A NUTRIENT ANALYSIS OF PLANTS POTENTIALLY USEFUL AS DEER FORAGE ON CLEARCUT AND SELECTIVE-CUT PINE SITES IN SOUTHEASTERN OKLAHOMA

By

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Bachelor of Science

Oklahoma State University

Stillwater, Oklahoma

1972

Submitted to the Faculty of the Graduate College
of the Oklahoma State University
in partial fulfillment of the requirements
for the Degree of
MASTER OF SCIENCE
December, 1976

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ACKNOWLEDGEMENTS

Sincere appreciation is expressed to my major adviser, Dr. John Morrison, for his guidance and encouragement throughout this project. Appreciation is also expressed to my other committee members, Dr. Fred Owens and Dr. Ted Silker.

Financial support provided by the Weyerhaeuser Company, the Oklahoma State University School of Biological Sciences, and the Oklahoma Cooperative Wildlife Research unit, is gratefully acknowledged.

Laboratory analyses were conducted at the Nutrition Laboratory, Department of Animal Sciences and Industry, Oklahoma State University and at the Nutrition Laboratory, Southwestern Livestock and Forage Research Station, El Reno, Oklahoma. Thanks are extended to the supervisory laboratory personnel at these locations for extending these facilities for use.

Special thanks are also due Dr. Jim Lewis and Dr. Herbert Bruneau of Oklahoma State University, Dr. Ron Johnson of the University of Tennessee, Dr. Floyd Horn of the Southwestern Livestock and Forage Research Station, and Dr. Dennis King of the Weyerhaeuser Company for their support and encouragement. Mrs. Gay Williams, unit secretary, has my sincere appreciation and gratitude for her interest in unit students and her willingness to be of assistance.

Finally, special thanks are expressed to my family and to Karen, without whose patience, assistance, and understanding my graduate education would not have been possible.

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CHAPTER I

INTRODUCTION

Four major types of forests occur in southern states: bottomland hardwood, loblolly-shortleaf pine hardwood, upland hardwood, and longleaf-slash pine. These forests cover 88 million ha between Virginia and Texas (Wheeler 1966). By the year 2000, these southern pine-hardwood forests are expected to be the United States' main source of timber (U. S. Forest Service 1965). Because of this projected demand for southern timber, forest land in the south is being managed more intensively. In the southeast alone, forest land is being cleared and planted to pine at an average rate of 400,000 ha per year (Arner 1972).

Clearcutting, the complete removal of a forest stand in one cutting (Meyer and Eyre 1964), has become an integral part of intensive forest management. Much controversy surrounds the practice of clearcutting, particularly with respect to its effect on wildlife resources.

Clearcut areas replanted to pine offer food for wildlife in the form of understory herbage and hardwood browse before the canopy closes and after thinning (Blair 1967). When the understory is intentionally managed for wildlife forage, loblolly pine plantations on long-term rotation provide sustained habitat for deer. However, a loblolly pine plantation on a short-term pulpwood rotation of 20 to 25 years generally produces deer forage for a period of only 8 to 10 years (Blair and Enghardt 1976). The term "deer forage" refers to unharvested plant material of any kind that is available for consumption by deer (Meyer and Eyre 1964).

Because forage production is inversely related to timber density, clearcut areas provide a greater forage yield per ha than do undisturbed areas. Segelquist and Pennington (1968) reported that browse yields on the Ouachita National Forest in Oklahoma ranged from 94 kg per ha in undisturbed oak-pine forest to 285 kg per ha in oak-pine forest disturbed by timber-stand improvement or by harvest cutting. Lindzey (1951) found an increased abundance of browse plants where vegetation was cleared for the installation of a power line in the Carter Mountain area of southeastern Oklahoma. In east Texas, forage yields were 1800 kg per ha on clearcut areas, 818 kg per ha under shelterwood, 960 kg per ha under selective cuts, and 480 kg per ha in uncut loblolly-shortleaf pine hardwood stands (Schuster and Halls 1963). McGinnes (1949) reported that in a Virginia pine type in Pennsylvania, a clearcut area produced 44 kg of browse per ha whereas an uncut area produced only 10 kg per ha. Halls and Alcaniz (1948) found that 7 deer browse plant species at 5 years of age, grown in the open, averaged 32 times more fruit and nearly 7 times more twig growth than did the same browse species growing beneath a stand of saw-timber sized southern pine. Lawrence and Biswell (1972) found in a study of deer habitat in a giant sequoia grove that summer forage was more abundant, more closely utilized, and higher in nutritional value in areas treated by cutting, piling, and burning, than on untreated areas. They stated (1972:595) that "the vegetational responses to the forest treatment reflected the increased sunlight and openness of the canopy".

The effect of timber density on the quality or nutritional value of forage varies regionally. In Utah, the higher protein and phosphorus content of plants growing beneath aspen was attributed to shade and increased moisture (Cook and Harris 1950). McEwen and Dietz (1965) found that herbage growing in open meadows in the Black Hills of South Dakota contained less crude fiber, calcium, and phosphorus than did forage on pine-shaded sites. Dealy (1966), in the Pacific Northwest, found a lower crude fiber content in forage under a natural stand of pine than under thinned stands, but reported no difference in crude protein between stands. Lay (1956) stated that for the southern pine type, the removal of overstory by timber harvest increased browse and herbage, with the resultant growth being higher in quality. Halls and Epps (1969) found that browse plants growing in the open in east Texas usually contained more crude protein and phosphorus but less crude fiber and calcium than did plants beneath a stand of pines. In contrast, Vallentine and Young (1959) found that forage grown under canopied sites in west-central Texas contained more crude protein and phosphorus but less crude fiber than did forage collected in the open; canopy coverage had no effect on calcium content. Regelin et al. (1974) found in central Colorado that crude protein content, moisture content, and *in vitro* dry matter digestibility (IVDMD) within a collection date did not differ statistically between clearcut and uncut strips. Crawford et al. (1975), in comparing preferred deer forages in southwestern Virginia, found that forages from the selective-cut area had higher percentages of dry matter, crude protein, phosphorus, and ash, whereas the same forages growing in the clearcut area had higher digestibilities and higher percentages of soluble carbohydrates.

The quality of forage in a given area has a great effect on the health and reproduction of the deer population. Savage and Heller (1947) reported that the chemical composition of available range-forage plants is a more important criteria than is forage yield in evaluating plants for grazing purposes. As quality of forage declines, body growth and reproduction in the deer population decline also (Goodrum and Reid 1954, Dahlberg and Guettinger 1956). Cheatum and Severinghaus (1950) found that better forage conditions were followed by increased fertility. Verme (1967) stated that the quality of range is very important in promoting fertility in deer. He found that 19 of 20 yearling does subjected to poor-quality diets in summer and fall failed to breed, whereas does consuming a good-quality diet averaged 1.2 fawns. This difference was also noted in older does (Verme 1965, 1970).

Although nutrient content is only one of several criteria used in evaluating forage plants, it is, nevertheless, an important factor in evaluating habitat for deer productivity. A nutritional evaluation of plants potentially valuable as deer forage has not been undertaken to date in southeastern Oklahoma. The present investigation was designed to provide information on the nutritional quality of selected deer forage from clearcut and from selective-cut treatment plots in southeastern Oklahoma. Since the nutritional quality of most forages varies with the stage of plant maturity (Cook and Harris 1950), this investigation also studied the seasonal trends of plant nutrients for the plant species selected.

The objectives of the study were: (1) to gather data on seasonal trends in moisture, total mineral matter, calcium, phosphorus, Ca:P ratio, crude protein, and IVDMD of selected deer forages and (2) to note relative differences in nutrient content for deer forages that were sampled from both clearcut and selective-cut plots. For this study, seven plant species were collected from both clearcut and selective-cut, seven species were collected from the clearcut only, and three species were collected from the selective-cut only.

CHAPTER II

THE STUDY AREA

Location

This study was conducted in eastern McCurtain County, approximately 4.8 km southeast of Eagletown, Oklahoma, on timber land owned by the Weyerhaeuser Company (Fig. 1). This land, along with other timber land, was sold to the Weyerhaeuser Company by Dierks Forests, Inc. in 1969. Since that time the Weyerhaeuser Company has utilized the clearcutting method as its primary harvest practice in southeastern Oklahoma. The study area is located in Range 27 E, Township 6 S, Sections, 19, 20, 29, 30, and 31, and involves specifically two Weyerhaeuser clearcuts and the surrounding timbered area which was lightly selectively cut prior to Weyerhaeuser acquisition (Fig. 2). Weyerhaeuser Cut Number 11151, 266 ha in size, was clearcut from January 1971 through March 1972. The cut was tree crushed and burned in the spring of 1972 and regenerated by machine and hand planting. The clearcut was stocked with 330 loblolly pine seedlings (*Pinus taeda* L.) per ha. Weyerhaeuser Cut Number 11179, 214 ha in size, was clearcut from April of 1971 through August of 1972. This cut was tree crushed and burned in the spring of 1973 and regenerated during the 1973-1974 season by hand planting. The stocking rate for this clearcut was 260 loblolly pine seedlings per ha. At approximately five years of age, undesirable hardwoods competing with

