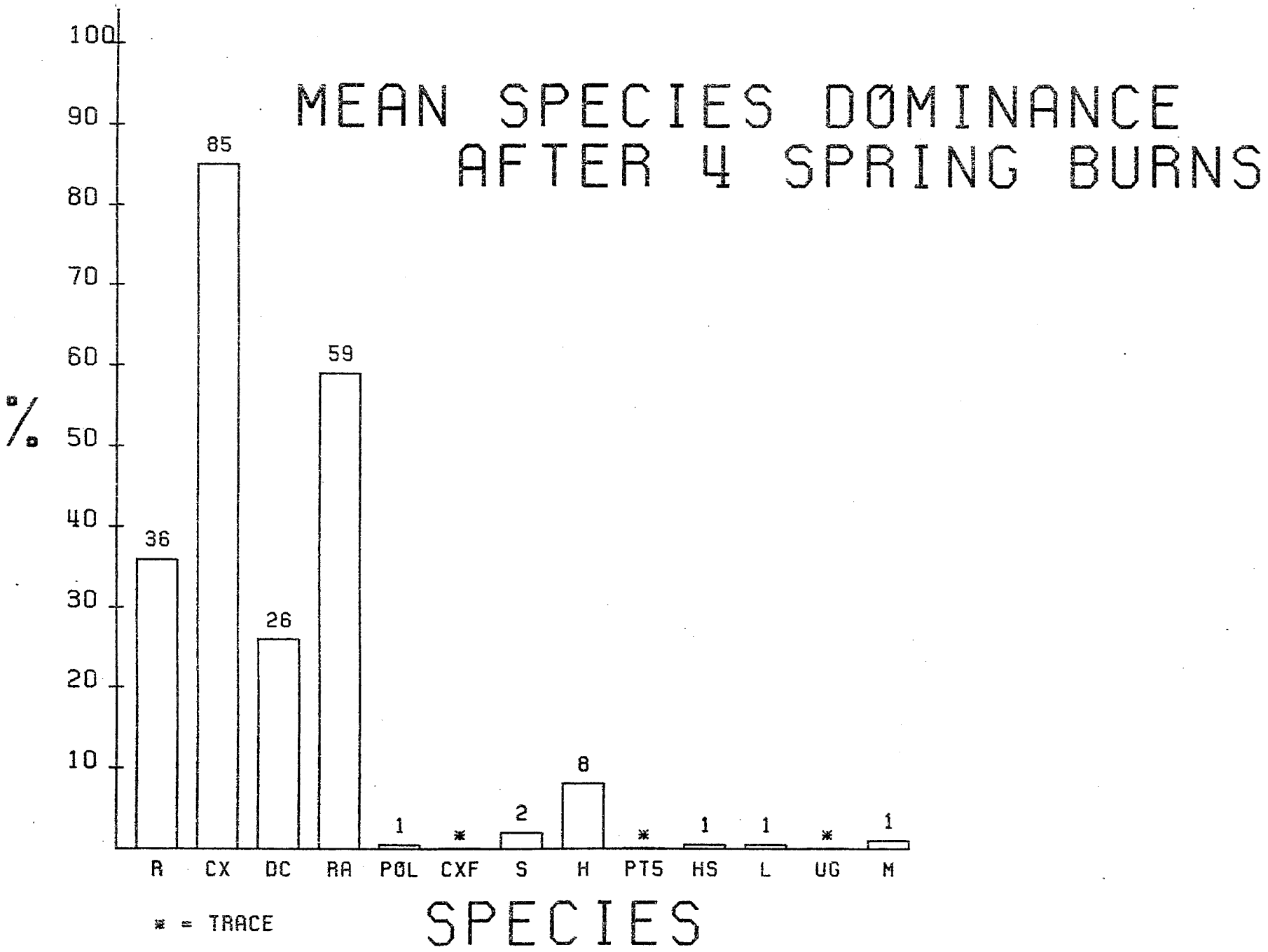

MEAN SPECIES DØMINANCE
IN SPRING-BURNED PLØTS
100
90
80
70
60
50
40
30
20
10
%
25
22
61
47
3
17
27
1
*
2
1
*
1
*
1
2
1
9
5
*
*
*
1
*
3
*
1
*
*
*
*
1
*
R
CX
DC
RA
SA
LØ
PPA
FR
C
RBG
ACH
HRC
LØD
V
M
PIC
DD
R-D
RCD
C-D
PPD
SC
SAD
* = TRACE
SPECIES

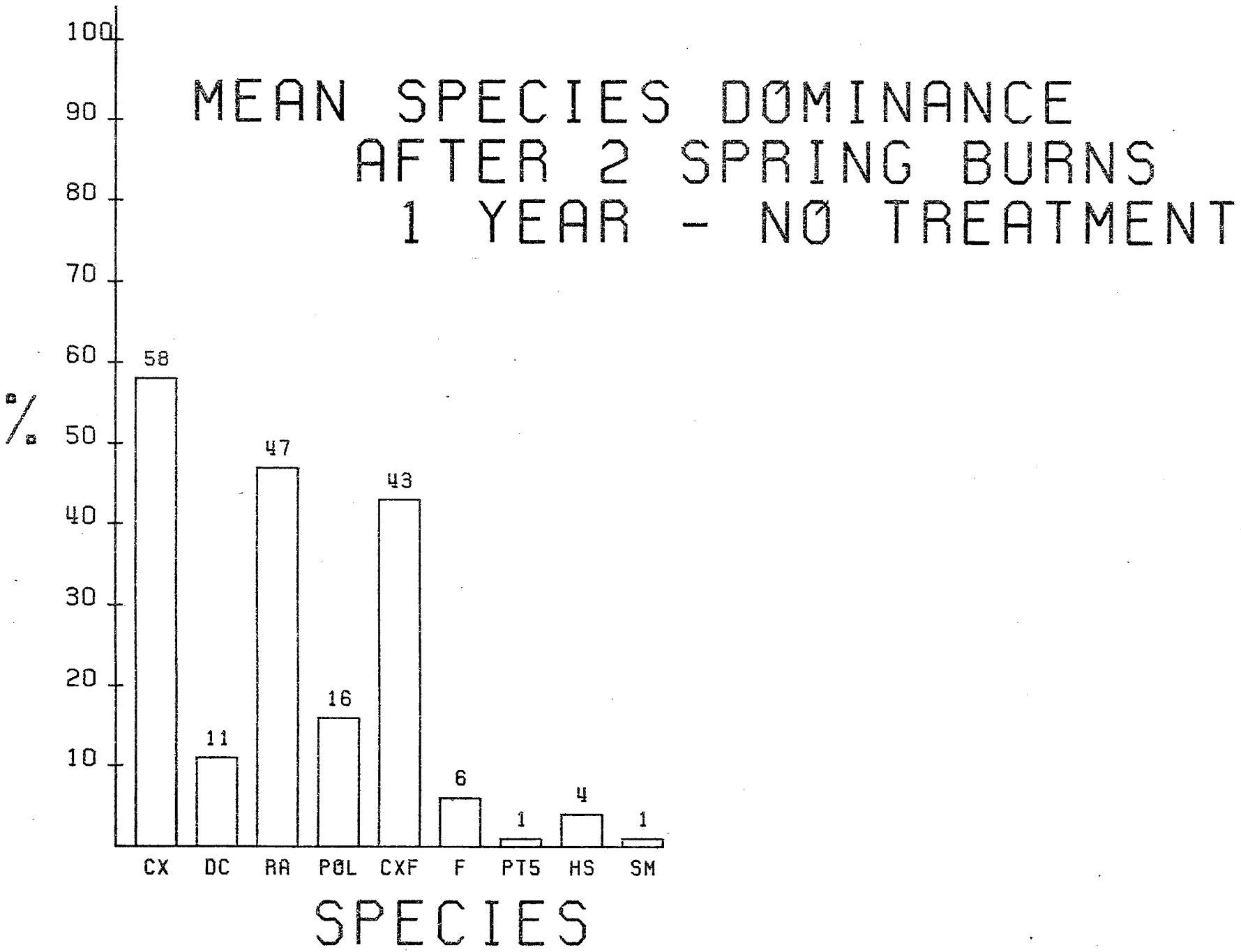
MEAN SPECIES DOMINANCE IN SPRING-BURNED PLOTS

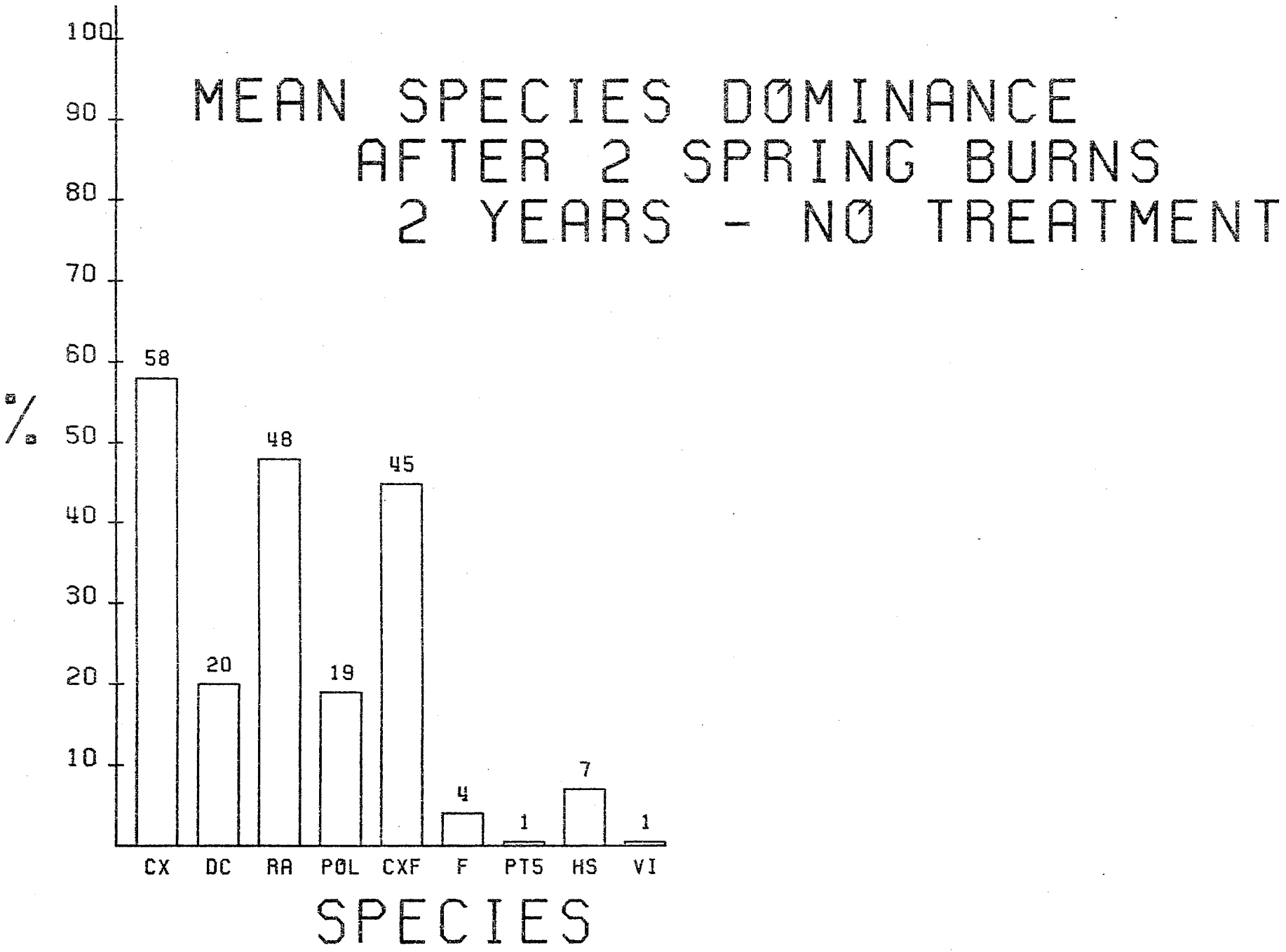


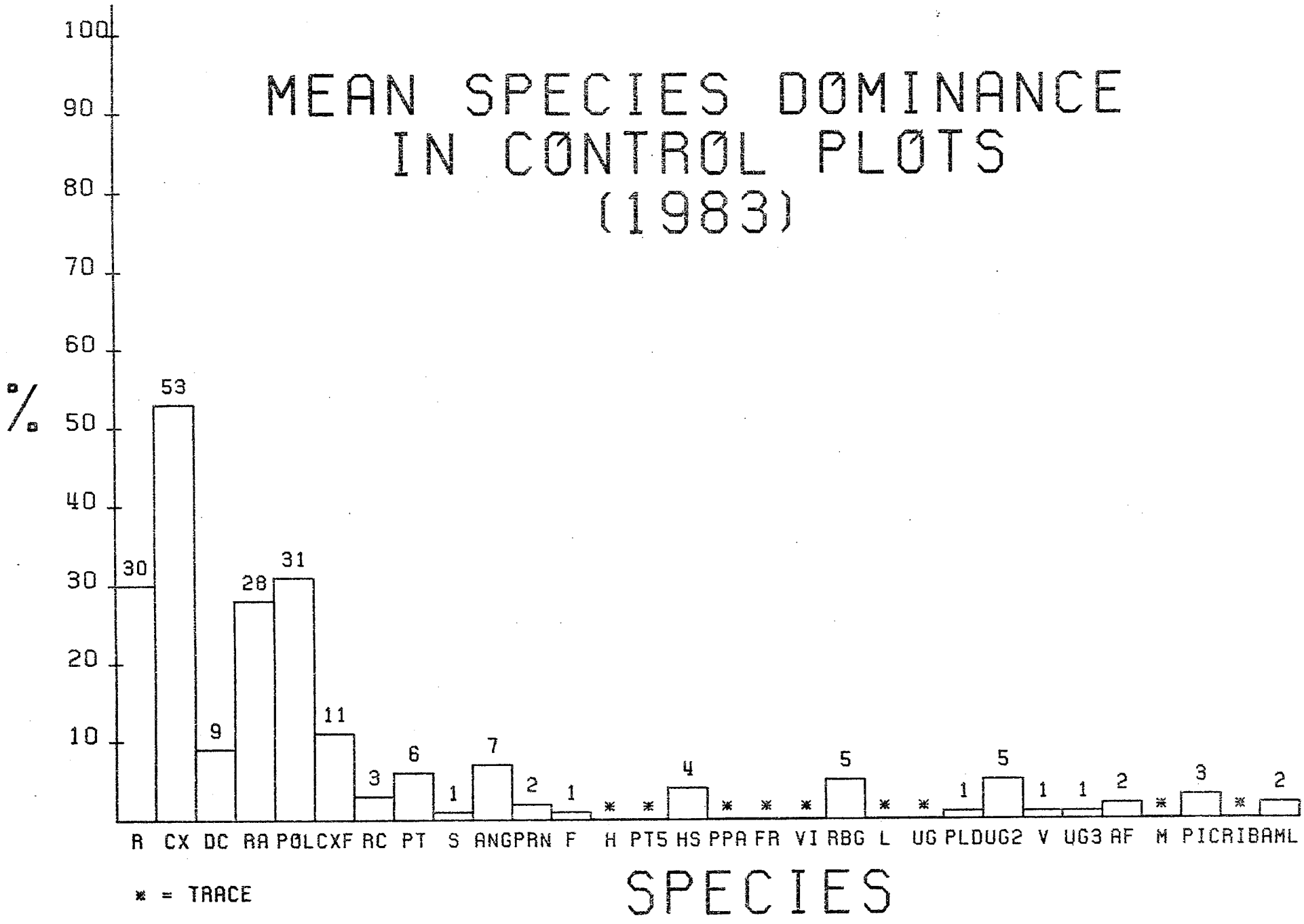

MEAN SPECIES DØMINANCE
AFTER 2 SPRING BURNS
100
90
80
70
60
50
40
30
20
10
%
69
31
31
23
18
2
*
3
1
5
5
1
1
2
3
1
*
2
*
*
3
1
1
R
CX
DC
RA
PØL
CXF
RC
S
PRN
F
H
PT5
LØ
HS
PPA
FR
VI
C
ACH
LØD
UG
SS
DD
* = TRACE
SPECIES


MEAN SPECIES DOMINANCE
AFTER 3 SPRING BURNS
100
90
80
70
60
50
40
30
20
10
%
38
90
17
58
*
2
8
*
*
*
2
2
R
CX
DC
RA
POL
S
H
PT5
HS
FR
UG
DD
* = TRACE
SPECIES


MEAN SPECIES DOMINANCE
AFTER 4 SPRING BURNS
100
90
80
70
60
50
40
30
20
10
%
36
85
26
59
1
*
2
8
*
1
1
*
1
R
CX
DC
RA
POL
CXF
S
H
PTS
HS
L
UG
M
* = TRACE
SPECIES


MEAN SPECIES DOMINANCE
AFTER 2 SPRING BURNS
1 YEAR - NO TREATMENT
100
90
80
70
60
50
40
30
20
10
%
58
11
47
16
43
6
1
4
1
CX
DC
RA
POL
CXF
F
PT5
HS
SM
SPECIES


MEAN SPECIES DØMINANCE
AFTER 2 SPRING BURNS
2 YEARS - NØ TREATMENT
100
90
80
70
60
50
40
30
20
10
%
58
20
48
19
45
4
1
7
1
CX
DC
RA
PØL
CXF
F
PT5
HS
VI
SPECIES


MEAN SPECIES DOMINANCE
IN CONTROL PLOTS
(1983)
%
100
90
80
70
60
50
40
30
20
10
30
53
9
28
31
11
3
6
1
7
2
1
*
*
4
*
*
*
5
*
*
1
5
1
1
2
*
3
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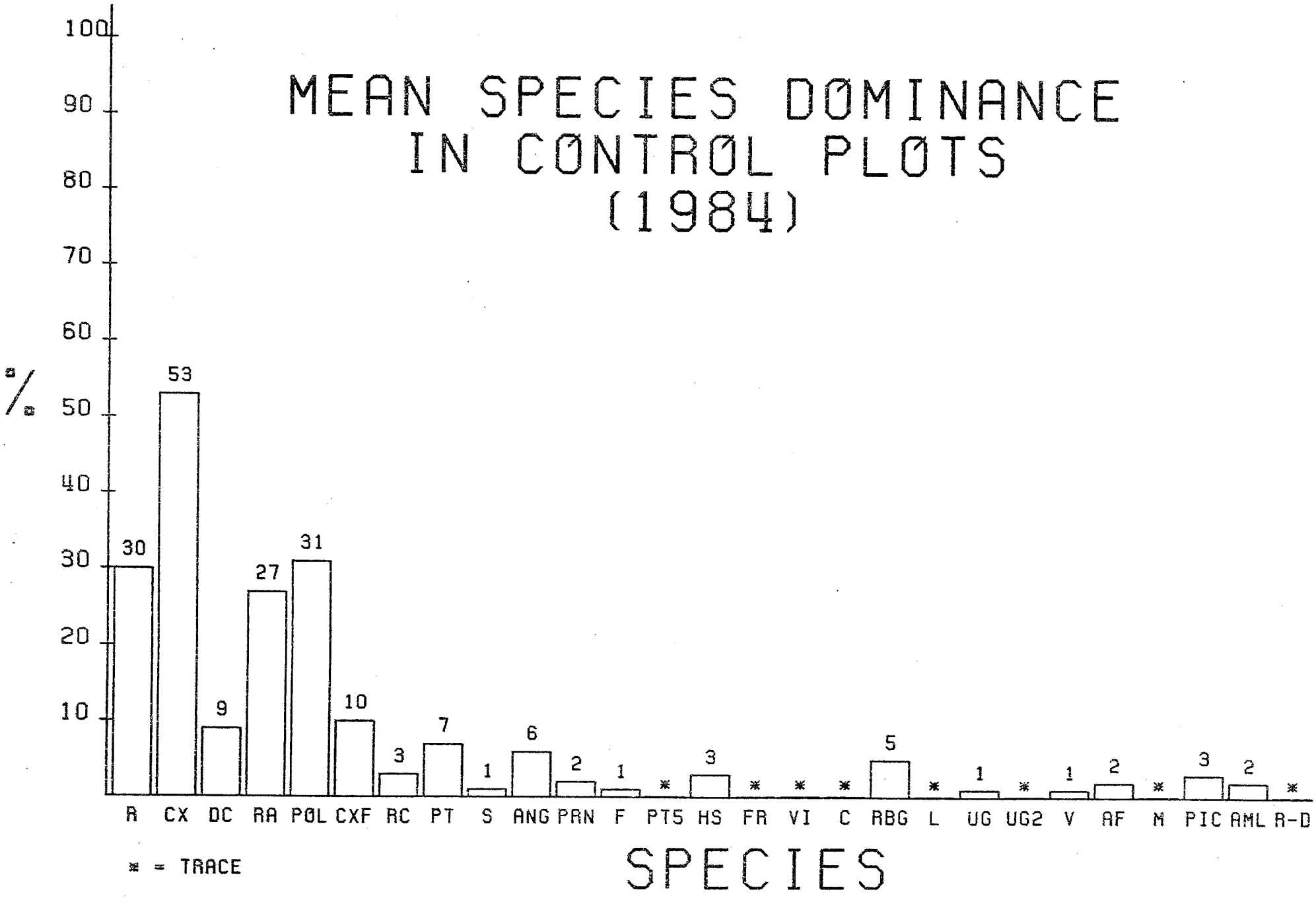
2
R CX DC RA POLCXF RC PT S ANGPRN F H PT5 HS PPA FR VI RBG L UG PLDUG2 V UG3 AF M PICRIBAML
* = TRACE
SPECIES


MEAN SPECIES DOMINANCE
IN CONTROL PLOTS
(1984)
%
100
90
80
70
60
50
40
30
20
10
30
53
9
27
31
10
3
7
1
6
2
1
*
3
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5
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1
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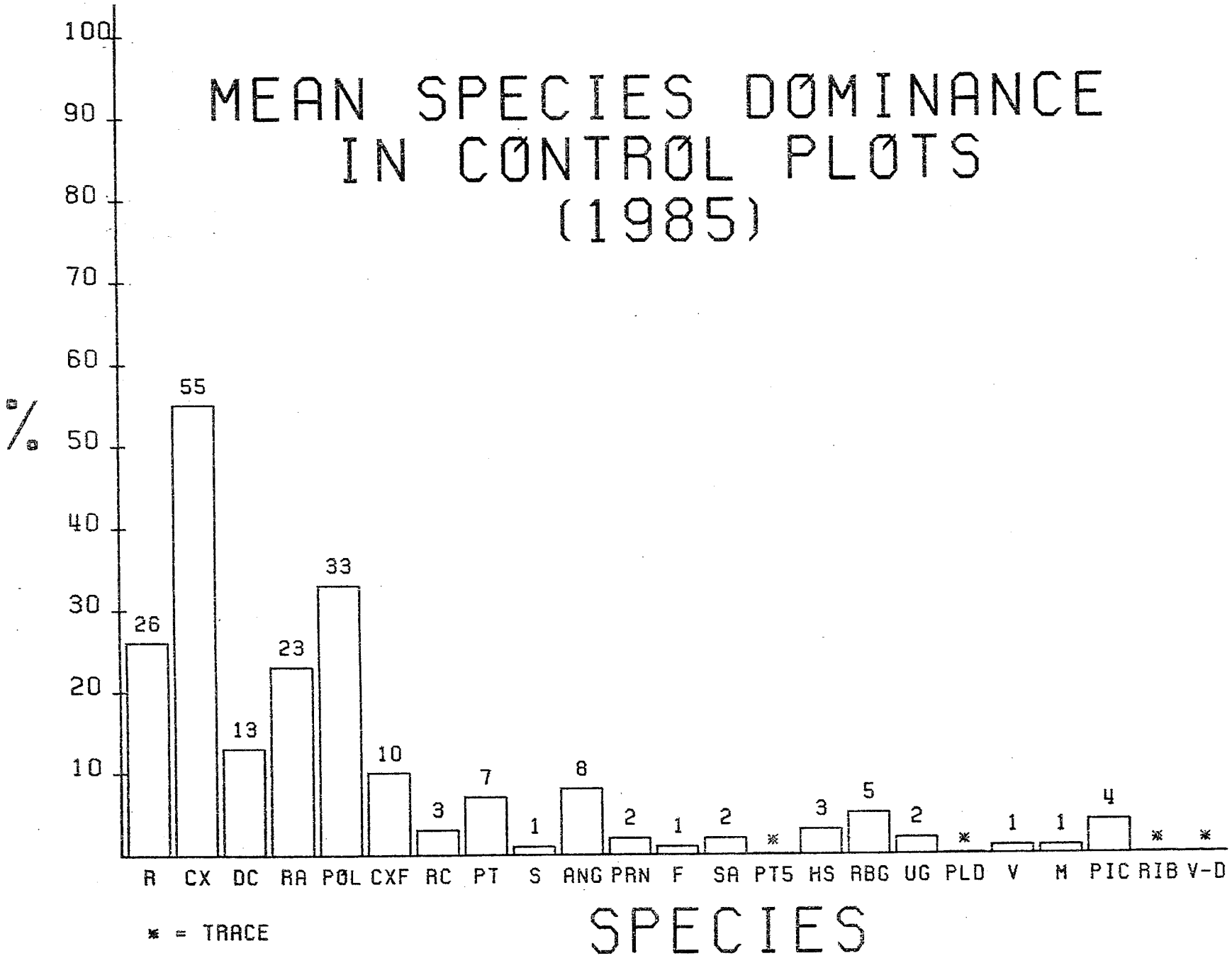
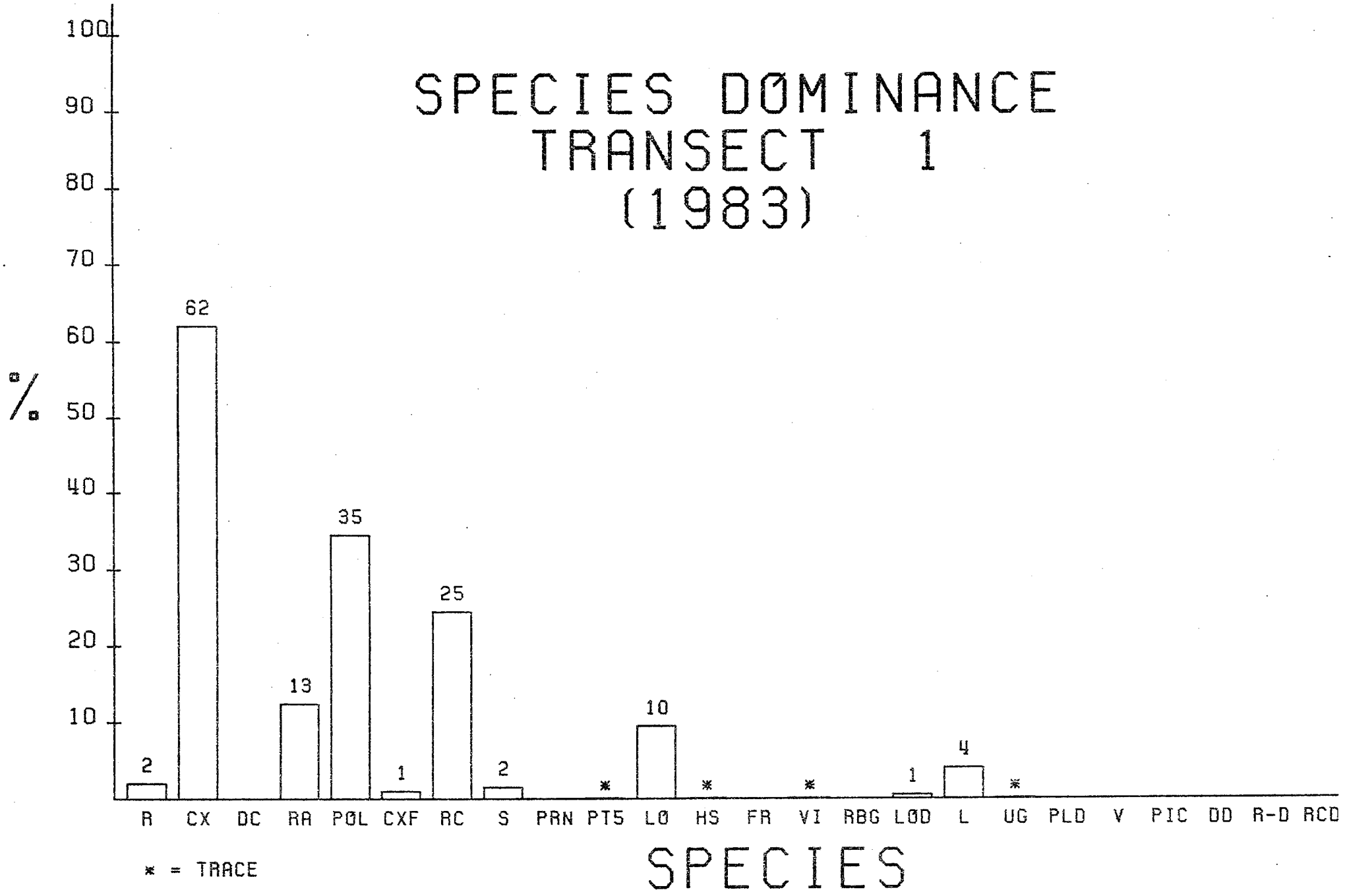
1
2
*
3
2
*
R CX DC RA POL CXF RC PT S ANG PRN F PT5 HS FR VI C RBG L UG UG2 V AF M PIC AML R-D
* = TRACE
SPECIES

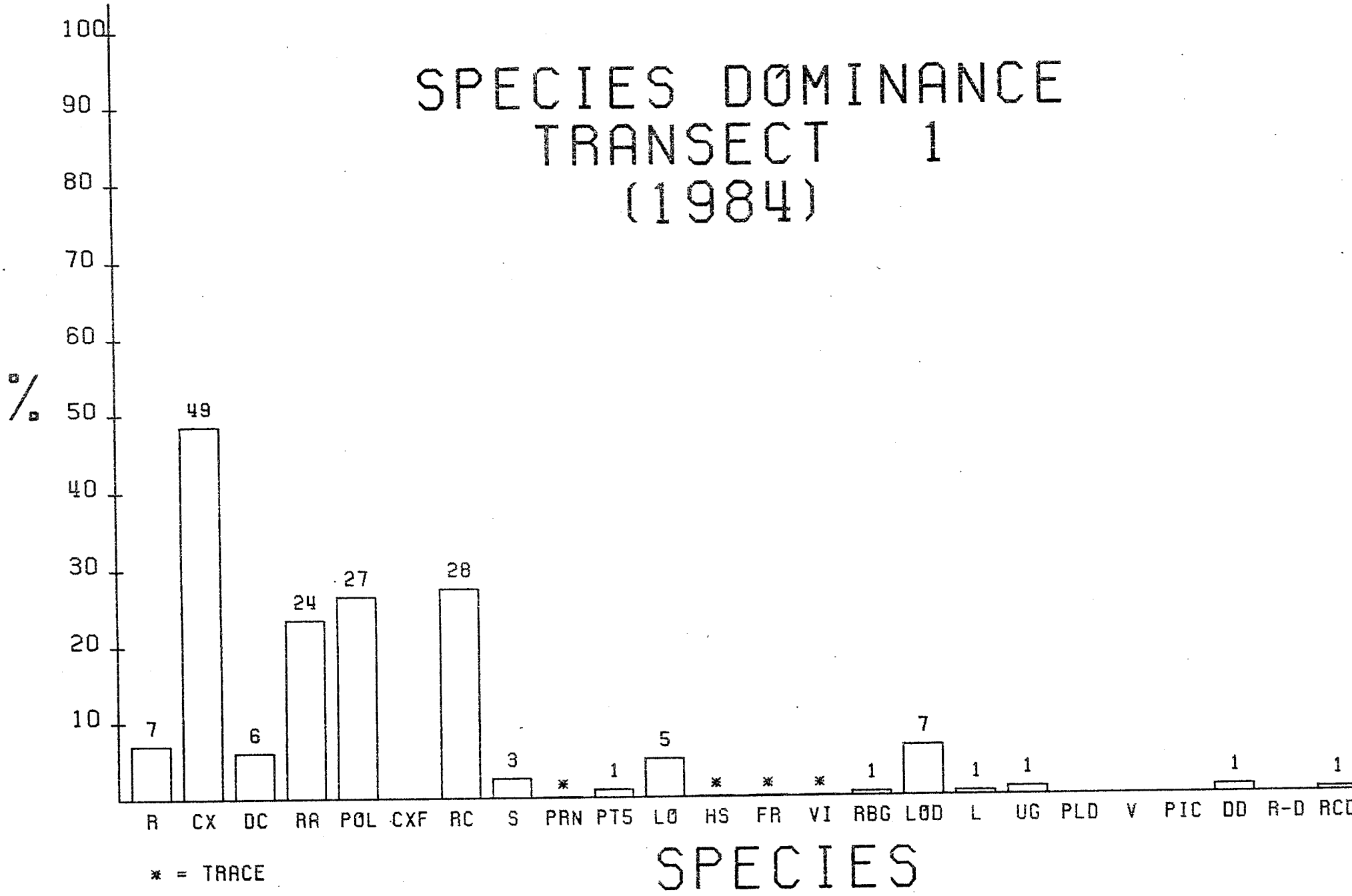

MEAN SPECIES DOMINANCE
IN CONTROL PLOTS
(1985)
100
90
80
70
60
50
40
30
20
10
%
26
55
13
23
33
10
3
7
1
8
2
1
2
*
3
5
2
*
1
1
4
*
*
R
CX
DC
RA
POL
CXF
RC
PT
S
ANG
PRN
F
SA
PT5
HS
RBG
UG
PLD
V
M
PIC
RIB
V-D
* = TRACE
SPECIES