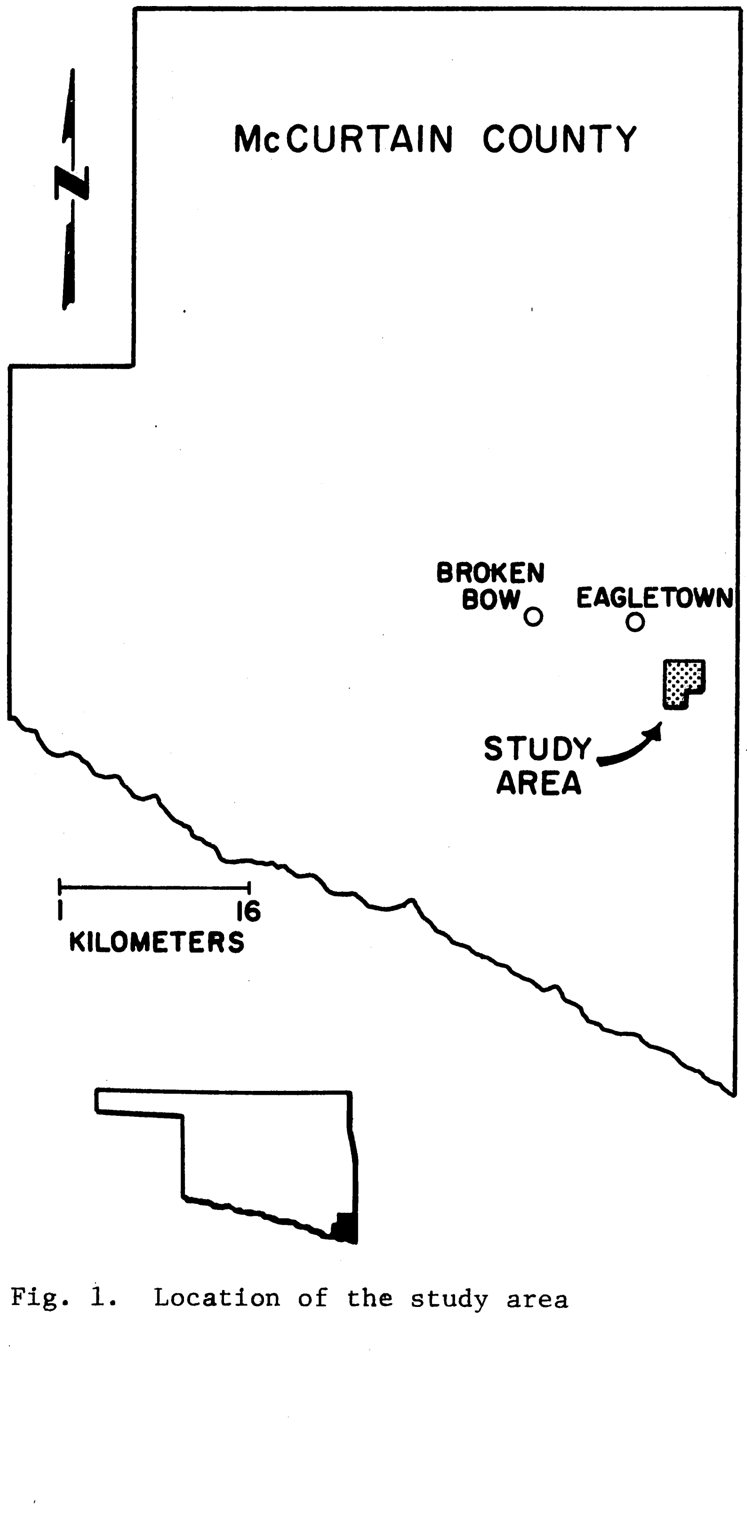


Fig. 1. Location of the study area

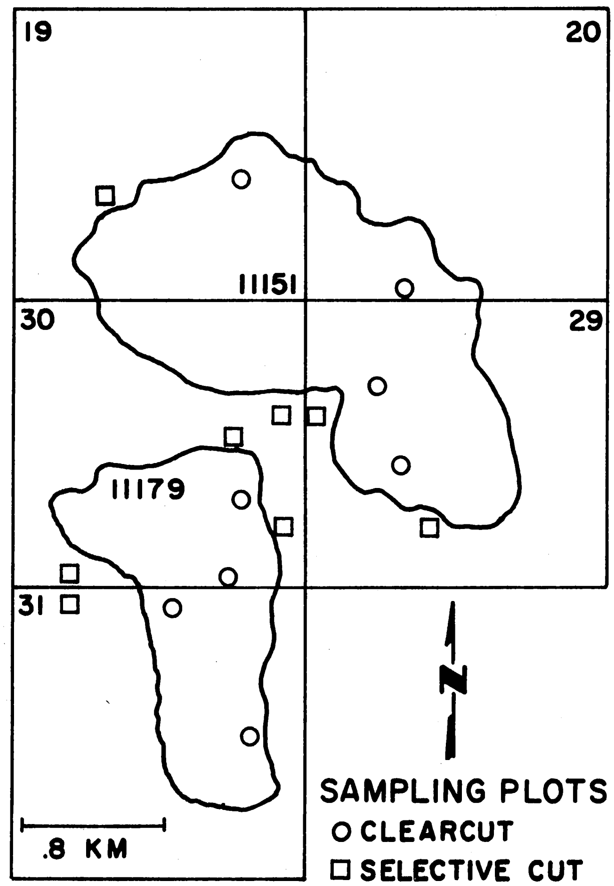


Fig. 2. Map of the study area and the location of sampling plots

the pines will be controlled by basal or aerial chemical spray methods. In addition, the clearcuts will be fertilized twice, approximately at the ages of 12 and 17 years. The pine growth on these two cuts is expected to peak out between 20 and 25 years, at which time the timber will be harvested (Cledith Davenport, Inventory Forester, Weyerhaeuser Company, personal communication).

The selective-cut timber surrounding the clearcuts was last cut from August through October of 1964, at which time the Dierks Timber Company removed some pole and saw timber. Although not documented, it is believed that the 1964 cut was the second cut on this timber. The original virgin timber in the area was clearcut around 1920 (Clyde Dildine, District Forester, Weyerhaeuser Company, personal communication).

This study area is also being used in a complementary study by the Oklahoma State University Department of Forestry. That study involves the relationships existing between wildlife and cut areas in terms of plant succession and utilization of clearcuts by wildlife. Transect lines are used to measure species frequency, composition, and retrogression trends on both clearcut and selective-cut areas.

Geology and Soils

Geographically, the study area is located in the extreme northern edge of the Western Gulf Coastal Plain. The elevation at the study area is approximately 122 m above sea level. The U. S. Geological Survey map shows the study area to be part of a vast basin once covered by the sea. Recession of the sea, after land surface erosion, left behind a series of on-lapping deposits that are mostly marine in nature (U. S.

Geological Survey 1960). The geological material in the study area is early Cretaceous in age; the rock nature is hard limestone (Silker 1974).

The soils in eastern McCurtain County overlaying the antecedent bedrock are red-yellow podzolics (Alfisols and Ultisols), being deeply leached and strongly acidic (Silker 1974). The soils are low in potassium and low or very low in phosphorus (Gray and Galloway 1959). These red-yellow podzolics are considered to be an alluvial plain deposit made by a series of meandering and/or braided-channel streams (Silker 1974).

There are two soil associations involved in this study: the Ruston-Tiak-Saffell and the Felker-Kullit. The Ruston-Tiak-Saffell association is characterized by deep, very gently sloping to moderately steep, well-drained or moderately well-drained loamy soils on uplands. The Felker-Kullit association is characterized by deep, nearly level, and very gently sloping, somewhat poorly drained or moderately well-drained, loamy soils on uplands (Reasoner 1974). The majority of the sampling plots, clearcut and selective-cut, were located in the Ruston-Tiak-Saffell association.

The Coastal Plain soils involved in these associations are used primarily for woodlands and tame pastures, but also contain minor areas of cropland. Soil Conservation Service management practices indicated for these associations include improvement of soil fertility (particularly nitrogen fertilization), reduction of erosion, reduction of surface wetness, and return of crop residue to the soil. The suitability of these associations for wildlife is considered to be "suited" to "well-suited" (Reasoner 1974).

Climate

McCurtain County is well known for its humid climate. Seasonal changes are gradual; summers are hot and humid; and winters are mild. The mean minimum temperature for July is 20 C and the mean maximum temperature is 34 C. In January, the mean minimum temperature is -1 C and the mean maximum temperature is 12 C. Freezing temperatures occur on an average of 65 days per year, whereas temperatures above 31 C occur on an average of 94 days per year (Reasoner 1974).

Average annual precipitation in the study area is 137.2 cm. The area is characterized by rainfall of high intensity, whereas snowfall is generally light. About 5 to 10 cm of snow falls each year; it seldom remains on the ground for more than two days. The greatest amount of rainfall is usually recorded in the spring; autumn is the driest season (Reasoner 1974). The heavy rainfall in the area contributes to soil deficiencies and forage deterioration through erosion, leaching, and weathering (Lindzey 1951). The nutritional value of the forage is undoubtedly affected by this excessive amount of rainfall.

The precipitation for 1974-1975, the duration of the present study, was above average (Fig. 3). Precipitation of 180.8 cm was recorded during the year of the study in contrast to the 29-year average of 137.2 cm (Meteorological Data, Carnasaw Tower, Broken Bow, Oklahoma).

The monthly temperatures during the study year resembled the maximum and minimum average monthly temperatures recorded in the 29-year average (Fig. 4).

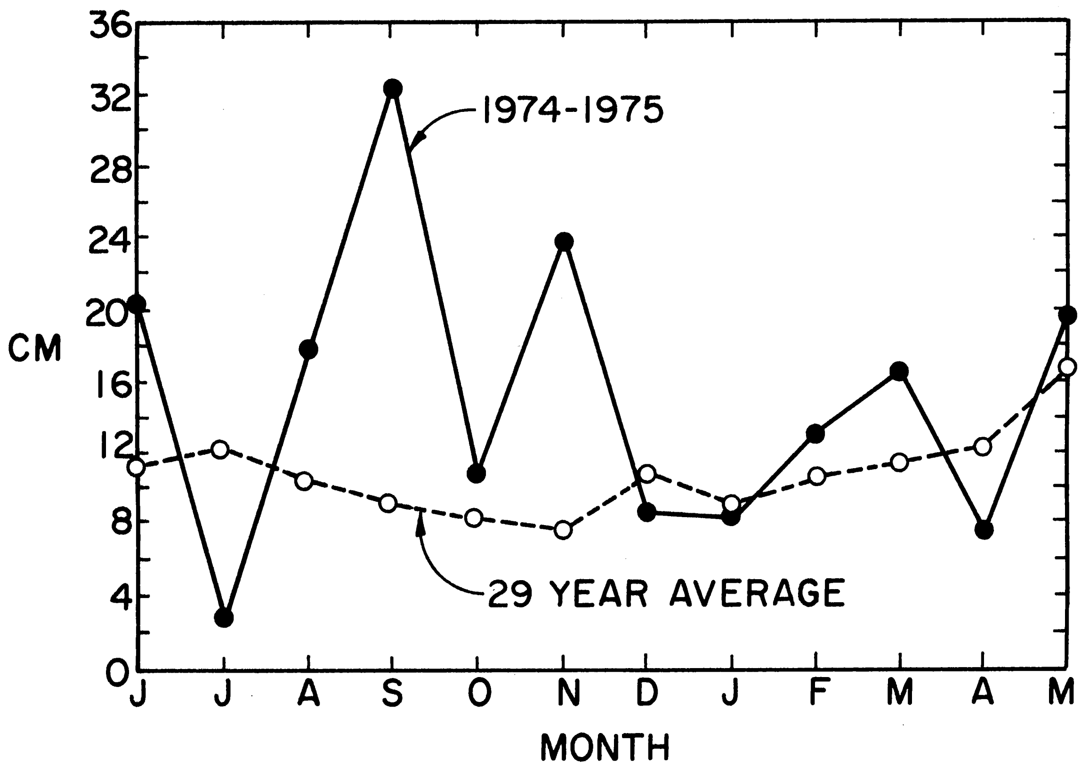


Fig. 3. Recorded precipitation in McCurtain County

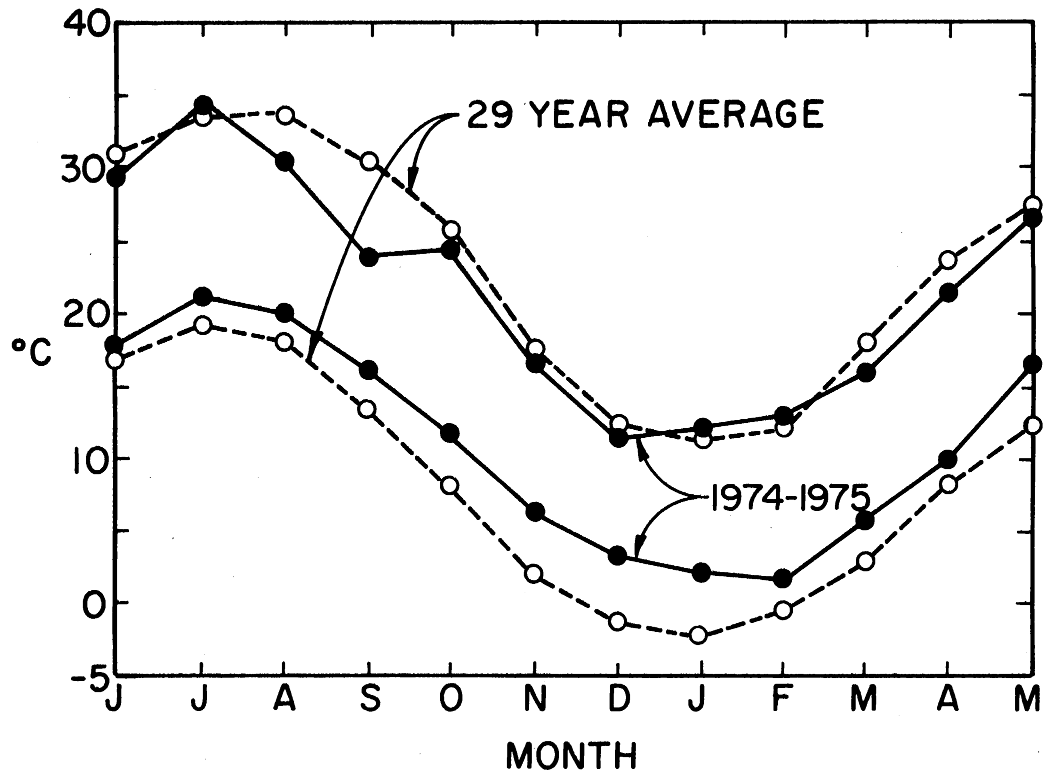


Fig. 4. Recorded maximum and minimum temperatures in McCurtain County

Vegetational Association

The principal forest growth in the selective-cut is mixed oak-pine. The white oak (Quercus alba L.) is considered to be the climax type for this region (Little and Olmstead 1931). Except for Nuttall wildindigo (Baptisia nuttalliana Small) and highbush blackberry (Rubus ostryifolius Rydb.) plant nomenclature follows that of Gray (Fernald 1950). Small (1903) was the authority for these two nomenclatural exceptions.

The principal trees occupying the selective-cut are white oak, black oak (Quercus velutina Lam.), shortleaf pine (Pinus echinata Mill.), hickory (Carya spp.), sweetgum (Liquidambar styraciflua L.), blackgum (Nyssa sylvatica Marsh.), red maple (Acer rubrum L.), and elm (Ulmus spp.). Woody midstory vegetation includes oak (Quercus spp.), winged elm (Ulmus alata Michx.), hickory, flowering dogwood (Cornus florida L.), American beautyberry (Callicarpa americana L.), farkleberry (Vaccinium arboreum Marsh.), hawthorn (Crataegus spp.), and American holly (Ilex opaca Ait.). Common deerberry (Vaccinium stamineum L.) and lowbush blueberry (Vaccinium vacillans Torr.) occur in large quantities in the understory. There is little herbaceous ground cover in the selective-cut, although various panic grasses (Panicum spp.) grow in irregularly occurring, small stands.

Predominating in the clearcuts are the planted loblolly pines. However, white oak, black oak, blackgum, sweetgum, winged elm, hickory, dwarf sumac (Rhus copallina L.), smooth sumac (Rhus glabra L.), highbush blackberry, St. Andrews cross (Ascyrum hypericoides L.), and numerous composites are also abundant. The woody plants in the clearcut mostly represent resprout stems. At the beginning of the study, bluestem broomsedge (Andropogon virginicus L.) was scarcely present; at the close of the study it appeared to be second in abundance only to the pine. At the beginning of this study, herbaceous vegetation, notably the composites, dominated the clearcut. At the close of the study, with the exception of broomsedge, woody species were beginning to outnumber herbaceous species (Dr. Ted Silker, personal communication, 1975). In addition, species which at the beginning of the study were found only in the selective-cut, were beginning to appear in the clearcut. This successional trend was noticed especially in common deerberry, American holly, lowbush blueberry, and flowering dogwood.

Game and Livestock Use

McCurtain County is considered to have some of the best white-tailed deer habitat in the state. Systematic studies of the white-tailed deer have shown the deer of southeastern Oklahoma to be Odocoileus virginianus macrourus (Lindzey 1951). The heaviest concentration of these deer occurs in the Ouachita Highlands, north of the study area. The Coastal-Plain area east of Eagletown has a resident herd of low density. The deer in this part of the state are physically small. One factor contributing to this small size is the subspecies of deer. However, it is suspected that the low nutrient quality of the forage, especially in certain seasons of the year, contributes to this small size (Lindzey 1951).

Livestock roam the study area freely because an essentially open-range grazing system still exists in this part of the state. The Weyerhaeuser Company has made some attempt to control indiscriminate cattle grazing, and it is expected that in the future some type of regulatory system will be implemented.

CHAPTER III

METHODS AND PROCEDURES

Species Selection

The plant species and the parts of plants selected for analysis in this study are listed in Table 1. Since this study was designed to compare the nutritional quality of plants in clearcuts to those in selective-cuts, it was important to analyze the most-abundant species, even though in some cases their value as deer forage might be low (Martin et al. 1951; Lay 1956, 1967; Halls 1970, 1973). Moreover, it was important to obtain sufficient sampling of species occupying both clearcut and selective-cut plots. Quantitative measurements of species abundance and density were not included within the scope of this study, therefore, a subjective evaluation of species abundance was made by a field reconnaissance of the study area. However, these quantitative measurements are being made in a concurrent study being conducted by the Forestry Department at Oklahoma State University (O.S.U.) (Silker 1973).

Because certain species were abundant in only one or the other of the two treatments, either clearcut or selective-cut, the same species was not always collected from both. Although the influence of clearcut and selective-cut growing conditions could not be compared in these cases, variations in seasonal nutritional values were recorded.

Table 1. Plant species collected for nutritional analysis

Scientific Name	Common Name	Plant Part(s) Analyzed	Amount of Terminal Growth Collected (cm) per Month
Clearcut-Selective Areas:			
Baptisia nuttalliana Small	Nuttall wildindigo	Current annual growth	11 cm
Callicarpa americana L.	American beautyberry	Leaf, stem, fruit	11 cm
Carya spp.	Hickory	Leaf	11 cm
Liquidambar styraciflua L.	Sweetgum	Leaf, stem	11 cm
Pinus taeda L.	Loblolly pine	Current annual growth	11 cm
Smilax rotundifolia L.	Common greenbrier	Leaf, stem	20 cm
Ulmus alata Michx.	Winged elm	Current annual growth	11 cm
Clearcut Area:			
Andropogon virginicus L.	Bluestem broomsedge	Current annual growth	Whole plant
Ascyrum hypericoides L.	St. Andrews cross	Current annual growth	5 cm
Nyssa sylvatica Marsh.	Blackgum	Leaf, stem	11 cm
Panicum lanuginosum Ell.	Woolly panicum	Current annual growth	Whole plant
Rhus copallina L.	Dwarf sumac	Leaf	11 cm
Rhus glabra L.	Smooth sumac	Leaf	11 cm
Rubus ostryifolius Rydb.	Highbush blackberry	Current annual growth	11 cm
Selective Cut Area:			
Cornus florida L.	Flowering dogwood	Leaf, stem	18 cm
Vaccinium arboreum Marsh.	Tree huckleberry	Current annual growth	5 cm
Vaccinium stamineum L.	Common deerberry	Leaf, stem	5 cm

Many authors have developed palatability ratings for deer forages (Lay 1956, Goodrum and Reid 1954, Lay 1967). Table 2 lists the plants sampled in the present study as related to the palatability scale compiled in an east Texas range-appraisal study (Lay 1967). In looking at these palatability ratings for plant species, it must be kept in mind that the true palatability value does not place emphasis on temporary fluctuations such as seasonal changes or sprouting after fire, but instead is an over-all palatability evaluation of the plant species throughout the year. Although it may at times be misleading to draw conclusions regarding the palatability of a certain species in one area from a palatability scale developed at a different geographical location, Lay (1967) indicated that the rating list is generally applicable in southern forests. Signs of deer browsing observed in the present study indicate that browse ratings for plants in McCurtain County are similar to those compiled by Lay.

Sampling Locations

Eight permanent sampling plots were selected on each of the two treatments, clearcut and selective-cut (Fig. 2). On Weyerhaeuser Cutting Number 11151, four sampling plots were selected from the clearcut and four plots were chosen from the adjoining selective-cut. The same procedure was followed for Cutting Number 11179. The sampling plots were located within and around 0.1 ha fenced cattle exclosures established by the O.S.U. Forestry Department for use in their previously mentioned study. In sampling vegetation in the selective-cut treatment, collections were made at least 19.8 m into the forest area to preclude "border effects".

Table 2. Palatability ratings of selected plant species used by white-tailed deer in east Texas[a]

Plant Species	Palatability Rating[b]
Clearcut-Selective Areas:	
Baptisia nuttalliana Small	-
Callicarpa americana L.	2
Carya spp.	3
Liquidambar styraciflua L.	3
Pinus taeda L.	3
Smilax rotundifolia L.	1
Ulmus alata Michx.	2
Clearcut Area:	
Andropogon virginicus L.	-
Ascyrum hypericoides L.	-
Nyssa sylvatica Marsh.	2
Panicum lanuginosum Ell.	-
Rhus copallina L.	3
Rhus glabra L.	2
Rubus ostryifolius Rydb.	1
Selective-Cut Area:	
Cornus florida L.	2
Vaccinium arboreum Marsh.	3
Vaccinium stamineum L.	3

[a]From Lay 1967.

[b]1 = first choice; 2 = second choice; 3 = third choice; - = no rating given.

Experimental Design

Samples of each species collected from the eight clearcut plots were composited monthly. Samples for the eight selective-cut plots were likewise composited monthly for each species. For those plant species collected from both treatments, comparisons of treatments and seasonal changes in nutritional parameters were defined. For plant species collected from only one of the two treatments, only seasonal changes in nutritional values were noted.

Sampling Dates and Techniques

The study period, June 1974 to May 1975, included 11 monthly collections, and provided data on nutritional characteristics for one annual cycle. Samples were not collected for the month of January 1975 because rainfall hampered access to the study area. Plants were sampled from each treatment in the last half of each month. In order to obtain field dry-matter values, samples were not collected during periods of rainfall or during early morning dew.

Nutritional values are expressed for each month, as it has been found that fluctuations occur not only seasonally but also monthly (Hellmers 1940). However, in analyzing the data from this study, seasonal trends in nutritional values were noted. Therefore, in discussion, seasonal names are utilized. Spring includes the months of March, April, and May; summer includes June, July, and August; fall includes September, October, and November; and winter includes December, January, and February.

For each treatment, collection of plants for monthly analysis involved removing stems, and leaves if present, of current annual growth. At least 25 plants of each species were sampled monthly for each treatment. No more than two stems were taken from any one plant during a sampling month. Care was taken to avoid sampling the same plant each month. In order to approximate browsing height of deer, samples were collected below the height of 1.6 m. The amount of the current annual growth collected varied with the plant species (Table 1).

Samples collected from each treatment were identified as to plant species, weighed, bagged, labeled as to treatment, and transported to O.S.U. In the laboratory, each sample was ovendried at 65 C, weighed, and ground through a 1-mm screen in a Wiley mill. Each ground sample was then mixed thoroughly and stored in a labeled polyethylene bottle until analysis.

Nutritional Parameters and Methods of Analysis

Chemical analyses for the collections made during the annual period, using standard procedures described by the Association of Official Agricultural Chemists (1960), included evaluations of field dry-matter, total mineral matter, calcium, phosphorus, and crude protein. In vitro dry matter digestibility (IVDMD) was estimated using bovine rumen liquor and pepsin following the two-stage procedure of Tilley and Terry (1963).

Field Dry-Matter

After collection each month, plant samples were dried at 65 C in a forced-draft oven. Upon attaining a constant weight, the samples were allowed to equilibrate in the atmosphere, re-weighed, and their field dry-matter value was calculated (A.O.A.C. 1960). Field dry-matter values were determined for the whole plant for each sample except American beautyberry. For this sample, fruit, when present, was removed before weights were taken.

Ovendry Matter

After being ground, a 1-g plant sample was weighed in a porcelain crucible and dried in an oven at 105 C overnight. After cooling, the sample was re-weighed and the 105 C dry-matter value was calculated (A.O.A.C. 1960). All chemical analyses are reported on a 105 C ovendry basis in order to compensate for differences in the moisture content of the plants.

Total Mineral Matter

Almost all of the mineral matter present in plant matter is recovered upon ignition of the material in a high-temperature furnace. After undergoing the 105 C dry-matter determination, the aliquot of oven-dried plant material was dry ashed in a muffle furnace at 580 C for 4 hours. Upon cooling, the sample was re-weighed and the total mineral matter content was calculated (A.O.A.C. 1960).

Calcium and Phosphorus

The ashed material from the total mineral matter determination was digested in hydrochloric acid, filtered, and stored in a plastic test tube until analysis for the individual mineral was performed. Calcium concentrations for the samples were measured through the use of atomic absorption spectroscopy. Phosphorus interference in the calcium analysis was eliminated by the addition of lanthanum (A.O.A.C. 1960). Phosphorus concentrations were measured through spectrophotometric determination of phosphorus as molybdenum blue (A.O.A.C. 1960).

Crude Protein

Crude protein includes both protein and nonprotein nitrogen. Since nitrogen occurs in the different proteins in a fairly constant percentage, 16 percent, for feeds in general, crude protein is calculated by dividing the nitrogen percentage found in the forage by 0.16. The macro-kjeldahl procedure for measuring crude protein levels was utilized in this study (A.O.A.C. 1960), using a 1-g plant sample.

In Vitro Dry Matter Digestibility (IVDMD)

Digestibility was determined by the IVDMD technique developed by Tilley and Terry (1963). In this procedure, a 0.4-g sample was incubated for a 48-hour period in bovine rumen liquor and artificial nutrient buffer then digested for a 48-hour period in a pepsin-hydrochloric acid solution. The amount of dry matter disappearing after both periods is considered to have been digested.

For this study, the rumen inoculum donor was a hereford-angus steer. Prior to collection of rumen fluid, the steer was maintained on a medium to high-roughage diet. This diet is considered compatible in maintaining a rumen microflora suitable for estimating forage digestion by deer (R. L. Cowan, Animal Nutritionist, Pennsylvania State University, personal communication). Since steer rumen inoculum instead of deer rumen inoculum was utilized for determining the

IVDMD, it cannot be stated that the digestibility percentages would be directly applicable to white-tailed deer, but comparative differences should be accurate.

Significance of Nutrient Parameters

The nutrient parameters quantitatively measured in this study have long been used in successfully evaluating the nutritional value of forages. In evaluating nutritional qualities of potential deer forages, undue emphasis should not be placed on any single nutrient or any single species or plant part. Literature on forage selection indicates that animals not only make definitive selections of forage plants and plant parts, but also choose species that are particularly nutritious (Swift 1948, Weir and Torell 1959, Longhurst et al. 1968). Therefore, one plant need not contain all nutrients at essential levels. If there are plants available with the essential nutrients, the deer may adjust their foraging habits to maximize nutritional quality in their diets.

Field Dry-Matter

Field dry-matter values indicate the percentage of moisture in the plant which is available to the animal. With advancing seasonal maturity, the moisture content of plants generally decreases. This decrease in moisture, as related to seasonal maturity, is also accompanied by a decrease in crude protein, phosphorus, and IVDMD (Cook and Harris 1950).

Moisture requirements for the white-tailed deer are not known. However, white-tailed deer are thought to require a dry-matter intake of feed per day that is approximately 2 to 5 percent of their body weight

(French et al. 1955, Dahlberg and Guettinger 1956). In the spring if lush, watery feeds are abundant, the high moisture level and bulkiness of feeds may limit intake of dry matter. Consequently, even though nutrient levels are highest during this season, an animal may not be able to consume sufficient quantities of forage to obtain adequate nutrients to meet its energy requirements (Dietz 1970).