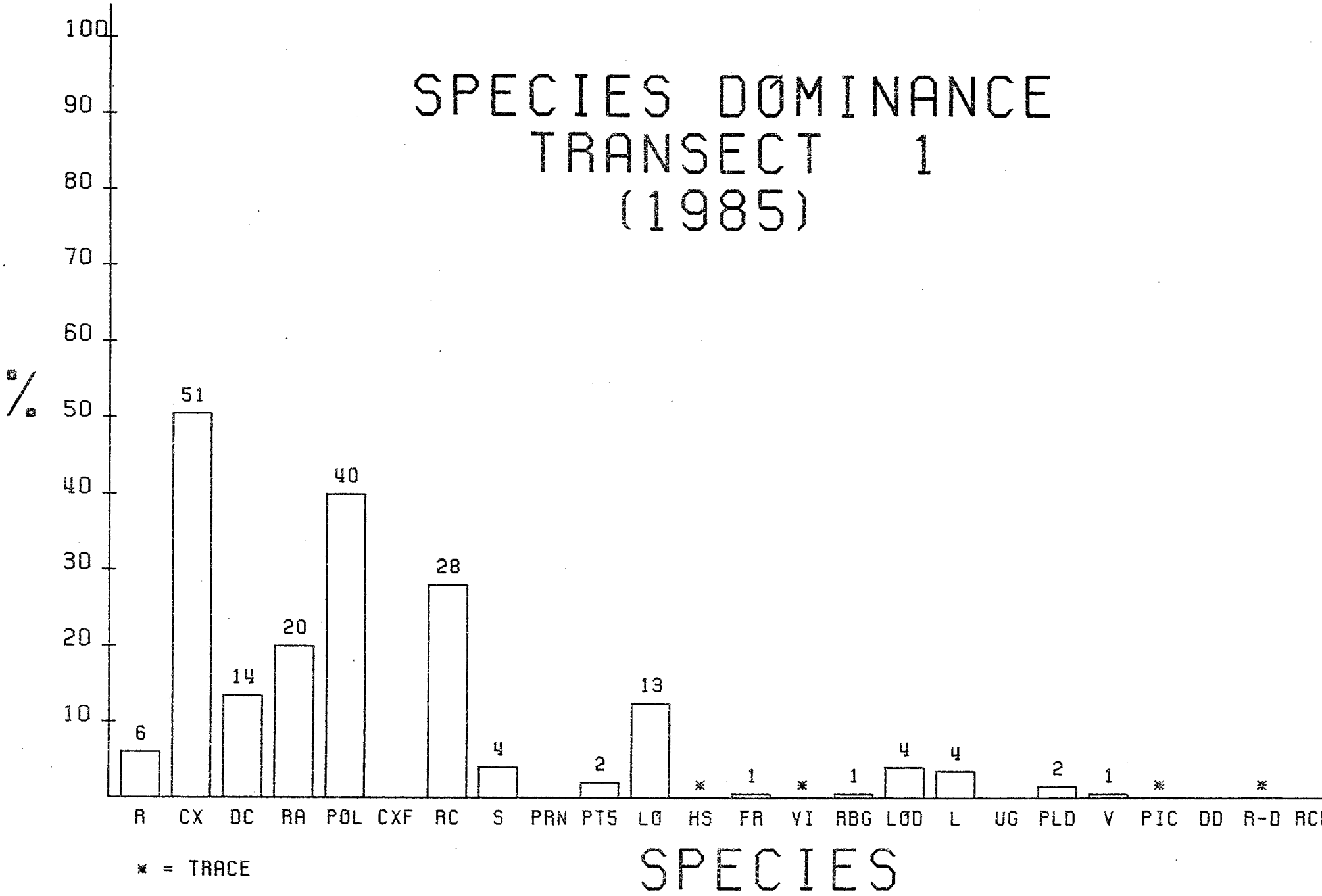
APPENDIX B

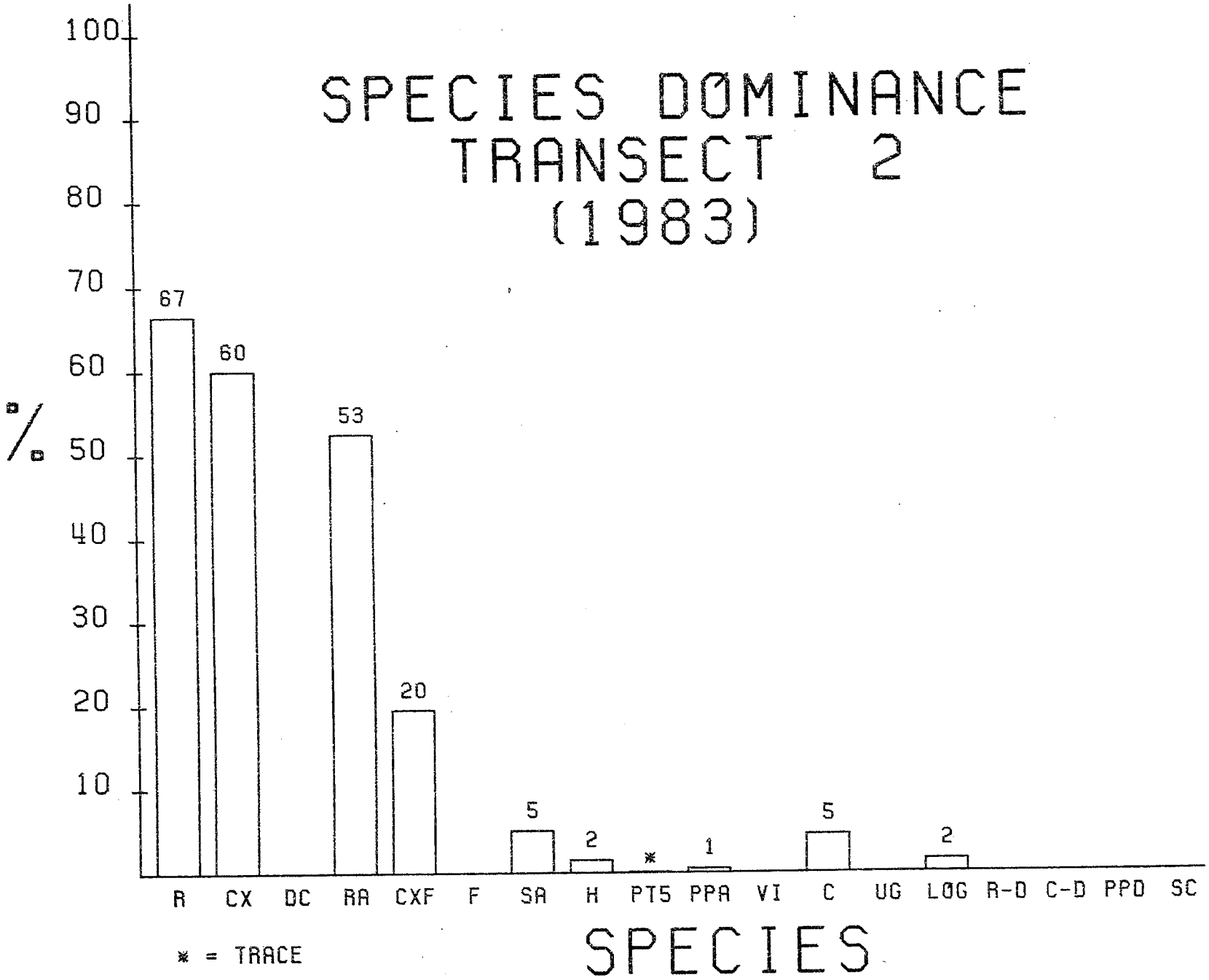
SPECIES DOMINANCE

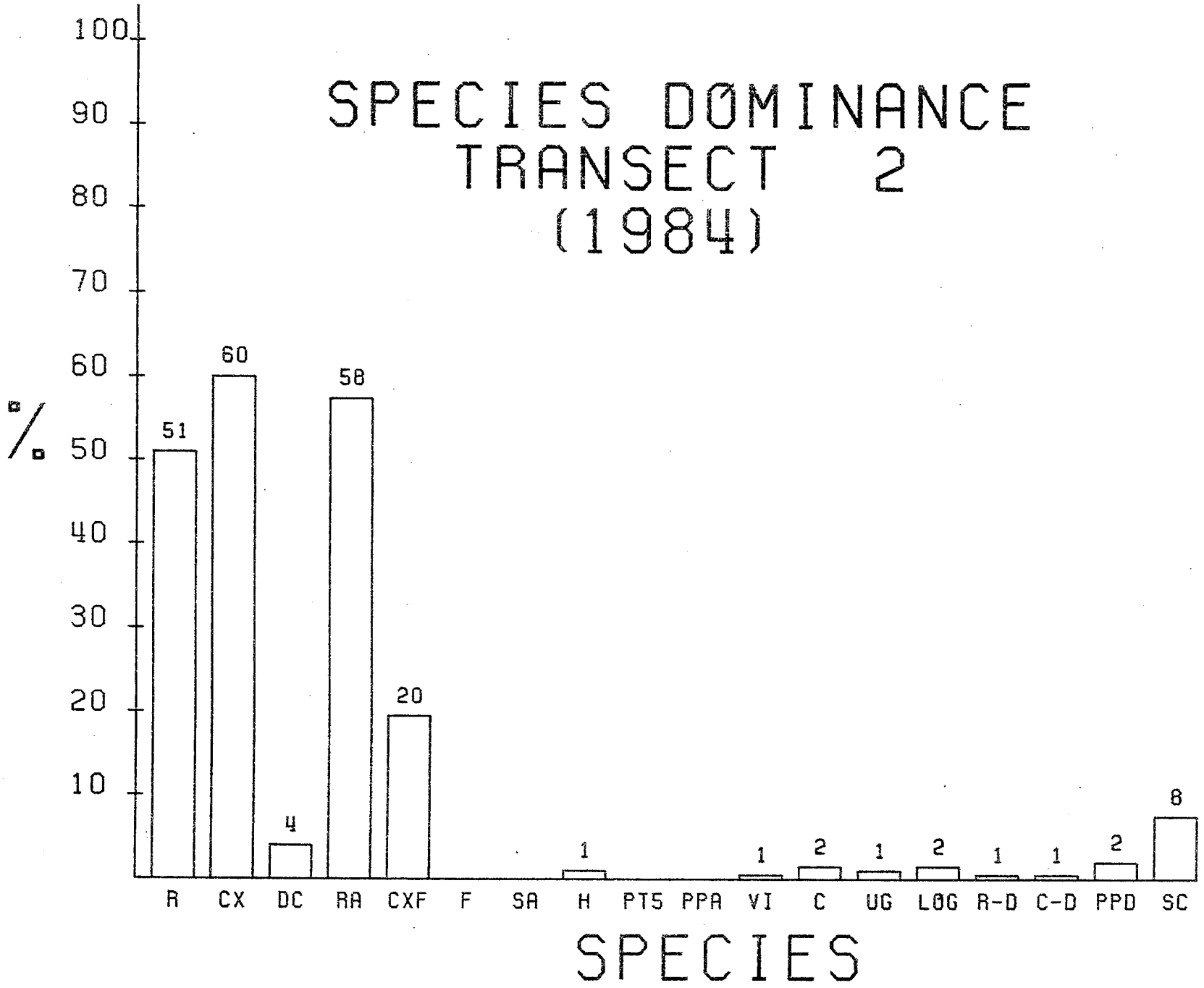
IN INDIVIDUAL TRANSECTS, 1983-1985

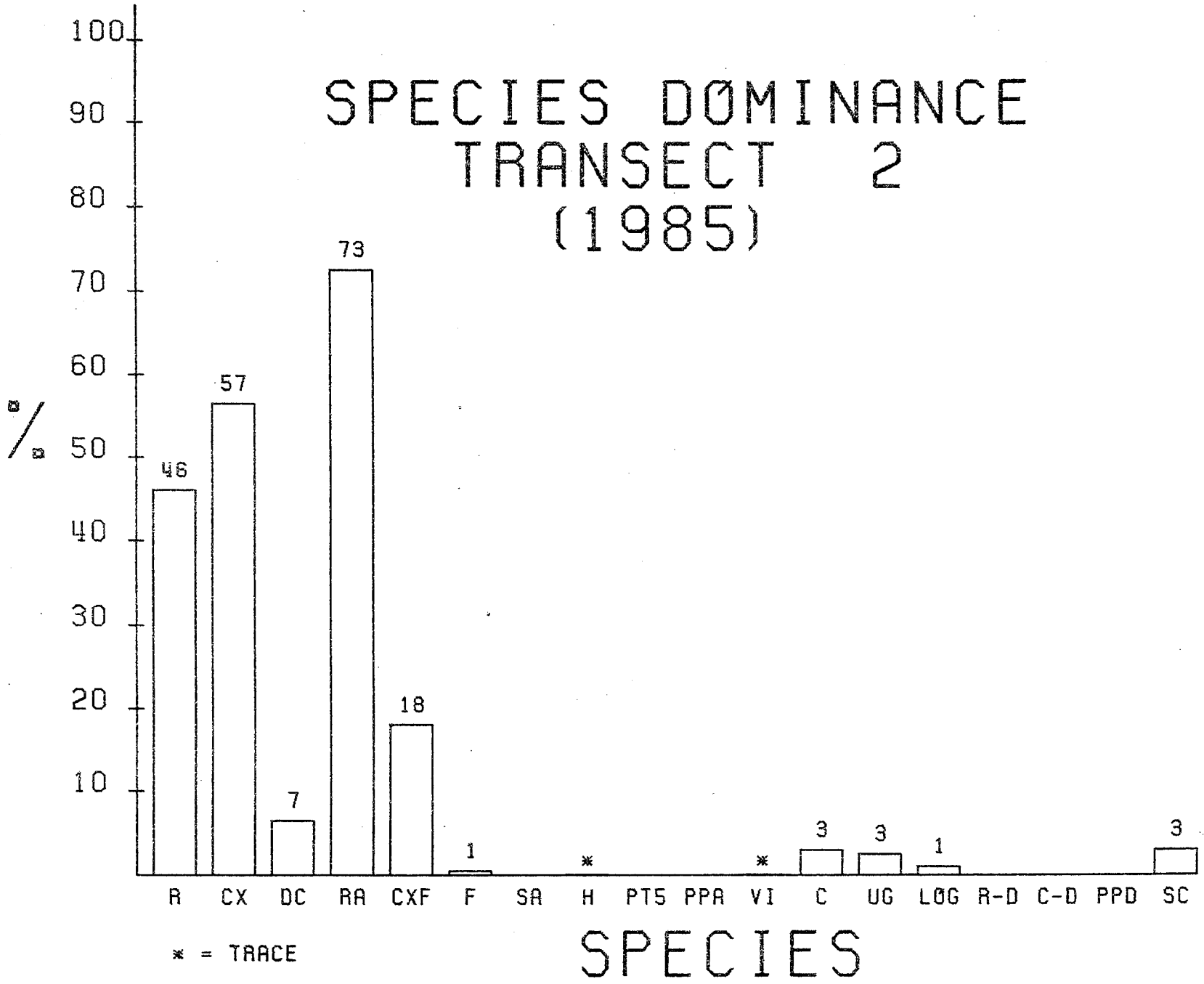

SPECIES DØMINANCE
TRANSECT 1
(1983)
100
90
80
70
60
50
40
30
20
10
%
62
35
25
13
10
4
2
1
2
1
*
*
*
*
R
CX
DC
RA
PØL
CXF
RC
S
PRN
PT5
LØ
HS
FR
VI
RBG
LØD
L
UG
PLD
V
PIC
DD
R-D
RCD
* = TRACE
SPECIES

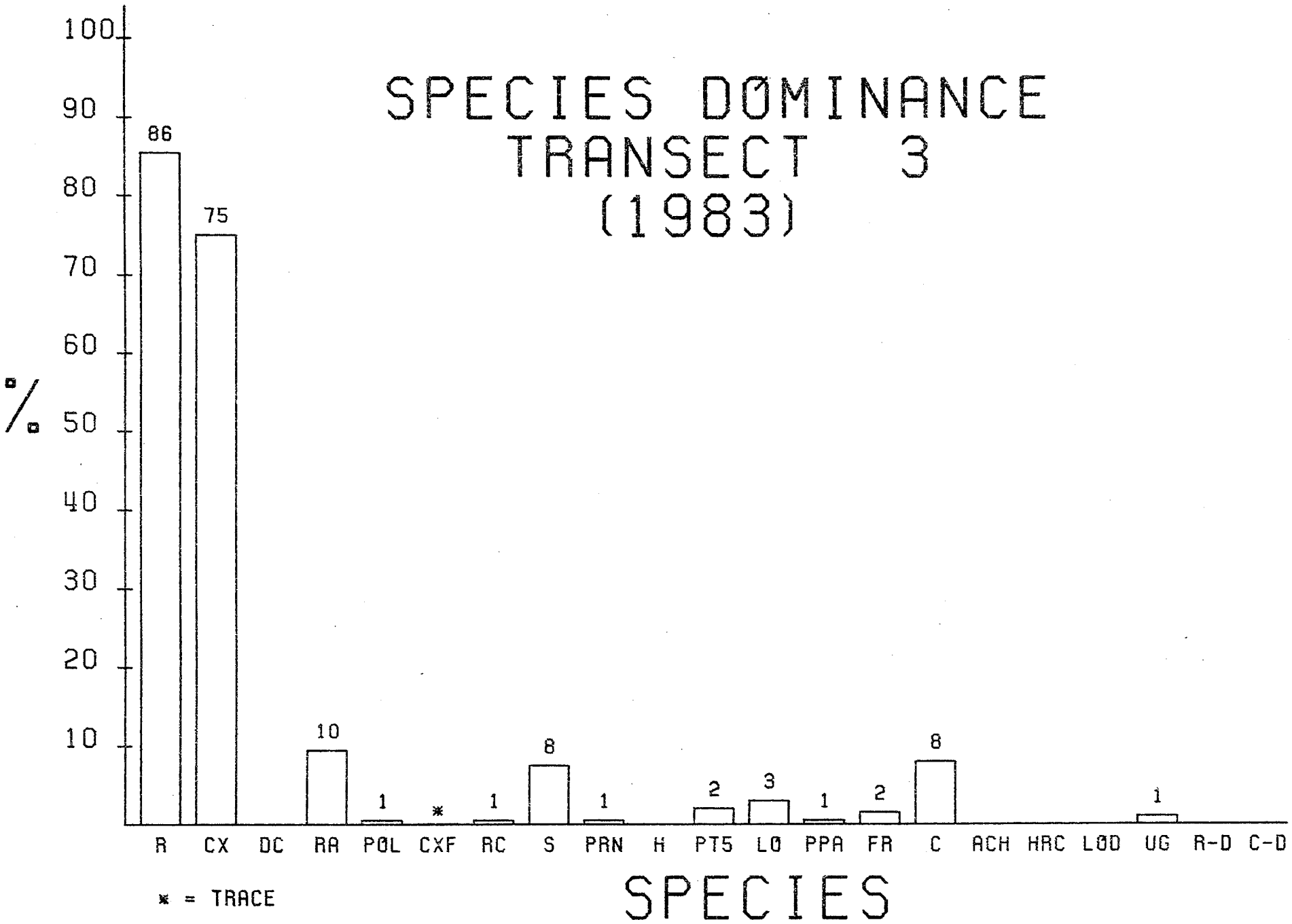

SPECIES DOMINANCE
TRANSECT 1
(1984)
%
100
90
80
70
60
50
40
30
20
10
7
49
6
24
27
28
3
*
1
5
*
*
*
1
7
1
1
1
1
R
CX
DC
RA
POL
CXF
RC
S
PRN
PT5
LO
HS
FR
VI
RBG
LOD
L
UG
PLD
V
PIC
DD
R-D
RCD
* = TRACE
SPECIES

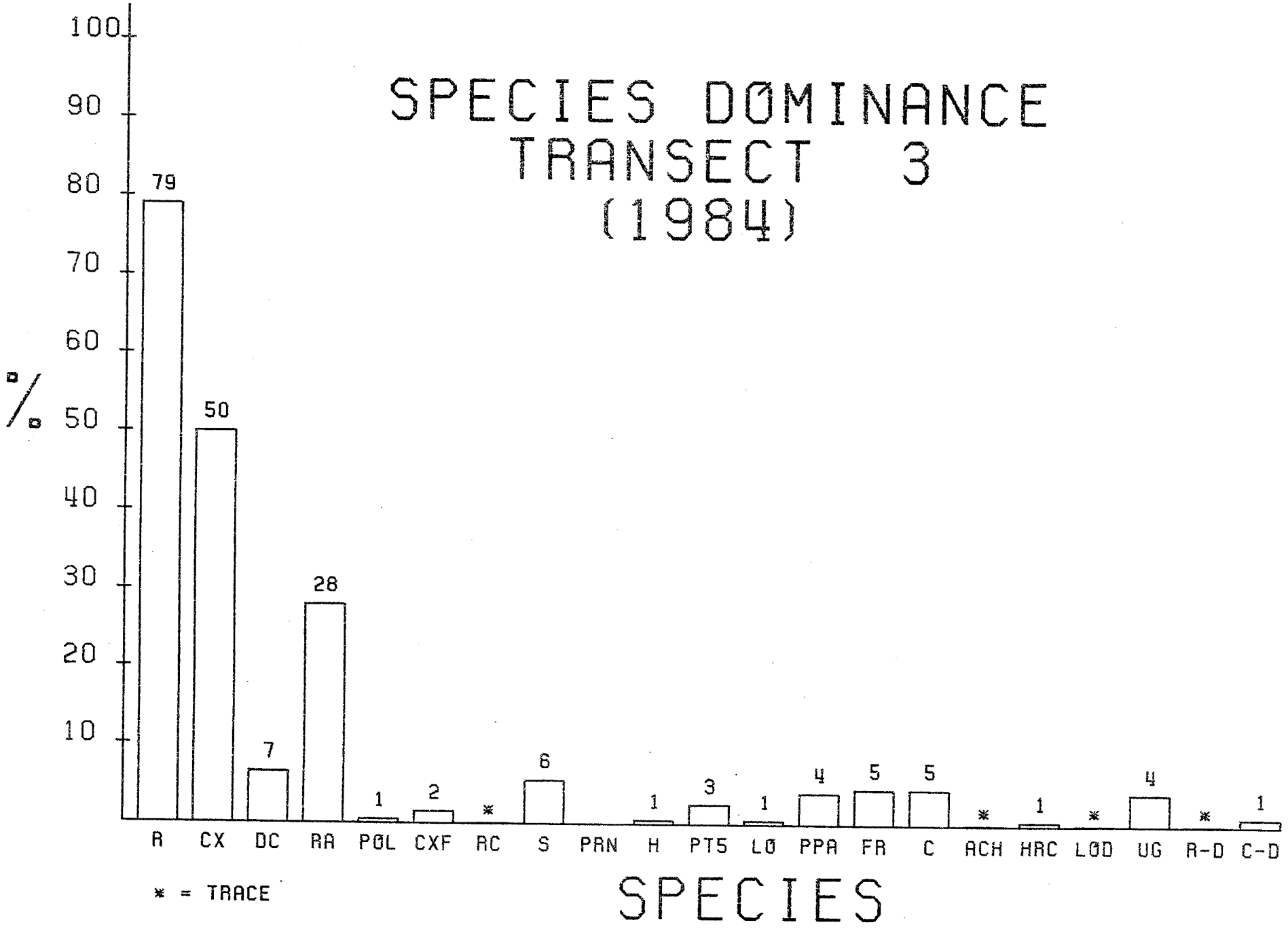

SPECIES DOMINANCE
TRANSECT 1
(1985)
%
100
90
80
70
60
50
40
30
20
10
6
51
14
20
40
28
4
2
13
*
1
*
1
4
4
2
1
*
*
R
CX
DC
RA
POL
CXF
RC
S
PRN
PTS
LO
HS
FR
VI
RBG
LOD
L
UG
PLD
V
PIC
DD
R-D
* = TRACE
SPECIES

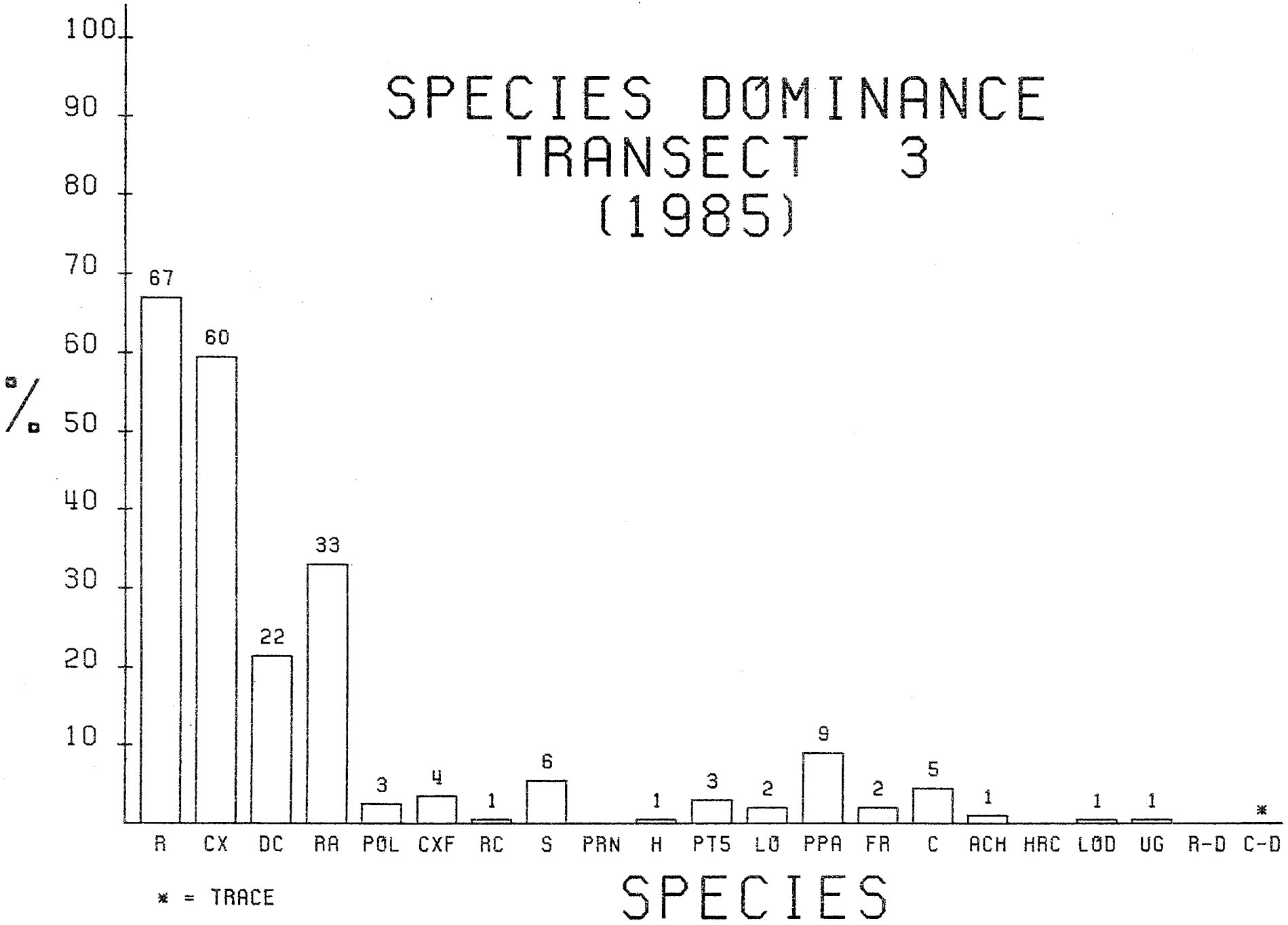

SPECIES DOMINANCE
TRANSECT 2
(1983)
100
90
80
70
60
50
40
30
20
10
%
67
60
53
20
5
2
*
1
5
2
R
CX
DC
RA
CXF
F
SA
H
PTS
PPA
VI
C
UG
LOG
R-D
C-D
PPD
SC
SPECIES
* = TRACE

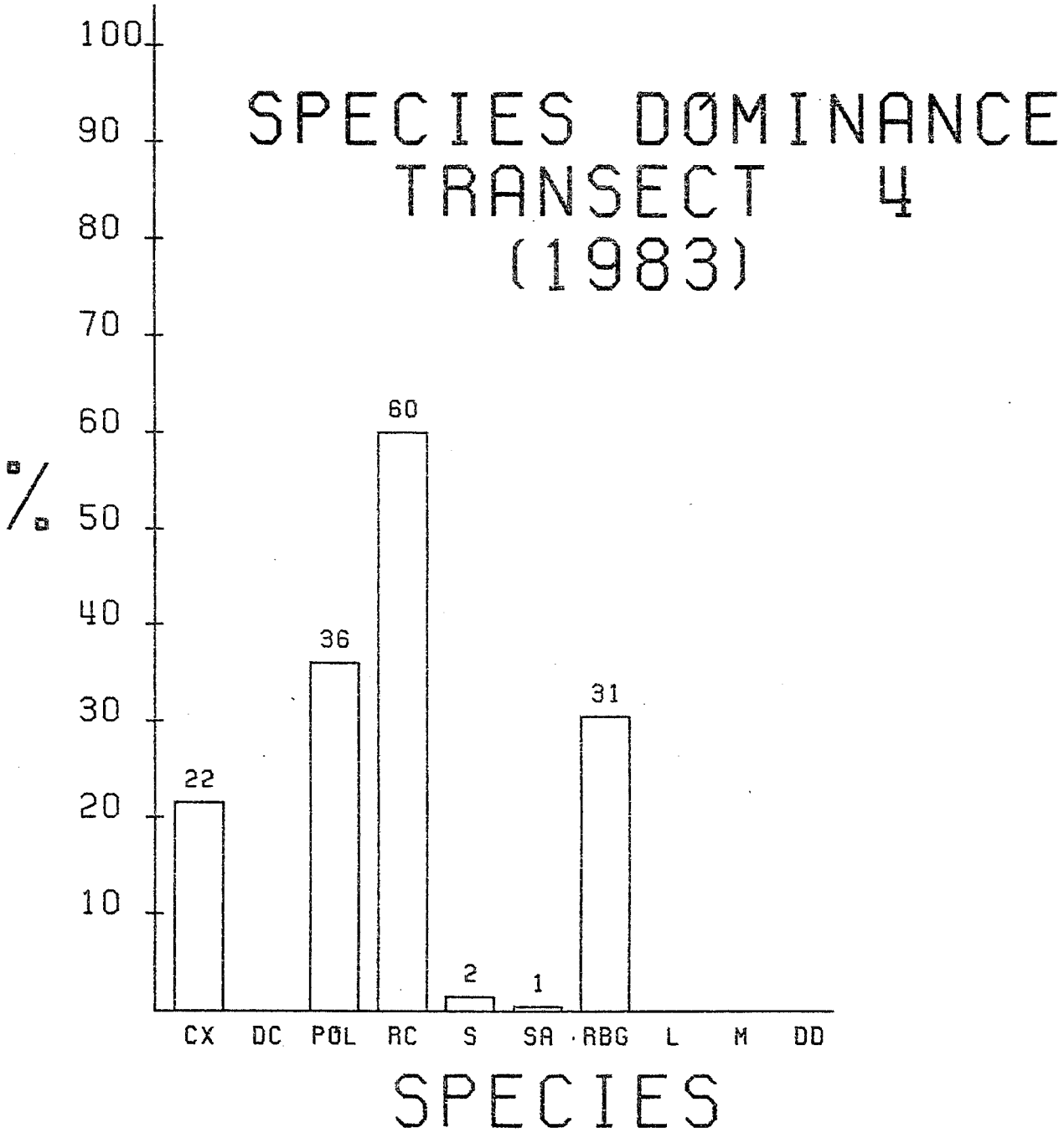

SPECIES DOMINANCE
TRANSECT 2
(1984)
%
100
90
80
70
60
50
40
30
20
10
51
60
4
58
20
1
1
2
1
2
1
1
2
8
R
CX
DC
RA
CXF
F
SA
H
PT5
PPA
VI
C
UG
LOG
R-D
C-D
PPD
SC
SPECIES

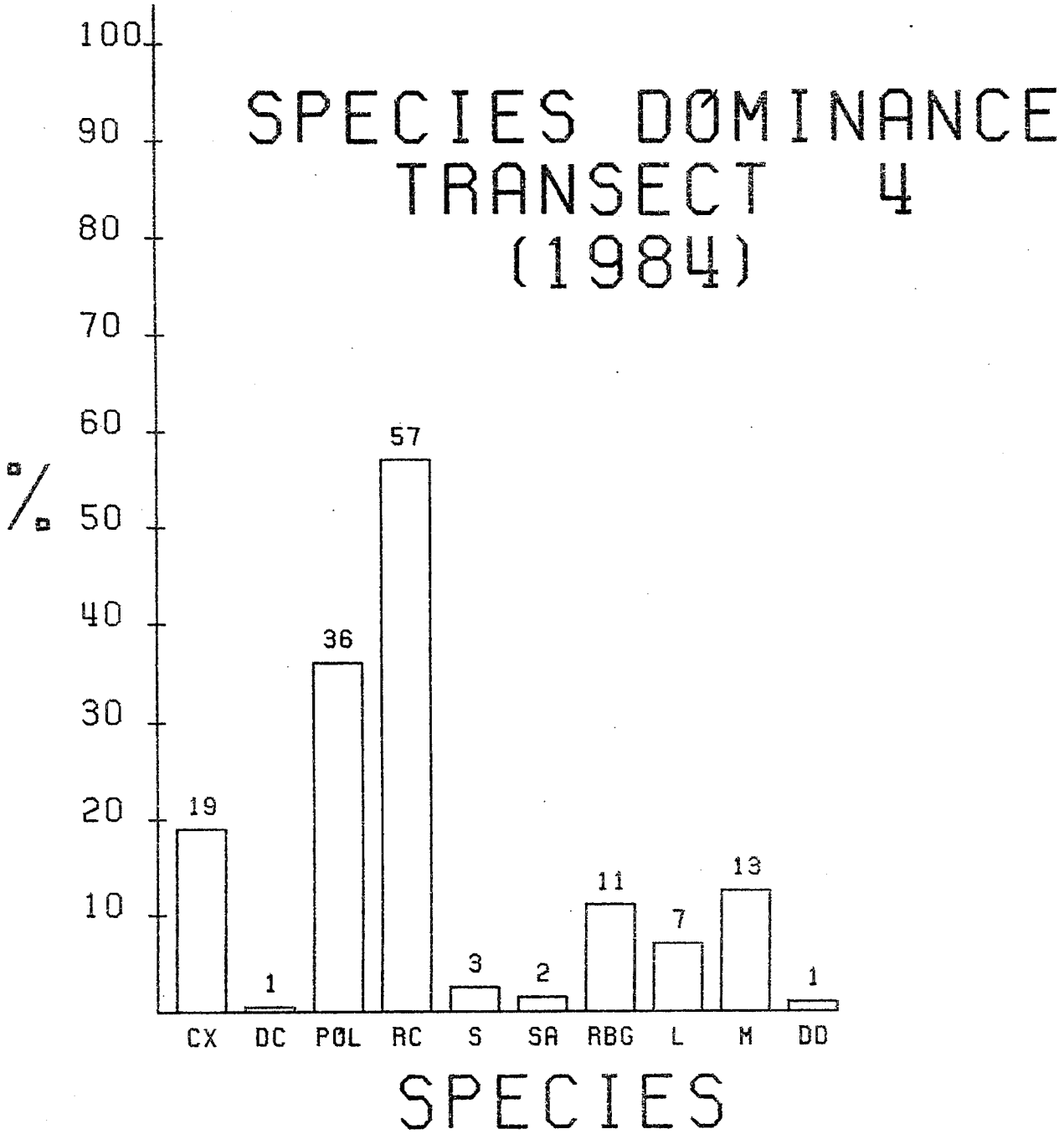

SPECIES DOMINANCE
TRANSECT 2
(1985)
%
100
90
80
70
60
50
40
30
20
10
46
57
7
73
18
1
*
*
3
3
1
3
R
CX
DC
RA
CXF
F
SA
H
PTS
PPA
VI
C
UG
LOG
R-D
C-D
PPD
SC
* = TRACE
SPECIES

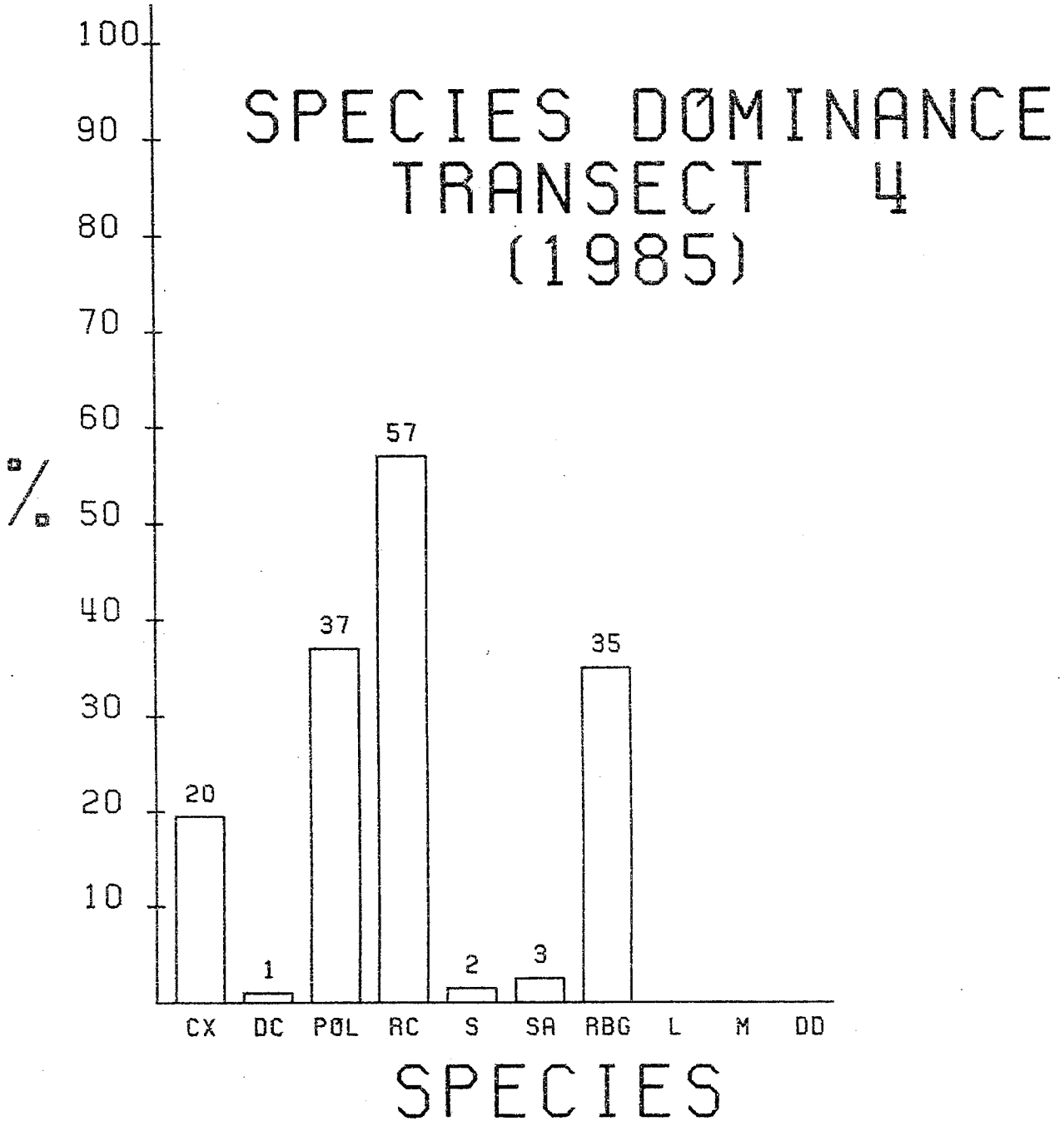

SPECIES DOMINANCE
TRANSECT 3
(1983)
%
100
90
80
70
60
50
40
30
20
10
86
75
10
1
*
1
8
1
2
3
1
2
8
1
R
CX
DC
RA
POL
CXF
RC
S
PRN
H
PTS
LO
PPA
FR
C
ACH
HRC
LOD
UG
R-D
C-D
* = TRACE
SPECIES

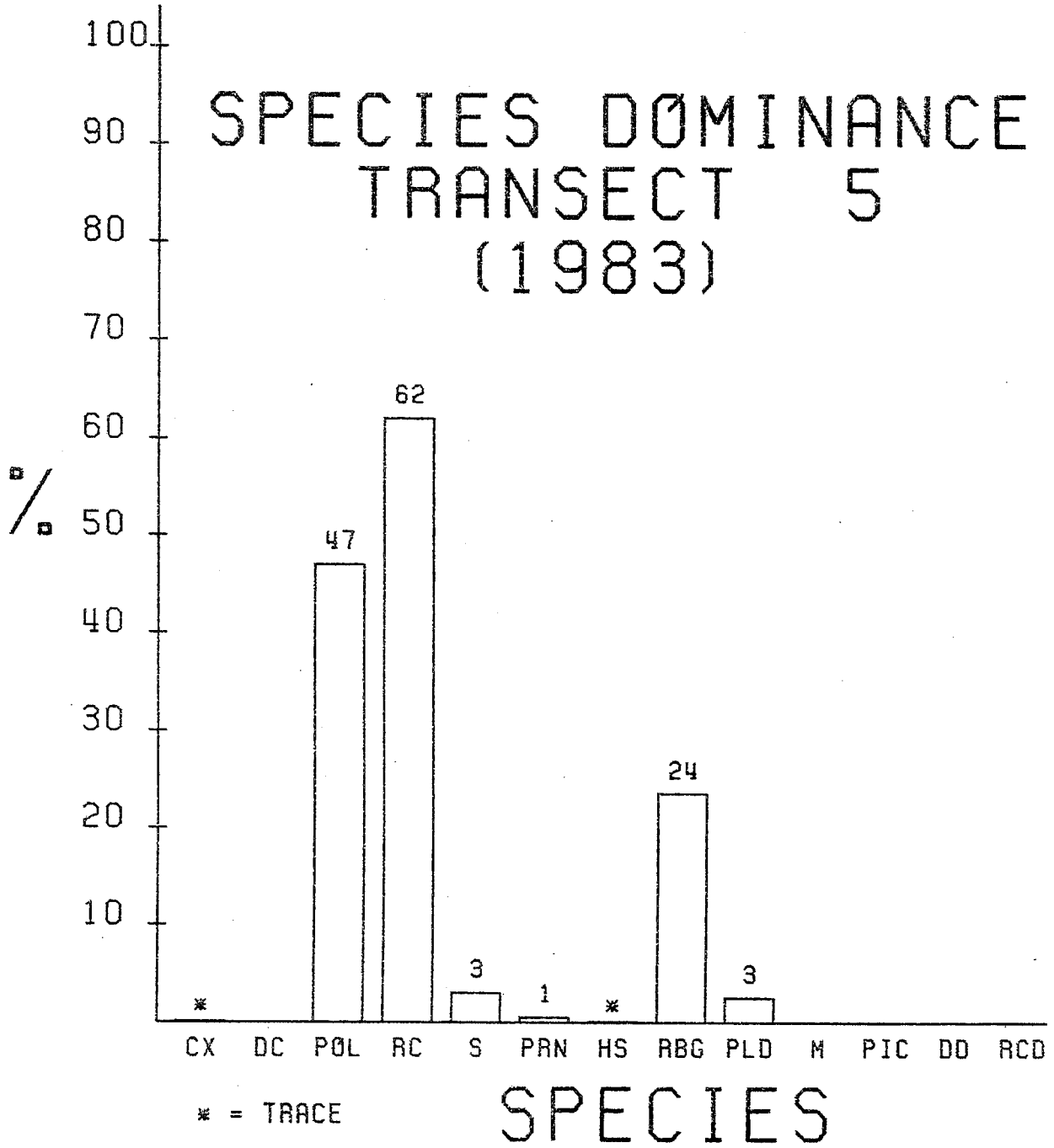

SPECIES DOMINANCE
TRANSECT 3
(1984)
%
100
90
80
70
60
50
40
30
20
10
79
50
7
28
1
2
*
6
1
3
1
4
5
5
*
1
*
4
*
1
R
CX
DC
RA
POL
CXF
RC
S
PRN
H
PTS
LO
PPA
FR
C
ACH
HRC
LOD
UG
R-D
C-D
* = TRACE
SPECIES

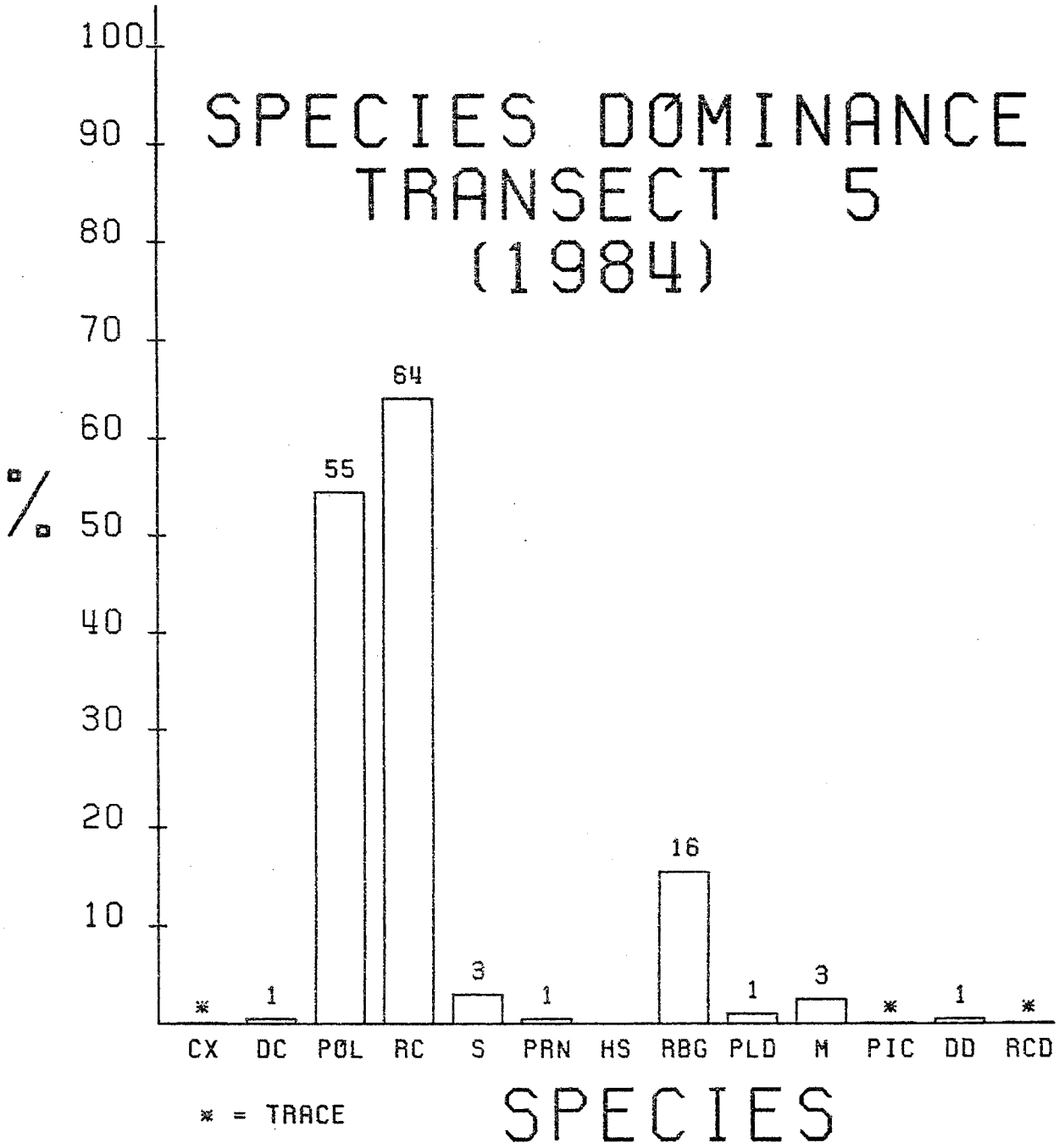

SPECIES DOMINANCE
TRANSECT 3
(1985)
%
100
90
80
70
60
50
40
30
20
10
67
60
22
33
3
4
1
6
1
3
2
9
2
5
1
1
1
*
R
CX
DC
RA
POL
CXF
RC
S
PRN
H
PT5
LO
PPA
FR
C
ACH
HRC
LOD
UG
R-D
C-D
* = TRACE
SPECIES

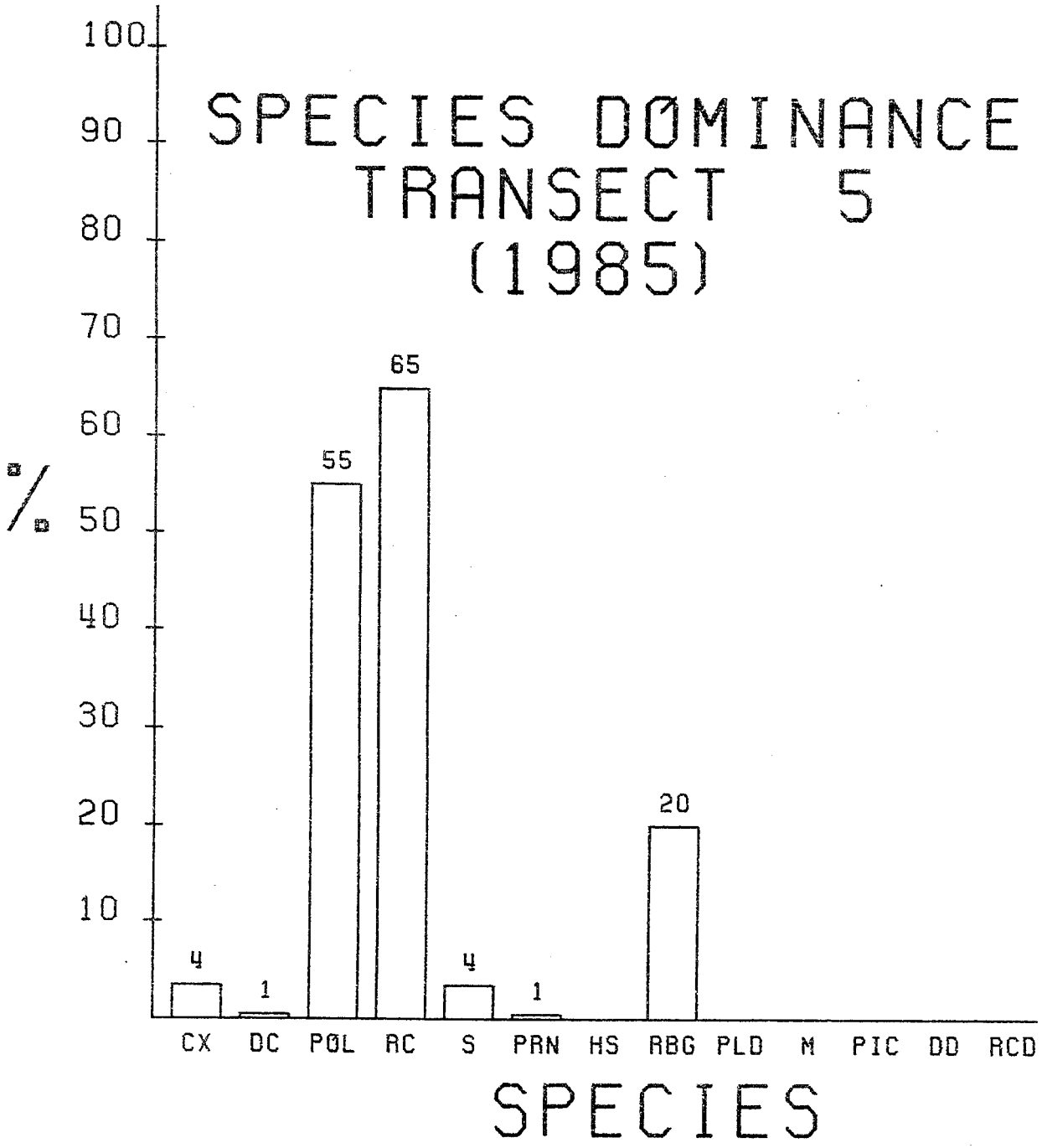

SPECIES DOMINANCE
TRANSECT 4
(1983)
100
90
80
70
60
50
40
30
20
10
%
22
36
60
2
1
31
CX
DC
POL
RC
S
SA
RBG
L
M
DD
SPECIES

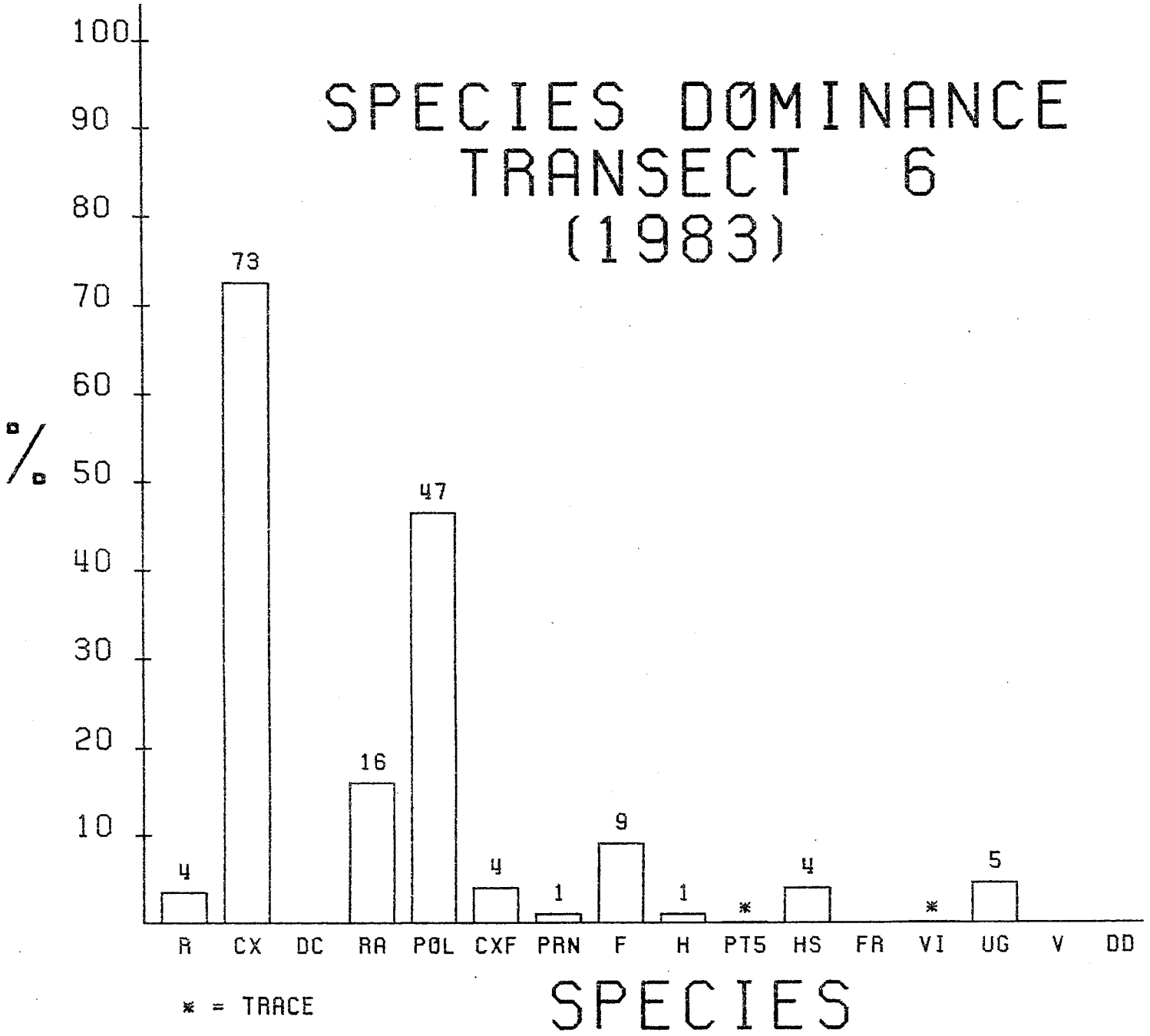

SPECIES DOMINANCE
TRANSECT 4
(1984)
%
100
90
80
70
60
50
40
30
20
10
19
1
36
57
3
2
11
7
13
1
CX
DC
POL
RC
S
SA
RBG
L
M
DD
SPECIES

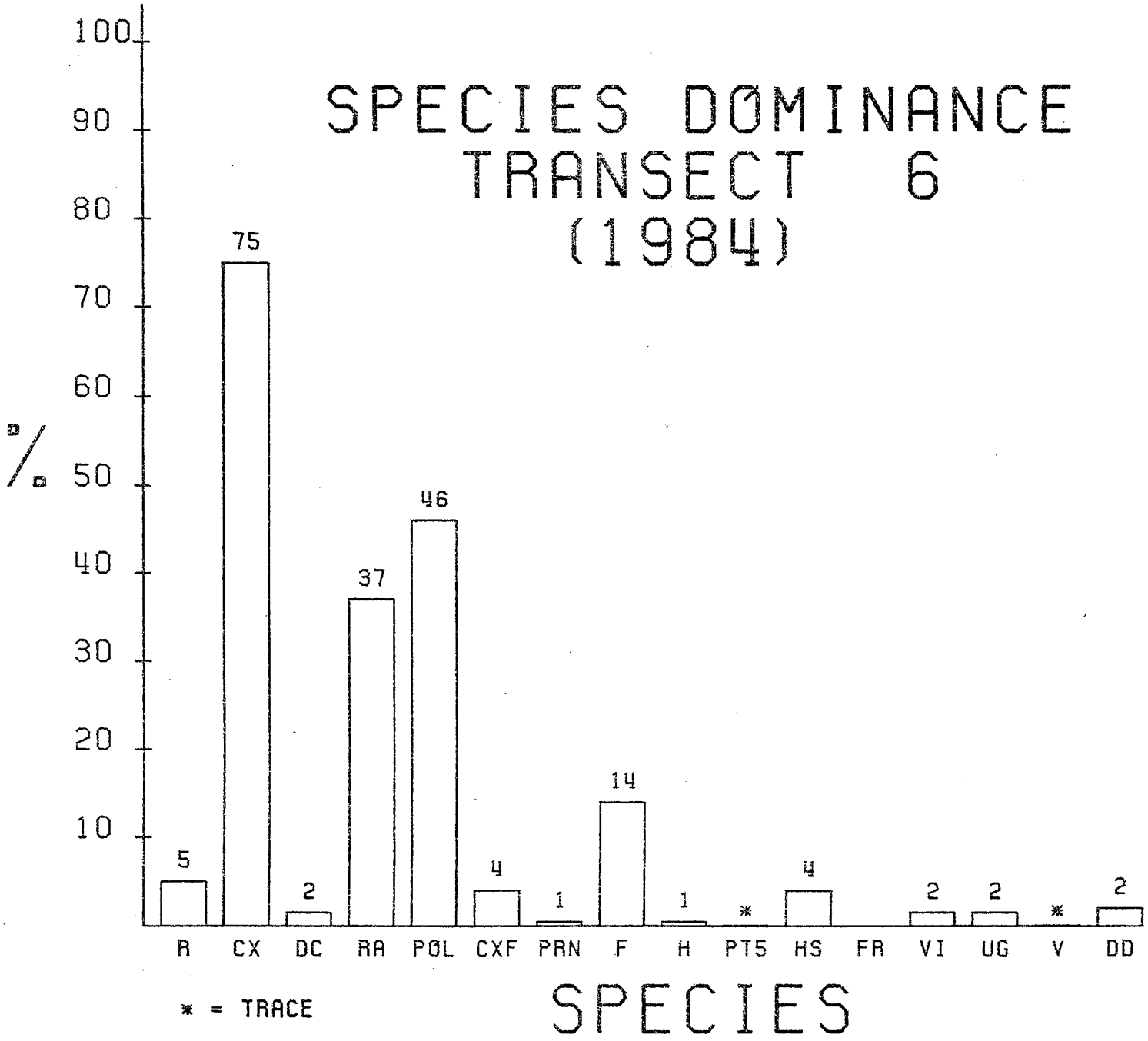

SPECIES DOMINANCE
TRANSECT 4
(1985)
100
90
80
70
60
50
40
30
20
10
%
20
1
37
57
2
3
35
CX
DC
POL
RC
S
SA
RBG
L
M
DD
SPECIES


SPECIES DOMINANCE
TRANSECT 5
(1983)
100
90
80
70
60
50
40
30
20
10
%
62
47
24
3
1
3
*
*
CX
DC
POL
RC
S
PRN
HS
RBG
PLD
M
PIC
DD
RCD
* = TRACE
SPECIES


SPECIES DOMINANCE
TRANSECT 5
(1984)
100
90
80
70
60
50
40
30
20
10
%
64
55
16
3
1
1
3
1
1
*
*
*
CX
DC
POL
RC
S
PRN
HS
RBG
PLD
M
PIC
DD
RCD
* = TRACE
SPECIES


SPECIES DOMINANCE
TRANSECT 5
(1985)
%
100
90
80
70
60
50
40
30
20
10
4
1
55
65
4
1
20
CX
DC
POL
RC
S
PRN
HS
RBG
PLD
M
PIC
DD
RCD
SPECIES


SPECIES DOMINANCE
TRANSECT 6
(1983)
100
90
80
70
60
50
40
30
20
10
%
73
47
16
9
5
4
4
4
1
1
*
*
R
CX
DC
RA
POL
CXF
PRN
F
H
PTS
HS
FR
VI
UG
V
DD
* = TRACE
SPECIES


SPECIES DOMINANCE
TRANSECT 6
(1984)
100
90
80
70
60
50
40
30
20
10
%
75
46
37
14
5
2
4
1
1
*
4
2
2
*
2
R
CX
DC
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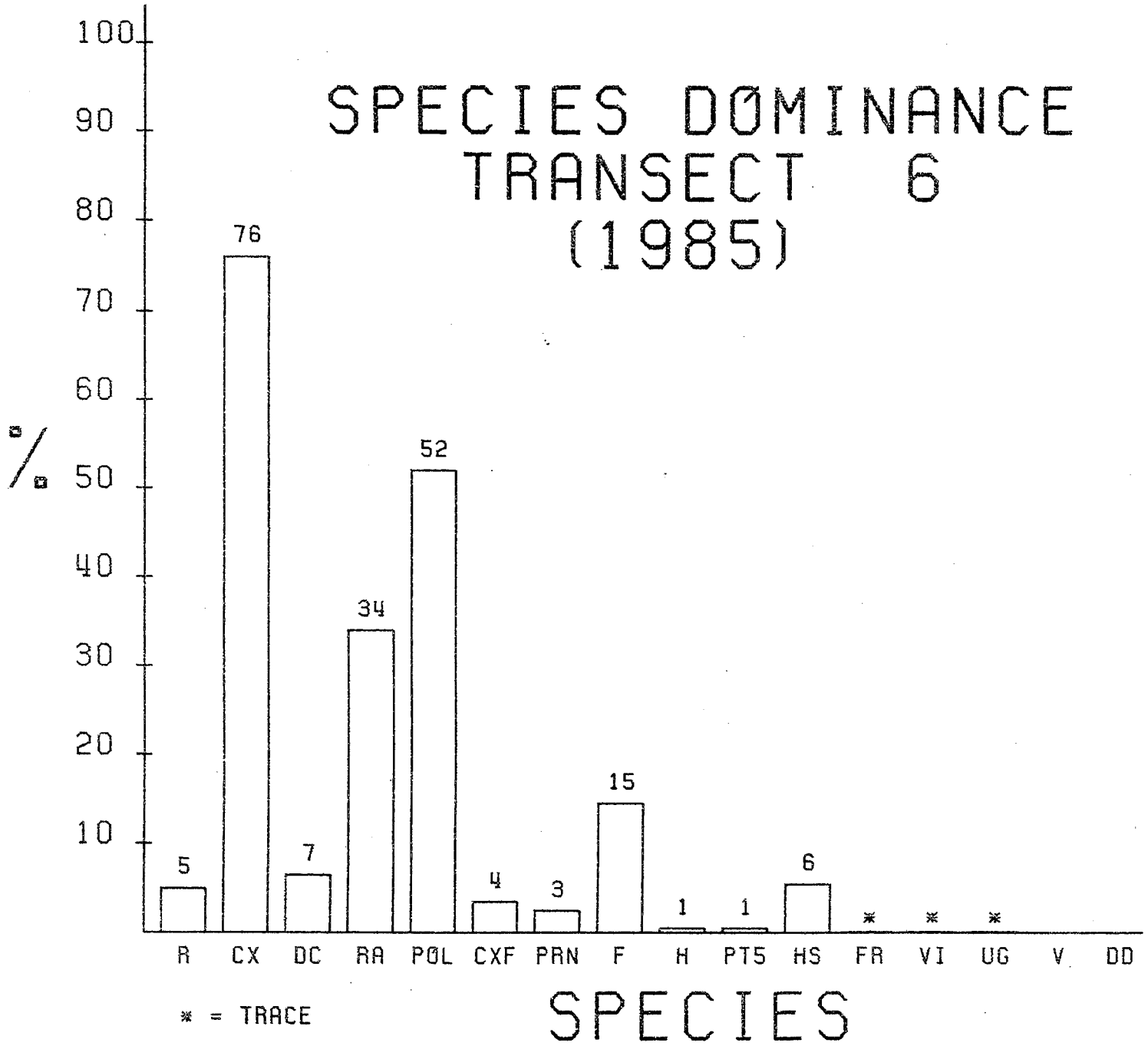
POL
CXF
PRN
F
H
PTS
HS
FR
VI
UG
V
DD
* = TRACE
SPECIES


SPECIES DOMINANCE
TRANSECT 6
(1985)
%
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90
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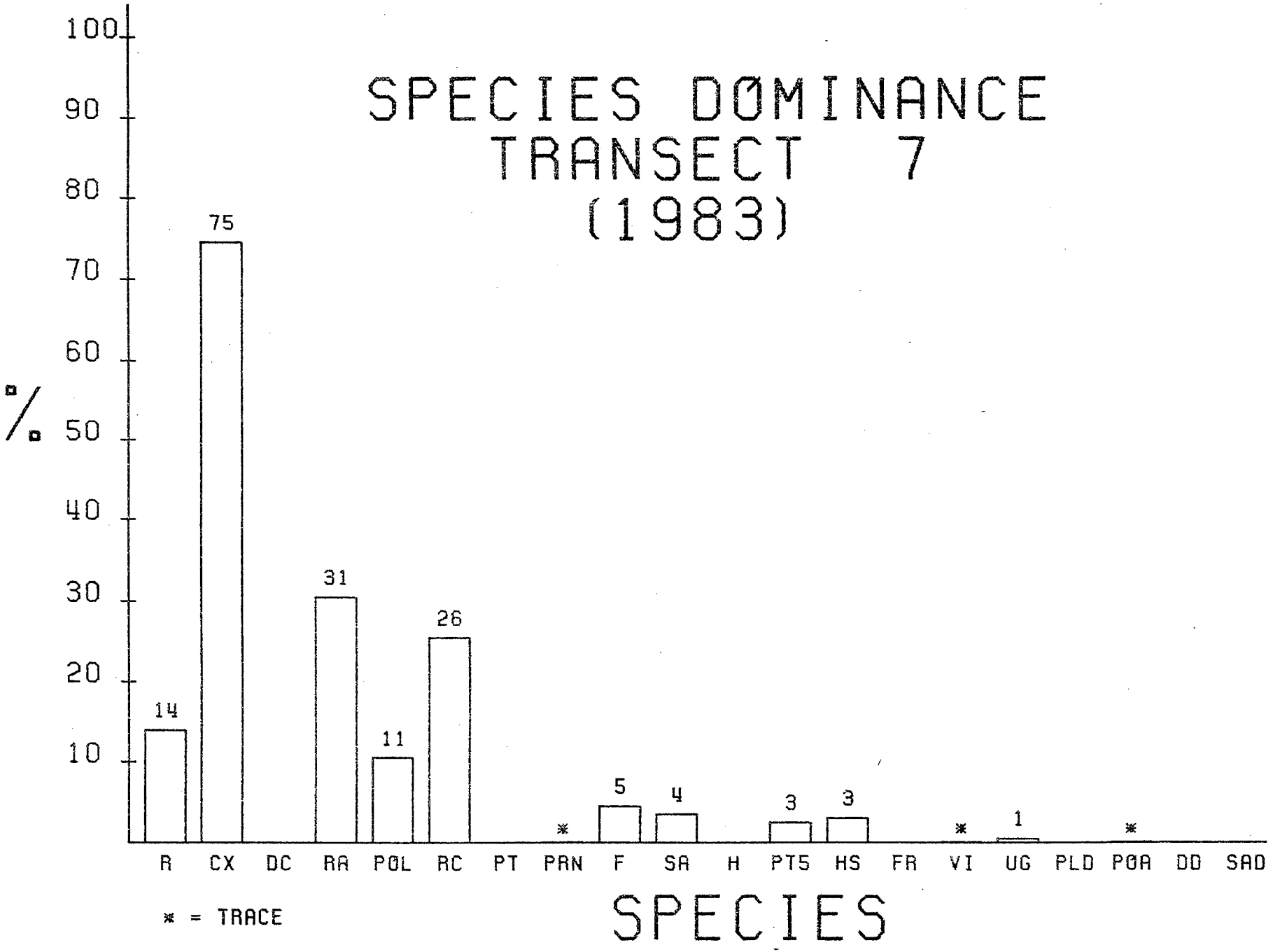
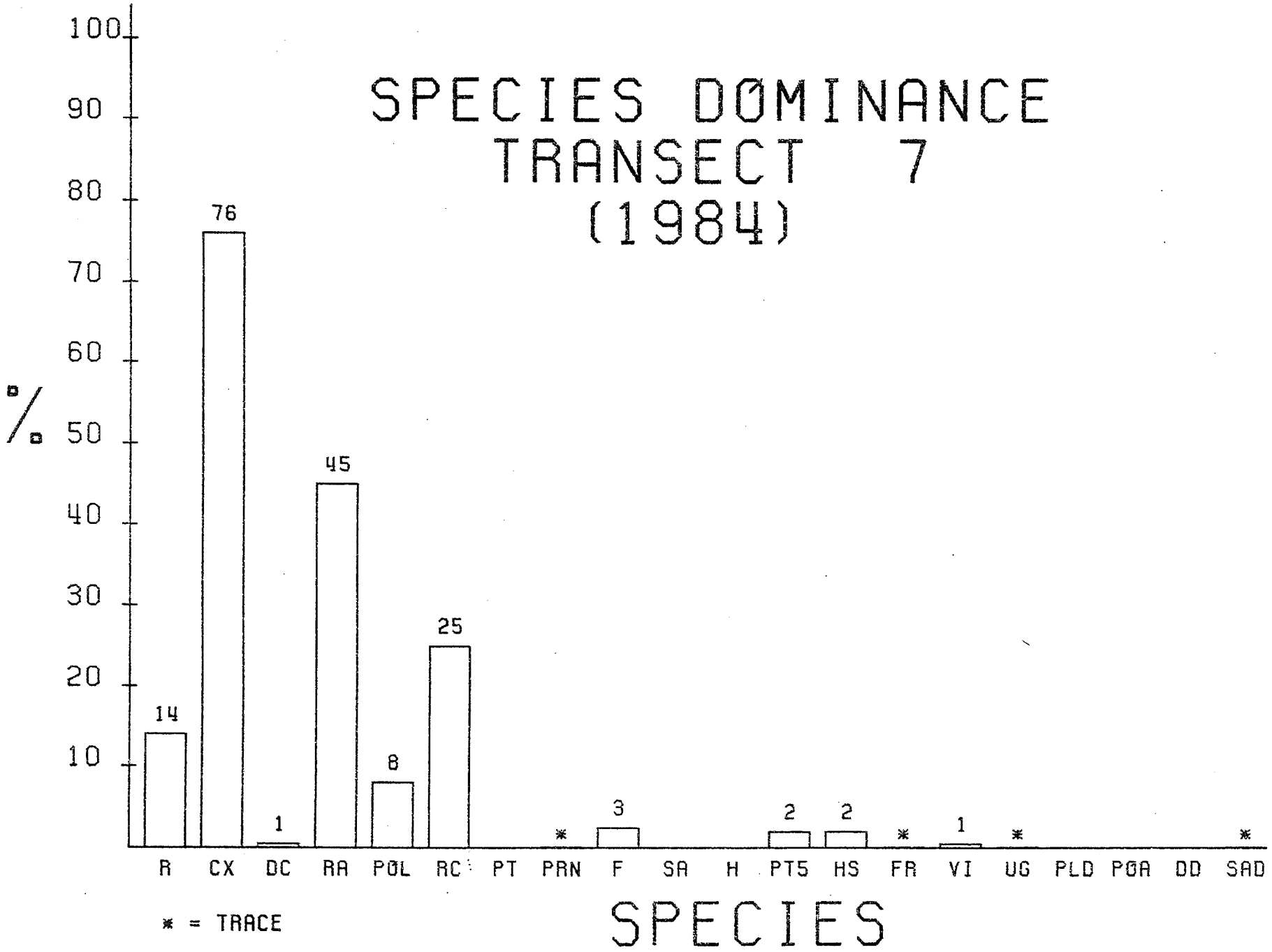
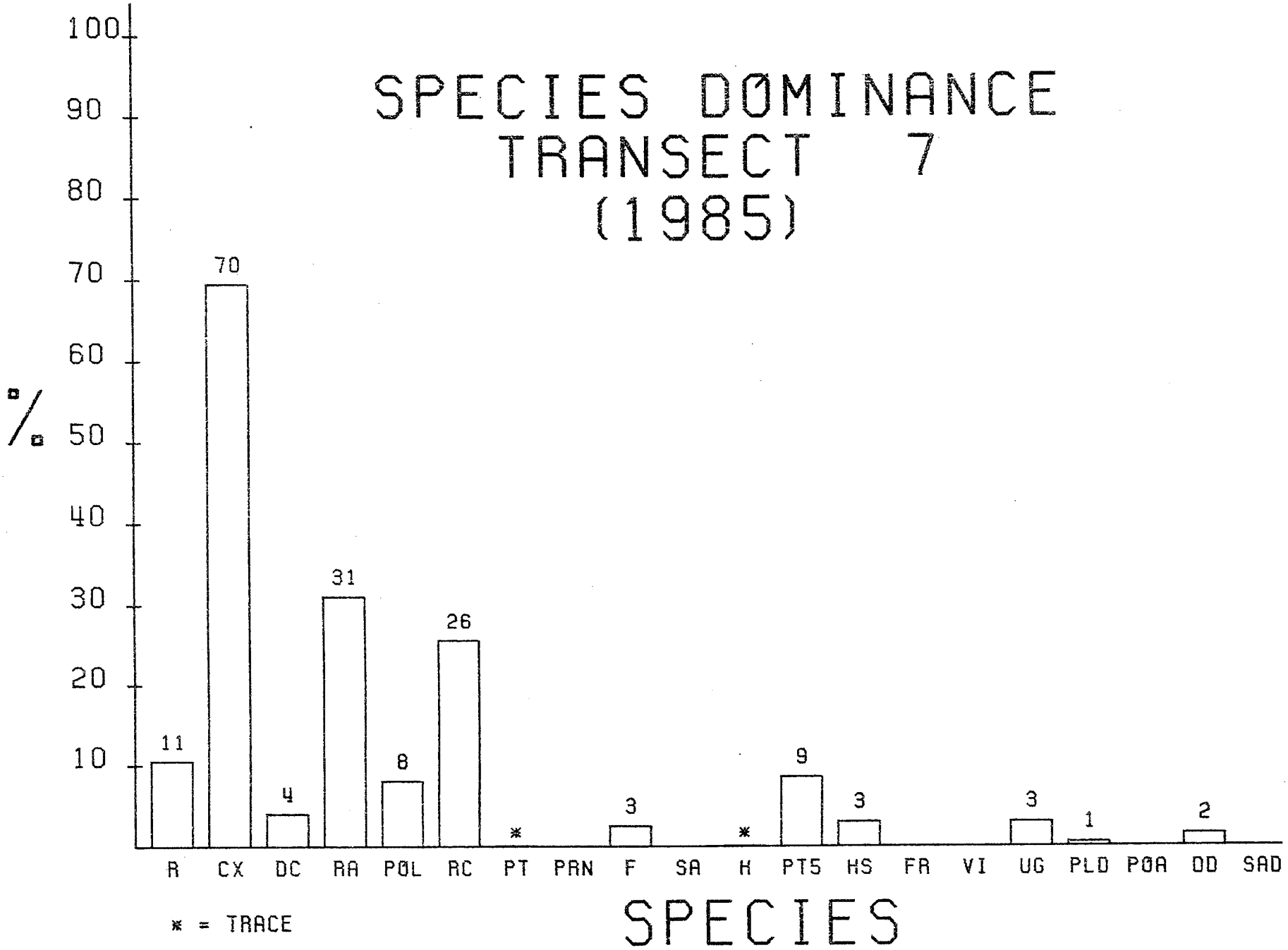
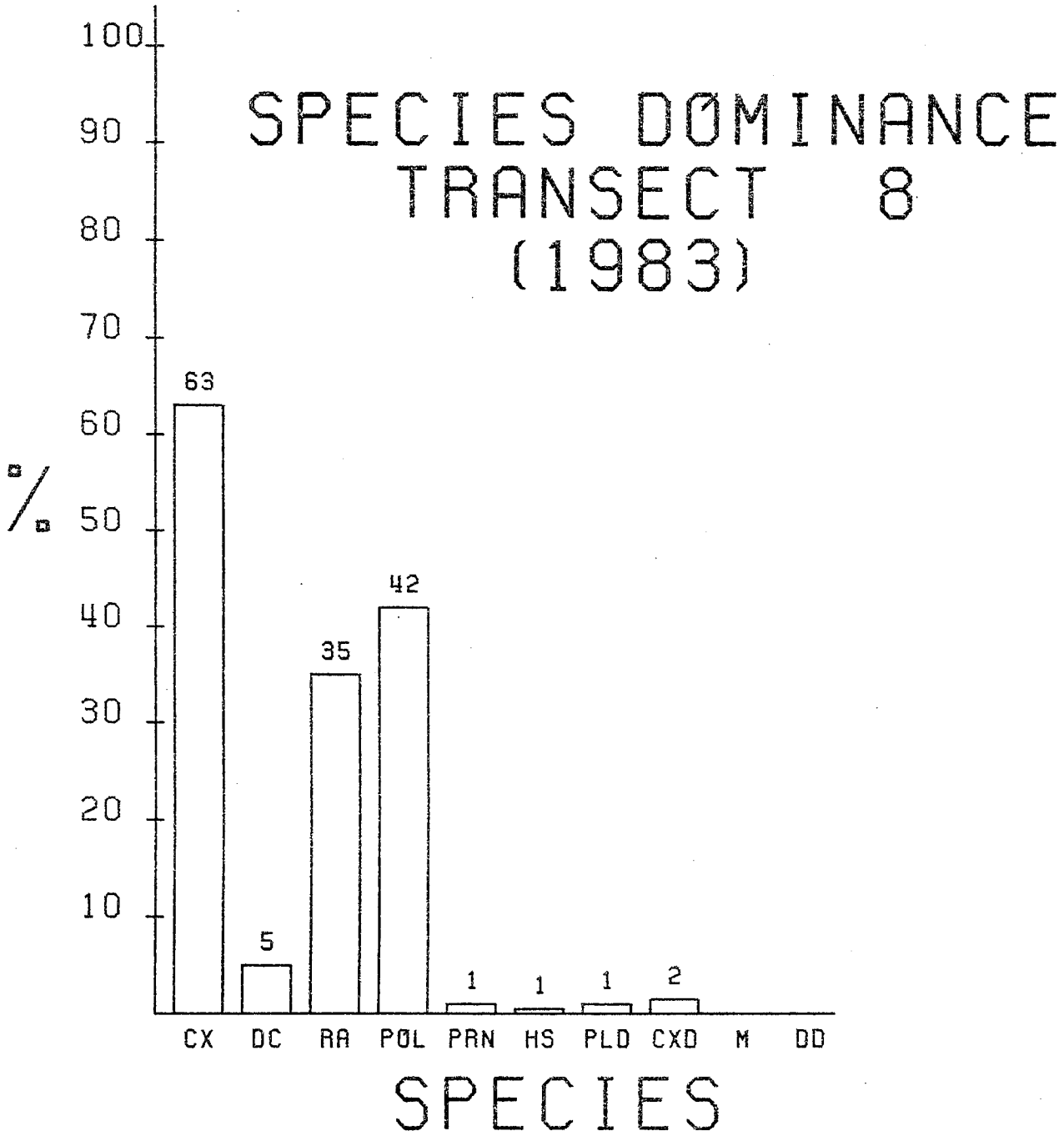
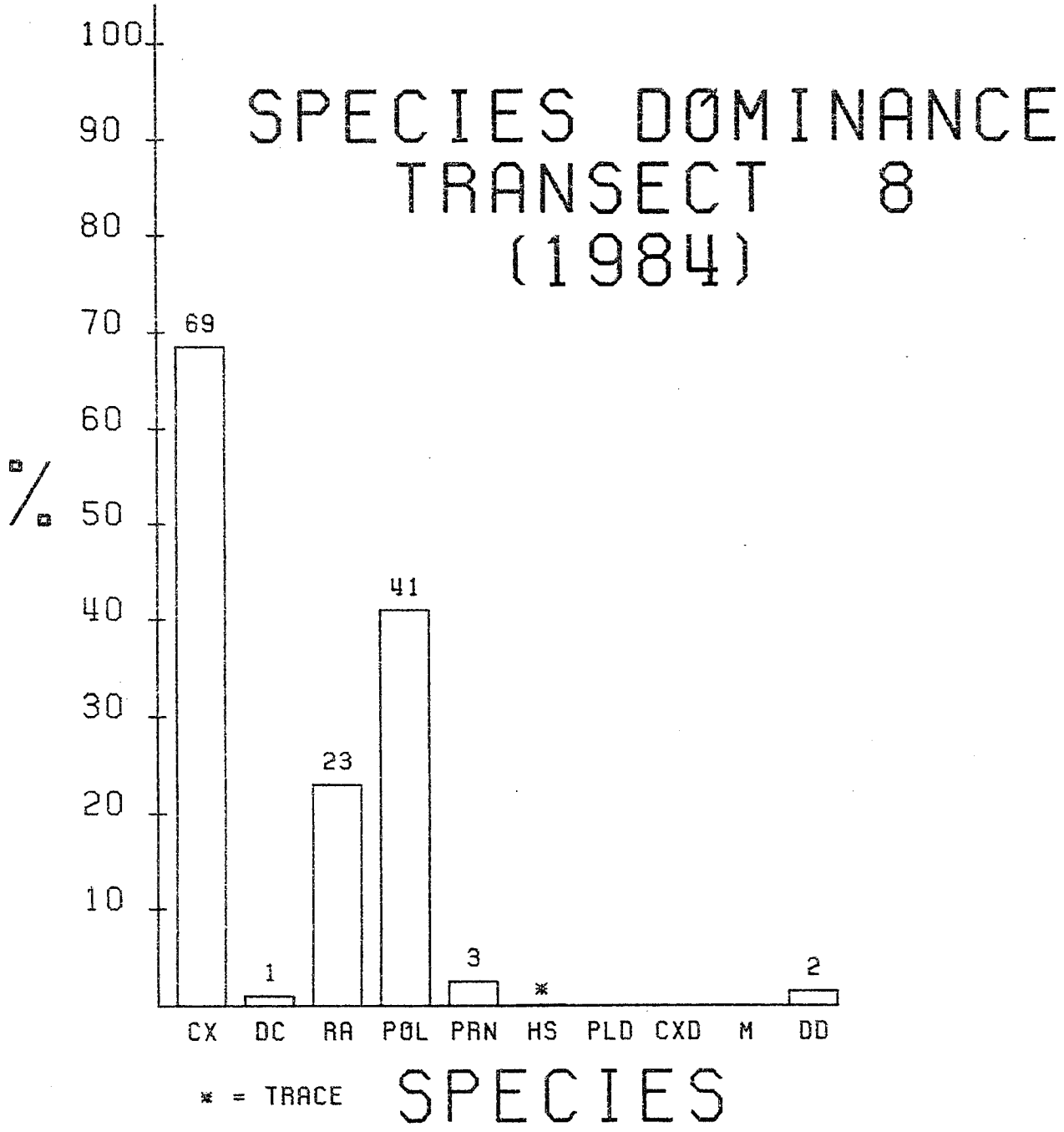
70
60
50
40
30
20
10
76
52
34
15
7
6
5
4
3
1
1
*
*
*
R
CX
DC
RA
POL
CXF
PRN
F
H
PT5
HS
FR
VI
UG
V
DD
* = TRACE
SPECIES

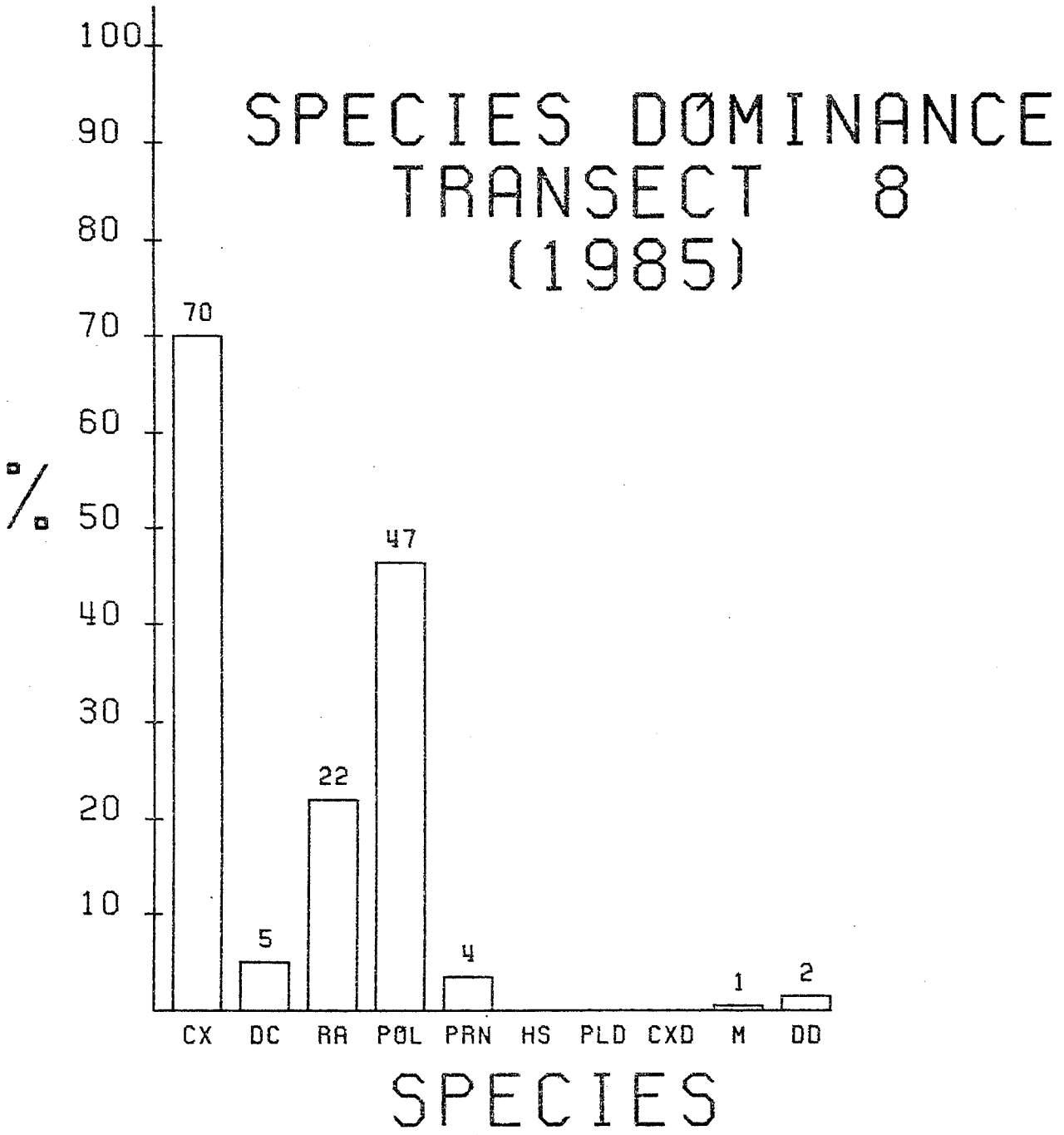

SPECIES DOMINANCE
TRANSECT 7
(1983)
100
90
80
70
60
50
40
30
20
10
%
75
31
26
14
11
5
4
3
3
1
*
*
*
R
CX
DC
RA
POL
RC
PT
PRN
F
SA
H
PT5
HS
FR
VI
UG
PLD
POA
DD
SAD
* = TRACE
SPECIES