Total Mineral Matter

Total mineral matter is the proportion of the plant consisting of minerals. This proportion gives no indication of type or quantity of individual minerals contained in the plant. However, total mineral matter values, when monitored over several sampling periods, may be used to indicate variability between the same species collected from different treatment areas.

Calcium and Phosphorus

Calcium and phosphorus are dietary essentials for the ruminant. The major function of these minerals is to form skeletal material (Halls 1970). Adequate calcium and phosphorus nutrition is dependent on three interrelated factors: a sufficient supply of each, a suitable ratio between the two, and the presence of vitamin D (Maynard and Loosli 1969). If an adequate supply of calcium and phosphorus is present, the ratio between the two elements determines how effectively the calcium and phosphorus are utilized. A desirable calcium to phosphorus ratio is between 1:2 to 2:1 (Halls 1970). Adequate nutrition, however, is possible outside these limits. The factor which makes calcium and phosphorus nutrition effective outside these ratios is the presence of vitamin D. If an adequate supply of vitamin D is available, the calcium to phosphorus ratio becomes less important and calcium and phosphorus present can be utilized more effectively. But if vitamin D is absent, calcium and phosphorus metabolism is inhibited no matter what the calcium to phosphorus ratio is (Maynard and Loosli 1969).

Calcium and phosphorus requirements for big game appear to equal or exceed those established for livestock (Halls 1970). Although the exact requirements for white-tailed deer have not yet been determined, Magruder et al. (1957) found best survival for three-year-old male white-tailed deer on rations containing 0.25 percent phosphorus and 0.30 percent calcium. Best antler growth was obtained with a ration containing 0.56 percent phosphorus and 0.64 percent calcium (Magruder et al. 1957). Despite these requirements, it is important to note that many white-tailed deer on southern forest ranges do survive on browse that contains much less than the recommended 0.25 percent of phosphorus (Blair and Halls 1968, Halls et al. 1957).

Protein

Protein is often considered to be the most critical nutrient for an animal, being needed for the formation of new cellular material. A serious deficiency of this nutrient results in eventual failure of body function. Even a slight deficiency adversely affects body growth, reproduction, and lactation (Morrison 1957). In addition to this need for amino acids in tissue metabolism, rumen microorganisms require ammonia to digest and metabolize carbohydrates and fats (Dietz (1970).

The optimum dietary protein level for white-tailed deer depends greatly upon the sex and age class of the deer (Murphy and Coates 1966, Ullrey et al. 1967). Protein requirements for adult, non-lactating white-tailed deer are said to be 13 to 16 percent for optimum growth and 6 to 7 percent for body maintenance (French et al. 1955). If protein levels fall below this 6 to 7 percent, rumen function is seriously impaired. However, very high protein levels are not only unnecessary, but are inefficient for ruminant animals (Dietz 1970). As noted for calcium and phosphorus levels, protein levels in southern browse fall below the recommended level for sustaining optimum deer body growth during much of the year (Halls et al. 1957, Blair and Halls 1968).

Since crude protein content is significantly correlated to digestible protein content, determination of the crude protein content of a plant can give a reasonably reliable indication of its feeding value (Sullivan 1962).

In Vitro Dry Matter Digestibility (IVDMD)

This technique for determining the digestibility of forage is useful for evaluating relative differences in digestibilities. The technique is particularly meaningful in white-tailed deer nutrition because of the large number of plant species and combinations of species utilized by the animal.

A problem arising in evaluating results of *in vitro* analysis of forages is the difference in magnitude of results between *in vitro* and *in vivo* digestion conditions. Although the IVDMD technique does imitate phenomena occurring in the rumen, the numerical values do not necessarily correspond to those values obtained *in vivo*. Therefore, IVDMD alone cannot precisely predict *in vivo* digestibility. Furthermore, the relationship between *in vivo* and *in vitro* digestibility may change depending on plant species, stage of maturity, protein level, mineral levels, and other complex factors. Digestibility can be predicted from *in vitro* values alone only after *in vivo* and *in vitro* determinations have been compared to calibrate these variable conditions.

If care is exercised in evaluating these results, however, the IVDMD does have merit. The digestibility values obtained through the *in vitro* technique are a relative reflection of forage quality. *In vitro* values can be used to compare relatively the digestibility of a particular species throughout the season. Plants of the same species, collected from different areas or at different dates, can be compared relatively, if *in vitro* digestibility determinations are made at the same time.

With *in vitro* determinations, care must also be taken in extrapolating from one animal species to another. Because of the difficulty encountered in obtaining and maintaining white-tailed deer rumen inoculum, many *in vitro* studies have been conducted utilizing rumen inoculum from a bovine. Robbins et al., in a study conducted in 1975, found that IVDMD depended on the inoculum source (deer vs. cow). The previous diet of the donor animal was also found to affect *in vitro* values. Most important, in relation to deer nutrition studies, was the finding that *in vitro* browse digestibility values using rumen inoculum from a fistulated cow on a standard forage were lower than *in vivo* digestibility values from white-tailed deer on the same forage.

Table 3 is a formulation of nutrient percentage ranges applicable to the white-tailed deer developed by Urness et al. (1971). Although the range of nutrient percentages presented should not be taken as absolute, the percentages do serve as a guide in evaluating forages in terms of meeting recommended nutrient requirement levels for the white-tailed deer.

Table 3. Recommended levels of nutrient percentages for deer forages[a]

Nutrient	Range of Nutrient Percentages			
	Excellent	Good	Fair	Poor
Protein	12	10-12	7-10	7
Calcium	0.20-0.50	0.50-1.00	1.00-1.50	1.50
Phosphorus	0.30	0.25-1.00	0.16-0.25	0.16
Ca:P Ratio	1:2-2:1	2:1-3:1	3:1-5:1	5:1
In Vitro Dry Matter Digestibility	50	40-50	30-40	30

[a]From Urness et al. 1971.

CHAPTER IV

RESULTS AND DISCUSSION

The monthly chemical analyses provide an estimate of the nutritional value of the forage. But, it should be noted that selectivity by deer was not measured in this study and, hence, these data must be used cautiously when attempting to predict health, performance, or nutritional status of indigenous deer. Blair and Epps (1967) showed a significant difference in nutritional quality of forage due to the amount of forage plant sampled. They found that the terminal 2.54 cm of rusty blackhaw (Viburnum rufidulum L.) contained 40 percent more crude protein than did the second 2.54 cm segment back from the terminal part, and the second segment contained 20 percent more than the third 2.54 segment. In addition, the nutrient data derived from chemical analysis of forage may not indicate the amount of a particular nutrient actually available for utilization by the animal. Interactions occurring between forage parameters may increase or decrease the availability of one or both nutrient components. However, the results derived from this study do provide insight into the relative qualities of plant species studied and the seasonal changes in their nutritional value.

In this study, nutrient levels for the plant species and treatments were compared in terms of the recommended nutrient ranges presented in Table 3 and the specific recommended nutrient levels presented in Chapter III.

Species on Clearcut and Selective-cut Treatments

Seven plant species were collected for chemical analysis from both clearcut and selective-cut treatments for the entire study period. These species were: winged elm, loblolly pine, common greenbrier, American beautyberry, sweetgum, hickory, and Nuttall wildindigo.

Winged Elm

Leaves and stems of winged elm were composited within each treatment monthly. Leaf fall occurred in November in this species; thus, only stems were analyzed in November, December, and February. Results of monthly nutrient analyses are presented in Table 4.

Field dry-matter values ranged from 33.91 percent to 67.50 percent in clearcut and from 28.57 to 83.33 percent in selective-cut. Values were generally lowest in the spring in both treatments. Field dry-matter values increased from spring through late winter.

Total mineral matter values ranged from 3.63 percent to 8.13 percent in clearcut and from 4.60 to 9.58 percent in selective-cut. The lowest mineral matter values occurred in November, December, and February in both treatments. This corresponded to the sampling months in which only stems were collected.

Calcium ranged from 0.90 percent to 1.52 percent in clearcut and from 1.02 percent to 1.77 percent in selective-cut (Fig. 5A). Calcium levels in winged elm in both treatments exceeded the recommended 0.30 percent for deer forage (Magruder et al. 1957).

Phosphorus percentages ranged from 0.15 percent to 0.82 percent in

Table 4. Comparison of monthly nutritional values, in percent dry matter, of winged elm (*Ulmus alata* Michx.) from clearcut and from selective-cut areas

Nutritional Parameter	Area	1974							1975			
		June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Feb.	March	April	May
Field Dry Matter	C	55.34	66.67	60.38	51.82	56.82	64.29	57.14	67.50	49.35	33.91	47.13
	S	46.73	62.75	57.41	57.69	53.85	83.33	55.17	64.86	28.57	32.76	44.12
Total Mineral Matter	C	8.03	7.45	6.31	6.99	8.13	4.81	3.63	3.86	6.63	7.06	7.66
	S	7.72	8.35	8.08	8.36	9.58	4.86	4.60	5.40	8.98	7.28	8.38
Calcium	C	1.36	1.14	1.27	1.24	1.41	1.17	0.90	0.93	1.52	1.07	1.48
	S	1.55	1.36	1.52	1.48	1.77	1.20	1.02	1.10	1.17	1.27	1.53
Phosphorus	C	0.24	0.15	0.20	0.29	0.33	0.26	0.19	0.17	0.82	0.52	0.41
	S	0.15	0.12	0.11	0.11	0.19	0.19	0.21	0.16	0.83	0.31	0.21
Ca: P Ratio	C	5.7:1	7.6:1	6.4:1	4.3:1	4.3:1	4.5:1	4.7:1	5.5:1	1.9:1	2.1:1	3.6:1
	S	10.0:1	11.3:1	13.8:1	13.5:1	9.3:1	6.3:1	4.9:1	6.9:1	1.4:1	4.1:1	7.3:1
Crude Protein	C	8.67	9.85	10.66	11.16	10.68	7.20	6.11	6.71	18.47	19.75	12.18
	S	8.45	9.20	9.39	8.76	8.05	5.99	5.95	5.94	29.24	16.69	13.47
In Vitro Dry Matter Digestibility	C	43.85	40.39	43.66	46.60	48.04	39.23	33.29	37.19	51.78	63.60	39.89
	S	45.89	43.12	40.65	40.80	46.32	36.13	34.06	34.78	71.34	54.37	43.52

C = Clearcut

S = Selective-cut

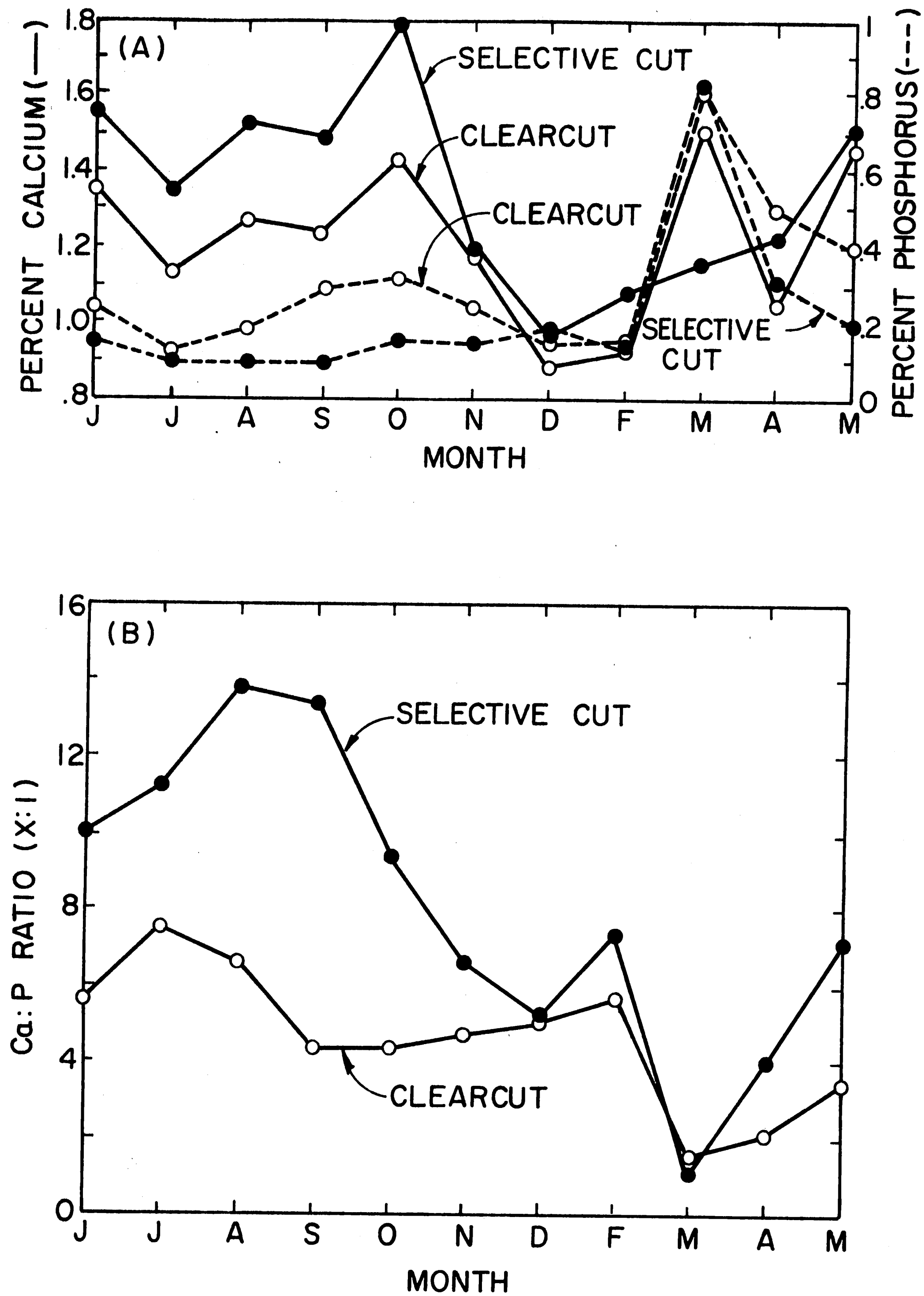


Fig. 5. Monthly trends in (A) Ca and P, and (B) Ca:P ratio of winged elm current annual growth

clearcut and from 0.11 percent to 0.83 percent in selective-cut (Fig. 5A). The clearcut treatment approached the recommended phosphorus level of 0.25 percent (Magruder et al. 1957) in seven of the sampling periods, whereas the selective-cut treatment met recommended levels in March and April only.