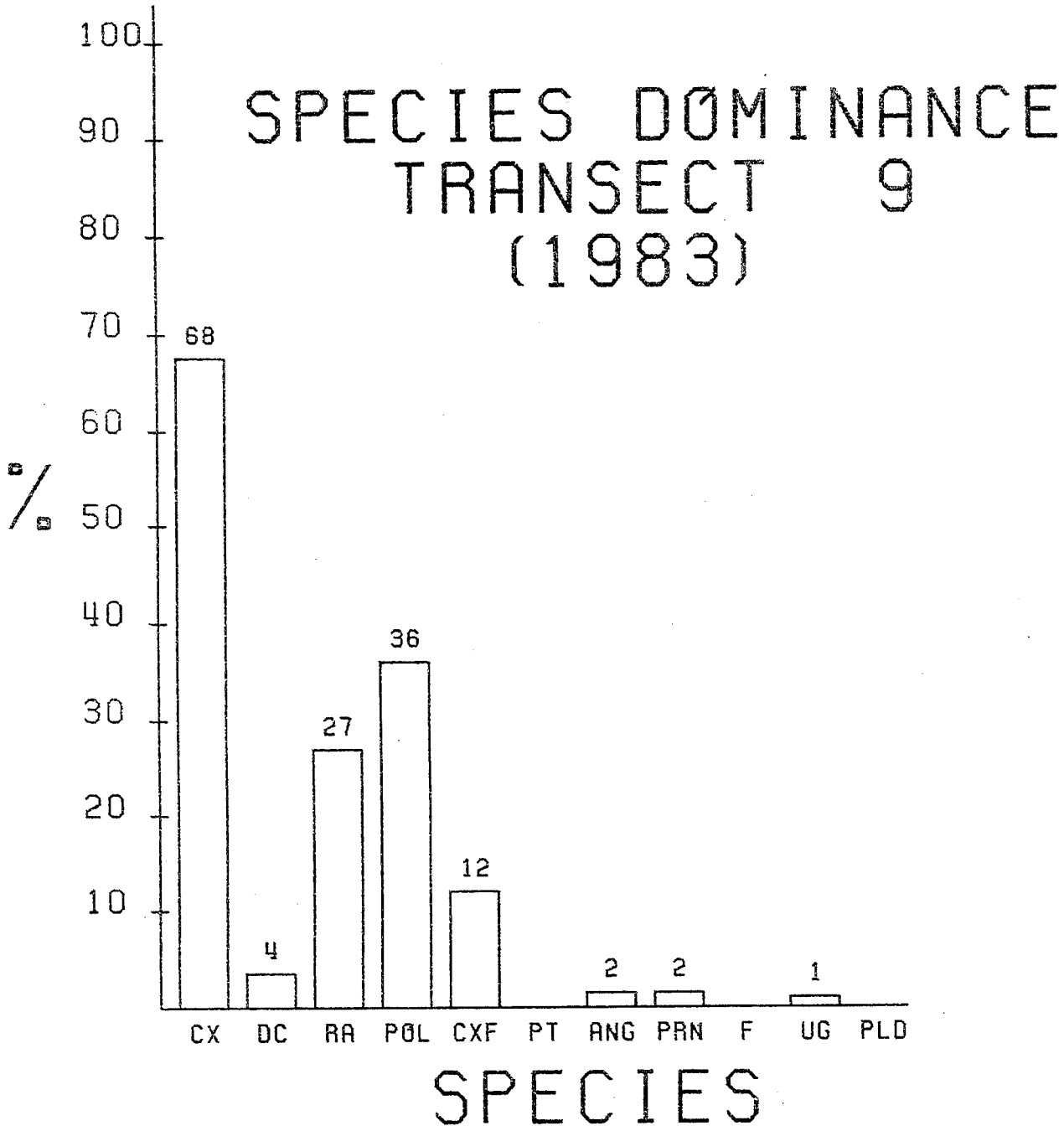

SPECIES DOMINANCE
TRANSECT 7
(1984)
%
100
90
80
70
60
50
40
30
20
10
76
14
1
45
8
25
*
3
2
2
*
1
*
*
R
CX
DC
RA
POL
RC
PT
PRN
F
SA
H
PT5
HS
FR
VI
UG
PLD
POA
DD
SAD
* = TRACE
SPECIES

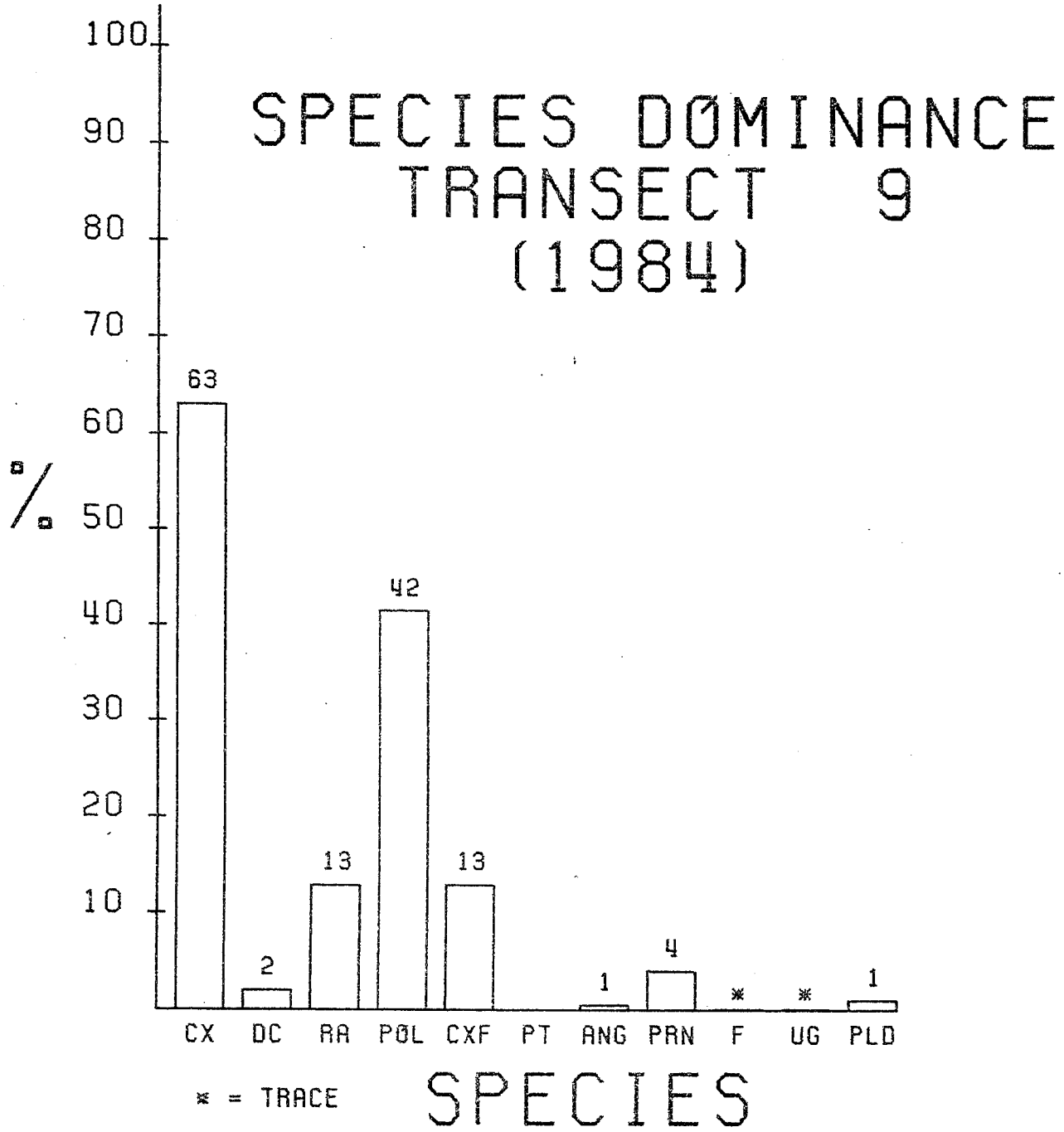

SPECIES DOMINANCE
TRANSECT 7
(1985)
100
90
80
70
60
50
40
30
20
10
%
70
11
4
31
8
26
*
3
*
9
3
3
1
2
R
CX
DC
RA
POL
RC
PT
PRN
F
SA
H
PTS
HS
FR
VI
UG
PLD
POA
DD
SAD
* = TRACE
SPECIES

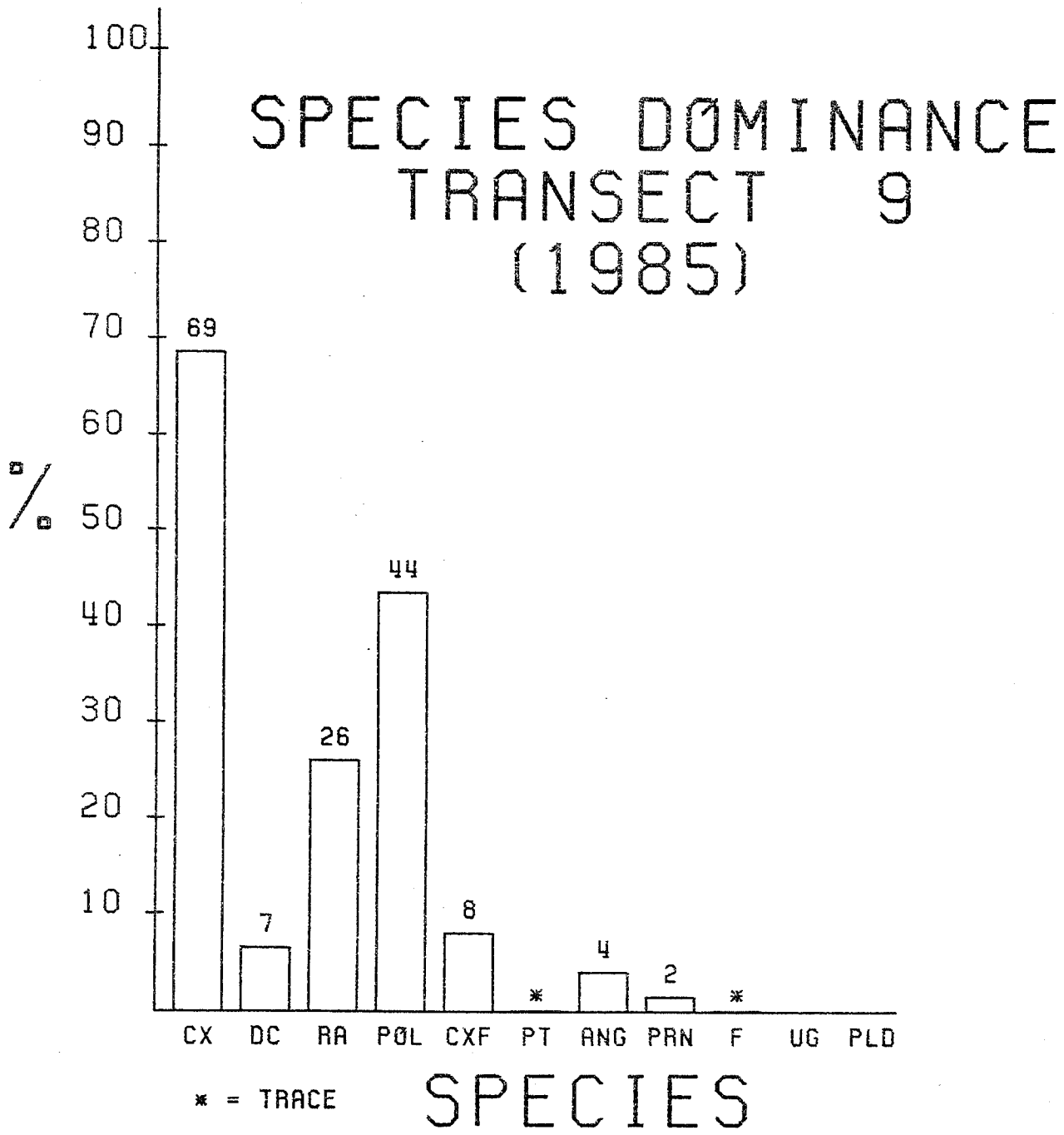

SPECIES DOMINANCE
TRANSECT 8
(1983)
100
90
80
70
60
50
40
30
20
10
%
63
5
35
42
1
1
1
2
CX
DC
RA
POL
PRN
HS
PLD
CXD
M
DD
SPECIES

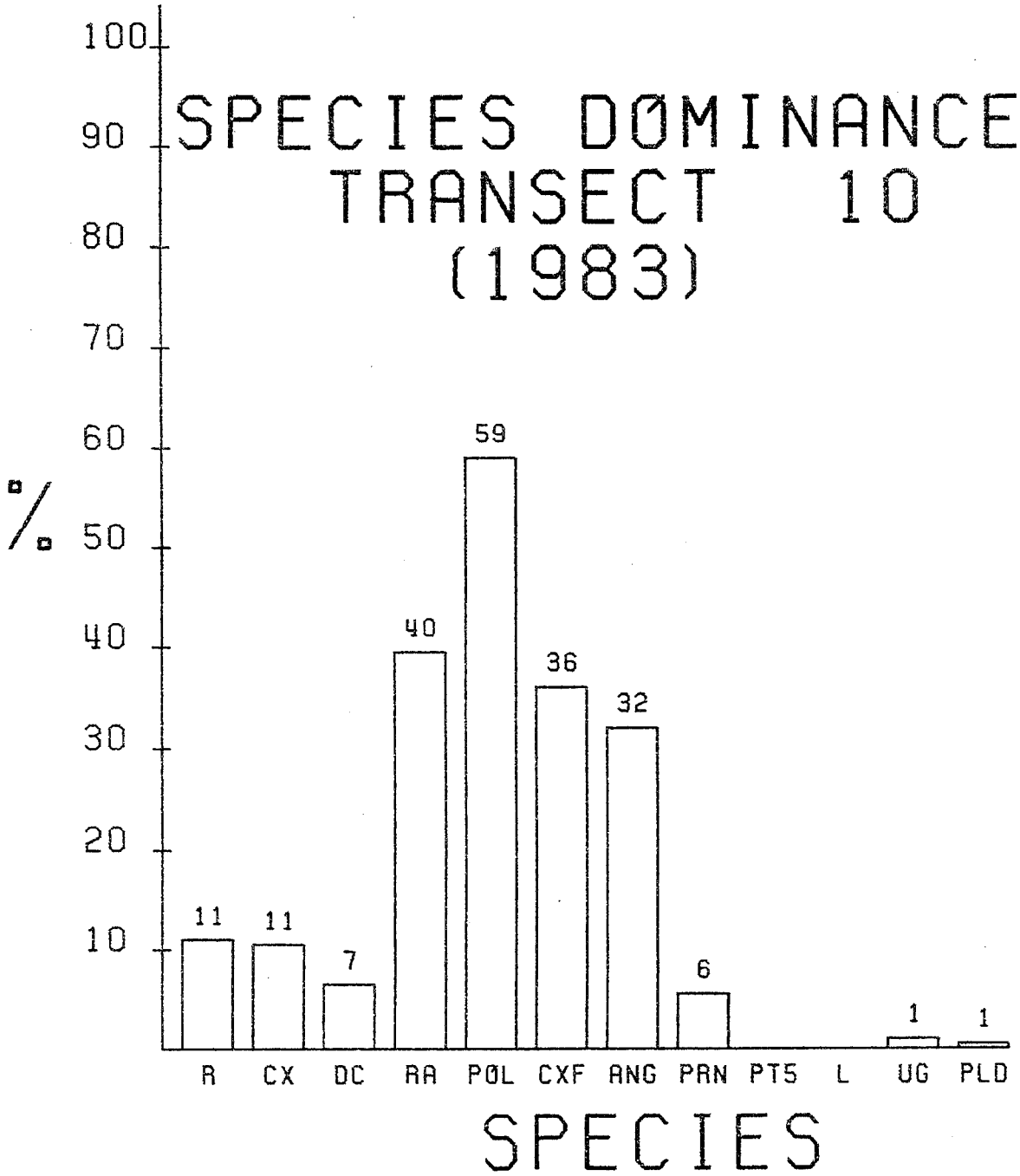

SPECIES DOMINANCE
TRANSECT 8
(1984)
100
90
80
70
60
50
40
30
20
10
%
69
1
23
41
3
*
2
CX
DC
RA
POL
PRN
HS
PLD
CXD
M
DD
* = TRACE
SPECIES

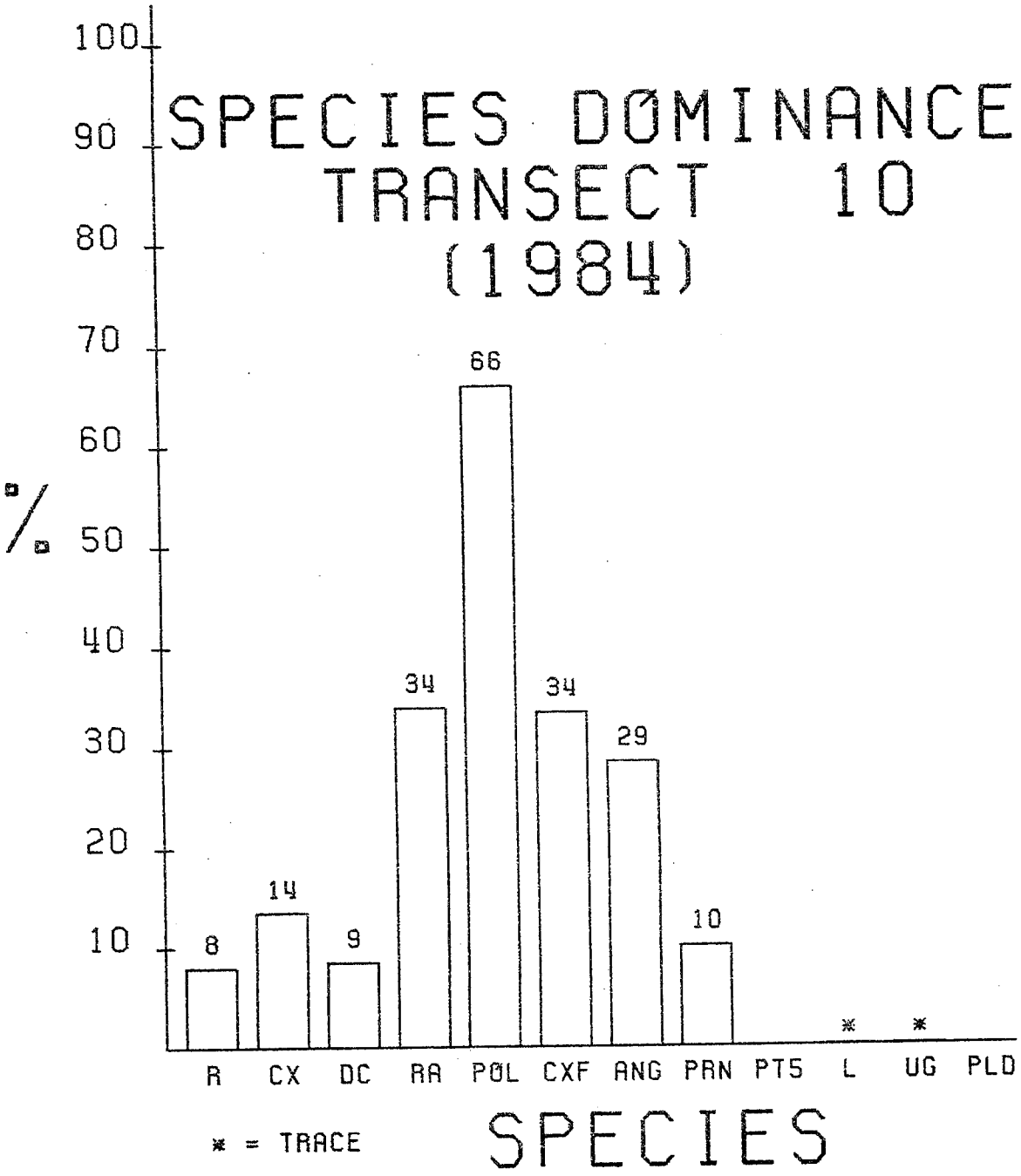

SPECIES DOMINANCE
TRANSECT 8
(1985)
100
90
80
70
60
50
40
30
20
10
%
70
5
22
47
4
1
2
CX
DC
RA
POL
PRN
HS
PLD
CXD
M
DD
SPECIES


SPECIES DOMINANCE
TRANSECT 9
(1983)
100
90
80
70
60
50
40
30
20
10
%
68
4
27
36
12
2
2
1
CX
DC
RA
POL
CXF
PT
ANG
PRN
F
UG
PLD
SPECIES


SPECIES DOMINANCE
TRANSECT 9
(1984)
100
90
80
70
60
50
40
30
20
10
%
63
2
13
42
13
1
4
*
*
1
CX
DC
RA
POL
CXF
PT
ANG
PRN
F
UG
PLD
* = TRACE
SPECIES


SPECIES DOMINANCE
TRANSECT 9
(1985)
100
90
80
70
60
50
40
30
20
10
%
69
7
26
44
8
*
4
2
*
CX
DC
RA
PØL
CXF
PT
ANG
PRN
F
UG
PLD
* = TRACE
SPECIES


SPECIES DØMINANCE
TRANSECT 10
(1983)
100
90
80
70
60
50
40
30
20
10
%
11
11
7
40
59
36
32
6
1
1
R
CX
DC
RA
PØL
CXF
ANG
PRN
PT5
L
UG
PLD
SPECIES


SPECIES DOMINANCE
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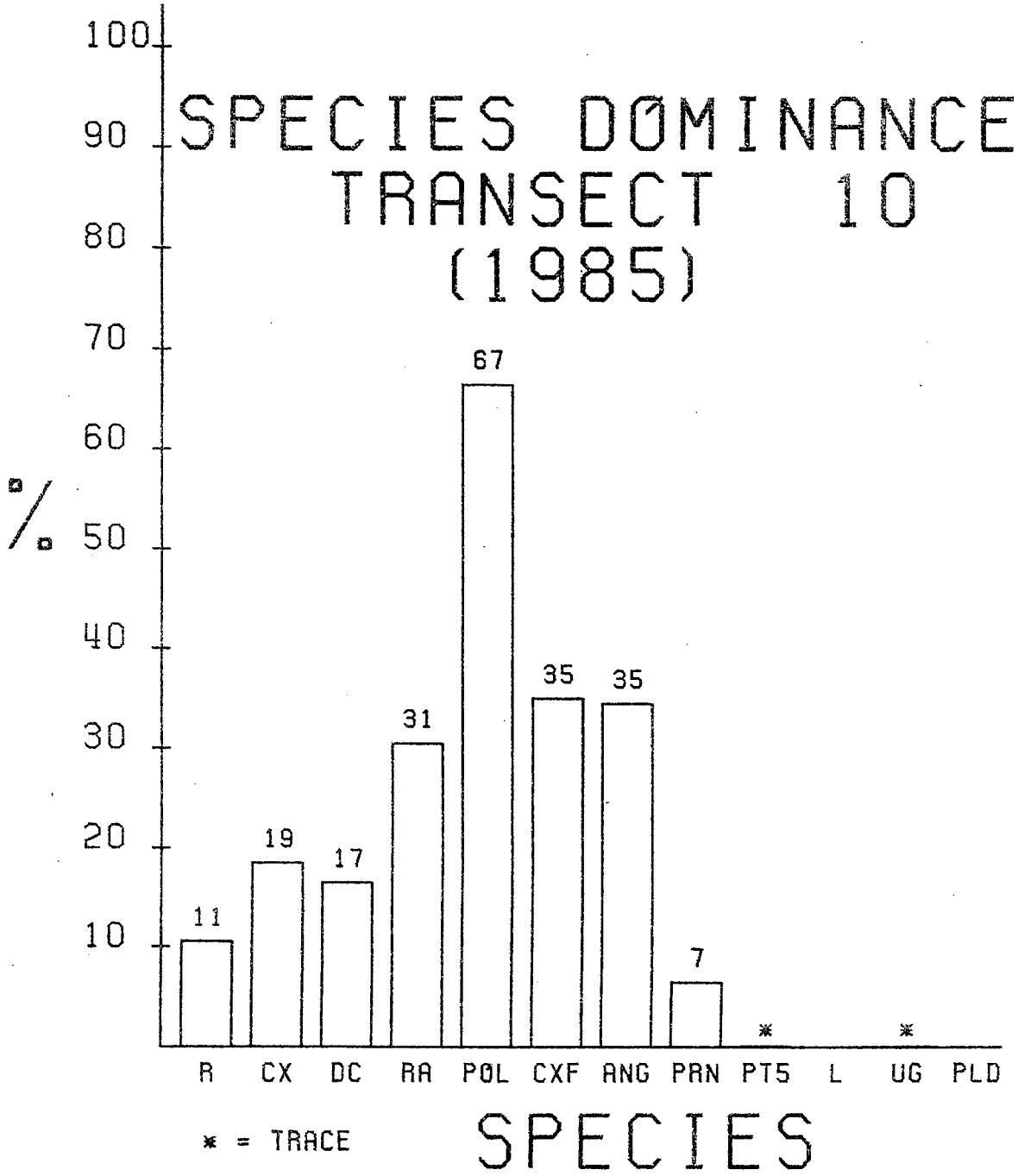
SPECIES


SPECIES DOMINANCE
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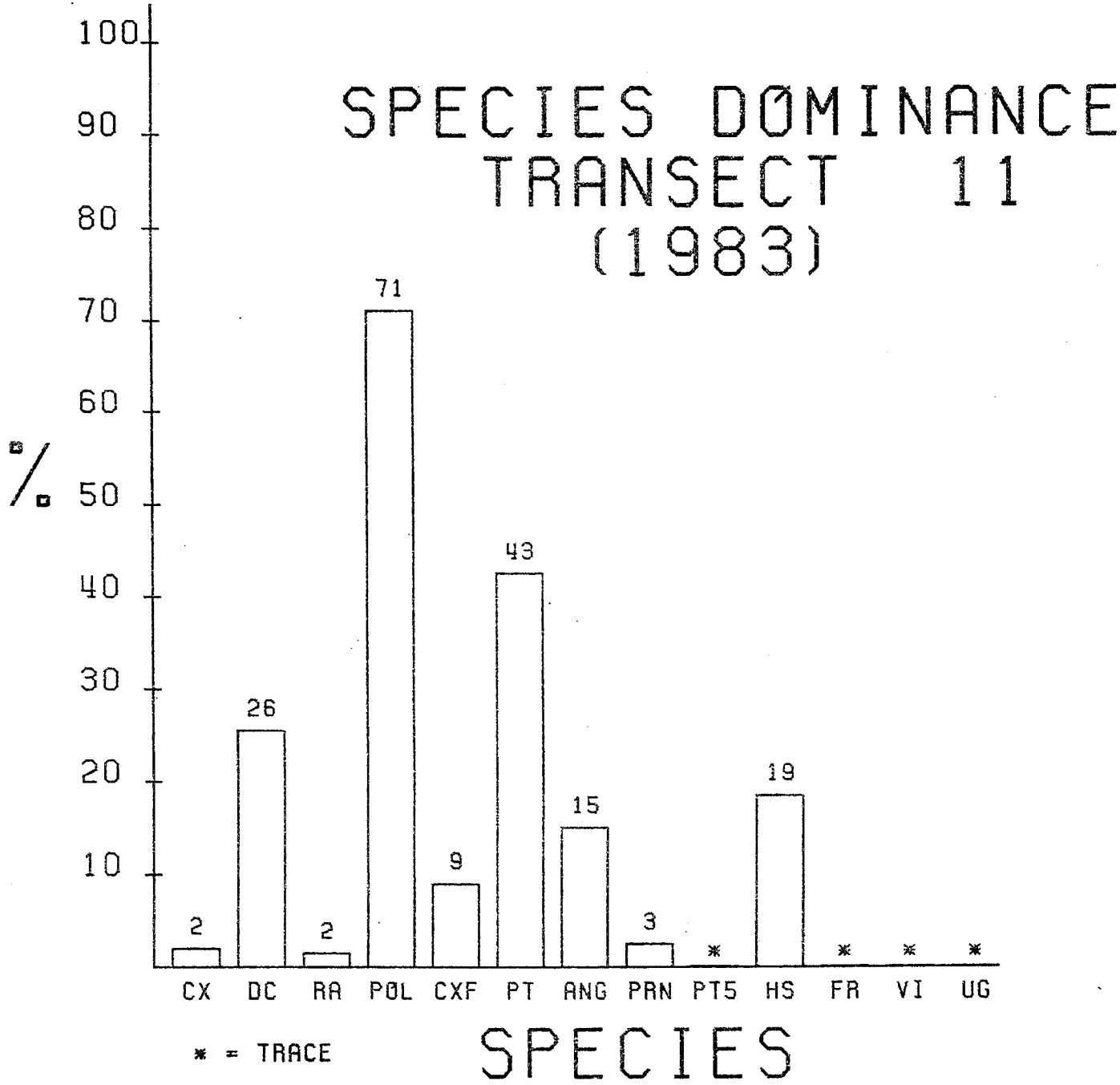
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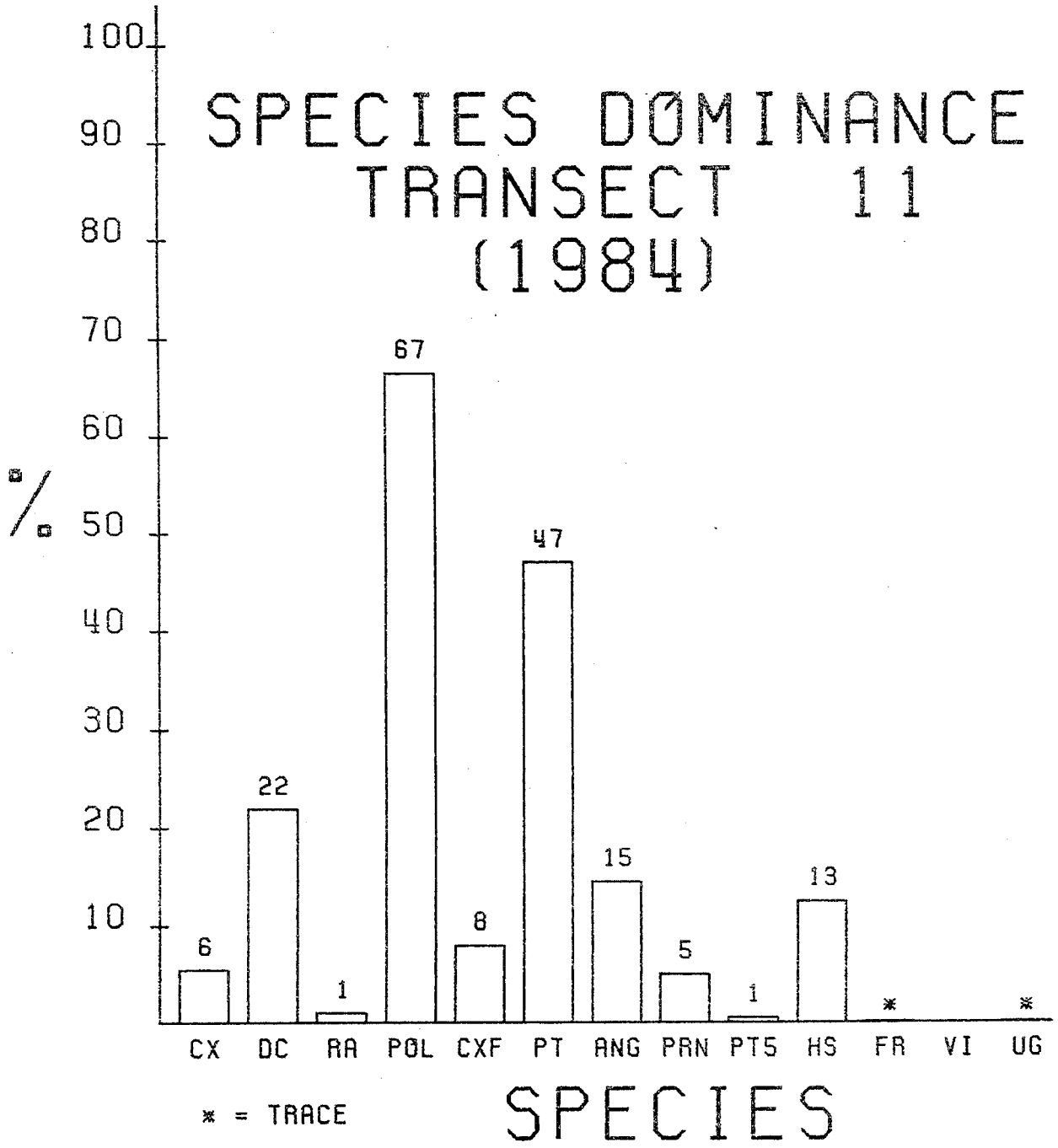
SPECIES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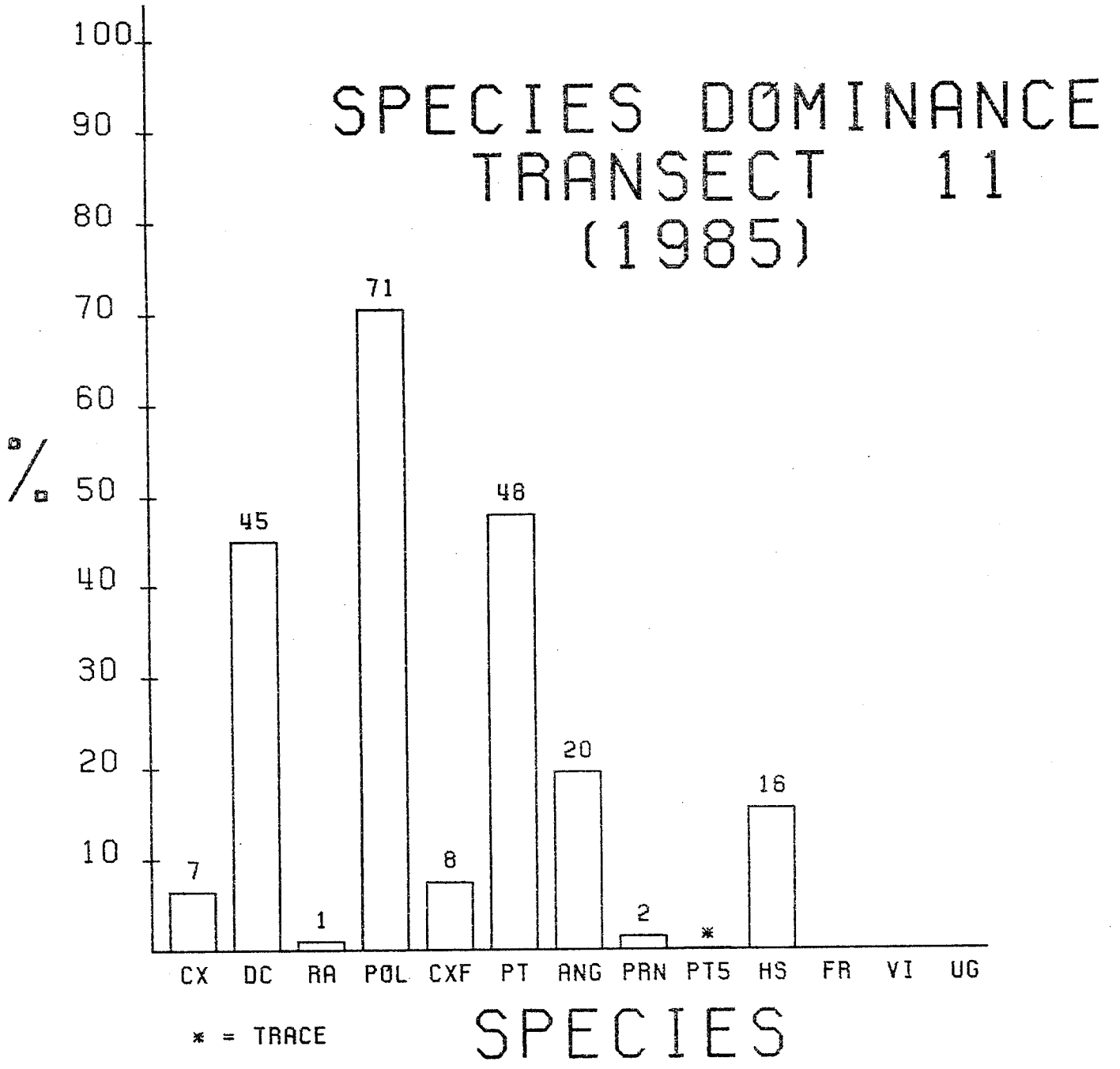
SPECIES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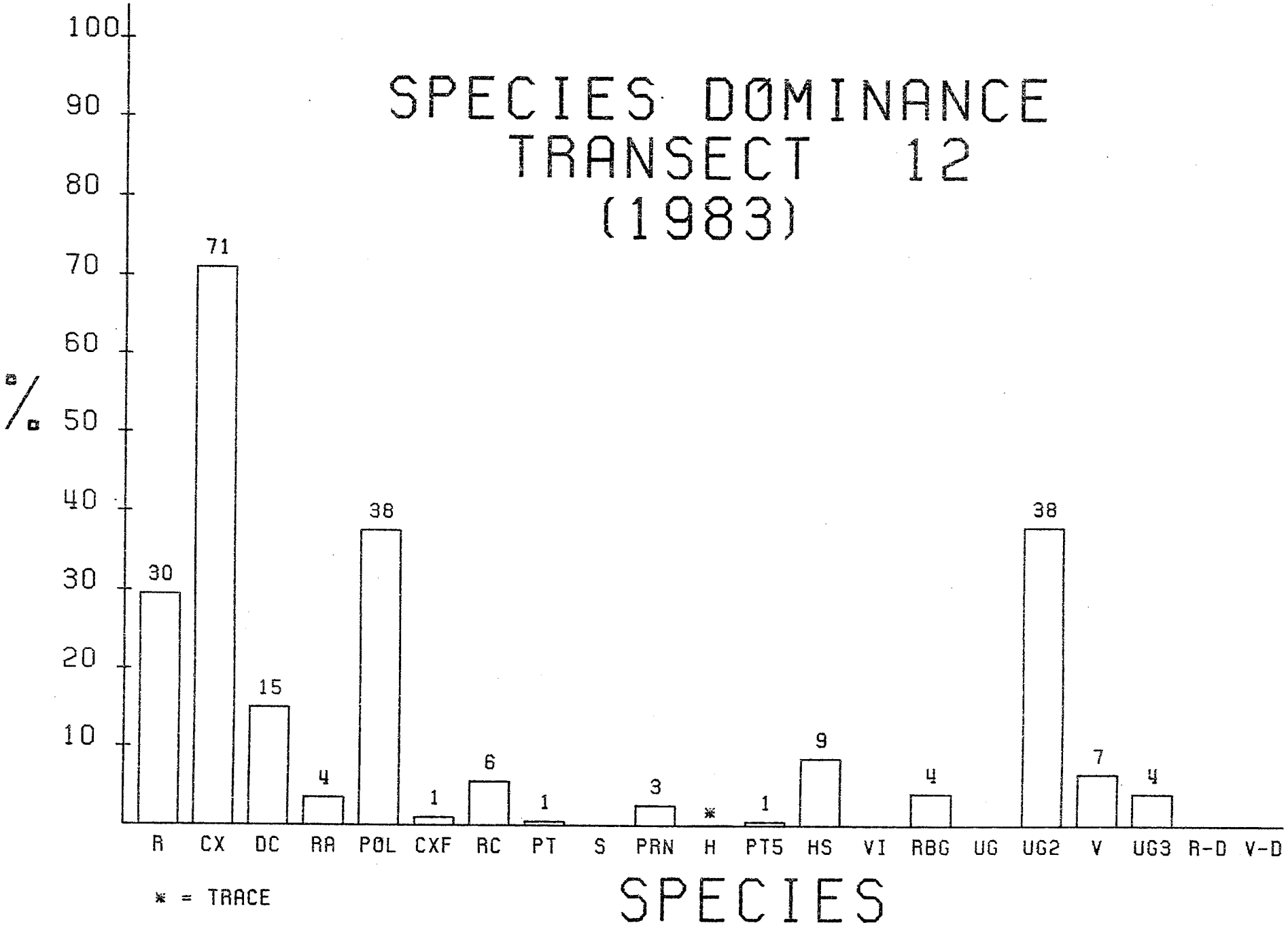
SPECIES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38
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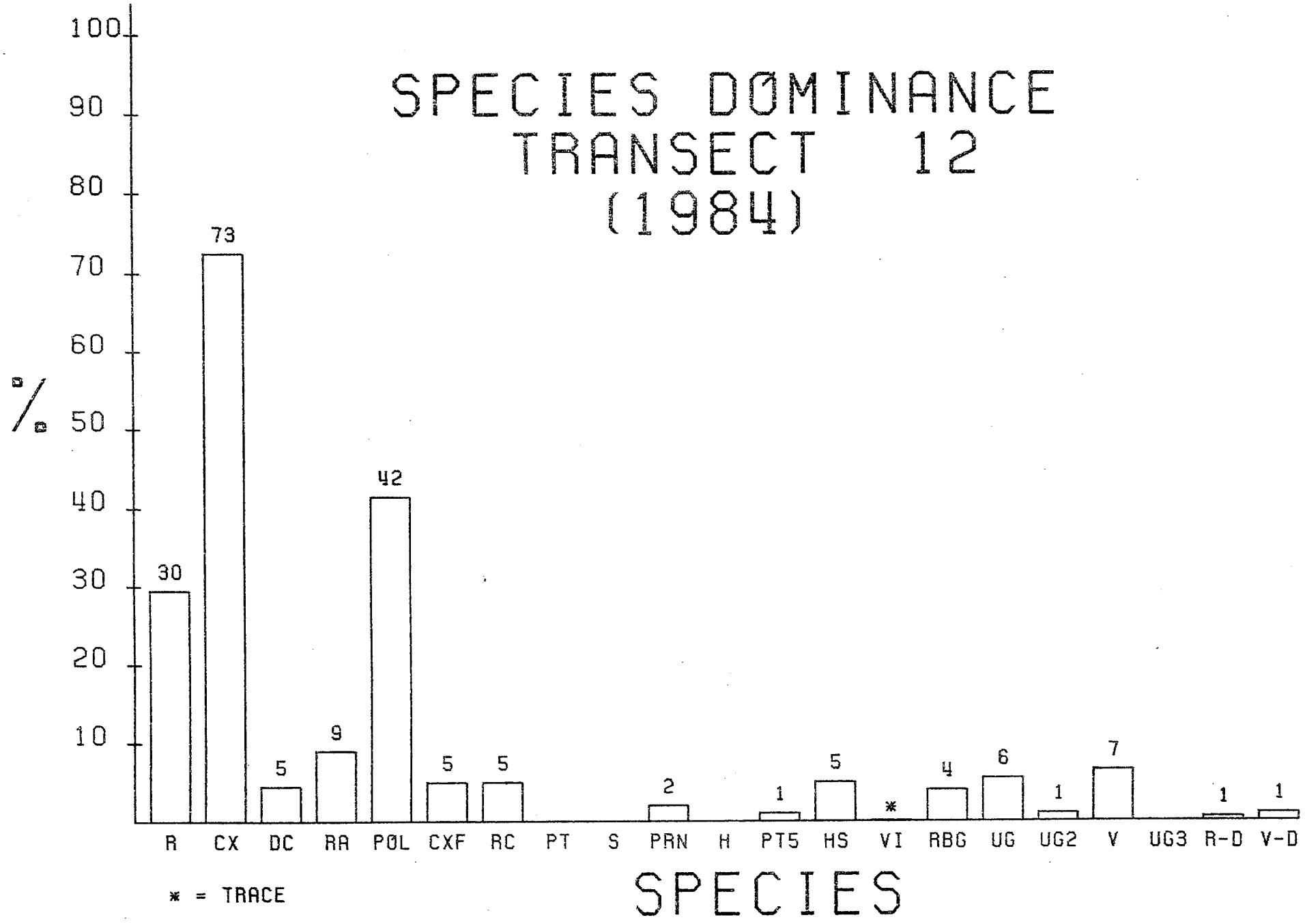
SPECIES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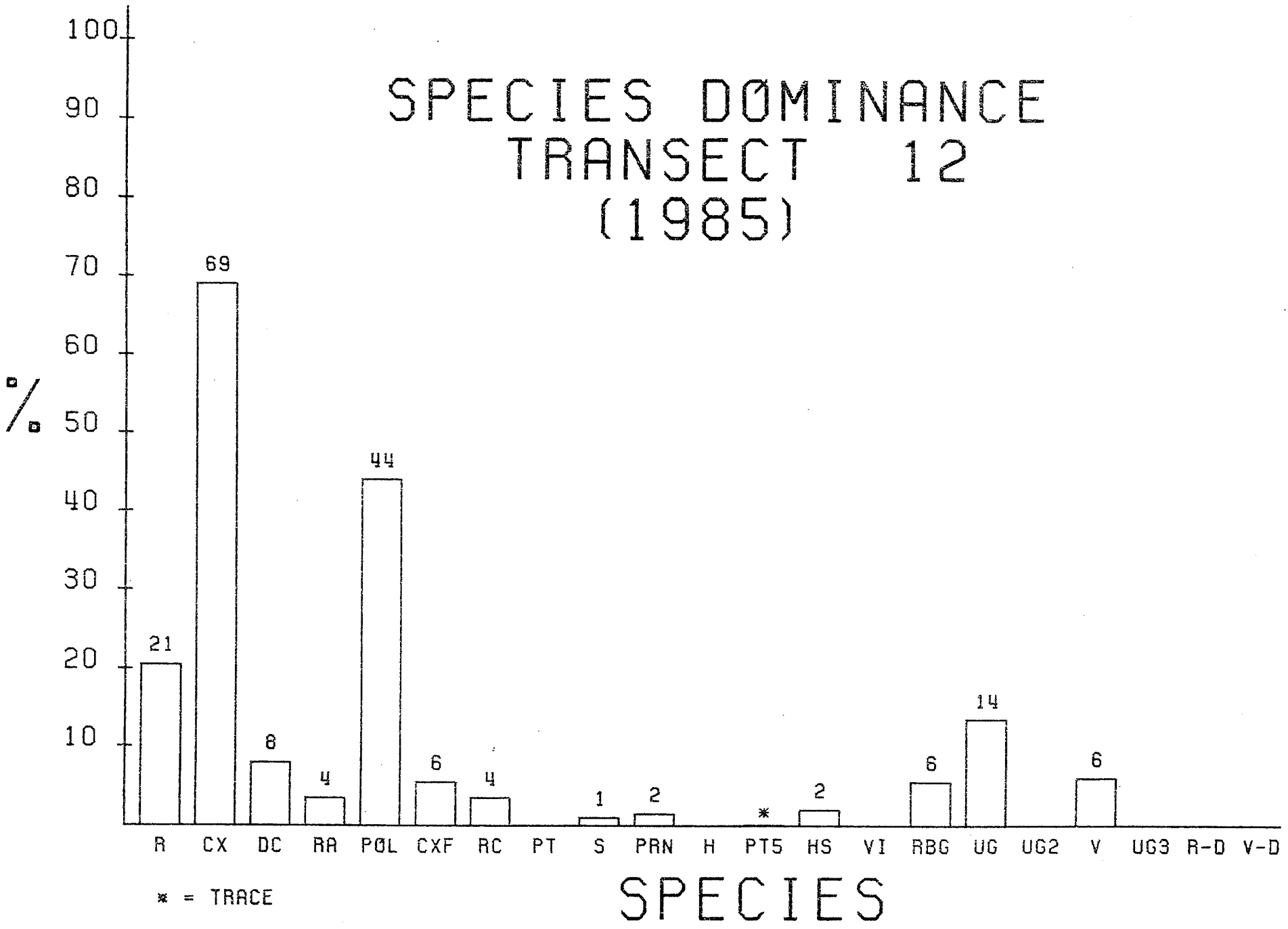
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V-D
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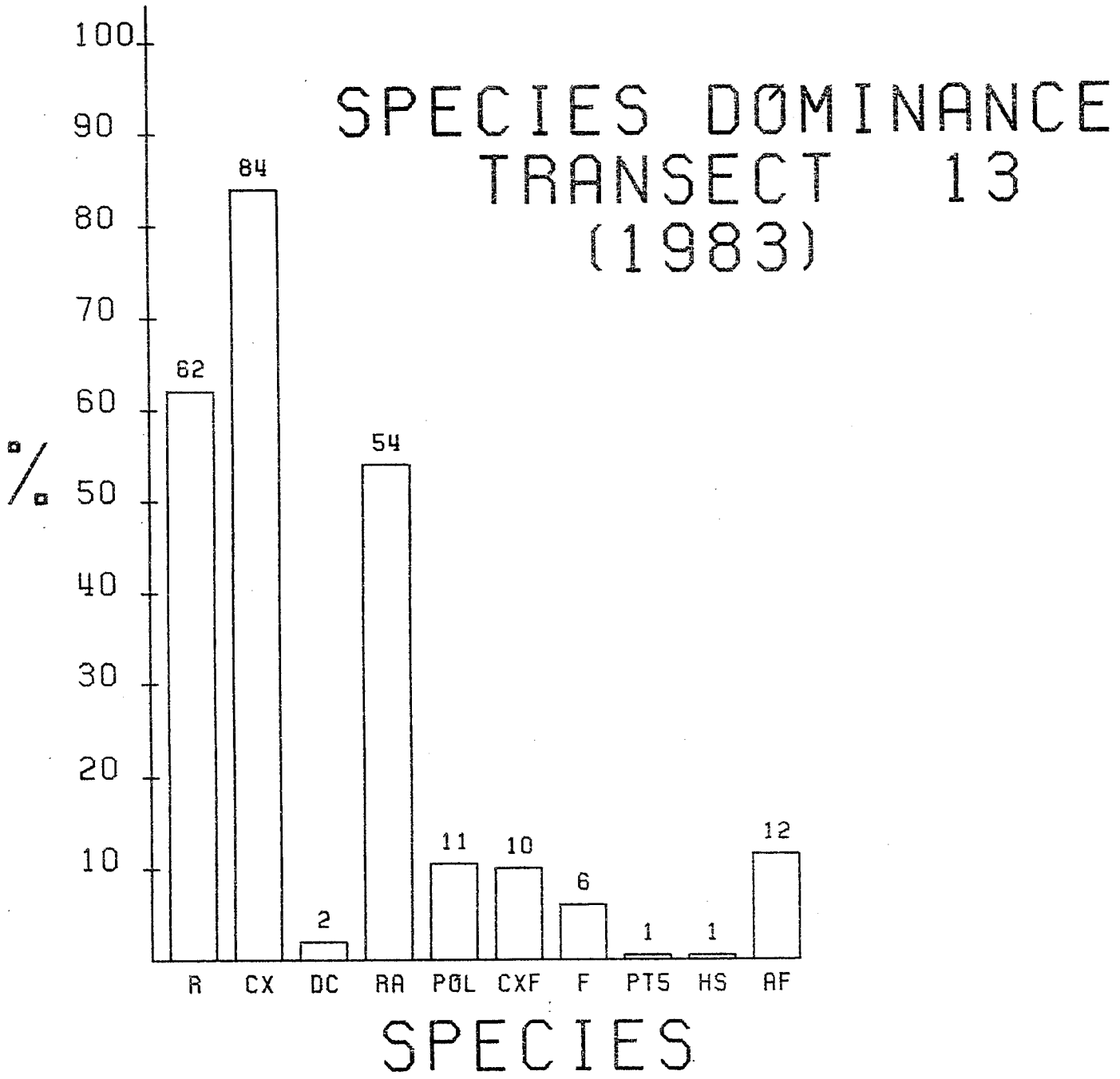
SPECIES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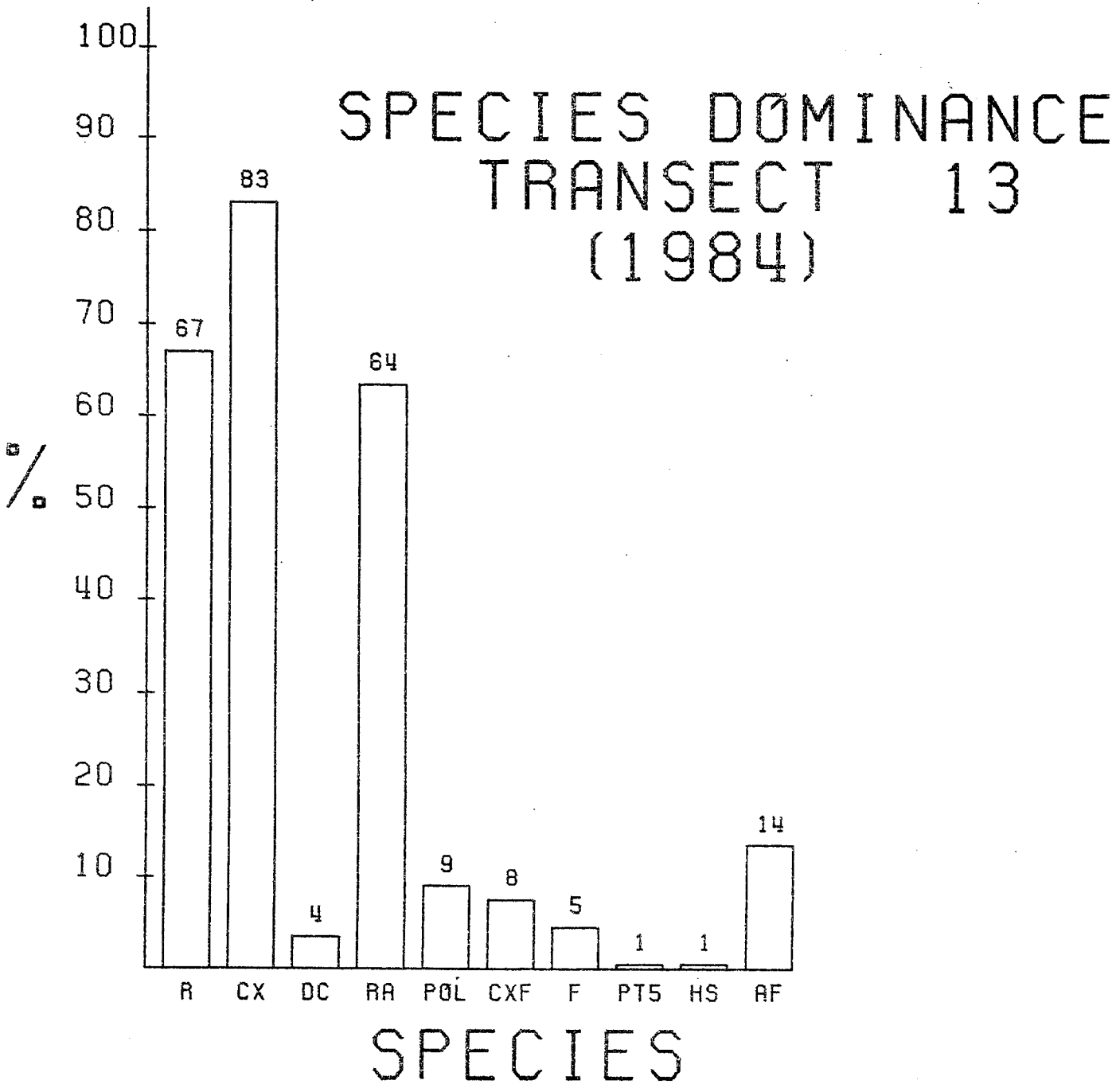
SPECIES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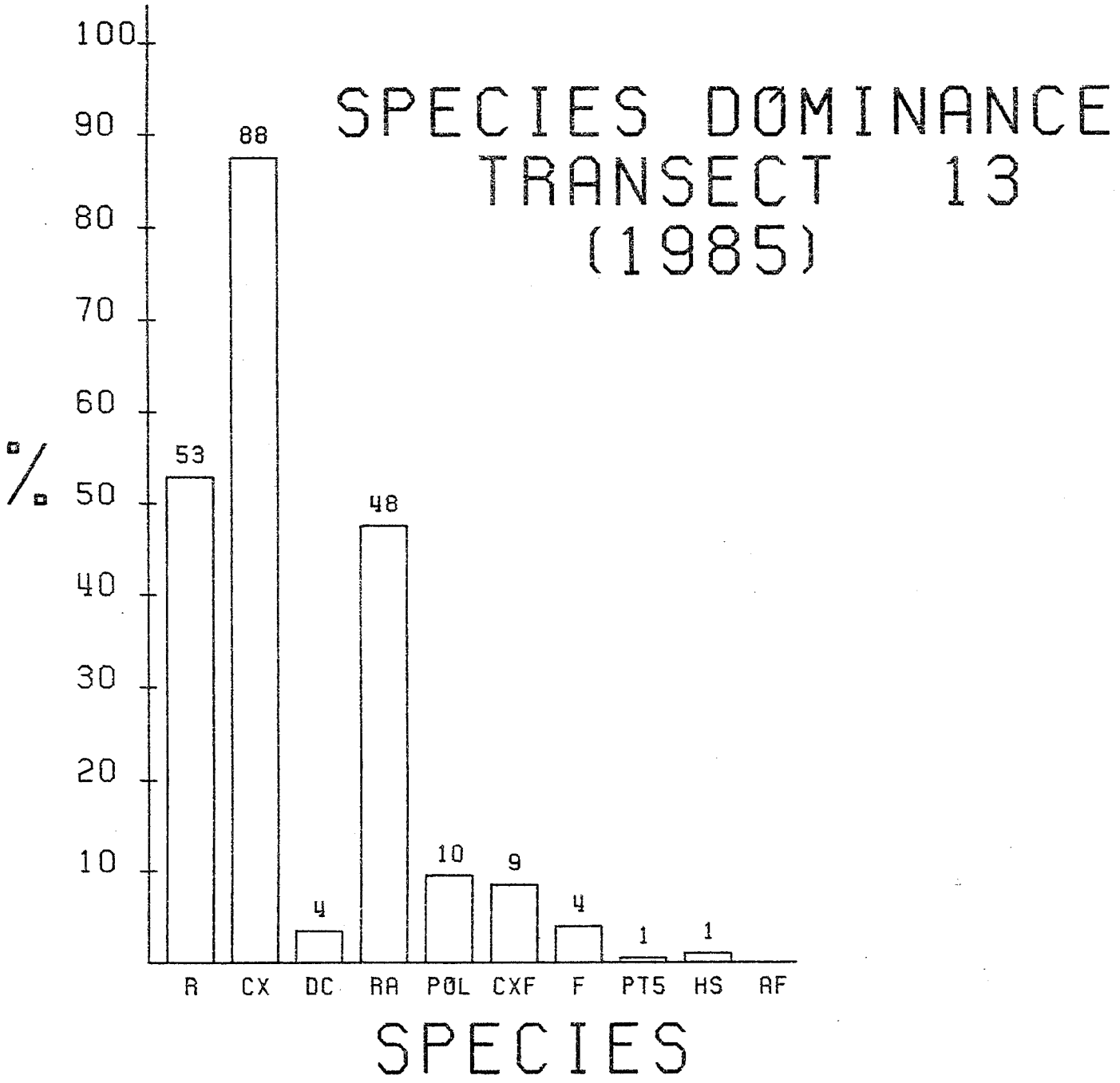
HS
AF
SPECIES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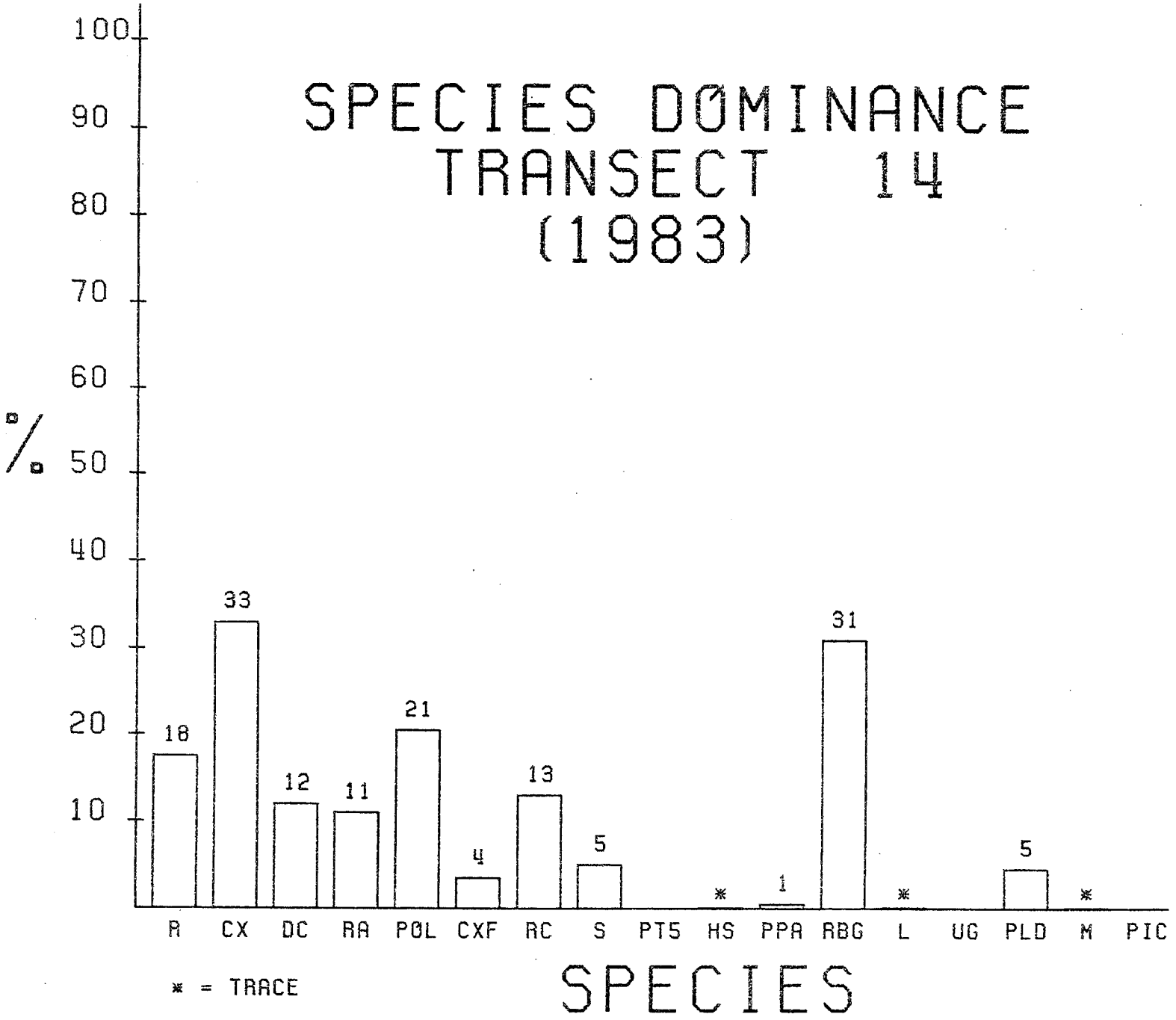
SPECIES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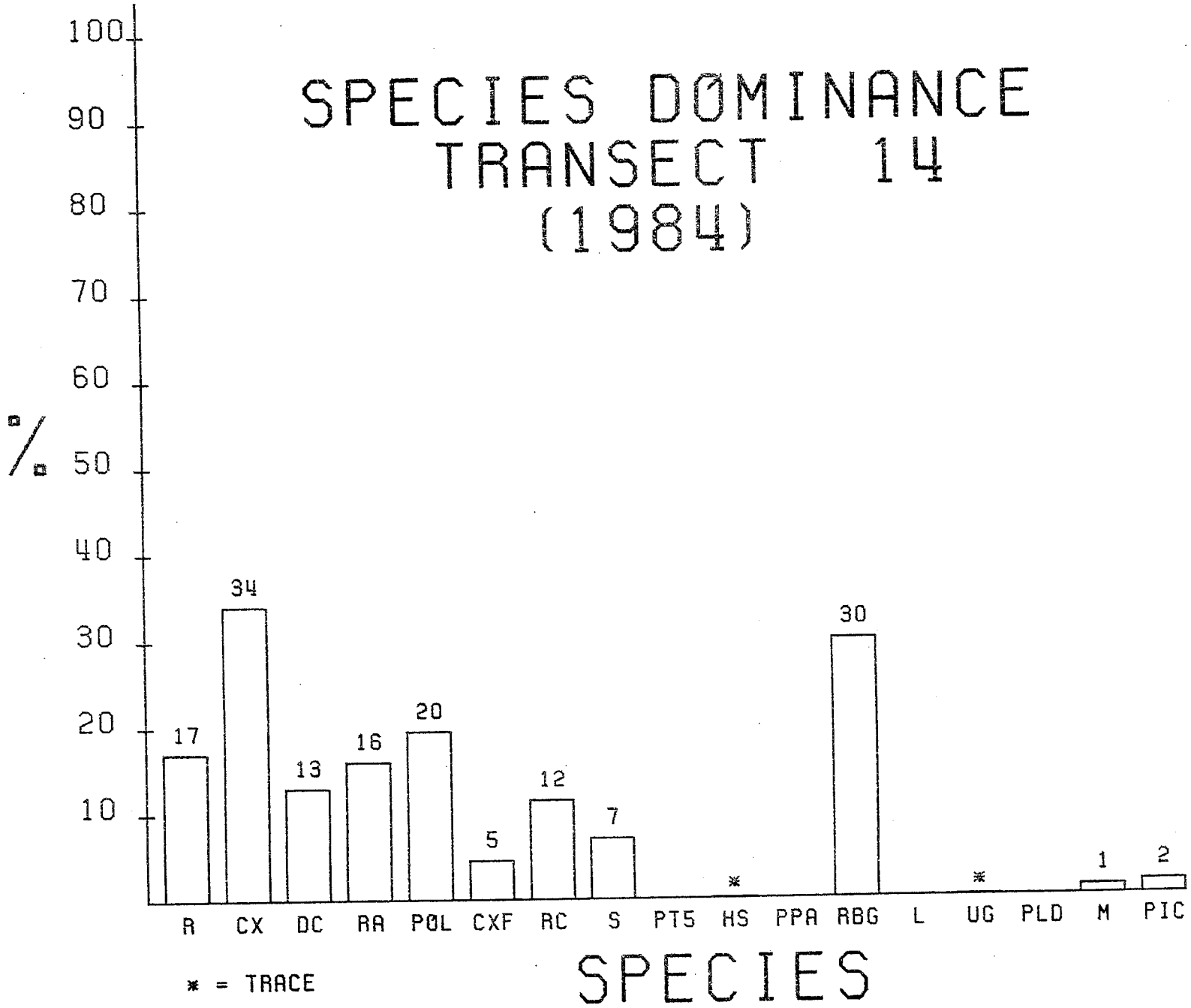
* = TRACE
SPECIES