Ca:P ratios ranged from 1.9:1 to 7.6:1 in clearcut and from 1.4:1 to 13.8:1 in selective cut (Fig. 5B). Except in March and April in the clearcut and in March in the selective-cut, Ca:P ratios exceeded those recommended (Halls 1970). The high calcium and low phorphorus levels in the selective-cut led to very high Ca:P ratios in this treatment.

Crude protein ranged from 6.11 percent to 19.75 percent in the clearcut and from 5.94 percent to 29.24 percent in the selective-cut (Fig. 6). Crude protein levels met minimum requirements of 6 to 7 percent (French et al. 1955) in the clearcut throughout the year. The selective-cut was only slightly deficient in November, December, and February. The lowest protein values in both treatments occurred in November, December, and February when only stems were present. In both treatments, crude protein approached or exceeded the recommended level for optimum growth (French et al. 1955) during March, April, and May.

IVDMD values ranged from 33.29 percent to 51.78 percent in clearcut and from 34.06 to 71.34 percent in the selective-cut (Fig. 6). The greatest digestibilities occurred in March and April. Digestibility decreased in both treatments during November, December, and February when only stems were present. In winged elm, in general, an increase in digestibility coincided with an increase in crude protein content.

Spring growth in both treatments led to a general decrease in field dry-matter, an increase in phosphorus, a decrease in the Ca:P ratio, an

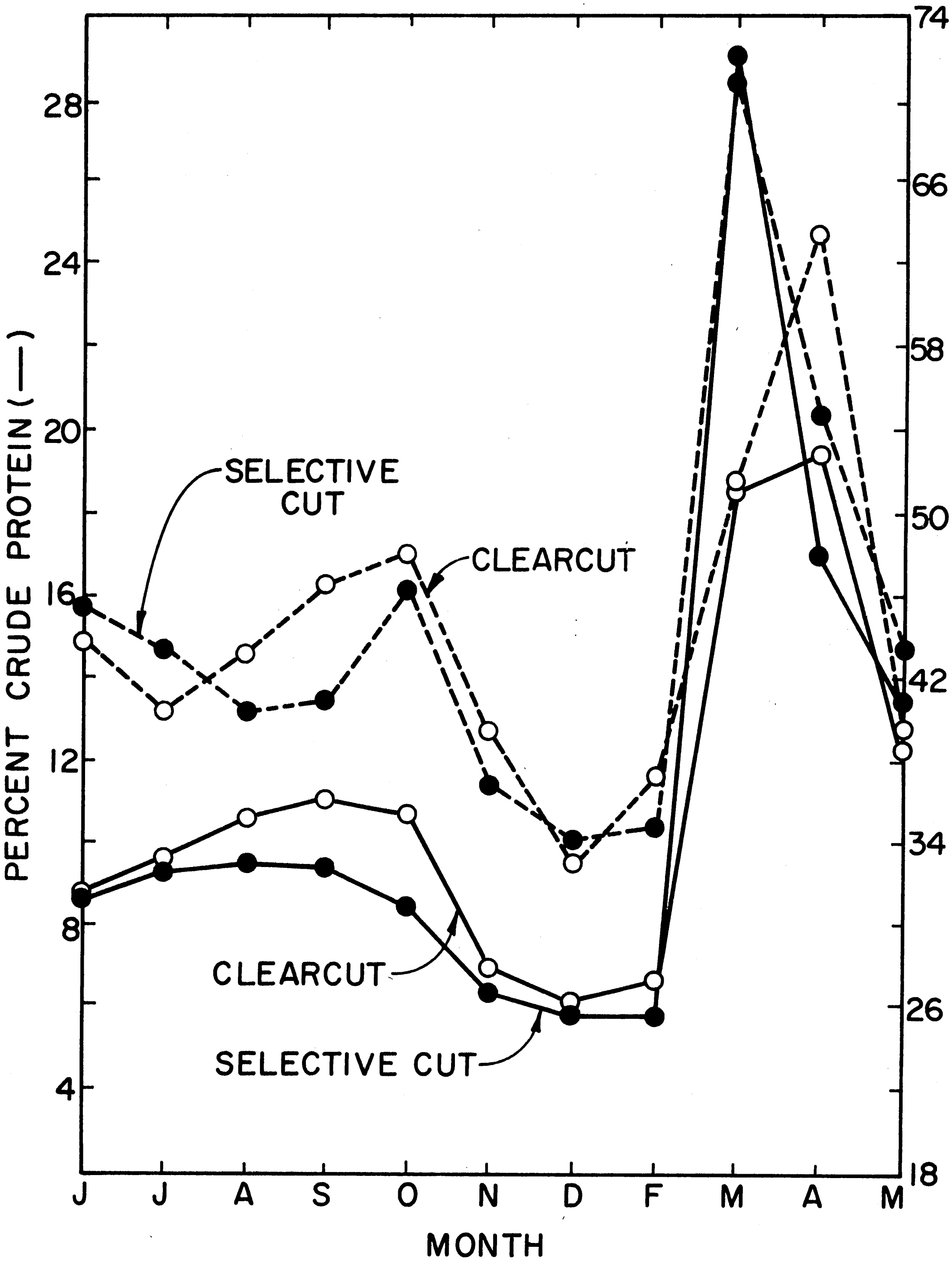


Fig. 6. Monthly crude protein and *in vitro* dry matter digestibility trends of winged elm current annual *growth*

increase in crude protein, and an increase in IVDMD.

In both treatments, November, December, and February, when only stems were present, constituted a period of increased field dry-matter, decreased total mineral matter, decreased calcium, decreased crude protein, and decreased IVDMD.

The two treatments differed with particular respect to calcium and phosphorus percentages, the Ca:P ratio, and crude protein. The selective-cut had a larger spread between calcium and phosphorus percentages than the clearcut. This led to an increased Ca:P ratio for the selective-cut (Fig. 5B). Crude protein levels were generally lower in the selective-cut area with the exception of March and May (Fig. 6). There was no consistent effect of treatment on IVDMD values (Fig. 6).

Loblolly Pine

Leaves and stems of loblolly pine collected were composited within each treatment monthly. Results of monthly nutrient analyses are presented in Table 5.

Field dry-matter values ranged from 19.44 percent to 44.25 percent in the clearcut and from 21.17 to 69.01 percent in the selective-cut. Values were generally lowest in late spring and early summer. Field dry-matter values tended to increase from late spring through the winter months.

Total mineral matter values ranged from 1.95 to 3.74 percent in the clearcut and from 1.93 to 3.37 percent in the selective-cut. Mineral levels in both treatments were stable throughout the year with a slight increase noted in April.

Table 5. Comparison of monthly nutritional values, in percent dry matter, of loblolly pine (*Pinus taeda* L.) from clearcut and from selective-cut areas

Nutritional Parameter	Area	1974							1975			
		June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Feb.	March	April	May
Field Dry Matter	C	30.95	34.90	36.72	31.43	36.16	41.23	40.38	44.25	44.12	19.44	28.72
	S	31.56	33.18	34.68	33.68	36.23	37.37	69.01	44.44	44.17	21.17	28.69
Total Mineral Matter	C	2.95	2.62	2.67	2.37	2.98	2.69	1.95	2.05	2.16	3.74	3.04
	S	2.84	3.10	1.93	2.32	2.68	2.42	2.23	2.26	2.14	3.37	3.08
Calcium	C	0.24	0.24	0.23	0.31	0.38	0.35	0.43	0.40	0.50	0.33	0.33
	S	0.31	0.28	0.28	0.42	0.41	0.41	0.39	0.50	0.41	0.36	0.33
Phosphorus	C	0.24	0.19	0.17	0.24	0.24	0.22	0.23	0.18	0.24	0.44	0.22
	S	0.17	0.13	0.11	0.19	0.18	0.18	0.17	0.27	0.17	0.28	0.19
Ca: P Ratio	C	1.0:1	1.3:1	1.4:1	1.3:1	1.6:1	1.6:1	1.9:1	2.2:1	2.1:1	0.8:1	1.5:1
	S	1.8:1	2.2:1	2.5:1	2.2:1	2.3:1	2.3:1	2.3:1	1.9:1	2.4:1	1.3:1	1.7:1
Crude Protein	C	6.78	7.50	8.22	8.44	10.14	9.04	9.25	9.56	8.96	12.46	9.18
	S	8.57	7.24	7.97	7.77	8.04	8.40	8.18	8.23	7.68	11.98	9.57
In Vitro Dry Matter Digestibility	C	31.65	31.49	31.84	21.42	18.91	22.70	23.18	22.33	31.30	32.32	27.28
	S	33.26	31.31	32.98	25.75	26.52	28.96	27.79	28.58	32.64	35.80	30.51

C = Clearcut

S = Selective-cut

Calcium values ranged from 0.23 percent to 0.50 percent in the clearcut and from 0.28 percent to 0.57 percent in the selective-cut (Fig. 7A). Calcium levels in loblolly pine approached the recommended 0.30 percent level for deer forage (Magruder et al. 1957) in both treatments throughout the year.

Phosphorus values ranged from 0.17 percent to 0.44 percent in the clearcut and from 0.11 percent to 0.28 percent in the selective-cut (Fig. 7A). Phosphorus percentages were generally below the recommended level of 0.25 percent for deer forage (Magruder et al. 1957).

Ca:P ratios ranged from 0.8:1 to 2.2:1 in the clearcut and from 1.3:1 to 2.5:1 in the selective-cut (Fig. 7B). The ratios in both treatments generally met the recommended ratio for deer forages (Halls 1970) throughout the year.

Crude protein values ranged from 6.78 percent to 12.46 percent in the clearcut and from 7.24 to 11.98 in the selective-cut (Fig. 8). Crude protein levels in both treatments remained near the minimum recommended level of 6 to 7 percent for deer forage (French et al. 1955) throughout most of the year. The only variation was an increase in crude protein during April.

Overall IVDMD values were low. Values ranged from 18.91 percent to 32.32 percent in the clearcut and from 25.75 percent to 35.80 percent in the selective-cut (Fig. 8). In both treatments, the highest digestibility values occurred in April. Digestibility decreased in both treatments in the months of September through February. This decrease was particularly evident in the clearcut.