SPECIES DOMINANCE
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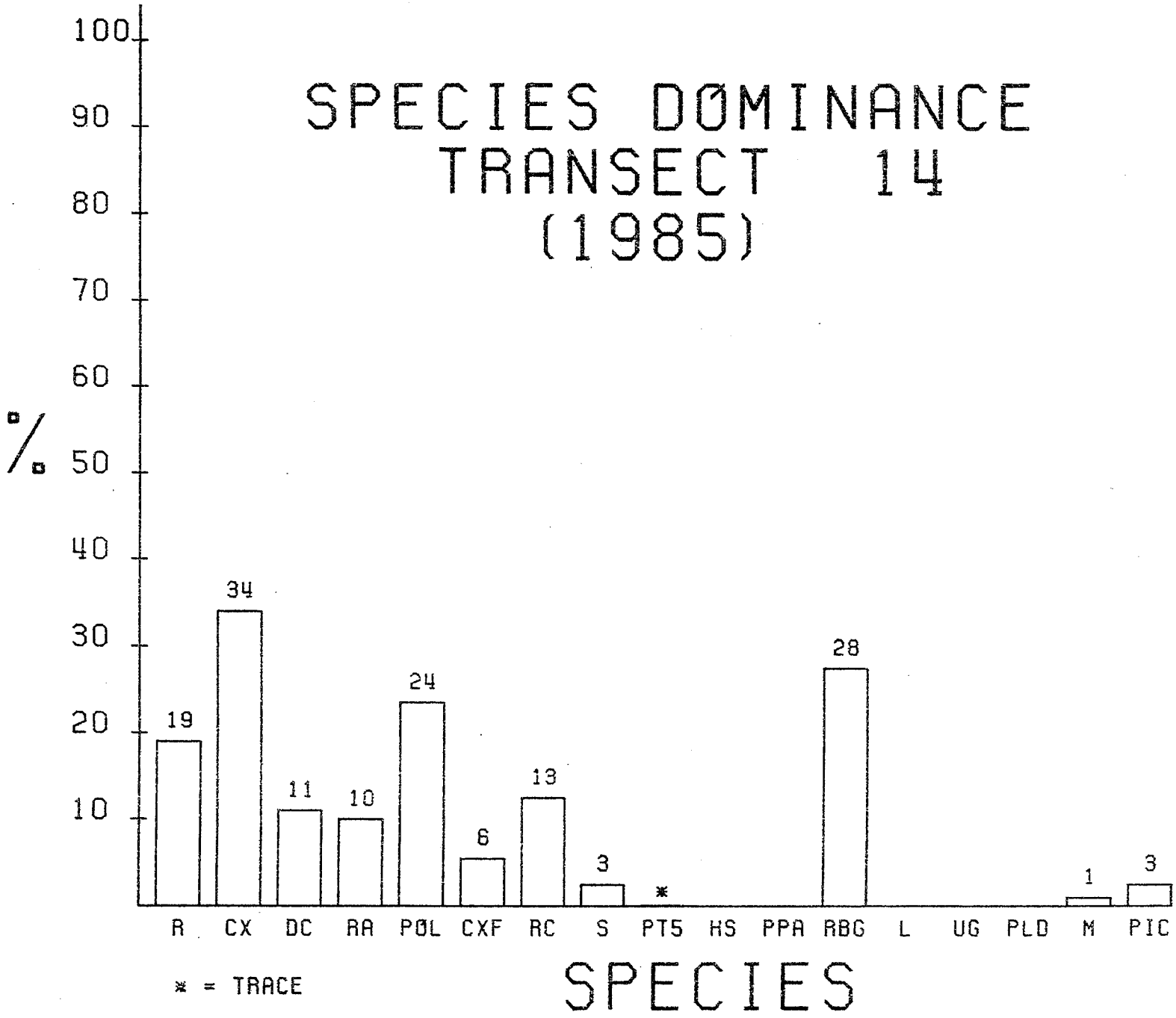
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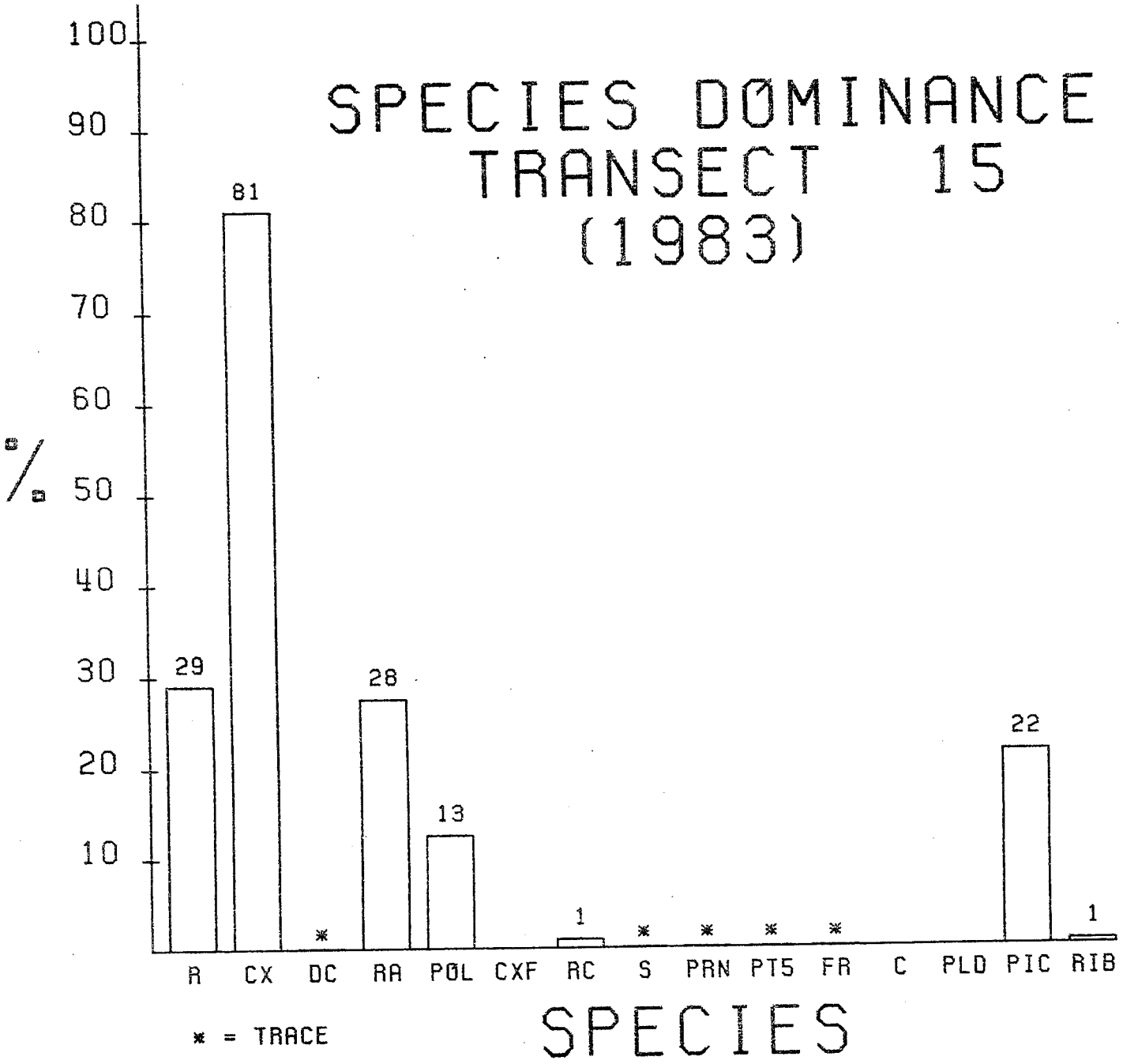
SPECIES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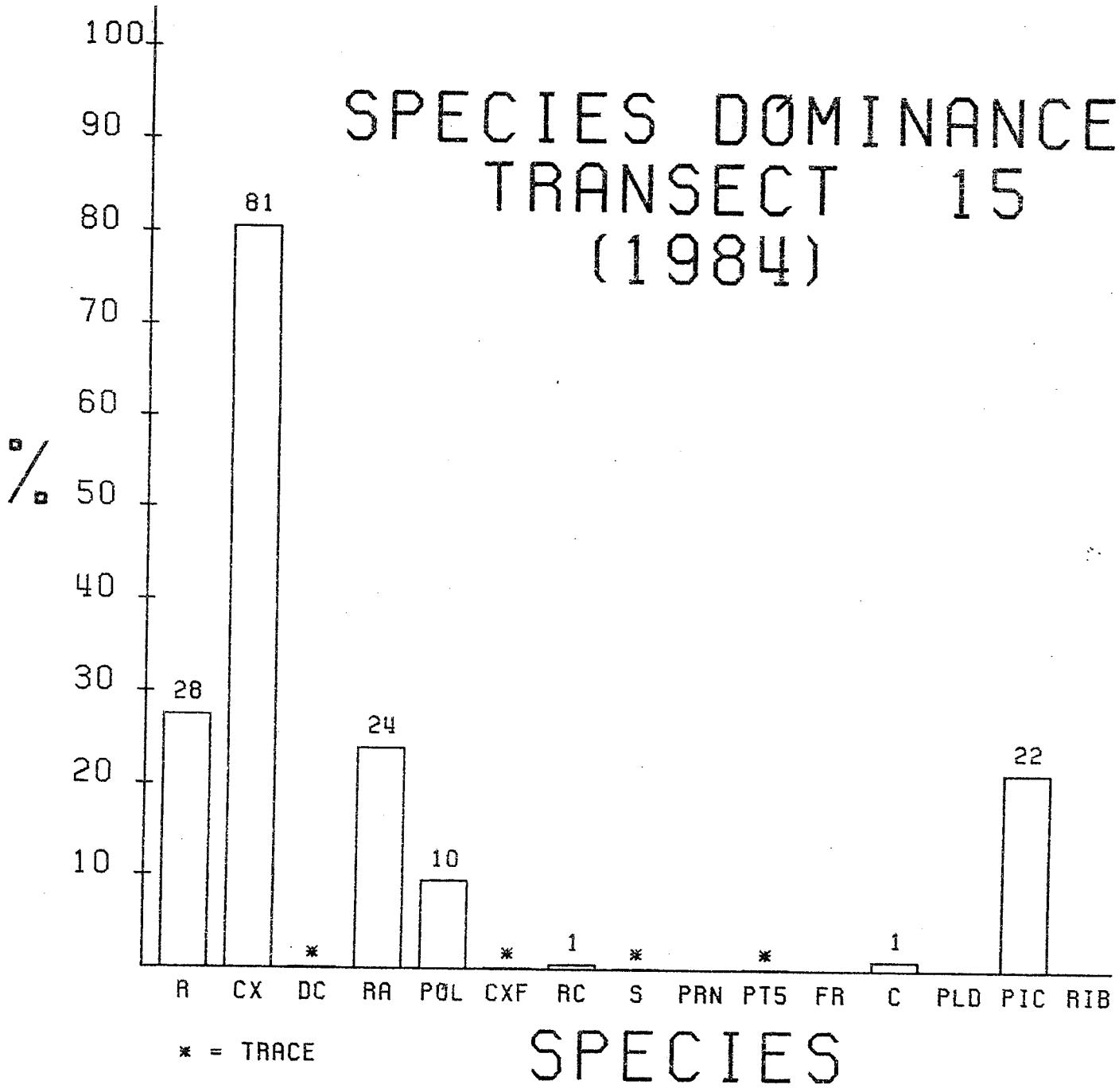
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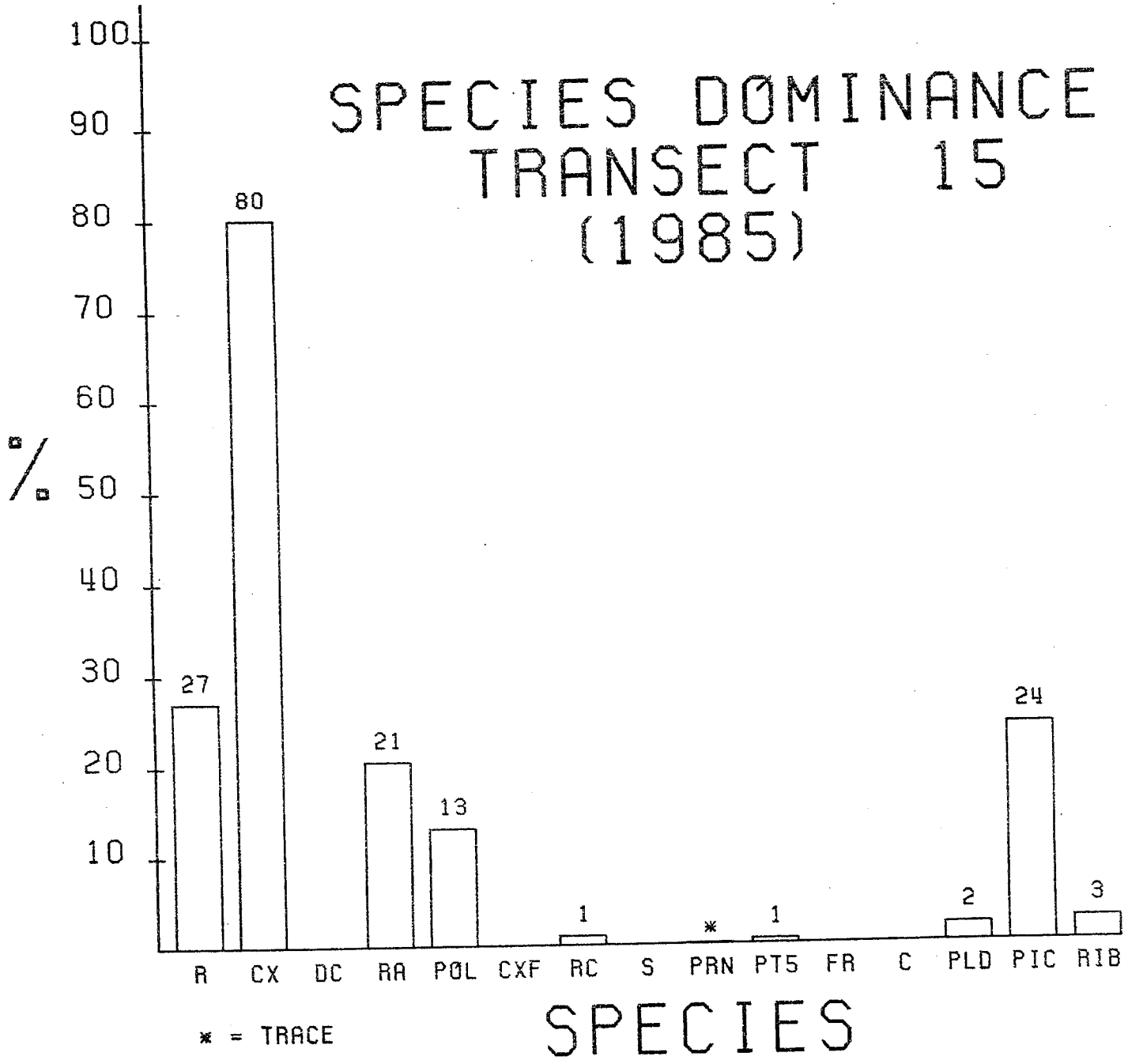
SPECIES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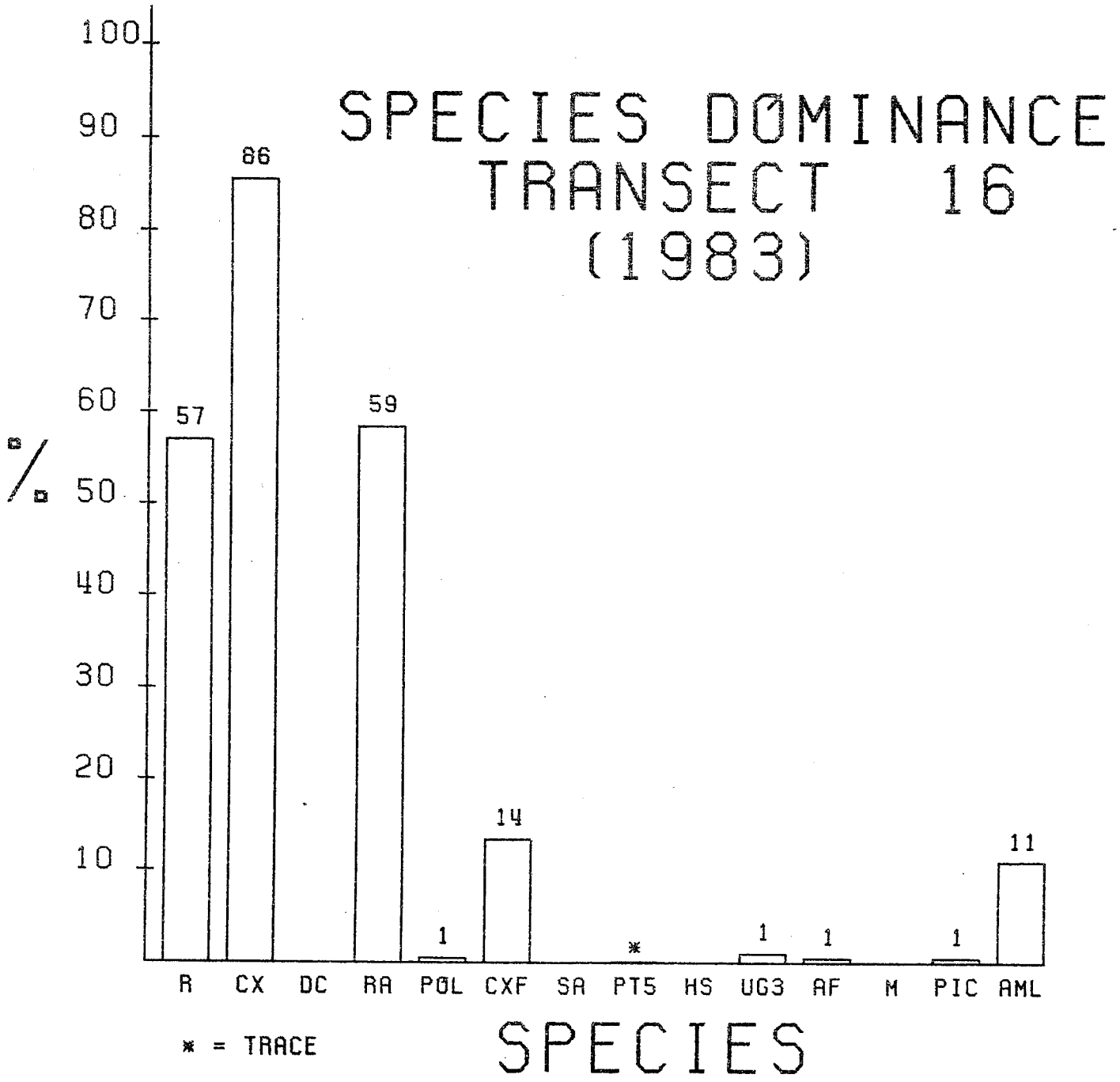
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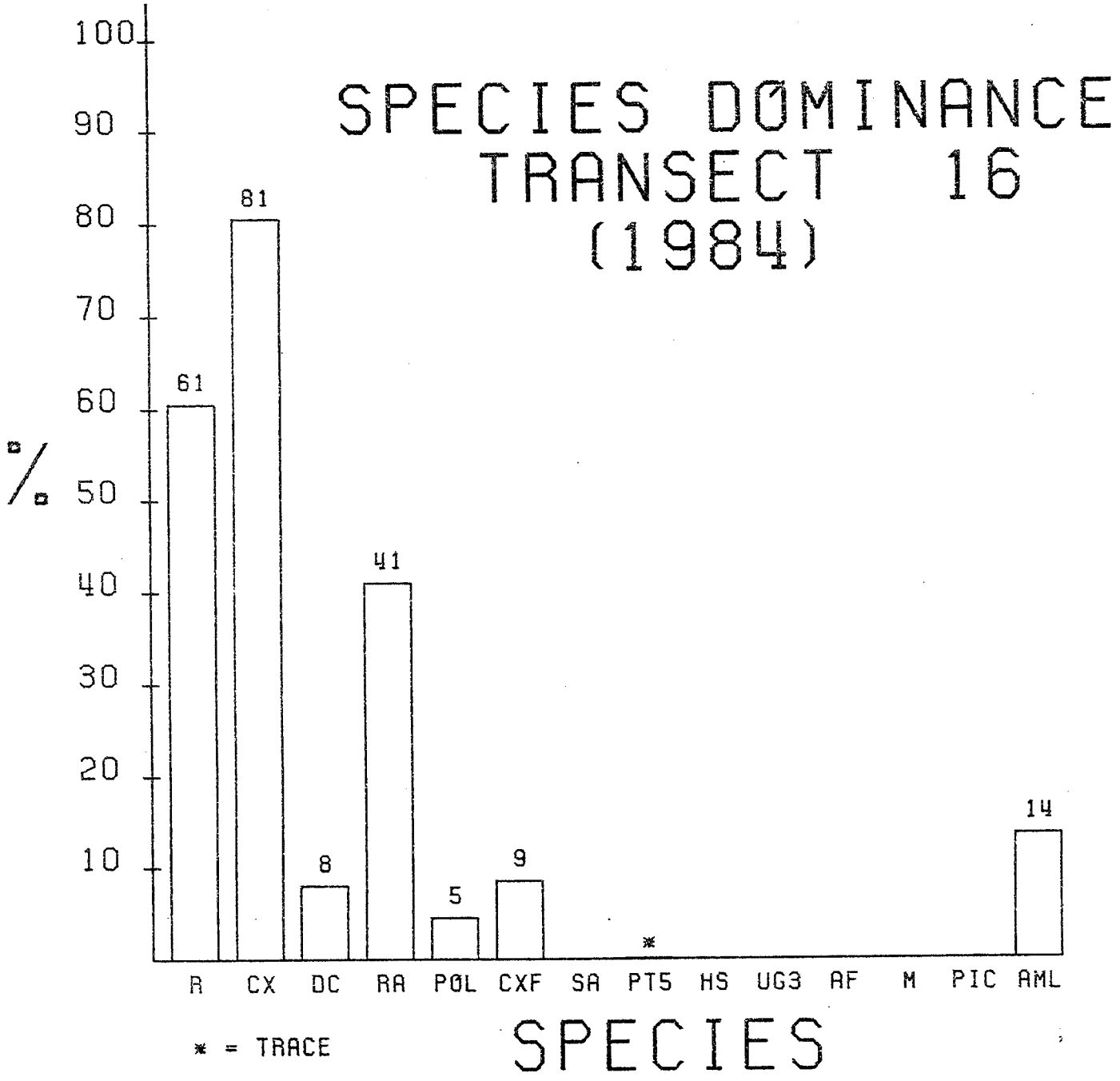
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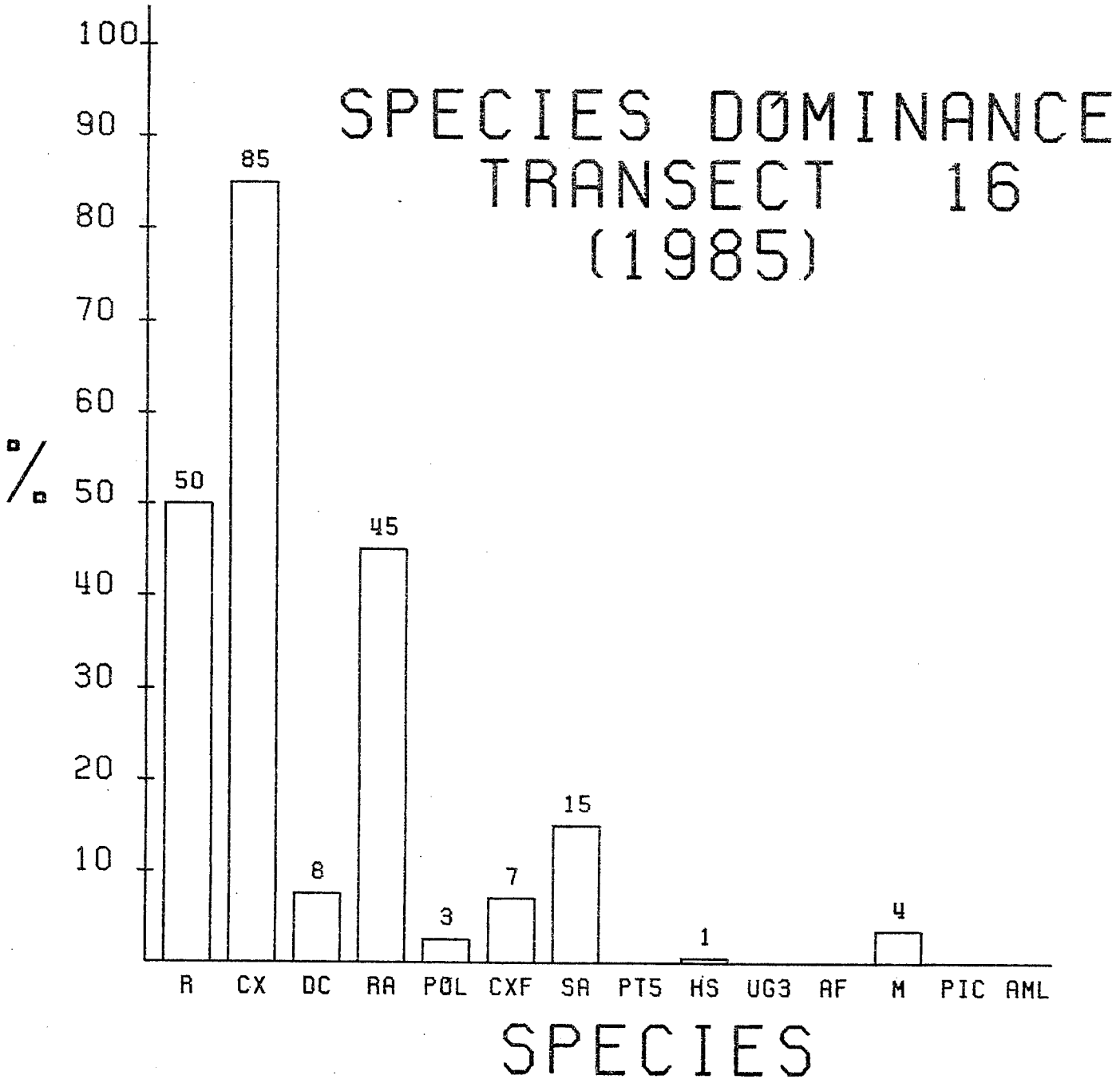
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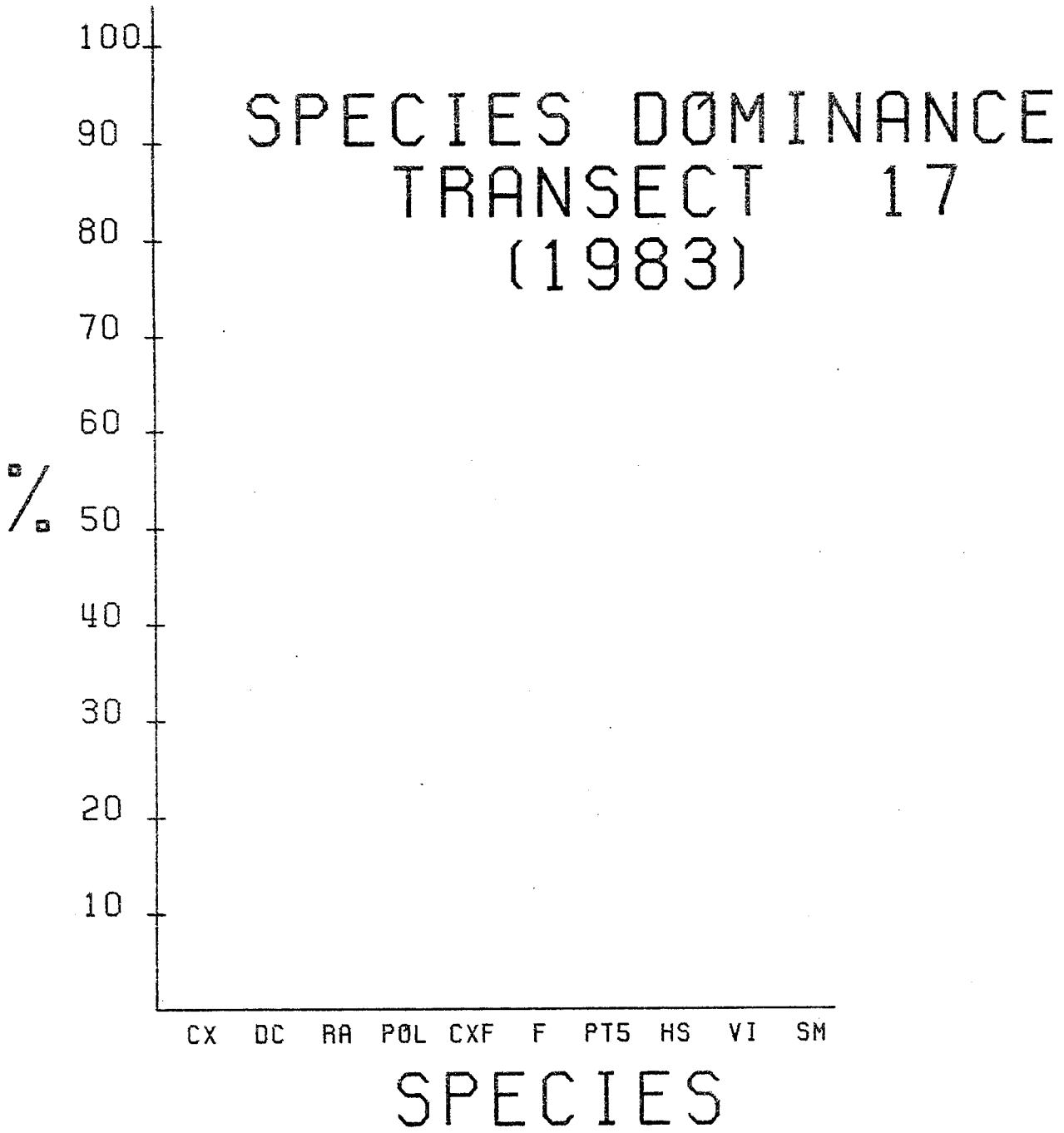
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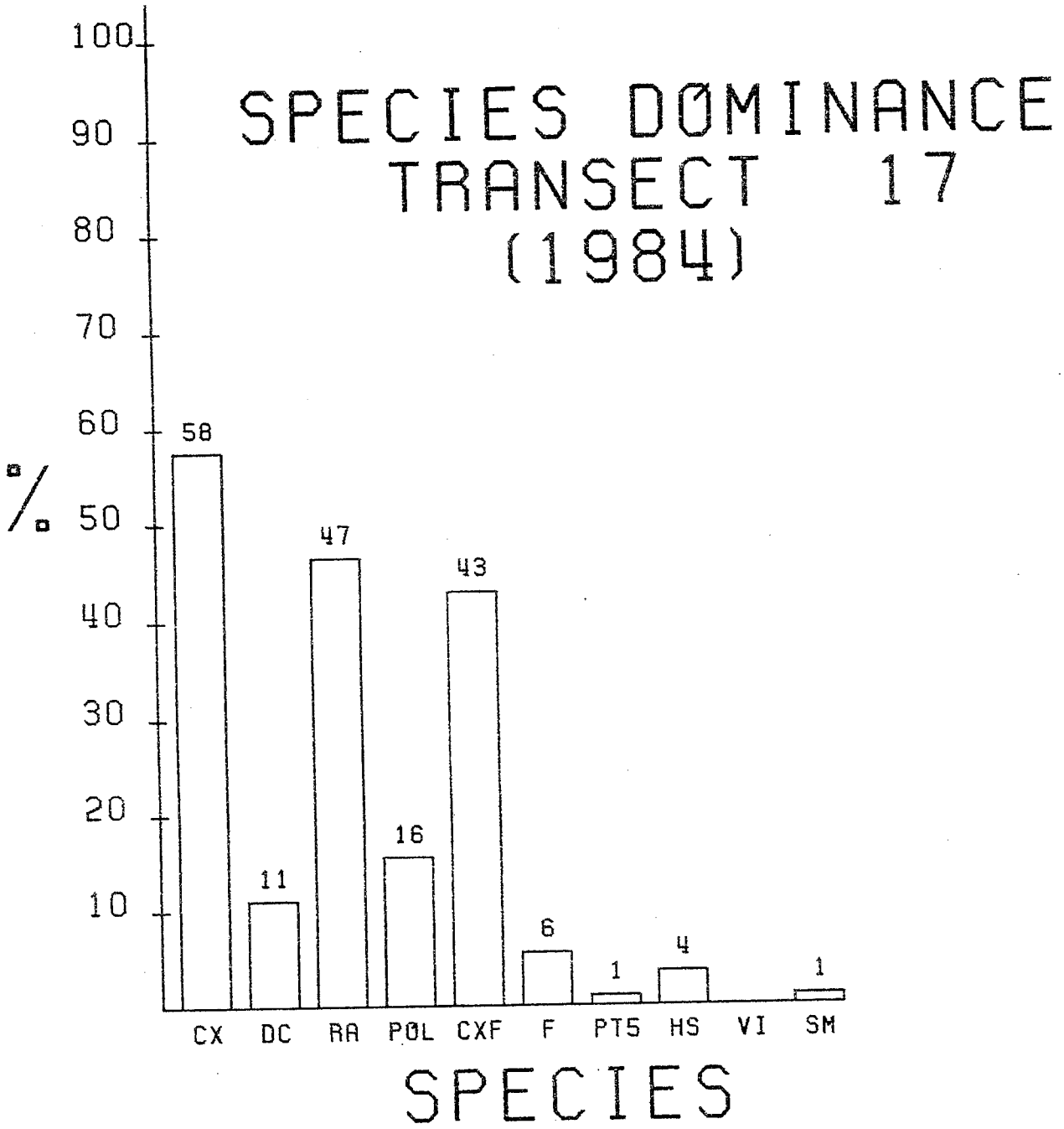
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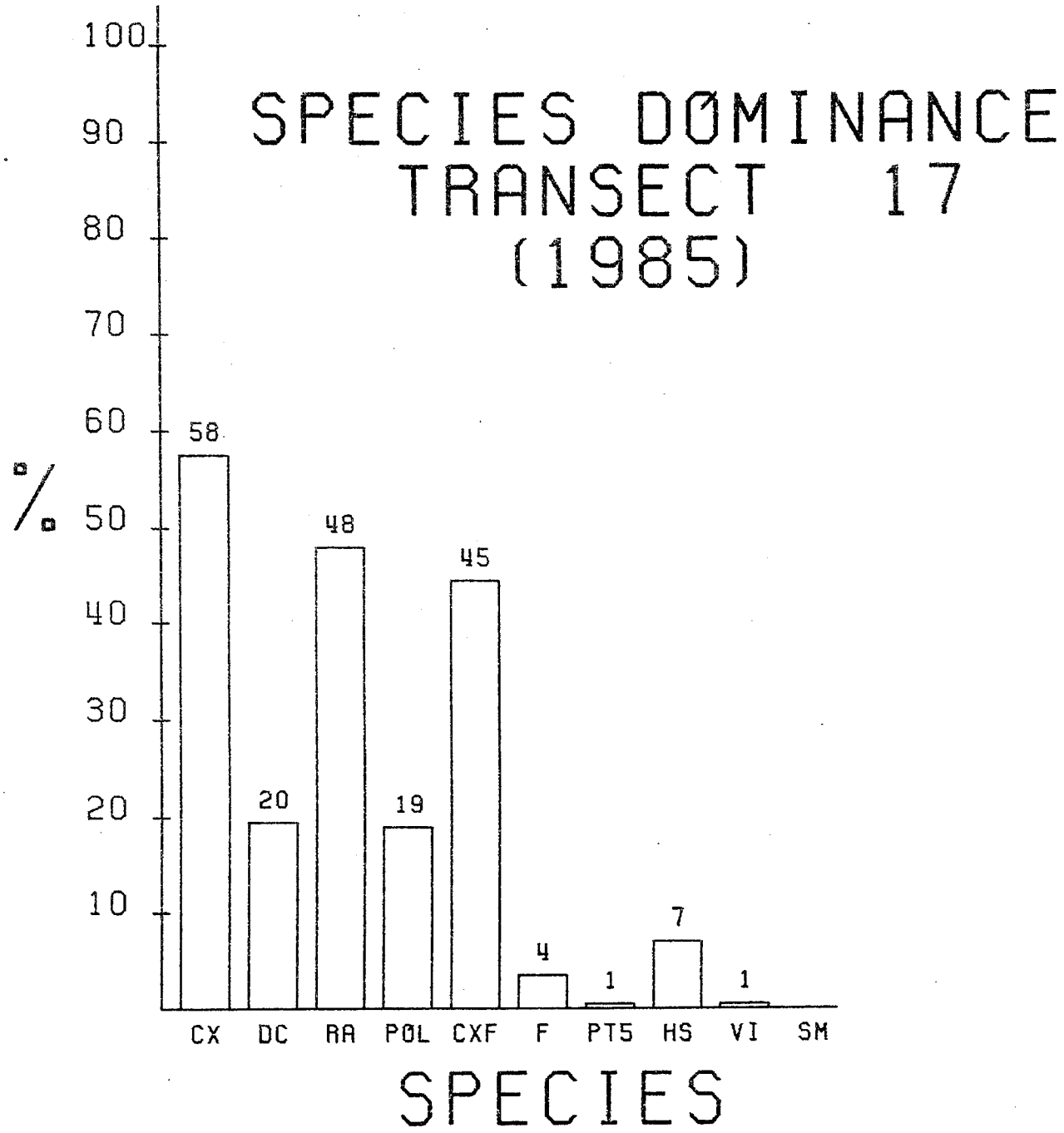
SPECIES DOMINANCE
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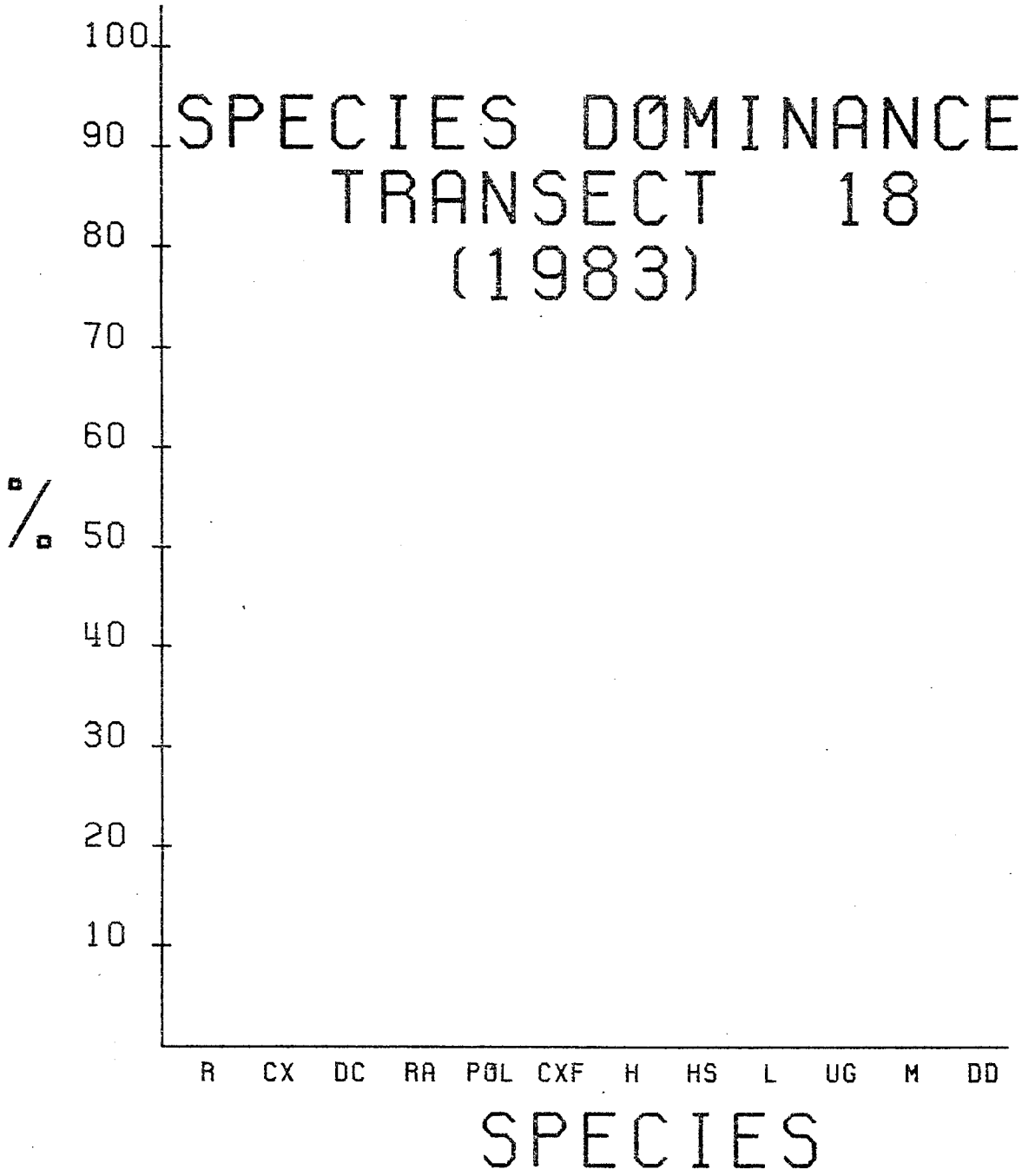
SPECIES


SPECIES DOMINANCE
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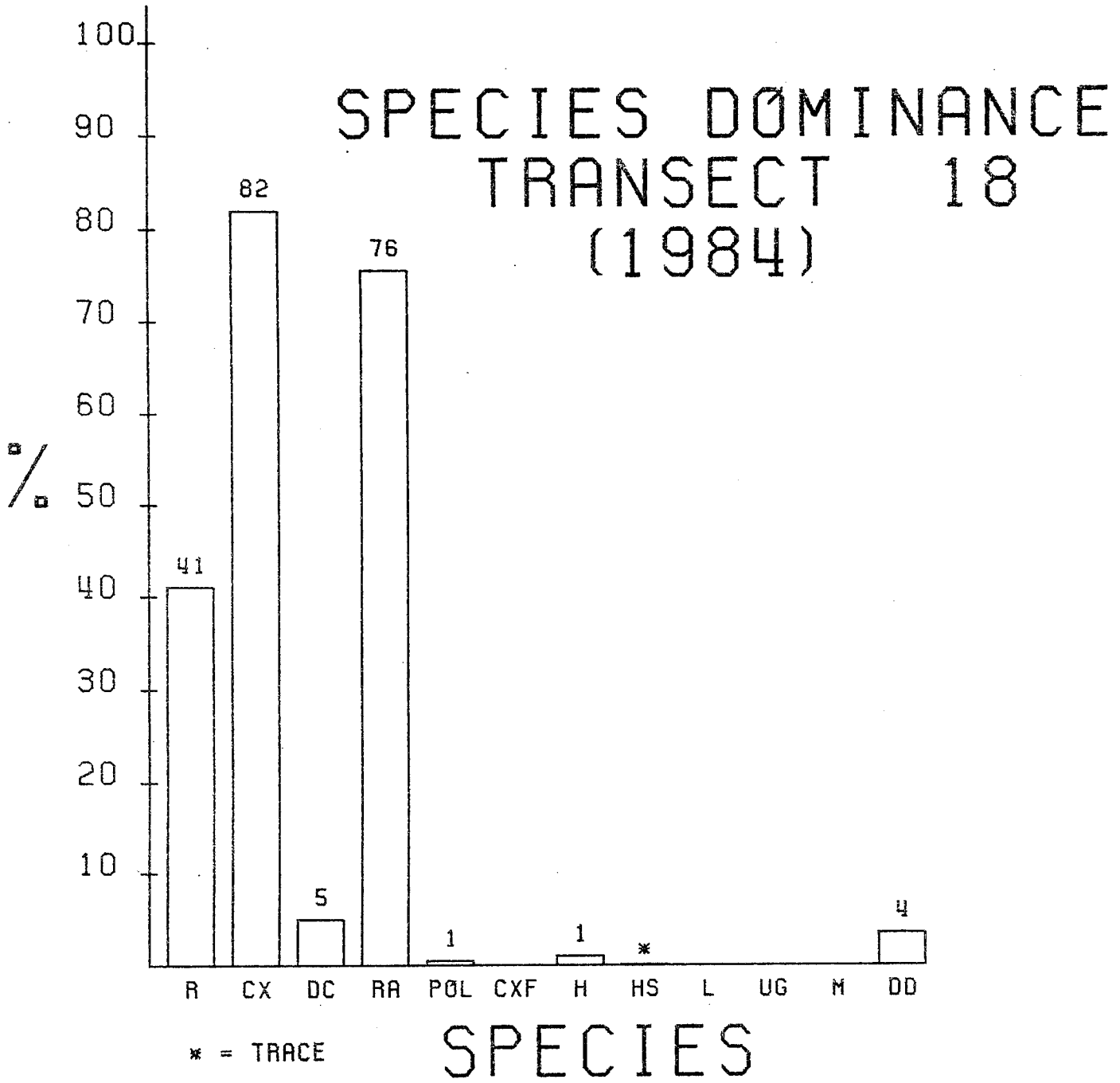
SPECIES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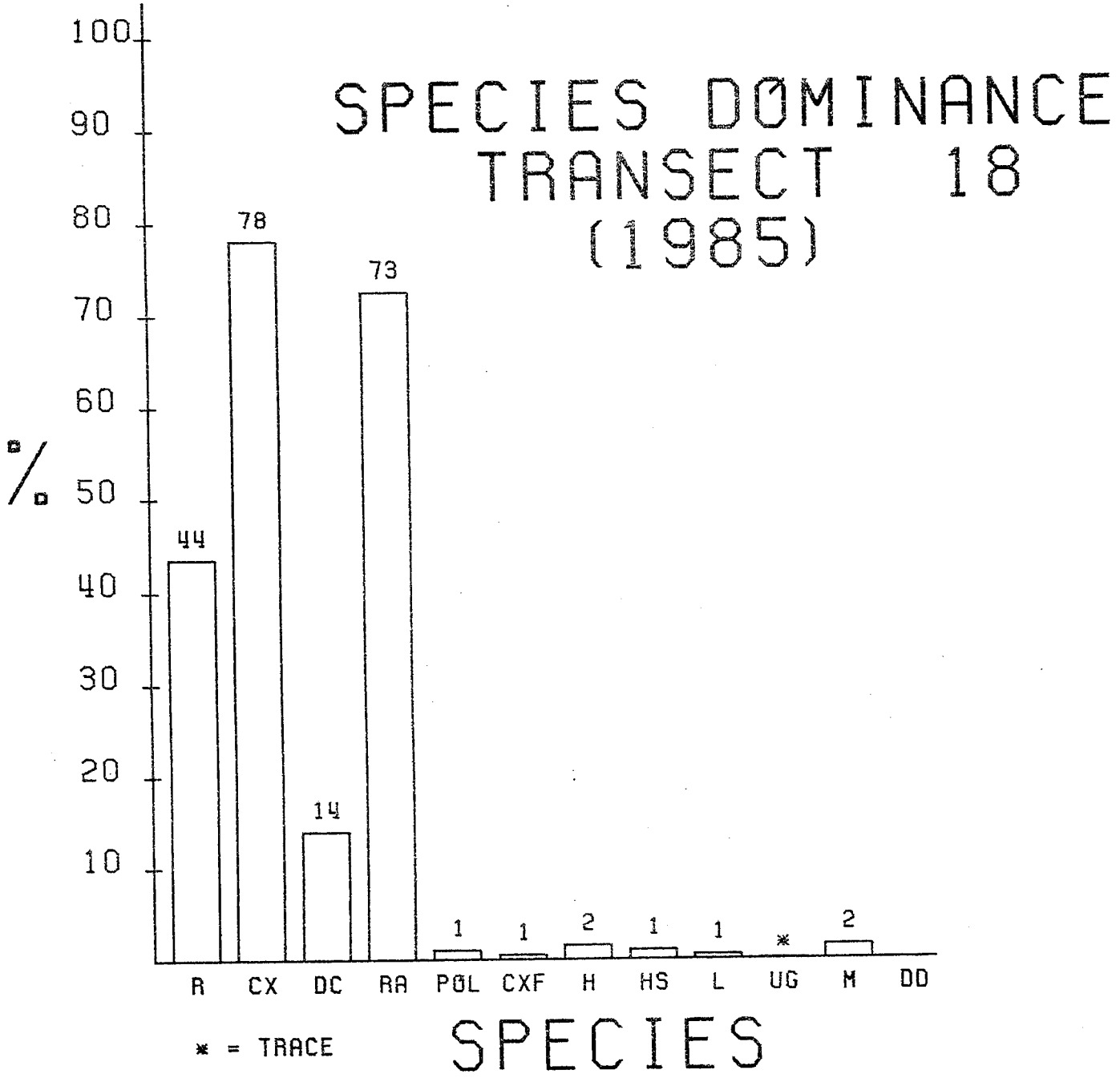
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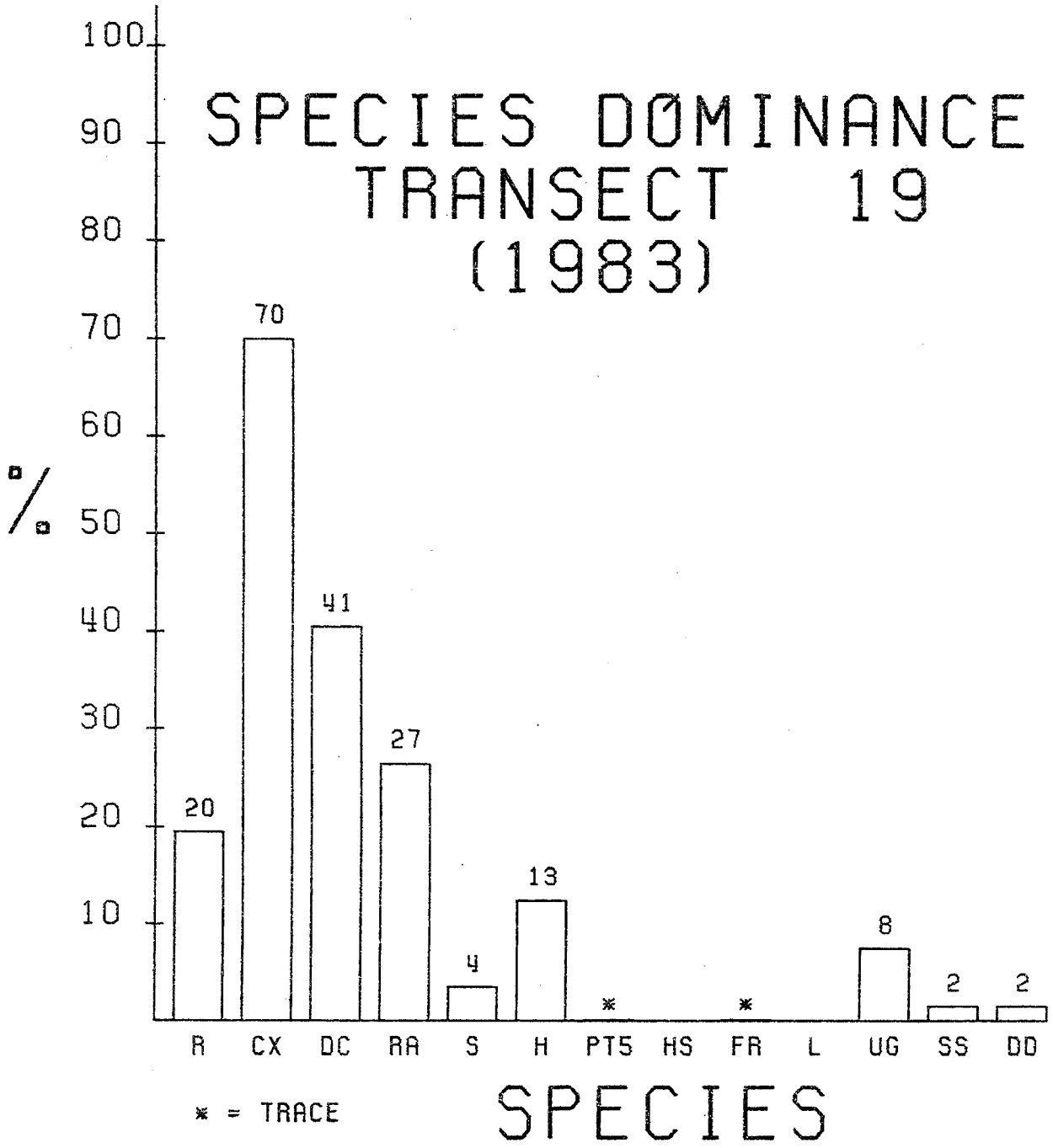
SPECIES


SPECIES DOMINANCE
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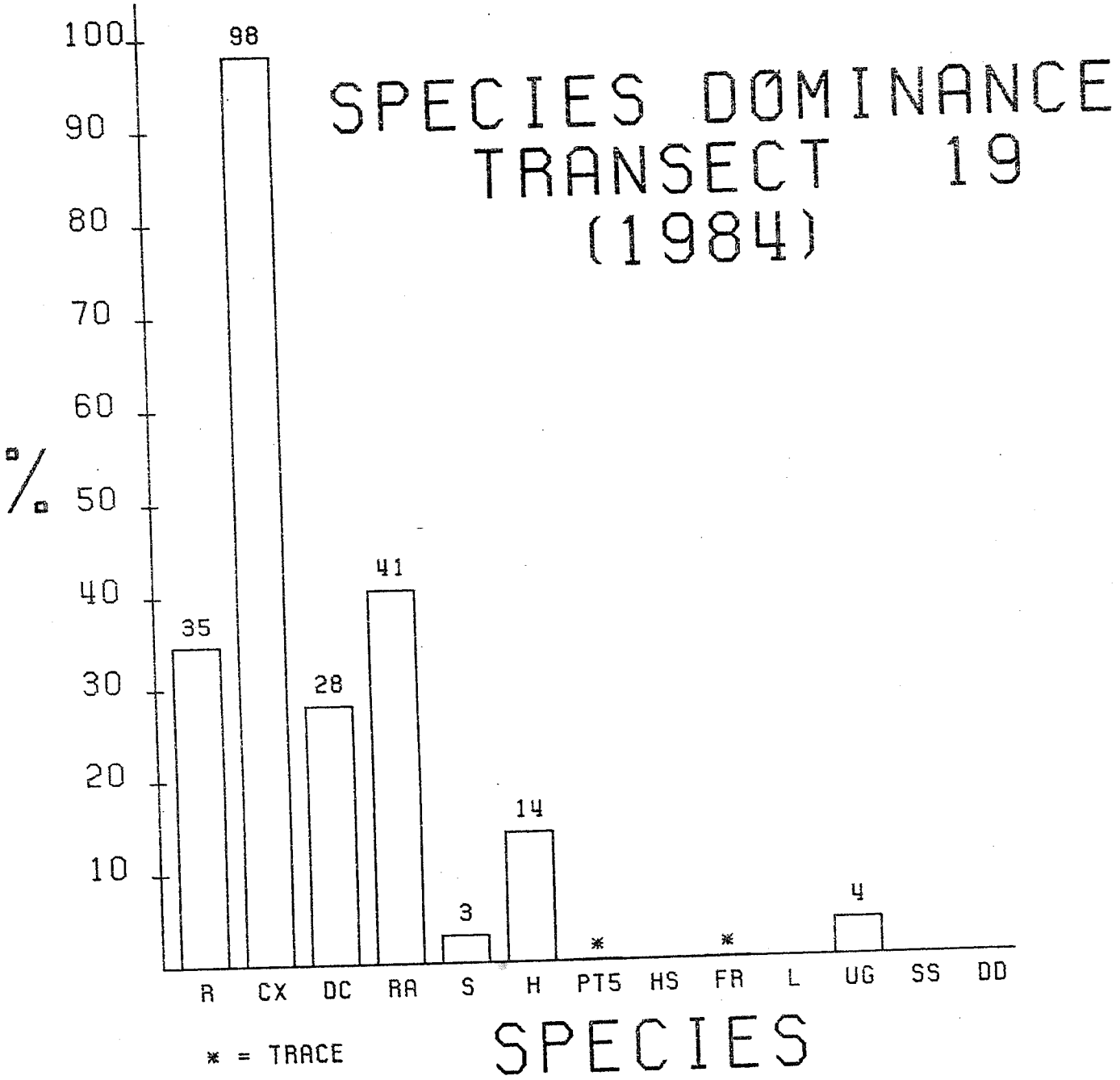
SPECIES


SPECIES DOMINANCE
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SPECIES
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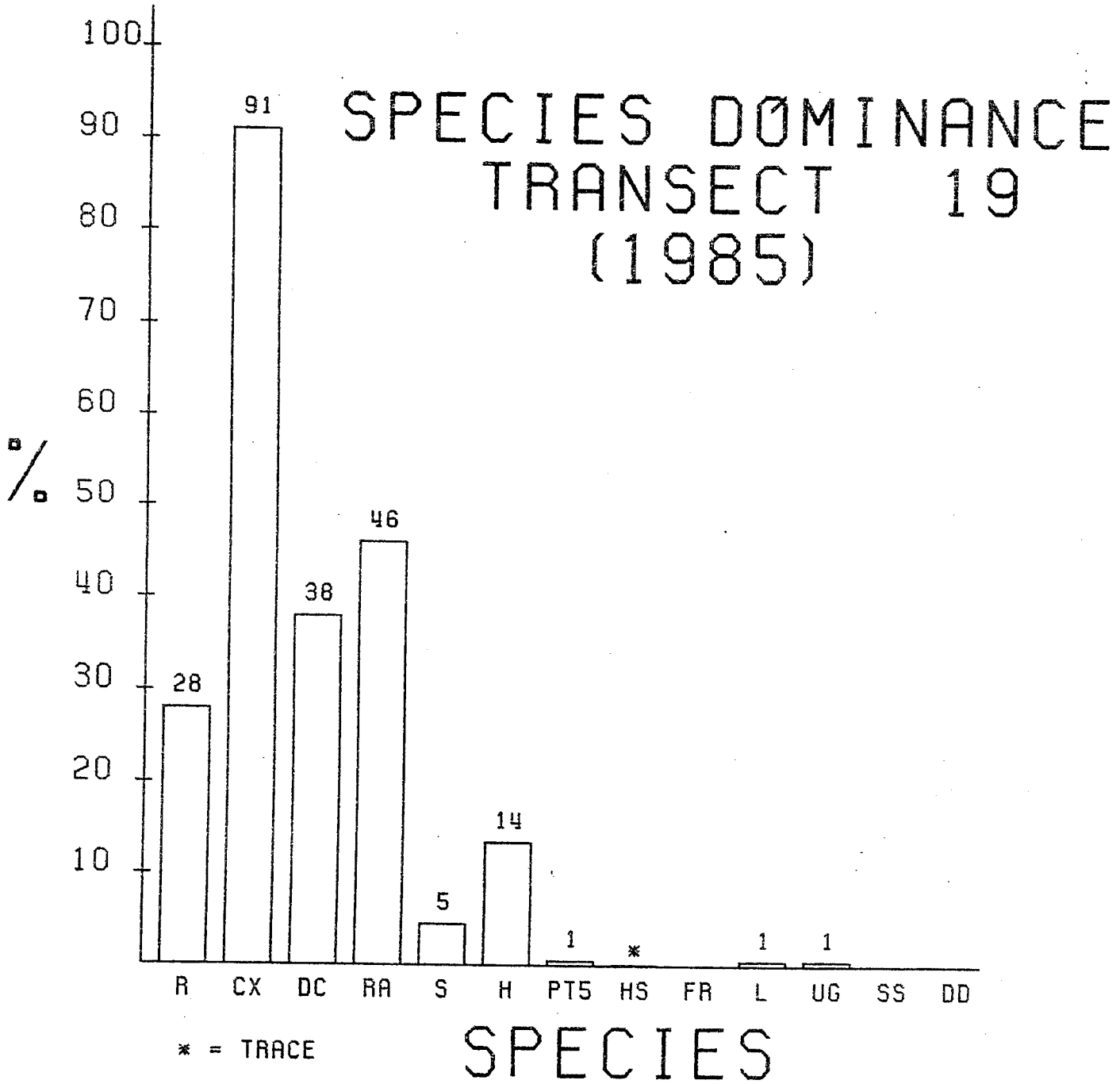
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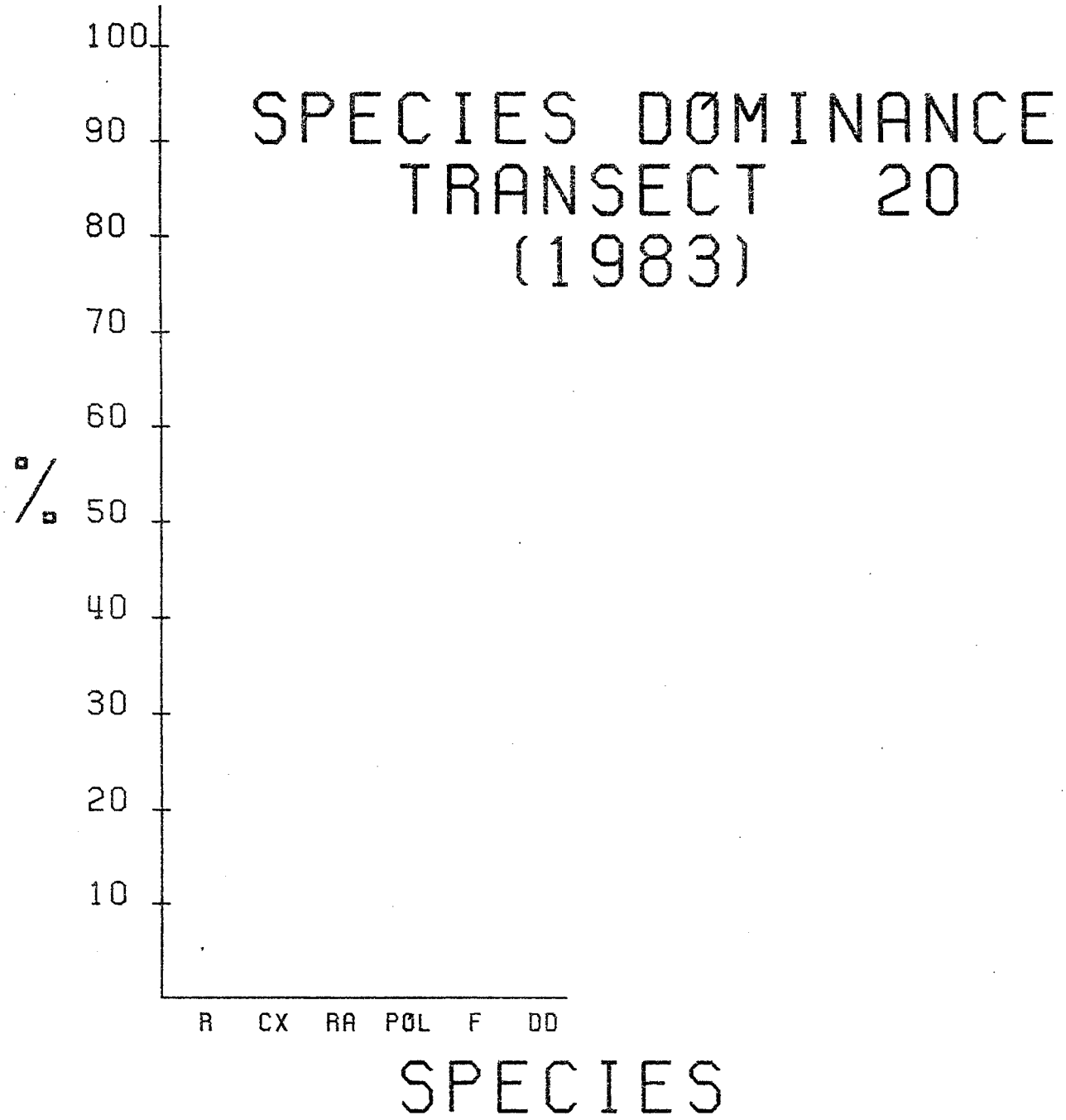
* = TRACE
SPECIES


SPECIES DOMINANCE
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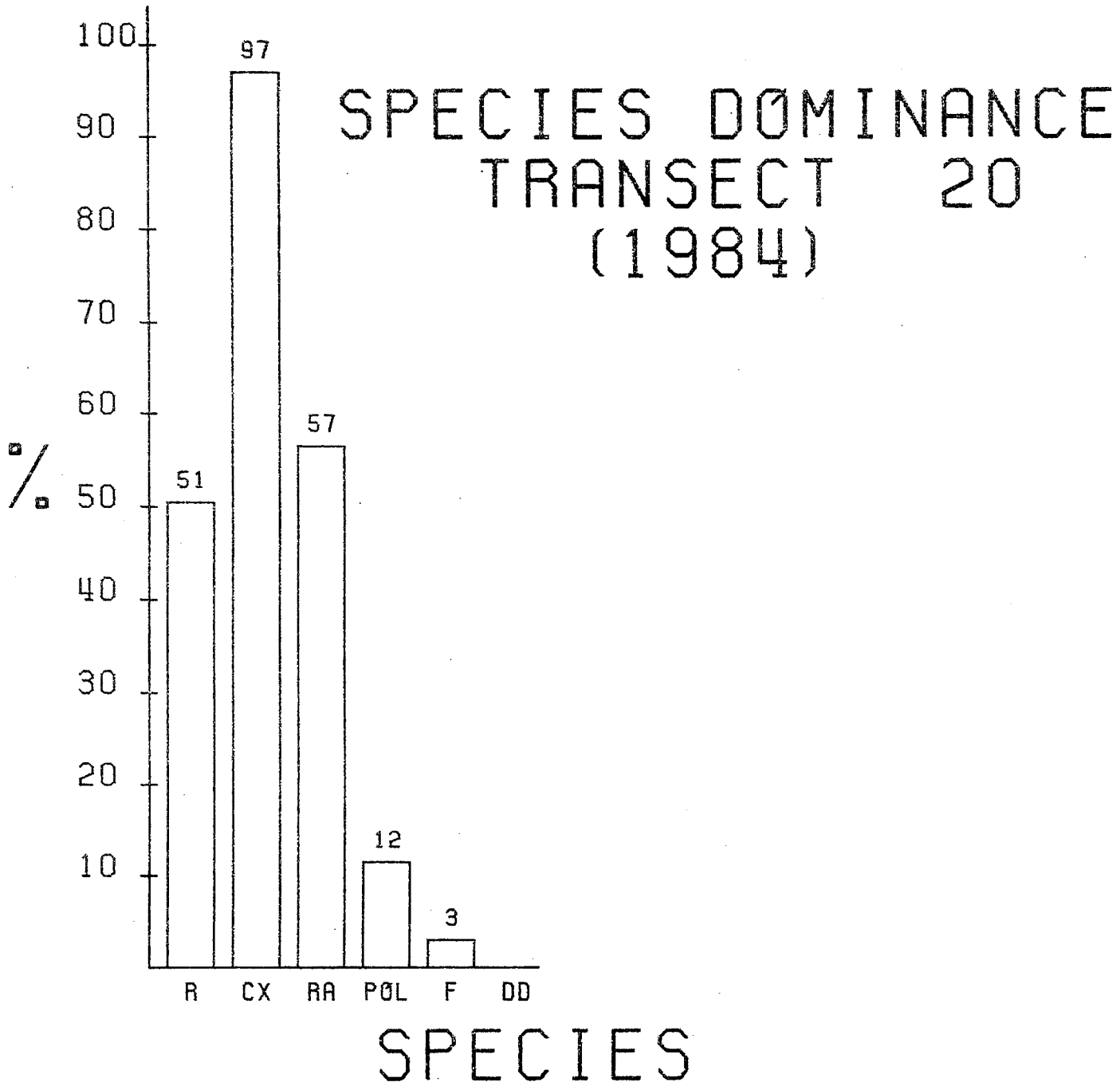
SPECIES


SPECIES DOMINANCE
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POL
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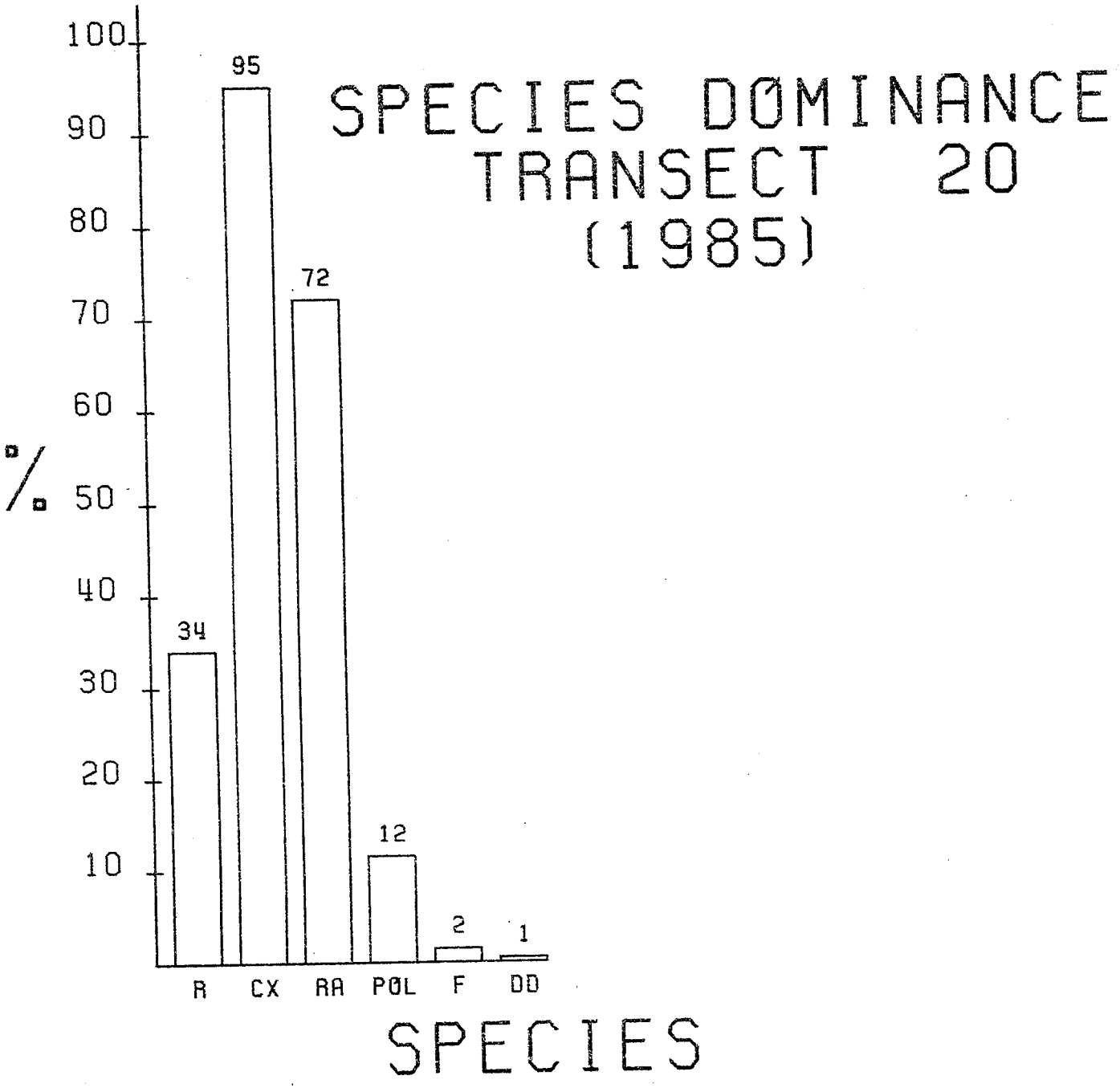
DD
SPECIES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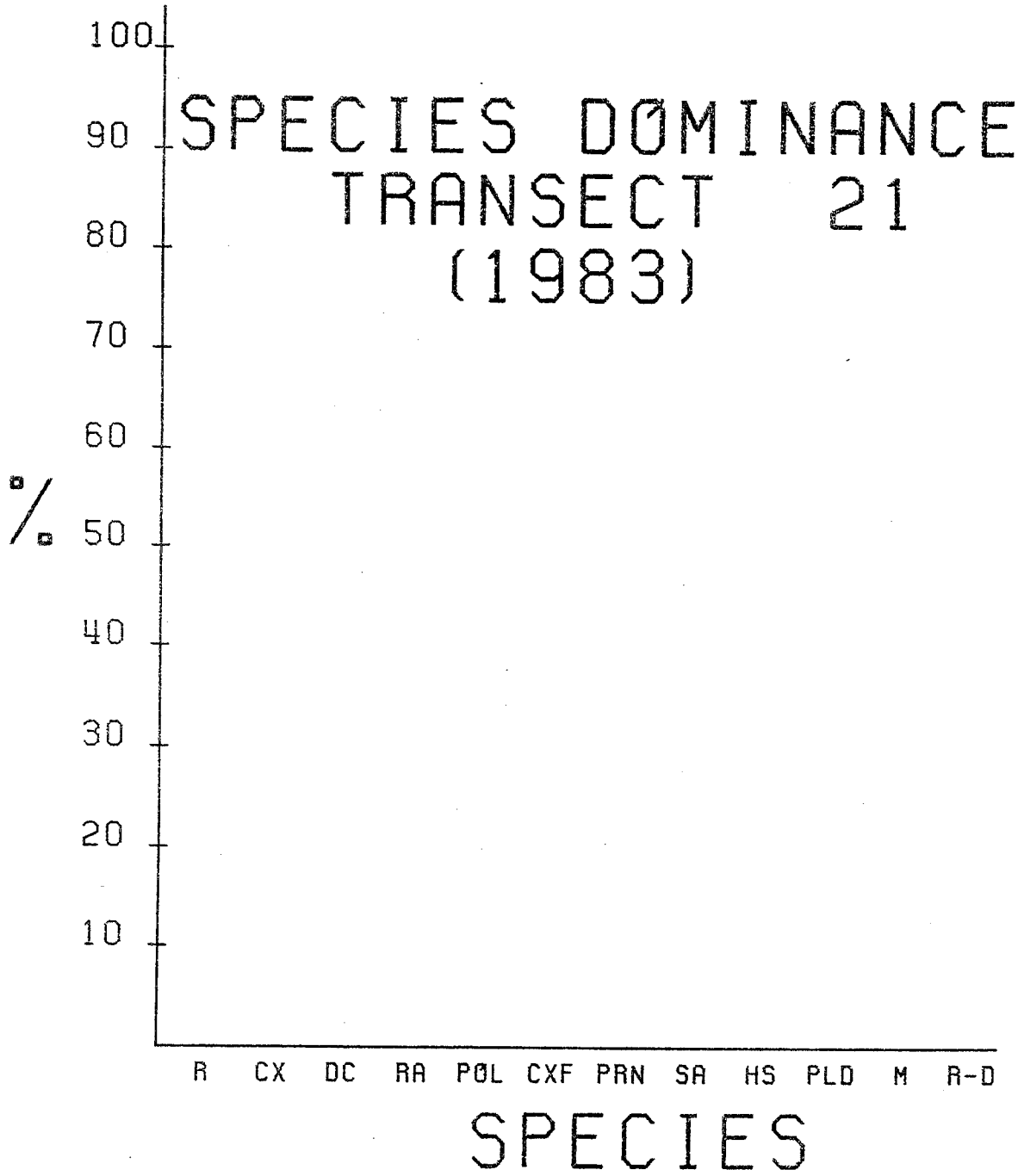
SPECIES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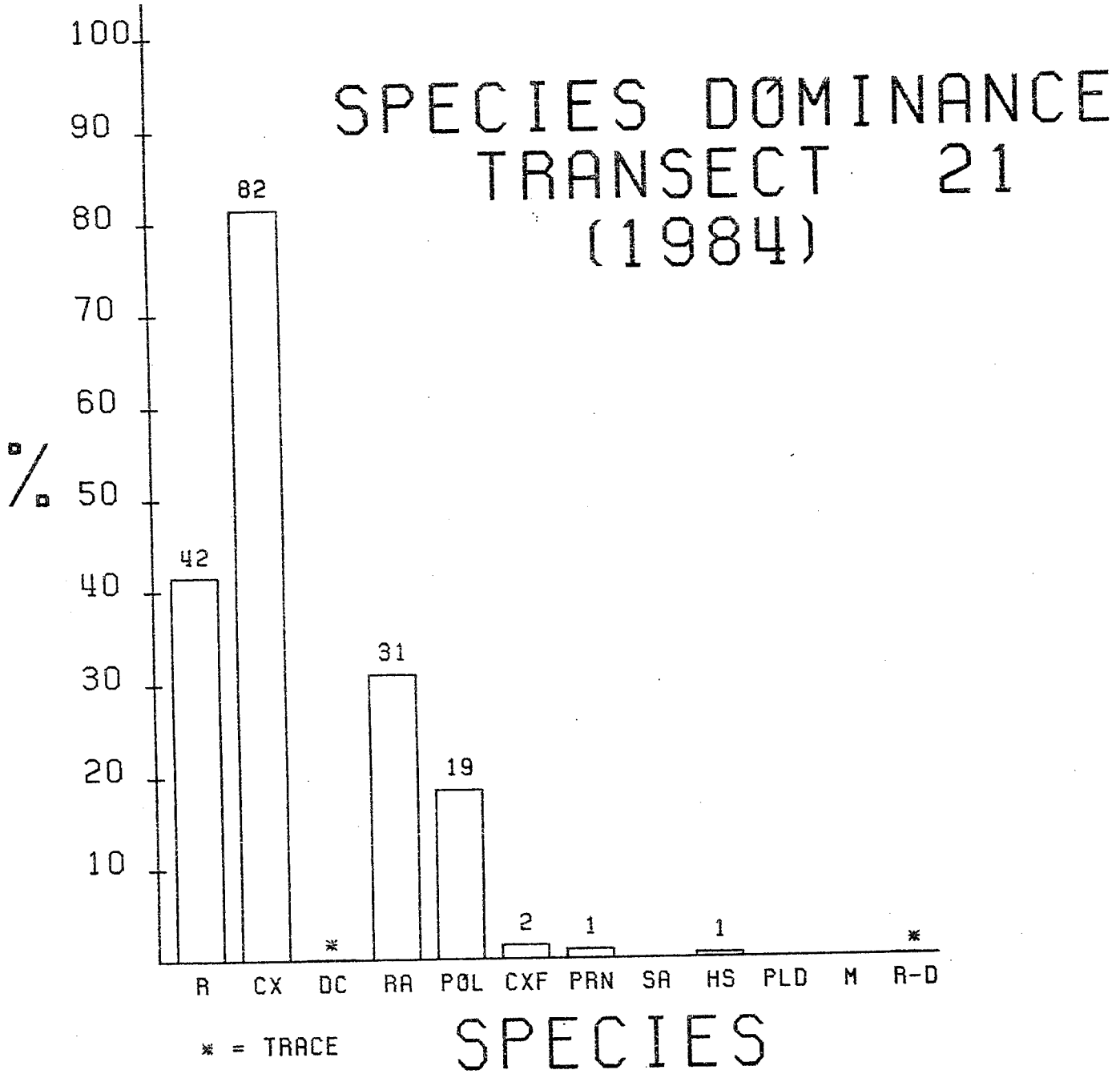
R-D
SPECIES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2
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PRN
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HS
PLD
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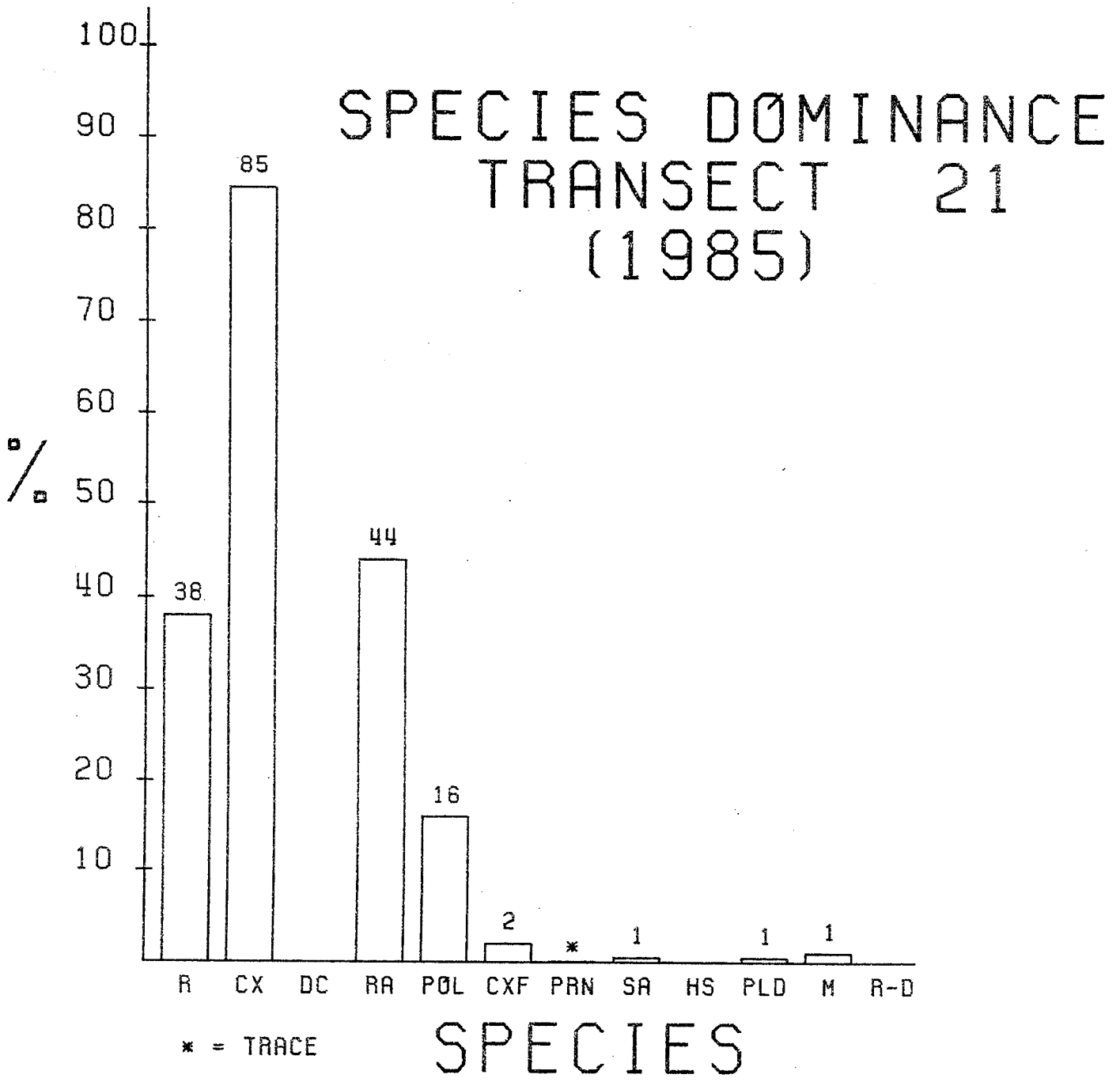
R-D
* = TRACE
SPECIES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16
2
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HS
PLD
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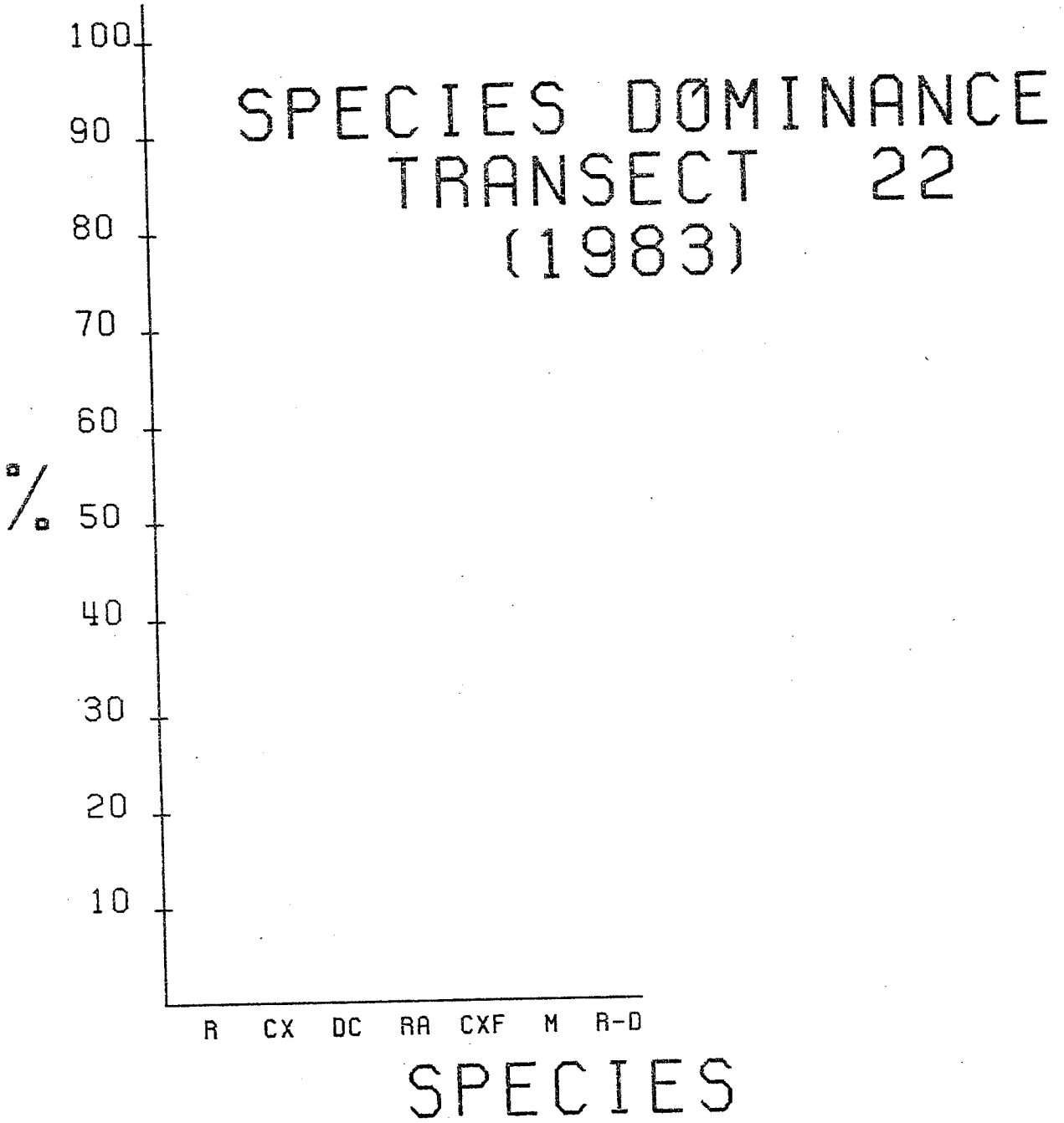
R-D
* = TRACE
SPECIES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(1983)
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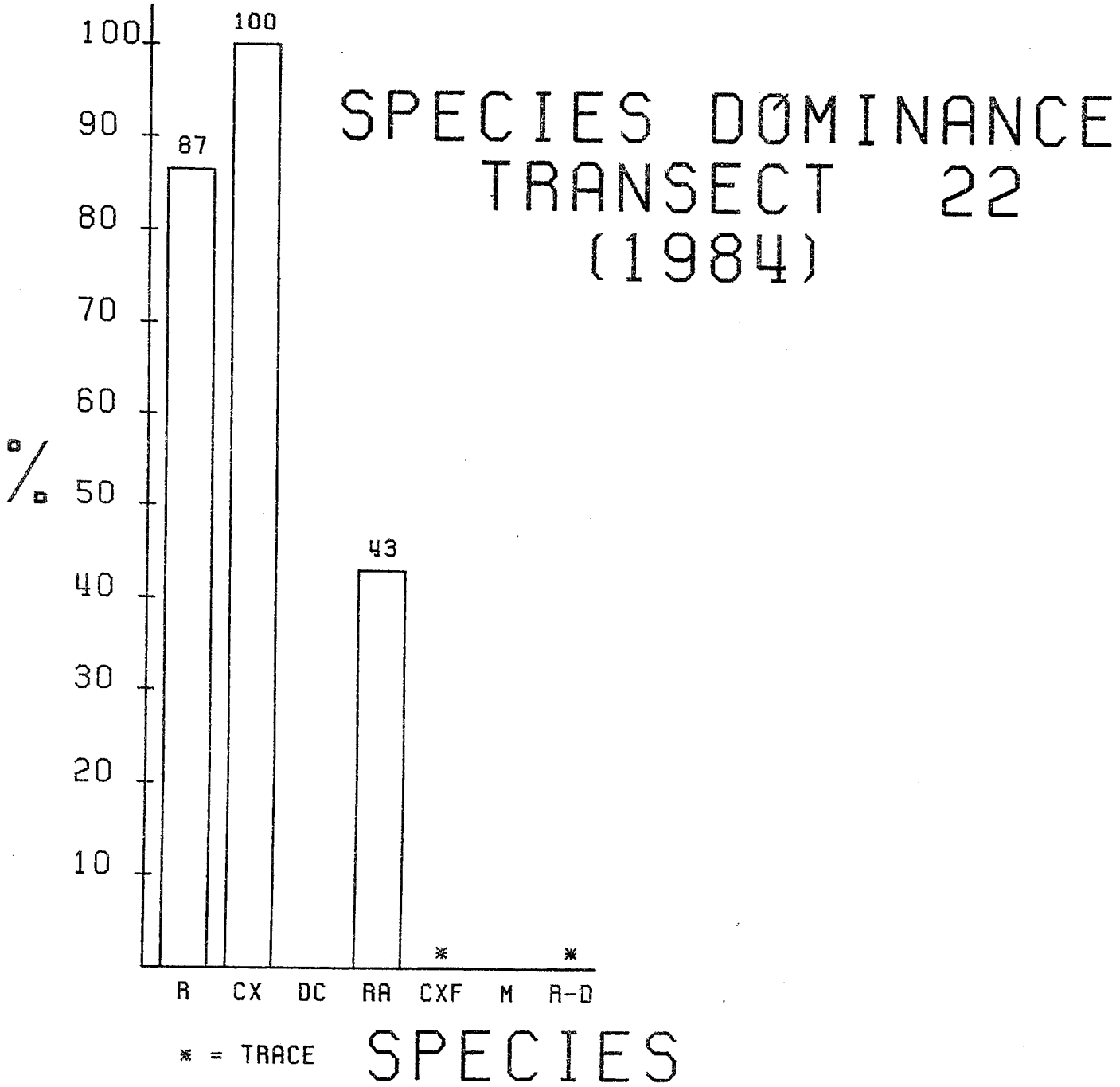
SPECIES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CXF
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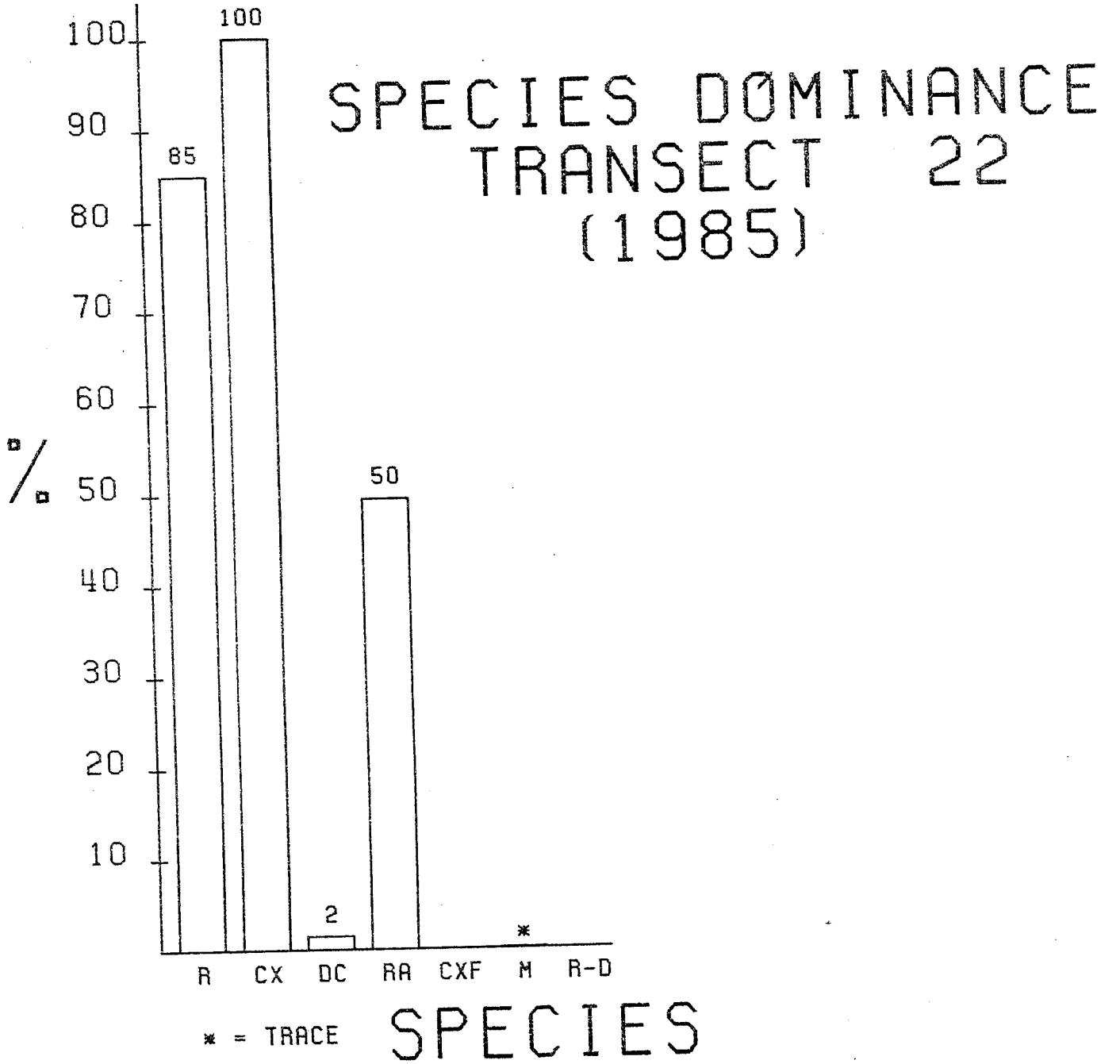
SPECIES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R-D
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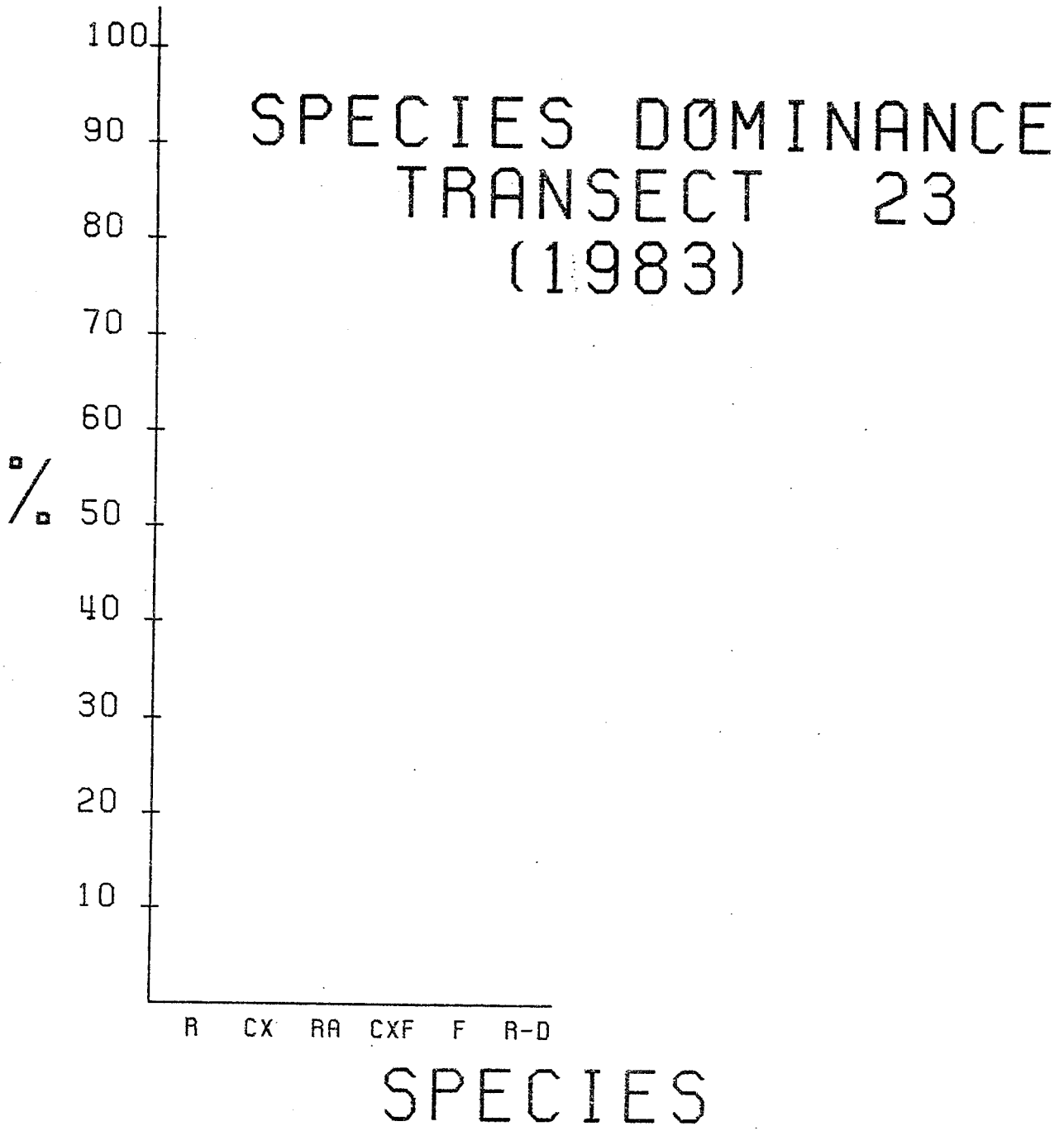
SPECIES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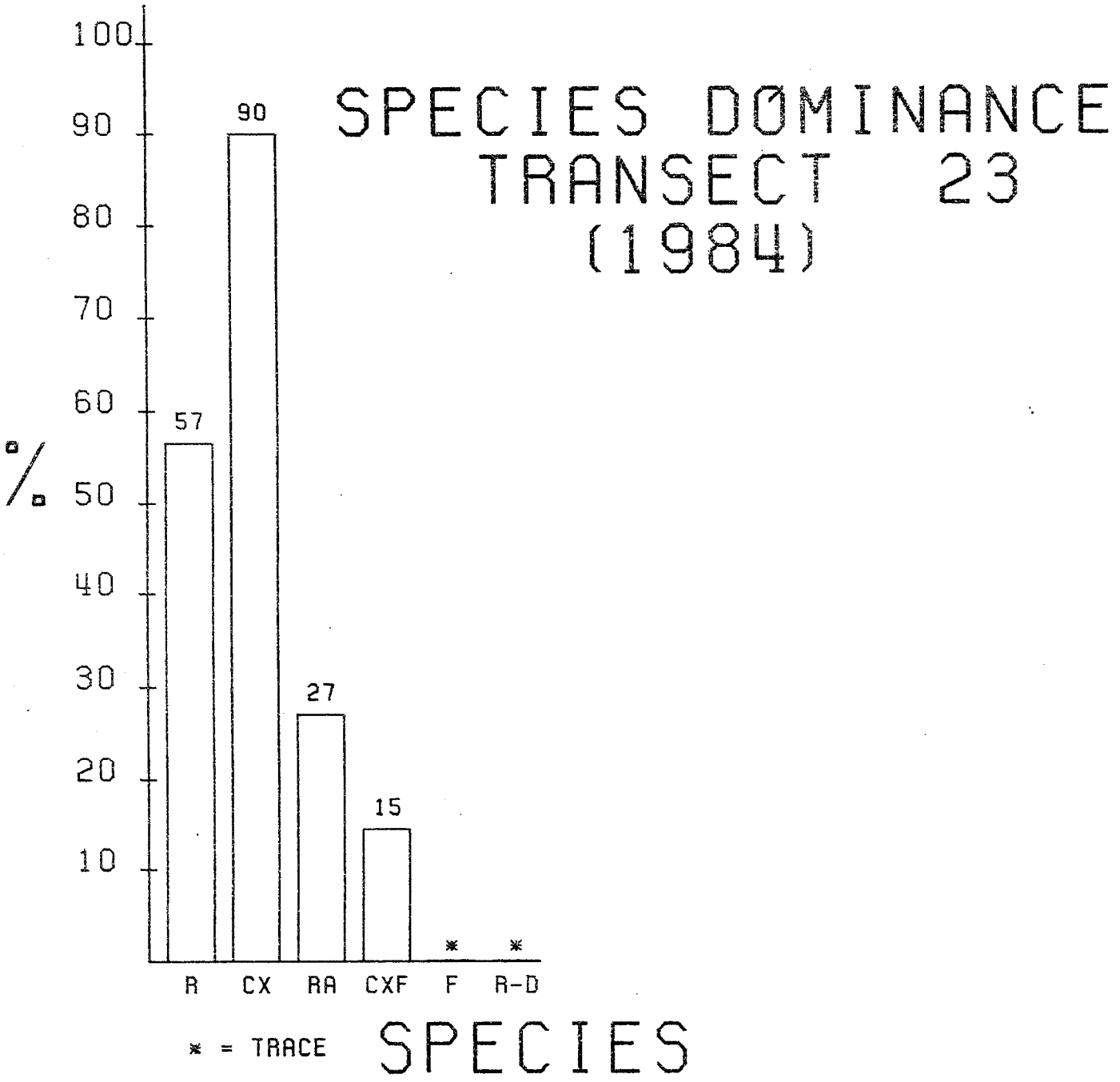
SPECIES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CXF
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R-D
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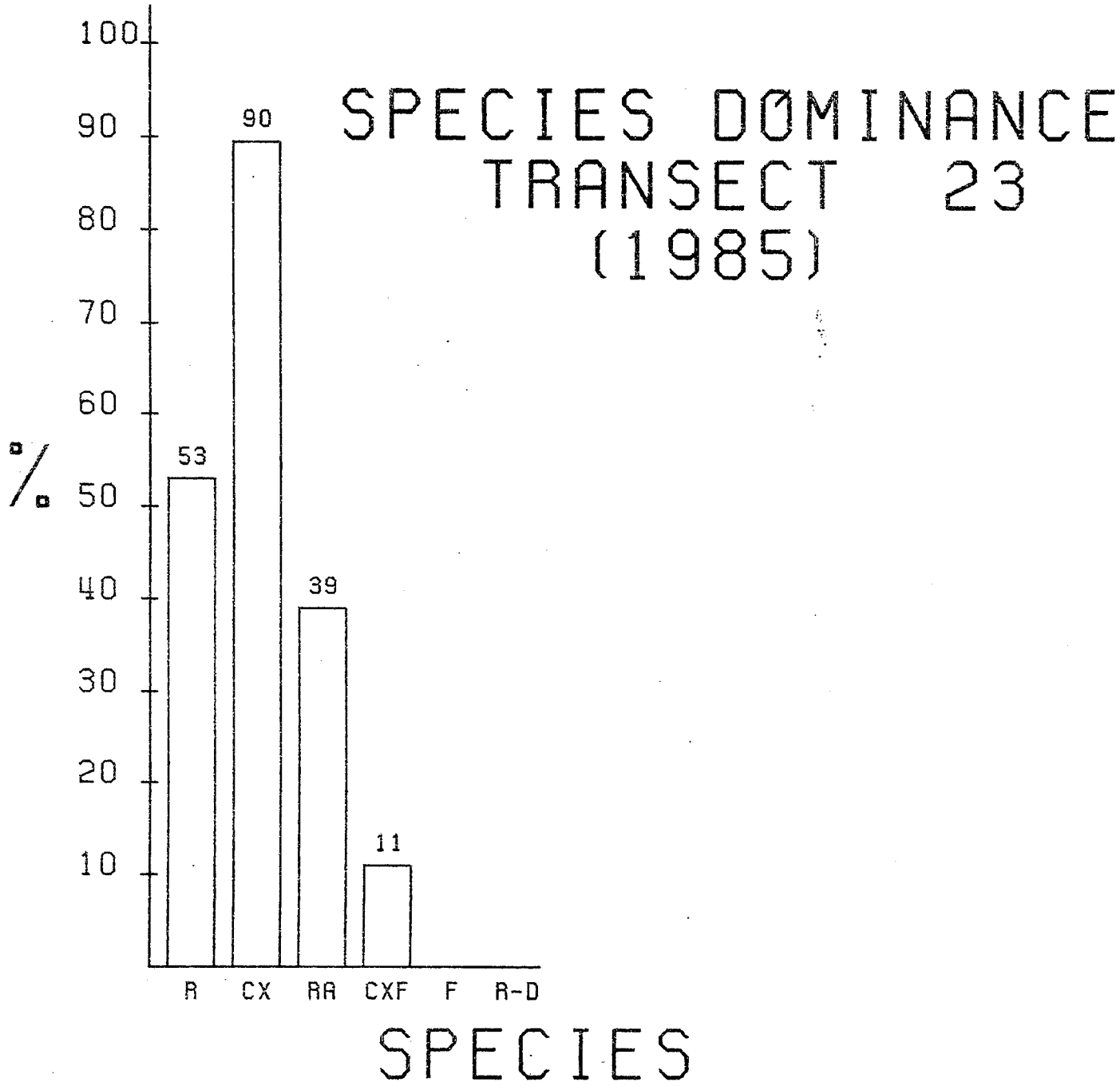
SPECIES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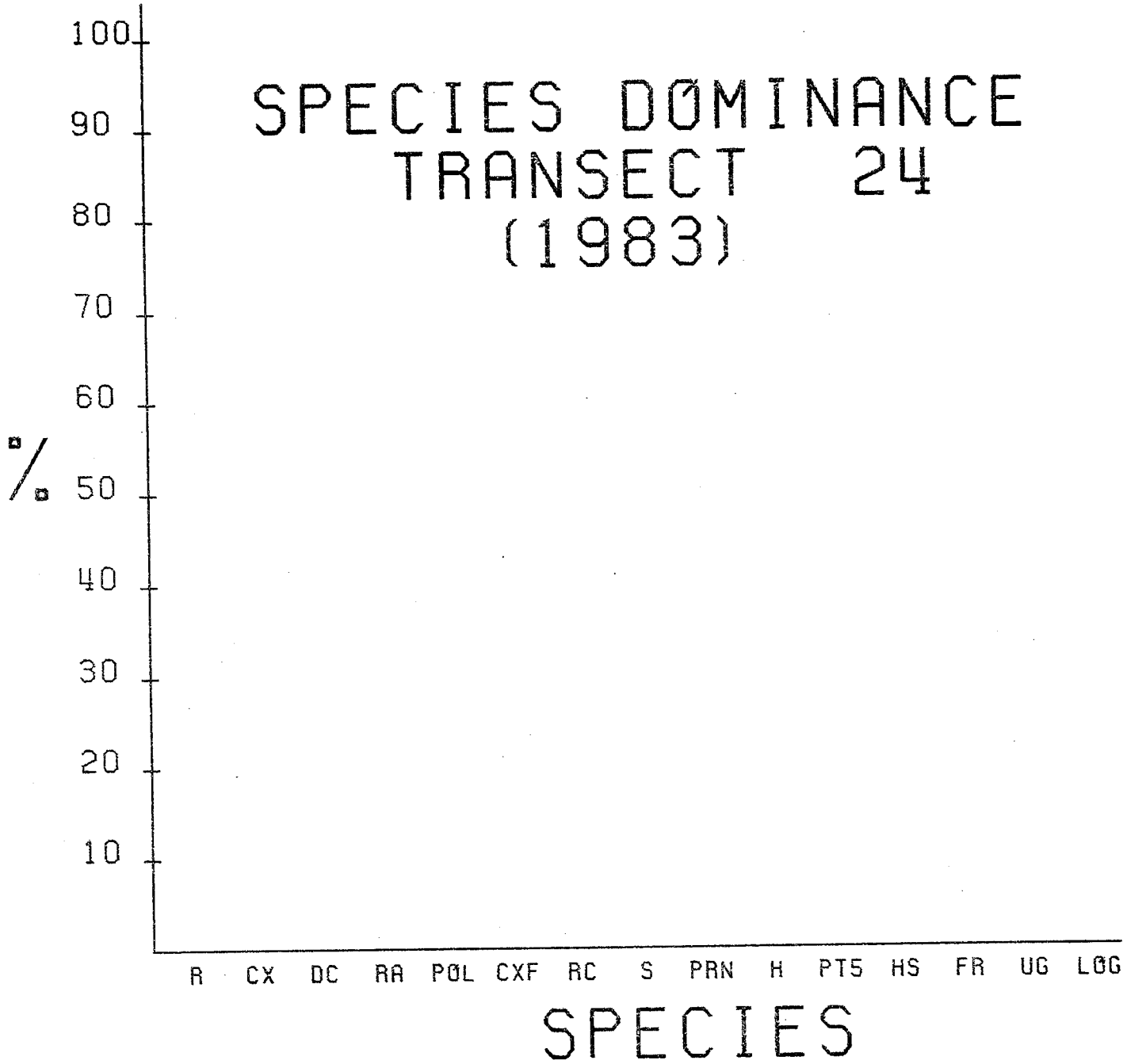
R
CX
RR
CXF
F
R-D
SPECIES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%
50
40
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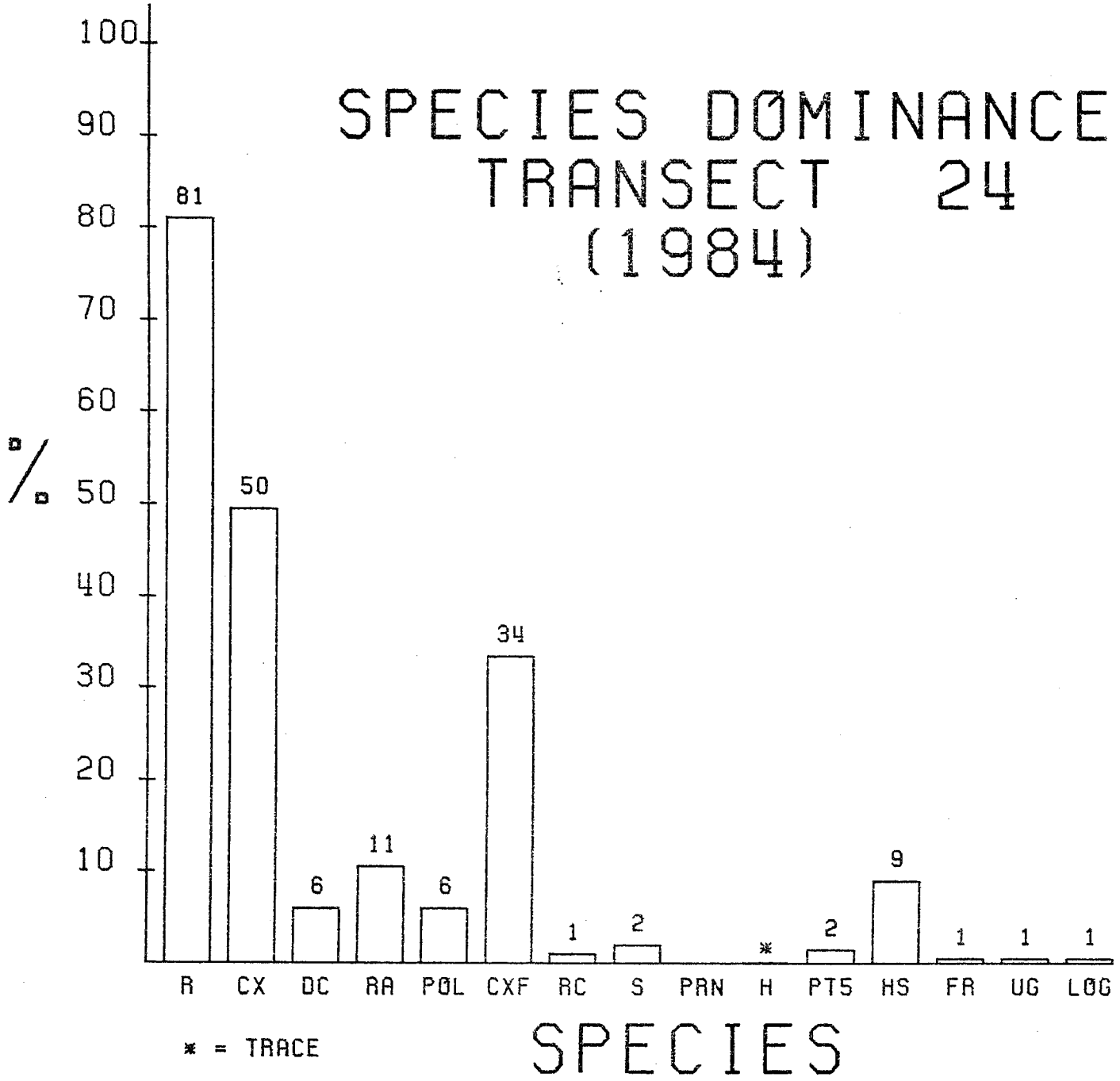
DC
RA
POL
CXF
RC
S
PRN
H
PT5
HS
FR
UG
LOG
SPECIES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2
9
1
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1
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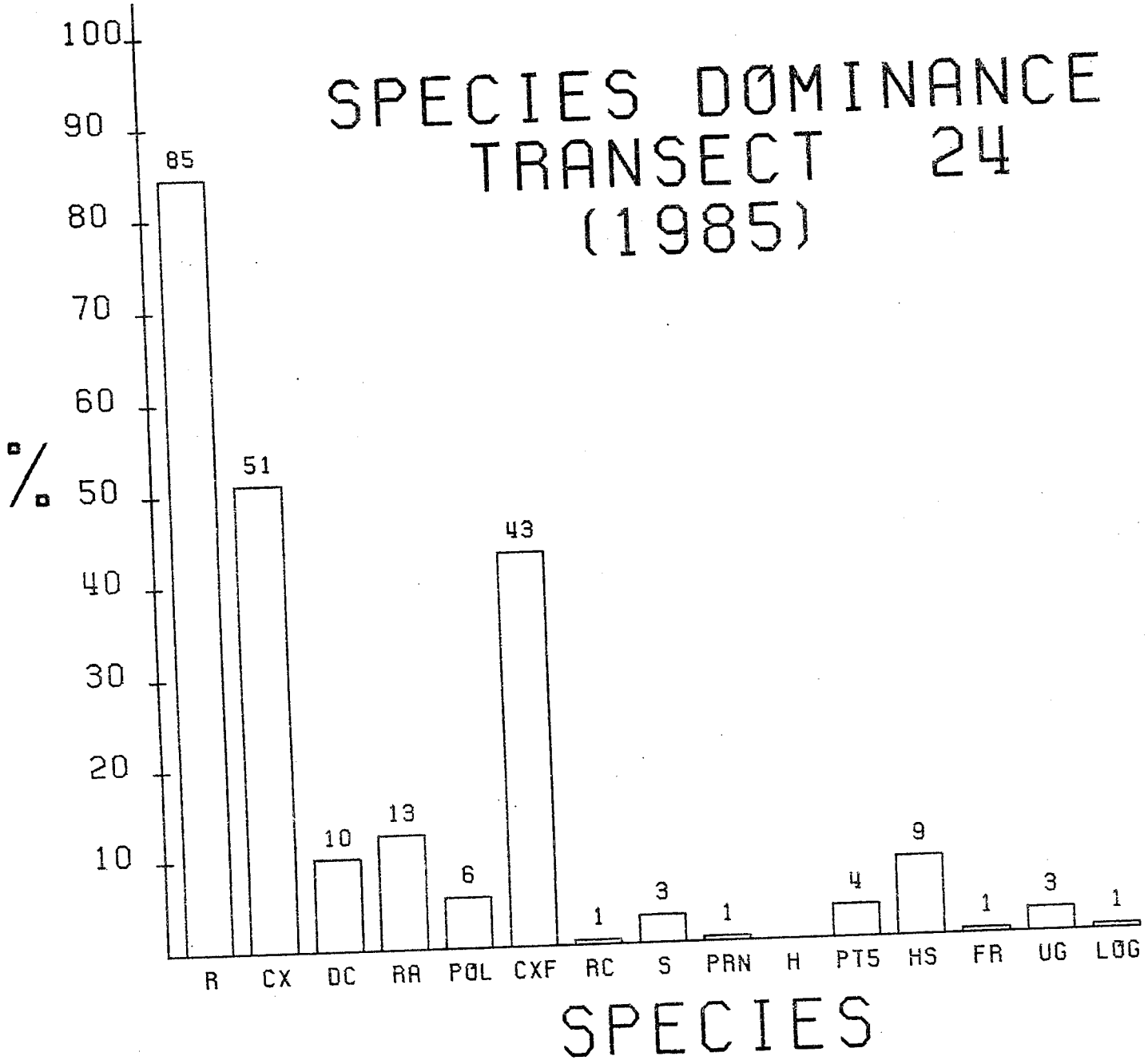
DC
RA
POL
CXF
RC
S
PRN
H
PTS
HS
FR
UG
LOG
* = TRACE
SPECIES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4
9
1
3
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R
CX
DC
RA
POL
CXF
RC
S
PRN
H
PT5
HS
FR
UG
LOG
SPECIES