The major seasonal trend was a decrease in field dry-matter values in both treatments in the spring. In addition, a lower Ca:P ratio,

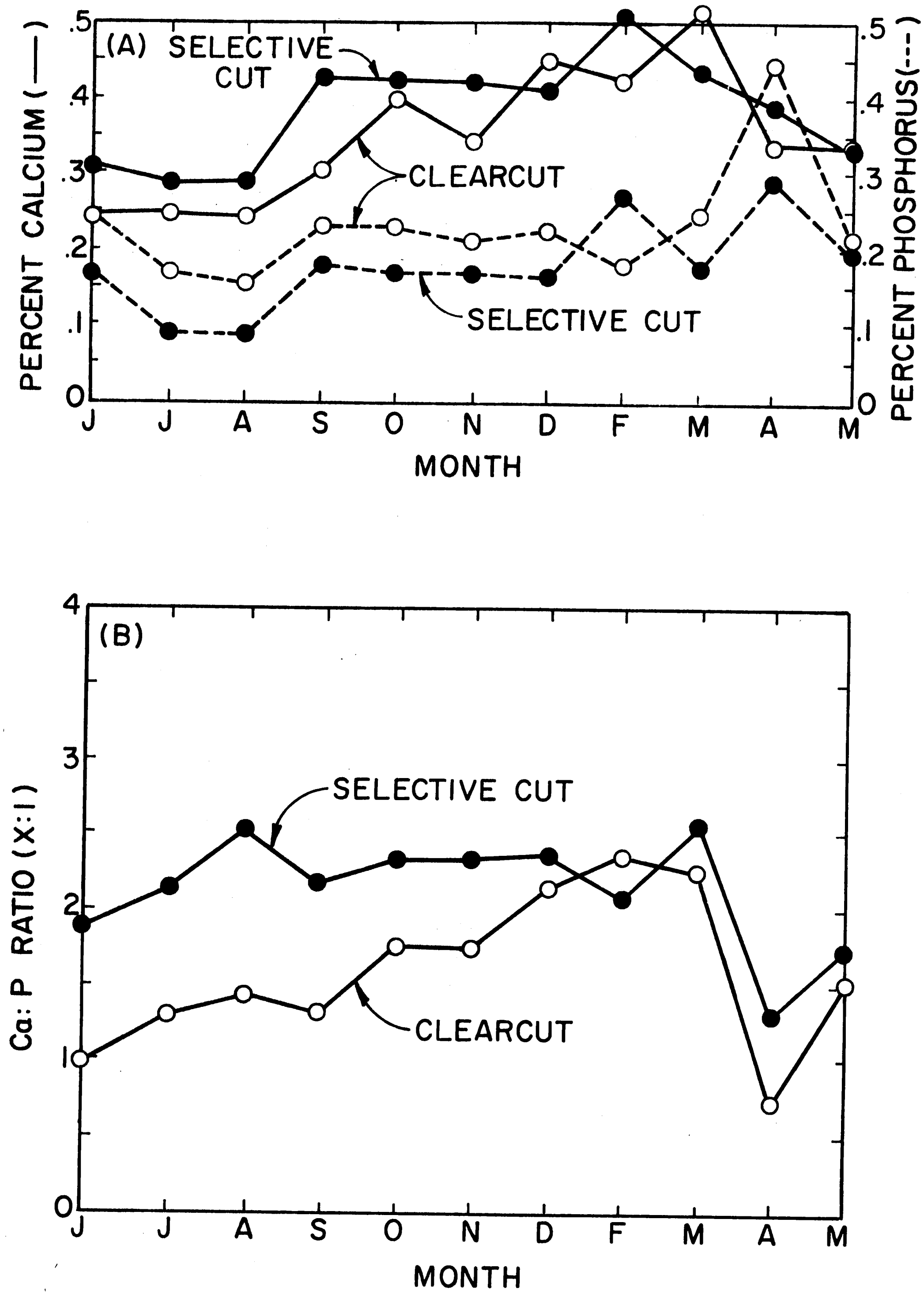


Fig. 7. Monthly trends in (A) Ca and P, and (B) Ca:P ratio of loblolly pine current annual growth

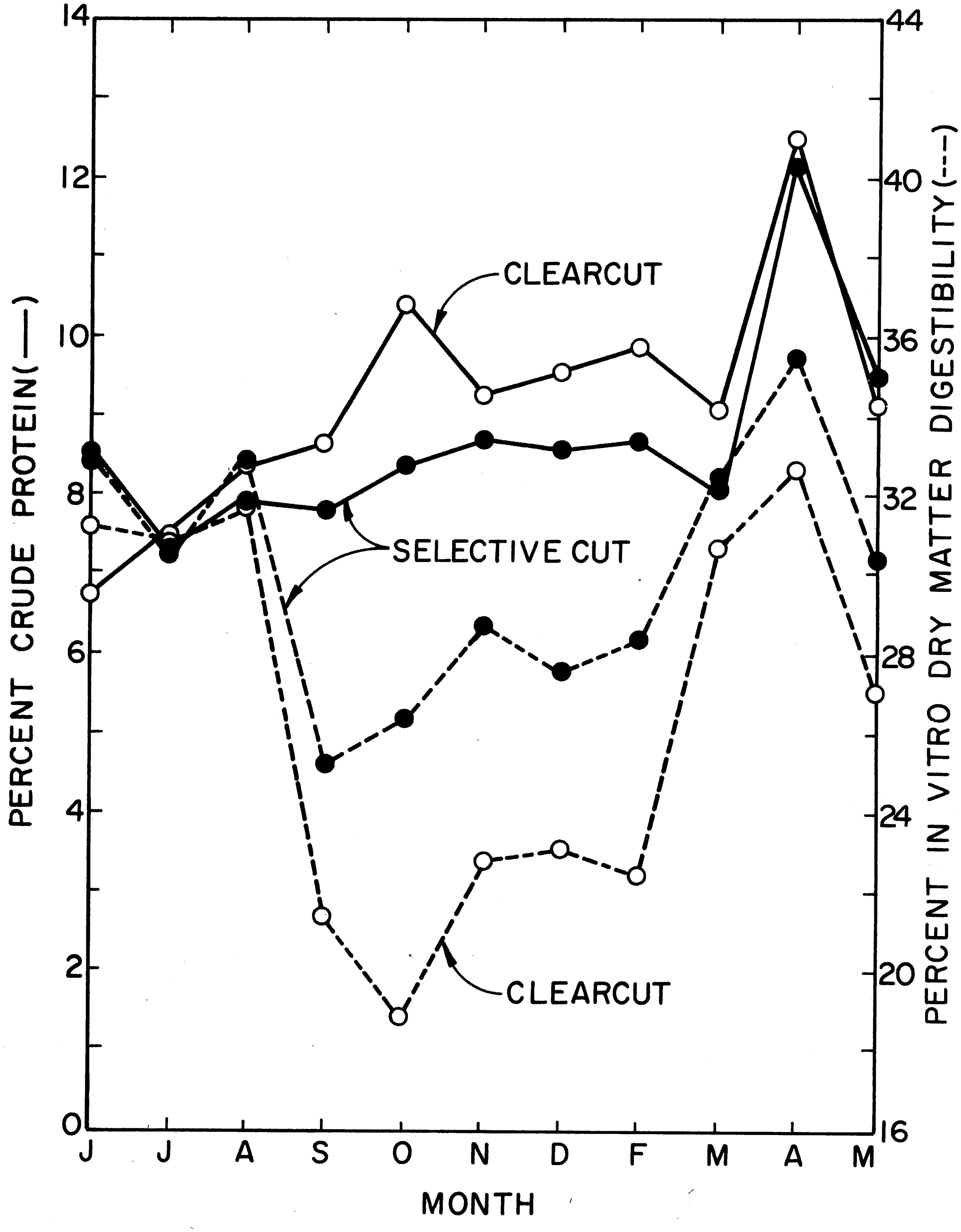


Fig. 8. Monthly crude protein and in vitro dry matter digestibility trends of loblolly pine current annual growth

higher crude protein content, and higher digestibility occurred in both treatments in April.

The two treatments differed with respect to calcium and phosphorus percentages and the Ca:P ratio. The selective-cut had a larger spread between calcium and phosphorus percentages than the clearcut. This led to an increased Ca:P ratio for the selective-cut treatment (Fig. 7B). Crude protein levels were generally higher in the clearcut (Fig. 8), while IVDMD values were higher in the selective-cut (Fig. 8).

Common Greenbrier

Leaves and stems within each treatment were separated for monthly nutritional analysis after field dry-matter values were determined. Leaf-fall occurred in November in the selective-cut and in December in the clearcut. Spring leaf-out occurred in both treatments in April. Results of monthly nutritional analyses are presented in Table 6.

Field dry-matter values ranged from 17.05 percent to 59.43 percent in the clearcut and from 22.73 percent to 56.94 percent in the selective-cut. Values were lowest in April.

Total mineral matter values in leaves ranged from 3.64 percent to 6.39 percent in clearcut and from 4.40 percent to 6.34 percent in the selective-cut. Values of stems ranged from 1.69 percent to 5.59 percent in clearcut and from 2.24 percent to 3.60 percent in selective-cut.

Calcium values in leaves ranged from 0.58 percent to 1.13 percent in clearcut and from 0.70 percent to 1.63 percent in selective-cut (Fig. 9A). Values were all above the recommended 0.30 percent for deer forage (Magruder et al. 1957). The lowest values for both treatments occurred in spring and generally increased through the year.

Table 6. Comparison of monthly nutritional values, in percent dry matter, of common greenbrier (*Smilax rotundifolia* L.) from clearcut and from selective-cut areas

Nutritional Parameter	Area and Plant Part		1974 June	July	Aug.	Sept.	Oct.	Nov.	Dec.	1975 Feb.	March	April	May
Field Dry Matter		C	44.33	59.43	53.97	48.41	44.87	53.41	48.48	57.58	57.50	17.05	39.32
		S[a]	35.86	38.68	38.89	41.11	38.24	39.29	48.33	54.35	54.35	56.94	31.75
Total Mineral Matter	L	C	4.83	4.51	4.96	4.48	4.78	4.60	---	---	---	6.39	3.64
		S	5.87	5.44	6.16	5.51	6.34	---	---	---	---	4.40	4.89
	S[b]	C	3.53	2.50	1.69	2.48	2.73	2.30	1.72	1.86	2.17	5.59	2.07
		S	3.60	3.53	2.69	3.35	2.88	2.81	2.43	2.30	2.24	3.16	2.89
Calcium	L	C	0.90	0.92	1.00	1.13	1.03	1.02	---	---	---	0.58	0.74
		S	1.20	1.27	1.12	1.63	1.41	---	---	---	---	0.70	1.05
	S	C	0.22	0.20	0.20	0.37	0.28	0.31	0.17	0.42	0.44	0.31	0.26
		S	0.33	0.29	0.23	0.39	0.35	0.44	0.50	0.49	0.27	0.28	0.31
Phosphorus	L	C	0.13	0.12	0.11	0.22	0.22	0.18	---	---	---	0.69	0.15
		S	0.14	0.10	0.11	0.18	0.18	---	---	---	---	0.35	0.32
	S	C	0.14	0.08	0.10	0.17	0.18	0.20	0.15	0.16	0.18	0.45	0.19
		S	0.12	0.09	0.10	0.17	0.18	0.16	0.12	0.15	0.17	0.23	0.20
Ca: P Ratio	L	C	6.9:1	7.7:1	9.1:1	5.1:1	4.7:1	5.7:1	---	---	---	0.8:1	4.9:1
		S	8.6:1	12.7:1	10.2:1	9.1:1	7.8:1	---	---	---	---	2.0:1	3.3:1
	S	C	1.6:1	2.5:1	2.0:1	2.2:1	1.6:1	1.6:1	1.1:1	2.6:1	2.4:1	0.7:1	1.4:1
		S	2.8:1	3.2:1	2.3:1	2.3:1	1.9:1	2.8:1	4.2:1	3.3:1	1.6:1	1.2:1	1.6:1
Crude Protein	L	C	8.93	10.14	9.26	9.64	11.49	9.46	---	---	---	26.42	10.85
		S	11.43	9.89	10.78	9.82	10.23	---	---	---	---	14.89	11.95
	S	C	4.11	4.21	4.12	4.95	9.95	6.74	5.24	7.37	7.99	14.25	5.98
		S	4.84	4.21	4.77	5.25	6.85	6.48	6.08	6.57	7.03	8.64	5.00

Table 6 (Continued)

Nutritional Parameter	Area and Plant Part		1974							1975			
			June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Feb.	March	April	May
In Vitro Dry Matter Digestibility	L	C	63.87	60.55	63.21	60.56	65.85	67.25	---	---	---	81.09	62.81
		S	63.24	63.54	64.56	64.53	60.04	---	---	---	---	73.93	67.08
	S	C	29.98	26.13	29.02	25.72	22.98	24.62	18.84	22.94	25.43	58.94	25.89
		S	25.80	20.45	25.64	20.89	21.91	19.77	20.78	25.37	26.02	42.28	22.97

C = Clearcut

S^a = Selective-cut

L = Leaves

S^b = Stems

--- = Plant part not available

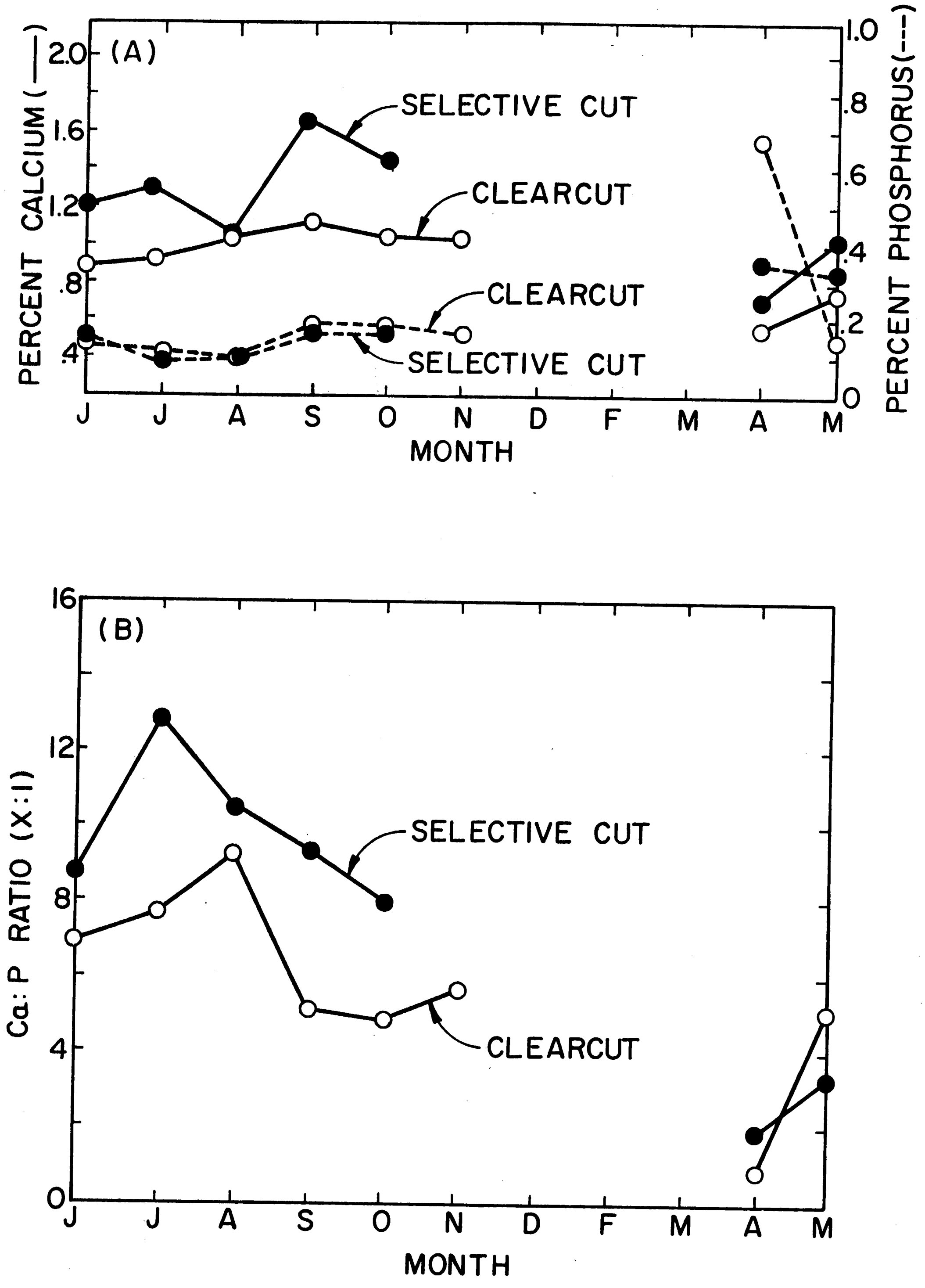


Fig. 9. Monthly trends in (A) Ca and P, and (B) Ca:P ratio of common greenbrier leaves

Calcium values in stems ranged from 0.17 percent to 0.44 percent in clearcut and from 0.23 percent to 0.50 percent in selective-cut (Fig. 10A). Calcium values remained relatively stable in this species, although some decrease occurred in the spring and summer.

Phosphorus values in leaves ranged from 0.11 percent to 0.69 percent in clearcut and from 0.10 percent to 0.35 percent in selective-cut (Fig. 9A). Leaves met the recommended phosphorus level of 0.25 percent for deer forage (Magruder et al. 1957) only in April in the clearcut and only in April and May in the selective-cut.

Phosphorus values in stems ranged from 0.08 percent to 0.45 percent in the clearcut and from 0.09 percent to 0.23 percent in the selective-cut (Fig. 10A). Only in April did clearcut stems meet the recommended phosphorus forage percentage for deer of 0.25 percent (Magruder et al. 1957); otherwise, phosphorus percentages remained low in both treatments throughout the year.

The Ca:P ratio in leaves ranged from 0.8:1 to 9.1:1 in the clearcut and from 2.0:1 to 12.7:1 in the selective-cut (Fig. 9B). Ratios in stems ranged from 0.7:1 to 2.6:1 in the clearcut and from 1.2:1 to 4.2:1 in the selective-cut (Fig. 10B). The lowest ratios in both treatments for both plant parts analyzed occurred in the spring.

Crude protein values for greenbrier leaves ranged from 8.93 percent to 26.42 percent in the clearcut and from 9.82 percent to 14.89 percent in the selective-cut (Fig. 11). Throughout the year, protein values in both treatments met the minimum recommended requirement of 6 to 7 percent for deer forage (French et al. 1955). The highest protein levels occurred in April.

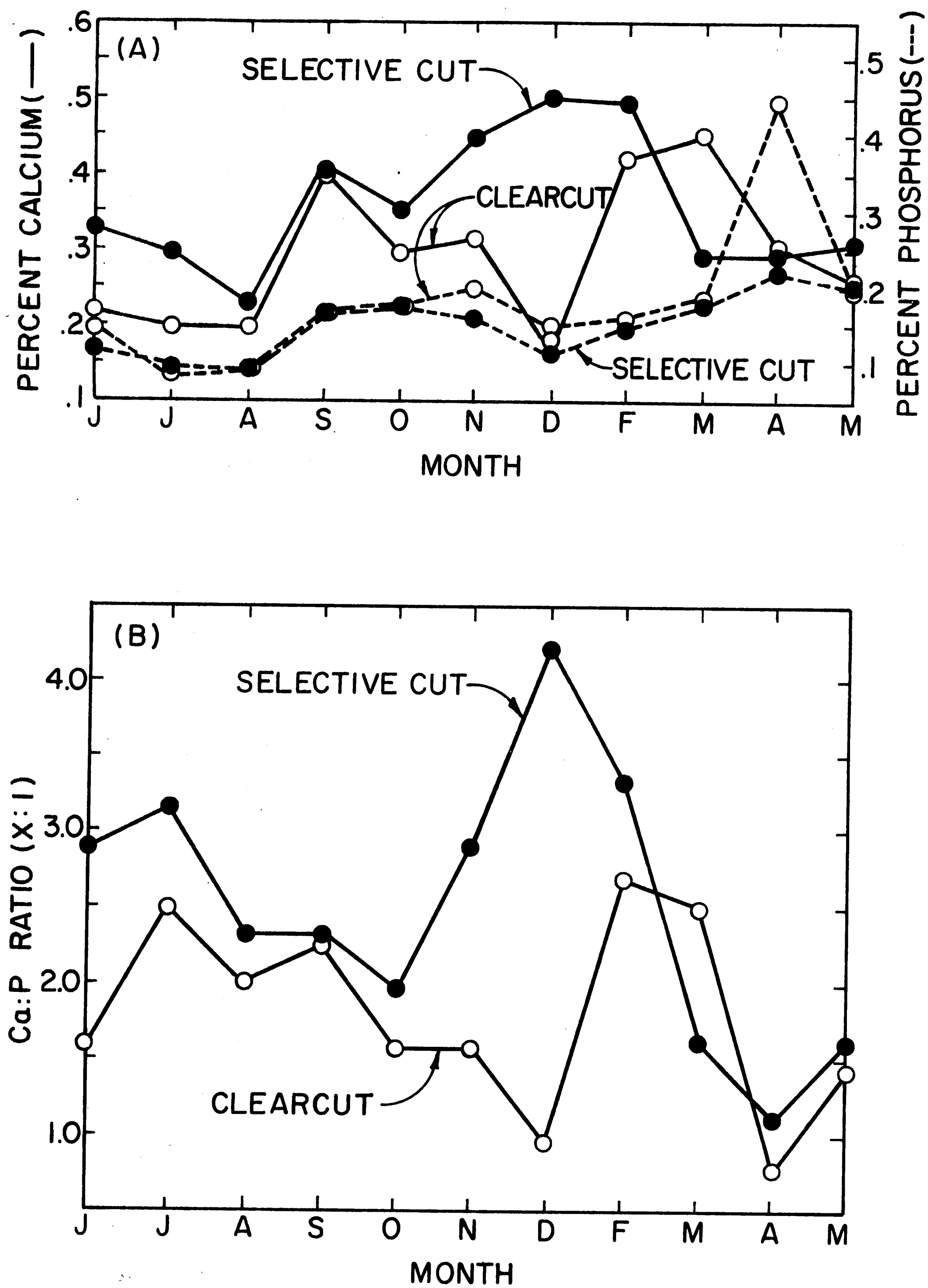


Fig. 10. Monthly trends in (A) Ca and P, and (B) Ca:P ratio of common greenbrier stems

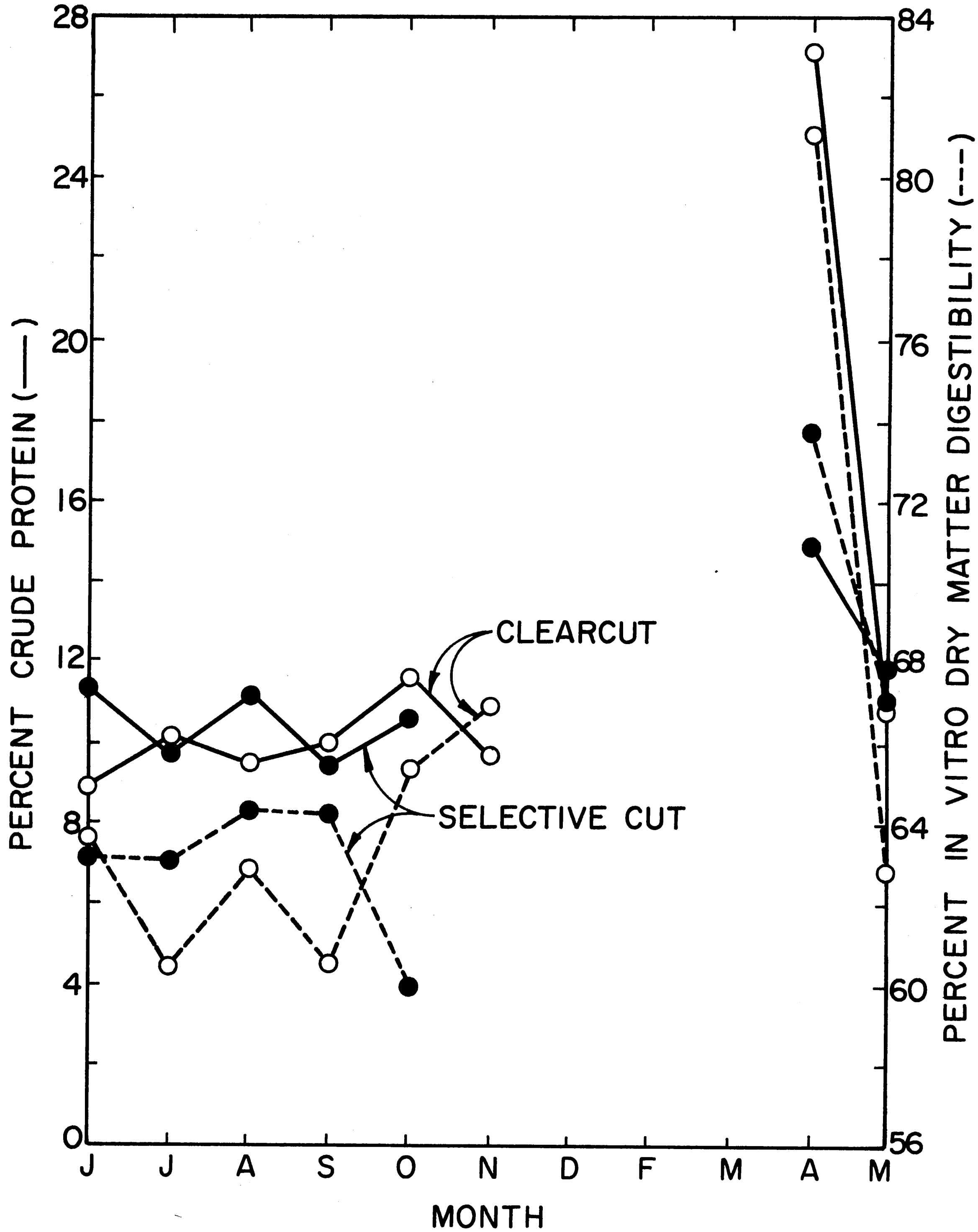


Fig. 11. Monthly crude protein and <u>in vitro</u> dry matter digestibility trends of common greenbrier leaves

Crude protein values for stems ranged from 4.11 percent to 14.25 percent in clearcut and from 4.21 to 8.64 in selective-cut (Fig. 12). The highest values in both treatments occurred in April; however, crude protein content of stems increased slightly in late fall and winter after leaf-fall had occurred.