APPENDIX C
Species List for Transects and Code to Abbreviations

(Alphabetically by symbol)

ACH = Achillea millefolium (yarrow)
AF = Abies fraseri (Fraser fir)
AML = Amelanchier laevis (serviceberry)
ANG = Angelica triquinata (angelica)
C = Crataegus sp. (hawthorn)
C-D = Dead Crataegus sp.
CX = Carex brunescens (brownish sedge)
CXD = Dead C. brunescens
CXF = Carex debilis (sedge)
DC = Danthonia compressa (mountain oat grass)
DD = Dead spot
DN = Anemone quinquefolia (wildflower)
F = Dryoptoris sp. (fern)
FR = Fragaria virginiana (strawberry)
H = Hypericum sp. (St. John's-wort)
HRC = Hieracium sp. (hawkweed)
HS = Houstonia serpyllifolia (bluets)
L = Lichens
LO = Lycopodium obscurum (clubmoss)
LOD = Dead L. obscurum
LOG = Log
M = Moss (other than Polytrichum)
PIC = Picea rubens (red spruce)
POA = Poa sp. (grass)
POL = Polytrichum commune (hairy cap moss)
PLO = Dead P. commune
PPA = Prunus pensylvanica (firecherry)
PPD = Dead P. pensylvanica
PRN = Prenanthes roanensis (rattlesnake-root)
PT = Potentilla tridentata (wineleaf cinquefoil)
PT5 = Potentilla canadensis (five-fingers)
R = Rubus allegheniensis (blackberry)
R-D = Dead R. allegheniensis
RA = Rumex acetosella (sour-grass)
RBG = Rocky bare ground (no vegetation)
RC = Rhododendron catawbiense (purple rhododendron)
RCD = Dead R. catawbiense
RIB = Ribes sp. (gooseberry)
S = Solidago sp. (goldenrod)
SA = Sorbus americana (mountain ash)
SAD = Dead S. americana
SC = Sambucus canadensis (elderberry)
SM = Saxifraga michauxii (Michaux' saxifrage)
UG = Unidentified graminoid
UG2 = Unidentified
UG3 = Unidentified
V = Vaccinium sp. (blueberry)
VD = Dead Vaccinium sp.

APPENDIX D

ENDANGERED AND THREATENED PLANTS OF THE ROAN MOUNTAIN HIGHLANDS

ENDANGERED, THREATENED, AND SPECIAL CONCERN PLANTS OF THE ROAN MOUNTAIN HIGHLANDS

SPECIES	STATE STATUS	NATIONAL STATUS	HABITAT
**Abies fraseri (Fraser fir)	TN-SC (Locally abundant southern Appalachian endemic; infestation of exotic insect and pollution threaten its existence.)	2	Above 5,000 feet elevation.
**Agrostis borealis var. americana (Arctic bent grass)	TN-SC NC-PP		Heath balds and rocky cliffs, spruce-fir forest.
**Alnus crispa (green alder)	TN-T (Roan Mountain is the only known locality in the southeastern United States for this species.)		Shrub and grass balds.
**Arenaria groenlandica var. groenlandica (mountain sandwort)	TN-T		Granitic outcrops, high elevations.
Astilbe crenatiloba Roan Mountain false goat's beard	TN-E (Possibly extirpated.)	1* (Possibly extinct.)	Wooded slopes.
Cardamine clematitis (mountain bittercress)	TN-T (Southern Appalachian endemic.)		In and along mountain streams and seeps at 6,000-foot elevations.

SPECIES	STATE STATUS	NATIONAL STATUS	HABITAT
Cardamine rotundifolia (round-leaved watercress)	TN-T		Boggy springs, high elevations.
**Carex aenea (Fernald's hay sedge)	NC-E (Very rare south of New York; Roan Mountain is only known locality in North Carolina for this species.)		Grass balds.
**Carex misera (wretched sedge)	TN-T; NC-T (Endemic to a few high mountains in North Carolina, Georgia, and Tennessee.)		Rocky crevices and balds at high elevations.
Carex roanensis (Roan Mountain sedge)	TN-E (Possibly extirpated.)	1* (Posibly extinct.)	Moist soil, northern hardwood forests, 4,700 feet.
Carex ruthii (Ruth's sedge)	TN-T		Seepage slopes, northern hardwood forests.
Carex trisperma (three-seeded sedge)	TN-SC; NC-SR		Wet woods and boggy areas.
Clintonia borealis (Clinton's lily)	TN-SC		Moist, high elevation forests.

ENDANGERED, THREATENED, AND SPECIAL CONCERN PLANTS OF THE ROAN MOUNTAIN HIGHLANDS

SPECIES	STATE STATUS	NATIONAL STATUS	HABITAT
Coeloglossum viride var. virescens (long-bracted orchid)	TN-SC		Moist woodlands, low elevation.
Cymophyllus fraseri (Fraser's sedge)	TN-T (Endemic to Southern Appalachians.)		North-facing wooded coves; low-mid elevation.
Dryopteris cristata (crested shield fern)	TN-SC		Boggy areas; low elevation.
Epilobium angustifolium (fireweed)	TN-SC		Roadsides, recent clearings.
Epilobium ciliatum (willow-herb)	TN-T; NC-SR		Bogs.
**Gentiana austromontana (Appalachian gentian)	TN-T (Endemic to the Appalachians of Virginia, West Virginia, North Carolina, and Tennessee.)		Grass and shrub balds at high elevations.
**Gentiana crinita (fringed gentian)	NC-E (One unconfirmed report.)		Meadows, streambanks, low woods.

SPECIES	STATE STATUS	NATIONAL STATUS	HABITAT
**Geum geniculatum (bent avens)	TN-E; NC-E (Endemic to the Southern Appalachians; limited to just a few high mountains.)	2	Balds and high elevation deciduous woods and streambanks.
**Geum radiatum (spreading avens)	TN-E; NC-T-SC (Endemic to the Southern Appalachians; limited occurrence.)	2	Balds and cliff faces at high elevations.
Helianthus glaucophyllus (white-leaved sunflower)	TN-E; NC-PP (Restricted to a few localities in North Carolina and Tennessee.)	2	Mid-elevation deciduous woods, roadsides.
**Hedyotis purpurea var. montana or Houstonia montana (Roan Mountain bluet)	TN-E (Endemic to only a few localities in the Blue Ridge.)	2	Rock outcrops and cliff faces.
Hydrophyllum virginianum (water leaf)	TN-T		Rich woods and streambanks, low-mid elevation.
**Hypericum graveolens (mountain St. Johnswort)	TN-T (Endemic to the high mountains of Virginia, Tennessee, and North Carolina.)		Grass and shrub balds.

SPECIES	STATE STATUS	NATIONAL STATUS	HABITAT
**Hypericum mitchellianum (Mitchell's St. Johnswort)	TN-T (Has same habitat and range as species above; may be conspecific.)		Grass and shrub balds.
Isopyrum biternatum (Atlantic isopyrum)	NC-SR		Woodlands and shrub balds.
Liatris helleri (Heller's blazing star)	NC-T (This species, known from just a few high mountains in North Carolina, has been reported from balds on the Roan. Cannot be found here at present.)	2	Open, rocky areas, high elevation.
**Lilium grayi (Gray's lily)	TN-E; NC-T-SC (Endemic to the Southern Appalachians; limited to a few summits in North Carolina, Tennessee, and Virginia.)	2	Shrub and grass balds.
**Lilium philadelphicum (wood lily)	TN-E (There has been one unconfirmed report of this species from Roan Mountain.)		Balds and high elevation meadows.
Listera smallii (Appalachian twayblade)	TN-T		Rhododendron thickets, boggy areas, moist mountain slopes.

ENDANGERED, THREATENED, AND SPECIAL CONCERN PLANTS OF THE ROAN MOUNTAIN HIGHLANDS

SPECIES	STATE STATUS	NATIONAL STATUS	HABITAT
Lonicera canadensis (American fly honeysuckle)	TN-SC		Spruce-fir forest
**Lycopodium selago (fir clubmoss)	TN-T; NC-SR (Northern, circumpolar species; reaches its southernmost distribution on Roan Mountain.)		Grass balds and high elevation rocky areas
**Menziesia pilosa (Minnie-bush)	TN-SC		Grass and shrub balds and northern hardwood forest.
Panax quinquefolis (ginseng)	TN-T; NC-SC		Rich deciduous woods, low-mid elevation.
**Paronychia argyrocoma (silverling)	TN-E		Rock crevices on high mountains, outcrops on grass balds.
**Phlox subulata (moss pink)	NC-SR		Roadsides, grass balds.
Platanthera orbiculata (round-leaved orchid)	TN-E		Moist woods, northern hardwood forest.

Platanthera psycodes (purple-fringed orchid)	TN-T		Mid-high elevation woods and boggy areas.
**Poa palustris (fowl bluegrass)	TN-SC		Grass balds and streambanks.
**Potentilla tridentata (three-toothed cinquefoil)	TN-SC		Grass balds, rock outcrops.
**Prenanthes roanensis (Roan Mountain rattlesnake-root)	TN-T (Endemic to mountain tops in the Blue Ridge of North Carolina and Tennessee.)		Grass balds.
Saxifraga careyana (Carey's saxifrage)	TN-SC (Endemic to the Southern Appalachians of North Carolina, Virginia, and Tennessee.)	2	Moist rocks and seepage slopes in upland forest.
Saxifraga pensylvanica (swamp saxifrage)	NC-PP		Boggy areas.
Scirpus caespitosus (deerhair bulrush)	NC-SR		Rock outcrops, high elevation.

Sedum rosea var. roanensis (Roan Mountain roseroot)	NC-E (A native of arctic regions; known in southeastern United States from only one other mountain besides Roan.)	2	High elevation cliff faces.
**Senecio schweinitzianus (formerly robbinsii) (Robbins' groundsel)	TN-E; NC-E		Grass balds, rock faces.
Solidago spithamaea (Blue Ridge goldenrod)	NC-E (Endemic to the Southern Appalachians; occurs on only two other mountains besides Roan Mountain.)	T	Exposed rock ledges and cliff faces, high elevations.
Solidago uliginosa (bog goldenrod)	NC-SR		Boggy areas.
Streptopus amplexifolius (white mandarin)	NC-PP; TN-T		High elevation deciduous forest.
Streptopus roseus (rosy twisted-stalk)	TN-SC		Northern hardwood forest, high elevation.
Trillium rugelii (nodding trillium)	TN-SC		Deciduous forest, low elevation.

Trisetum spicatum var. molle (Soft trisetum)	NC-E	Rocky cliffs, high elevation.

*Possibly extinct
**On balds

Abbreviations:
NC - North Carolina
TN - Tennessee
E - Endangered
T - Threatened
SC - Special Concern
PP - Primary Proposed
SR - Significantly Rare
1 - Current data indicates species should be federally listed as endangered or threatened.
2 - Federal listing possibly appropriate, but insufficient data on threats and vulnerability.

APPENDIX E

KNOWN AND EXPECTED EFFECTS OF MANAGEMENT TECHNIQUES ON RARE PLANT SPECIES

EFFECTS (KNOWN AND EXPECTED) OF MANAGEMENT PRACTICES ON RARE PLANTS OF ROAN MOUNTAIN GRASSY BALDS

Abies fraseri (fraser fir)

Fire intolerant.

Agrostis borealis var. *americana* (arctic bent grass)

Unknown.

Alnus crispa (green alder)

Relatively fire intolerant, based on subjective observations on Roan Mountain.

Wofford: Grazing and prescribed fire will damage, but recovery is likely.

Arenaria groenlandica var. *groenlandica* (mountain sandwort)

No species - specific data;

Kral: (comments on other species of *Arenaria*) Needs full sun; fire if properly managed would probably benefit.

Wofford: fire will damage; recovery likely.

Carex aenea (Fernald's hay sedge)

Kral: (based on other Carex species) Grazing may damage; effects of fire unknown; needs openings.

Gaddy: Impacts of fire unknown, but may improve its habitat. Thinning of trees and shrubs from balds is beneficial.

Carex misera (wretched sedge)

Kral: Burning will destroy; thinning or cutting of overstory will damage; grazing will damage.

Gentiana austromontana (Appalachian gentian)

Wofford: Effects of fire unknown; grazing detrimental. Requires open areas.

Geum geniculatum (bent avens) Not typically found on open balds

Kral: Needs shade; burning and grazing likely to destroy; clearing of overstory detrimental.

Geum radiatum (spreading avens)

Kral: Needs full sun; effects of burning and grazing unknown

Gaddy: Effects of fire unknown, but "undoubtedly detrimental."

Hedyotis purpurea var. montana (Roan Mountain bluet)

Kral: Effects of fire and grazing unknown; needs moist soil in open areas.

Hypericum graveolens (mountain St. Johns wort)

(Subjective observations on Roan Mountain indicate that at least some species of this genus can survive annual fire.)

Hypericum mitchellianum (Mitchell's St. Johns wort)

Wofford: Prescribed fire may be beneficial, if properly conducted; grazing will damage but recovery is likely.

Lilium grayi (Gray's lily)

Gaddy: fire may improve habitat

Kral: Needs openings; effects of fire unknown; grazing may destroy.

Wofford: Properly used fire probably beneficial; grazing detrimental.

Lilium philadelphicum (wood lily)

No species--specific information.

Lycopodium selago (fir clubmoss)

Wofford: Fire will damage; recovery likely; grazing detrimental. (Other species of Lycopodium on Roan Mountain appear relatively intolerant of fire.)

Menziesia pilosa (minnie-bush)

Unknown.

Paronychia argyrocoma (silverling)

Unknown.

Poa palustris (fowl bluegrass)

No species--specific information; prescribed burning benefits some other Poa species.

Potentilla tridentata (3-toothed cinquefoil)

Unknown.

Prenanthes roanensis (Roan Mountain rattlesnake-root)

Kral: Associated with openings; fire has no lasting effect.

Wofford: Might benefit if done properly; grazing will damage, but recovery is likely.

Senecio schweinitzianus (Robbins' groundsel)

Wofford: Prescribed burning probably would benefit; grazing may damage, but recovery is likely.

Phlox subulata (moss pink)

Unknown.

References:

Kral, Robert. 1982. Endangered and Threatened Species of the Southeastern United States Including Puerto Rico and the Virgin Islands. USDA Forest Service General Report SA-GR7.

Gaddy, L. L. 1983. An Inventory of the Endangered and Threatened Plants of the Nantahala and Pisgah National Forests, North Carolina. USDA Forest Service Contract Report #53-43ZP-00943.

Wofford, E. 1980. Inventory of Proposed Threatened and Endangered Plant Species, Cherokee National Forest, Tennessee. USDA Forest Service Contract Report #53-43ZP-8-00236.

APPENDIX F

CLIMATOLOGICAL DATA

FROM ROAN MOUNTAIN, 1983-1984

Roan Mt. Climatological Data. Temperaturesin Celsius and are the maximum and minimum values since the last reading.

11 May 1983 sunny, clear, and cool; in the 60's (F), windy. Last night 30's(F) or 40's(F).

17	-1-18°C	
20		sunny and hazy
23	7-22	partly cloudy and foggy in the AM
25	0-14	cool and partly cloudy
1 June 1983	-2-17	ptly cloudy and cool in the AM
2	0-15	mostly sunny
3		sunny-warm; severe thunderstorm w/ hail around 6PM
5	6-22	sunny-warm; little or no breeze
6	10-17	ptly sunny and warm
16	3-18	hot, humid, and hazy
17	10-19	cloudy-misty w/ rain in the afternoon
18	9-17	cloudy-misty in AM; clearing by afternoon
20	11-21	mild,misty
21	10-22	mostly sunny
23	11-23	mild and foggy
24	9-20	sunny and beautiful
26	11-24	ptly cloudy
27	12-22	sunny, hot, and humid
29	18-23	cool, mostly cloudy and misty
30	13-23	overcast, v. foggy, cool, windy
1 July 1983	13-19	overcast and muggy; heavy rain last night
2	11-23	mostly sunny and windy
6	10-24	cool, breezy, ptly sunny; wind 7-10 mph
7	6-16	sunny and beautiful
8	6-21	mostly sunny; light breeze
9	9-18	sunny and windy, 10 mph
13	8-21	hazy, burning off by late morning; 4-7 mph
14	15-24	sunny early, overcast later; little breeze 2-3 mph
15	13-17	sunny w/ slight breeze, 4-5 mph
16	13-24	sunny, mild, and clear w/ little breeze
17	15-24	v. hazy, light breeze
18	13-22	cloudy, cool, and windy w/ gusts to 10 mph
19	14-18	v. foggy, breezy, 7-10 mph
20	15-19	foggy w/ stiff wind to 10 mph, clearing by noon
21	13-25	foggy but clearing by noon, breezy, 8-10 mph
22	17-23	foggy and very windy, 30-50 mph
23	17-23	sunny and breezy
26		sunny, clear, little or no breeze
27	10-19	mostly sunny, slight breeze
28	10-20	sunny, slight breeze
29	11-20	ptly cloudy, slight breeze
30	8-21	sunny, slight breeze
2 August 83	9-22	foggy and misty--v. damp
3	10-21	sunny and hot
4	13-21	v. foggy wet, slight breeze
6	8-25	warm, ptly cloudy and breezy
7		overcast w/ rain by noon, breezy
8	9-22	sunny, warm, v. little breeze
11	12-24	overcast, hazy, windy 7-10 mph

Date	°C	ppt(in)	comments
12 Aug 1983	11-22		cold, foggy, windy 7 mph
13	6-15		sunny, v. clear, light breeze
14	8-17		mostly sunny, slight breeze
16	17-22		ptly cloudy w/ little or no breeze
18	12-22		sunny
20	9-21		sunny, no breeze, hot
21	13-27		" " "
8 Sept 1983	10-28		
23	-5-24		mostly clear, cool, windy w/ a few snowflakes in AM; sunny in PM; the low (-5) registered in the last night or two; final 1983 reading
1 June 1984			sunny, in the 70's (F) day and in the high 30's (F) or low 40's (F) at night
2	7-21	0	mostly sunny with a stiff wind
4	10-19	0	ptly cloudy, slight breeze
5	12-18	trc	sunny, slight breeze
12	10-23	.6	I'm told the past week has been warm w/ little rain;today ptly cloudy w/ thunderstorm around 3PM
13	12-17	.3	ptly cloudy
15	11-23	0	ptly cloudy w/ showers in the afternoon
18	11-23	.9	mostly cloudy, breezy
19	14-21	0	foggy until noon
21	11-23	.4	foggy turning to rain by 11AM
22	12-17	.8	cool and foggy
27	7-22	.5	ptly cloudy, breezy
28	12-20	.8	" " " ; vegetation soaking wet
2 July 1984	7-18	1.2	ptly cloudy, little breeze
3	10-15	.3	mostly sunny, windy
5	12-20	.3	windy and gray
6	13-19	.2	rain
7	12-17	.2	ptly cloudy, breezy
9	8-21	0	sunny, slight breeze
10	12-23	0	sunny, breezy
12	13-25	trc	rain, fog, cool
14	13-25	.7	sunny and warming, v. little breeze
16			rain
17			rain
18	12-19	2.7	rain and fog
19	7-17	trc	sunny, clear, some breeze
20	12-20	0	cool, foggy, breezy
21	12-19	.7	overcast, cool, breeze
22	10-17	.1	" " "
23	12-16	0	mostly cloudy
24	11-21	0	ptly sunny
25	13-23	0	sunny
27	13-23	.3	mostly cloudy, intermittent rain
30	10-17	1.3	mostly overcast and breezy
31	11-16	.1	windy, drizzle, gray, cool
1 Aug 1984	13-17	.4	overcast but pleasant
2	14-21	trc	ptly cloudy, breezy, pleasant
3	14-22	0	" " "
4	14-21	0	mostly sunny w/ a good breeze
5	13-23	trc	mostly cloudy, cool, breeze
6	13-19	0	ptly cloudy

7 Aug 1984	14-19	.1	ptly cloudy
8	14-21	trc	foggy
9	13-22	trc	mostly cloudy w/ rain in the afternoon
10	13-19	1.3	overcast
13	11-21	1.2	rain
14	14-17	.5	mostly cloudy
15	12-19	0	sunny, clear
16	12-23	0	overcast
17	11-19	0	sunny all day
19	11-23	.3	clearing by the afternoon
20	10-21	0	ptly cloudy
21	11-23	0	ptly cloudy turning to rain
22	11-20	trc	overcast in AM, clearing by late afternoon
23	13-21	.2	v. windy, cool, and foggy most of the day
24	17-19	0	clear, still, mostly sunny
25			ptly cloudy
26	7-20	0	
7 Sept 1984	4-25	.6	

APPENDIX G

U.S. FOREST SERVICE MANUAL:

1984 SUPPLEMENT FOR

BALD MANAGEMENT POLICY

FOREST SERVICE MANUAL
ATLANTA, GEORGIA
August 1984

2300 - RECREATION

R8 Supplement No. 44

R8-1100-2 (2/83)

POSTING NOTICE. SUPPLEMENTS TO THIS MANUAL are numbered consecutively. Check the last transmittal sheet received for this title to see that the above supplement number is in sequence. If not, order intervening supplement at once. Do not post this supplement until the missing one(s) is received and posted. After posting retain this transmittal until the next supplement to this title is received. Individual holders should keep only the last transmittal. Place it at the front of the title.

Page Code	Superseded (Number of Sheets)	New
2362.03--1 thru 2362.03--3	-	3

Digest: Gives direction on management of Appalachian Mountain Balds.

JOHN E. ALCOCK
Regional Forester

balds may be identified as management areas. Such identification will not prohibit nominating unusually scenic or botanical examples as special interest areas to be classified under 36 CFR 294.1 with the Regional Forester's approval (FSM 2362.2).

3. Standards and guidelines will be included in the Forest Land Management Plan that describe the general methods available to reduce or eliminate undesirable woody vegetation to preserve and perpetuate the desired successional stage. Such methods may include prescribed fire, herbicides, grazing and mechanical means as appropriate to meet the objectives.

4. Historical balds that have been lost to later stages of vegetative succession may be considered for restoration.

5. A detailed management and action plan with appropriate review by public and interested agencies should be prepared for each bald to be maintained or restored under this directive. The plan should, as a minimum, contain the following elements:

-- Inventory of the bald's existing and past boundaries. Documentation of boundaries selected for management, including acreage.

-- History of past use and present trends.

-- Inventory of existing flora and fauna and their distribution. Establish permanent plots where warranted.

-- Past or current research, or administrative studies relevant to the bald.

-- Management objective for the bald and the resources to be featured.

-- Develop specific plans for eliminating undesirable vegetation and managing the bald for it's desired uses, while assuring continued protection and maintenance of soil productivity.

a. Describe methods to be employed (e.g., prescribed fire, herbicides, grazing and mechanical), and the limitations or problems associated with each.

b. Frequency, timing, and extent or scope of the application of various treatments or their combinations.

2362 - NATURAL HISTORY RESOURCE

(Appalachian Mountain Balds)

2362.01 - Authority. The authority to provide, manage, protect, and regulate use of Appalachian Mountain Balds is found in the following legislation:

1. Organic Administration Act of June 4, 1897.

2. National Environmental Policy Act of 1969.

3. Endangered Species Act of 1973.

4. National Forest Management Act of 1976.

2362.02 - Objective. All areas of the Southern Region National Forests defined as Appalachian Mountain Balds will be managed and maintained at a desired successional stage. The purpose of this management will be to:

1. Ensure the re-establishment and/or perpetuation of the often-unique vegetative character of these areas for a variety of National Forest uses and purposes.

2. Provide a significant visual resource for recreationists to enjoy as well as special habitat requirements for unusual plant and animal life.

3. Provide the necessary survival needs for the protection of endangered, threatened and sensitive species occurring on certain balds.

2362.03 - Policies.

1. Balds will be managed to optimize the mix of existing or potential National Forest resources involved. Usually, this will include recreation, visual resources, wildlife, range, soil and water. However, management emphasis may vary for each bald. Where there is a conflict in management practices, some may be modified or eliminated to optimize selected resources. This will be done through trade-off analysis and management decisions established for a specific bald.

2. Forest Land Management Plans will inventory and describe qualified balds and provide direction for their management. Such

c. Describe the results that should be produced, such as; the irregular edge between the bald and adjacent timber stands that offers a desirable visual effect. Describe how treatments will favor or threaten the desired plant and/or animal communities to maintain the desired successional stage.

d. Identify woody vegetation to be retained and managed.

e. Plan for a trail system where necessary, to provide access both to and through the Bald. Provide trail design and construction guidelines to fit the situation.

-- Describe coordination needed with other responsible agencies and/or adjoining National Forests. Provide public involvement for interested groups.

-- Systematically and objectively monitor prescribed treatments to determine if effective and on course. Keep a permanent record of treatments for future evaluation. Include before and after photographs, from permanent photo points on the ground and from the air.

2362.04 - Responsibility. The responsibility for carrying out management objectives for balds is multifunctional.

The Director of Recreation is responsible for special interest areas, which include Balds, while the Director of Fisheries, Wildlife and Range is responsible for coordination of balds management in the Regional Office. Forest Supervisors will select a staff person to coordinate management of the Balds on each Forest and among Forests. Funds necessary to carry out planned work will be contributed by benefiting functions.

2362.05 - Definition. Mountain balds are those naturally-appearing, meadow-like, essentially treeless openings of grasses, forbs, shrubs, and similar vegetation which are found on the crests of mountains and ridges throughout the Southern Appalachian Mountains.