IVDMD values for leaves ranged from 60.55 percent to 81.09 percent in clearcut and from 60.04 percent to 73.93 percent in selective-cut (Fig. 11). The digestibility values for greenbrier leaves in both treatments were very high throughout the year compared to other deer forages analyzed.

IVDMD values for stems ranged from 18.84 percent to 58.94 percent in clearcut and from 19.77 percent to 42.28 percent in selective-cut (Fig. 12). Digestibilities were relatively low, except in April, in both treatments.

Seasonal changes in common greenbrier generally reflected a low field dry-matter in the spring followed by a general increase throughout the rest of the year. Greenbrier leaves had a lower calcium percentage, higher phosphorus percentage, lower Ca:P ratio, higher crude protein, and higher digestibility in the spring. Greenbrier stems had a higher phosphorus level, lower Ca:P ratio, higher crude protein level, and higher digestibility in the spring.

Leaves in relation to stems had a higher calcium content, higher Ca:P ratio, and higher crude protein and IVDMD values.

The clearcut treatment had a consistently higher field dry-matter value. In both greenbrier leaves and stems, there was a larger spread between calcium and phosphorus percentages in the selective-cut. This resulted in a higher Ca:P ratio in both leaves and stems in the

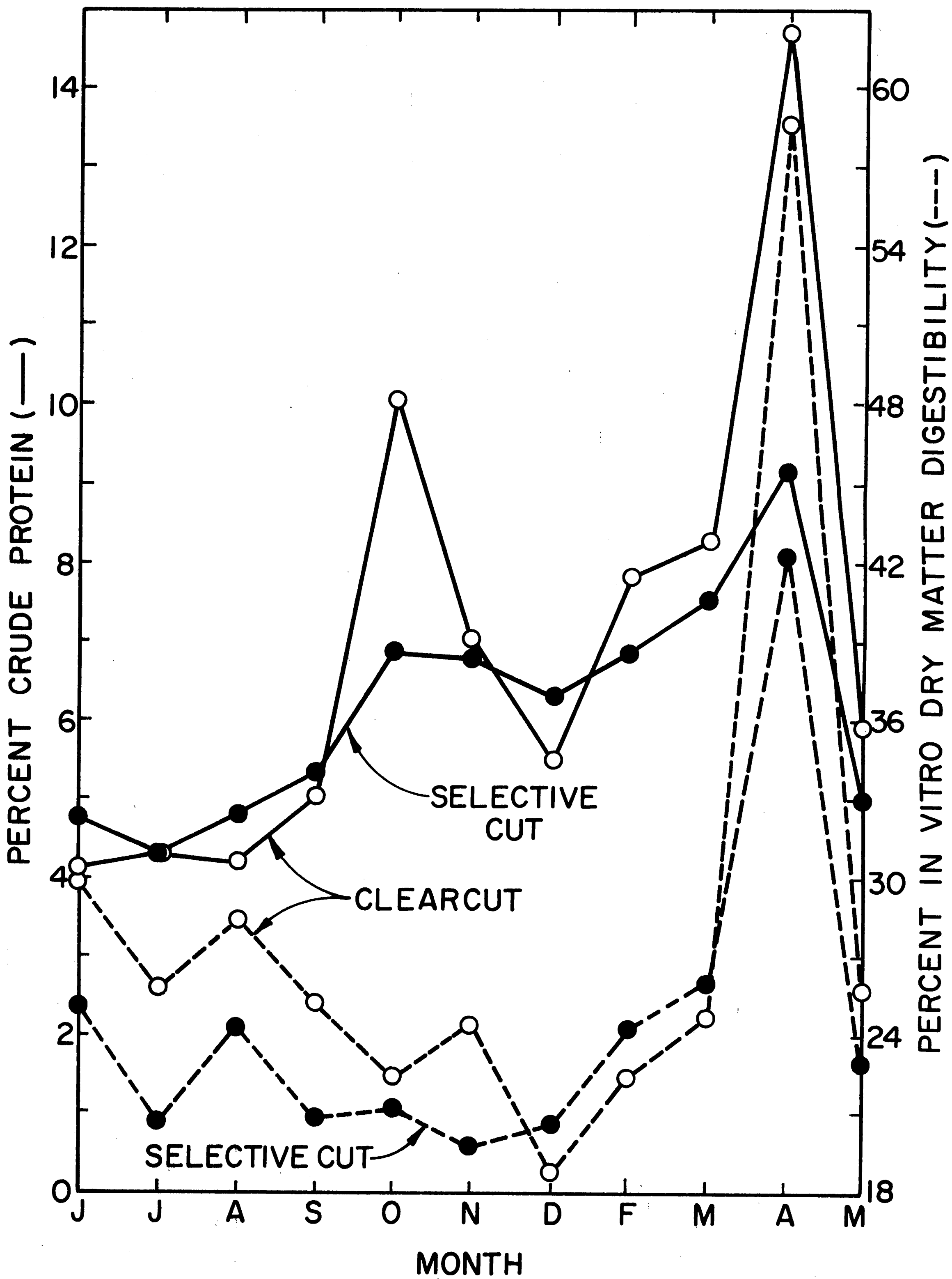


Fig. 12. Monthly crude protein and in vitro dry matter digestibility trends of common greenbrier stems

selective-cut treatment (Figs. 9B and 10B). There was no apparent treatment difference for crude protein of either leaves or stems (Figs. 11 and 12). Moreover, no differences in IVDMD of leaves was noted for either treatment (Fig. 11). IVDMD values for greenbrier stems were generally higher in the clearcut, except in December, February, and March (Fig. 12).

American Beautyberry

Leaves, stems, and fruit were separated for monthly nutritional analyses for each treatment. Field dry-matter values were determined by analyzing leaves and stems. Any fruit was removed before field dry-matter was determined. Results of monthly nutritional analyses are presented in Table 7.

Field dry-matter values ranged from 27.85 percent to 64.71 percent in the clearcut and from 23.14 percent to 66.67 percent in the selective-cut. The lowest field dry-matter values occurred in both treatments in April. Field dry-matter values increased from April through the collection period.

Total mineral matter values for beautyberry leaves ranged from 5.33 percent to 7.24 percent in clearcut and from 7.03 percent to 9.74 percent in the selective-cut. The values in both treatments remained fairly stable throughout the year.

Total mineral matter values for stems ranged from 2.38 percent to 7.14 percent in the clearcut and from 2.92 percent to 7.91 percent in the selective-cut. In both treatments mineral values increased from late spring through early summer.

Table 7. Comparison of monthly nutritional values, in percent dry matter, of American beautyberry (*Callicarpa americana* L.) from clearcut and from selective-cut areas

Nutritional Parameter	Area and Plant Part		1974							1975			
			June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Feb.	March	April	May
Field Dry Matter		C	36.12	43.78	50.34	48.03	56.38	60.00	59.52	64.71	51.85	27.85	29.81
		S[a]	25.88	34.70	40.97	36.04	51.47	55.17	60.00	66.67	53.85	23.14	24.90
Total Mineral Matter	L	C	5.33	6.36	5.52	5.87	---	---	---	---	---	7.24	5.76
		S	9.73	8.81	9.74	8.33	---	---	---	---	---	7.03	8.45
	S[b]	C	5.07	3.30	3.65	3.19	2.92	2.96	2.38	2.71	2.77	3.21	7.14
		S	5.82	3.57	3.34	2.96	3.17	3.35	2.60	2.92	2.96	6.02	7.91
	F	C	---	4.30	4.13	3.78	4.10	---	---	---	---	---	---
		S	---	5.54	4.40	4.04	4.63	4.96	---	---	---	---	---
Calcium	L	C	0.63	0.78	0.77	0.72	---	---	---	---	---	0.81	0.61
		S	0.96	1.12	1.25	1.17	---	---	---	---	---	0.86	0.91
	S	C	0.54	0.50	0.48	0.65	0.57	0.60	0.56	0.53	0.54	0.58	0.58
		S	0.42	0.48	0.49	0.54	0.55	0.52	0.49	0.54	1.02	0.43	0.39
	F	C	---	0.51	0.41	0.50	0.43	---	---	---	---	---	---
		S	---	0.51	0.44	0.43	0.42	0.36	---	---	---	---	---
Phosphorus	L	C	0.28	0.22	0.19	0.18	---	---	---	---	---	0.72	0.35
		S	0.26	0.16	0.15	0.12	---	---	---	---	---	0.55	0.41
	S	C	0.26	0.13	0.09	0.14	0.16	0.15	0.15	0.19	0.13	0.19	0.32
		S	0.15	0.05	0.06	0.11	0.12	0.12	0.10	0.11	0.23	0.31	0.24
	F	C	---	0.26	0.21	0.28	0.27	---	---	---	---	---	---
		S	---	0.23	0.21	0.25	0.20	0.27	---	---	---	---	---
Ca: P Ratio	L	C	2.3:1	3.5:1	4.1:1	4.0:1	---	---	---	---	---	1.1:1	1.7:1
		S	3.7:1	7.0:1	8.3:1	9.8:1	---	---	---	---	---	1.6:1	2.2:1
	S	C	2.1:1	3.8:1	5.3:1	4.6:1	3.6:1	4.0:1	3.7:1	2.8:1	4.2:1	3.1:1	1.8:1
		S	2.8:1	9.6:1	8.2:1	4.9:1	4.6:1	4.3:1	4.9:1	4.9:1	4.4:1	1.4:1	1.6:1
	F	C	---	2.0:1	2.0:1	1.8:1	1.6:1	---	---	---	---	---	---
		S	---	2.2:1	2.1:1	1.7:1	2.1:1	1.3:1	---	---	---	---	---

Table 7 (Continued)

Nutritional Parameter	Area and Plant Part		1974 June	July	Aug.	Sept.	Oct.	Nov.	Dec.	1975 Feb.	March	April	May
Crude Protein	L	C	11.64	10.48	9.99	10.54	---	---	---	---	---	29.22	15.24
		S	15.71	12.66	11.68	10.91	---	---	---	---	---	25.77	19.83
	S	C	6.33	3.77	3.95	4.88	4.48	5.28	6.07	5.42	5.71	6.44	8.96
		S	5.80	4.00	3.74	4.35	5.06	4.65	4.54	5.72	5.57	9.95	9.78
	F	C	---	8.81	6.38	5.36	6.72	---	---	---	---	---	---
		S	---	8.96	7.62	7.24	7.56	7.10	---	---	---	---	---
In Vitro Dry Matter Digestibility	L	C	48.51	50.35	49.96	50.03	---	---	---	---	---	63.01	53.74
		S	47.74	41.99	42.37	43.95	---	---	---	---	---	50.30	44.86
	S	C	45.75	32.55	33.35	38.02	30.69	33.24	34.82	29.49	32.94	32.65	49.09
		S	36.01	27.00	29.26	32.31	29.20	28.38	25.63	25.08	29.35	39.86	39.72
	F	C	---	39.40	33.98	52.92	50.96	---	---	---	---	---	---
		S	---	35.97	31.64	52.31	58.59	58.75	---	---	---	---	---

C = Clearcut

S[a] = Selective-cut

L = Leaves

S[b] = Stems

--- = Plant part not available

Total mineral matter values for fruit ranged from 3.78 percent to 4.30 percent in the clearcut and from 4.04 percent to 5.54 percent in the selective-cut. Values changed little in either treatment through the time period fruit was available.

Calcium values for leaves ranged from 0.61 percent to 0.78 percent in clearcut and from 0.86 percent to 1.25 percent in selective-cut (Fig. 13A). Calcium levels exceeded the recommended 0.30 percent level for deer forage (Magruder et al. 1957) in both treatments throughout the year.

Calcium values for stems ranged from 0.48 percent to 0.58 percent in clearcut and from 0.39 percent to 1.02 percent in selective-cut (Fig. 14A). Calcium levels generally remained stable throughout the year with the exception of an increase for the selective-cut in the month of March.

Calcium values for fruit ranged from 0.41 percent to 0.51 percent in clearcut and from 0.36 percent to 0.51 percent in the selective-cut (Fig. 15A).

Phosphorus values in beautyberry leaves ranged from 0.18 percent to 0.72 percent in clearcut and from 0.12 percent to 0.55 percent in selective-cut (Fig. 13A). The highest values occurred in both treatments in the spring. Values decreased gradually throughout the rest of the year.

Phosphorus values in stems ranged from 0.09 percent to 0.32 percent in clearcut and from 0.05 percent to 0.31 percent in selective-cut (Fig. 14A). The values tended to be higher in both treatments in the spring.

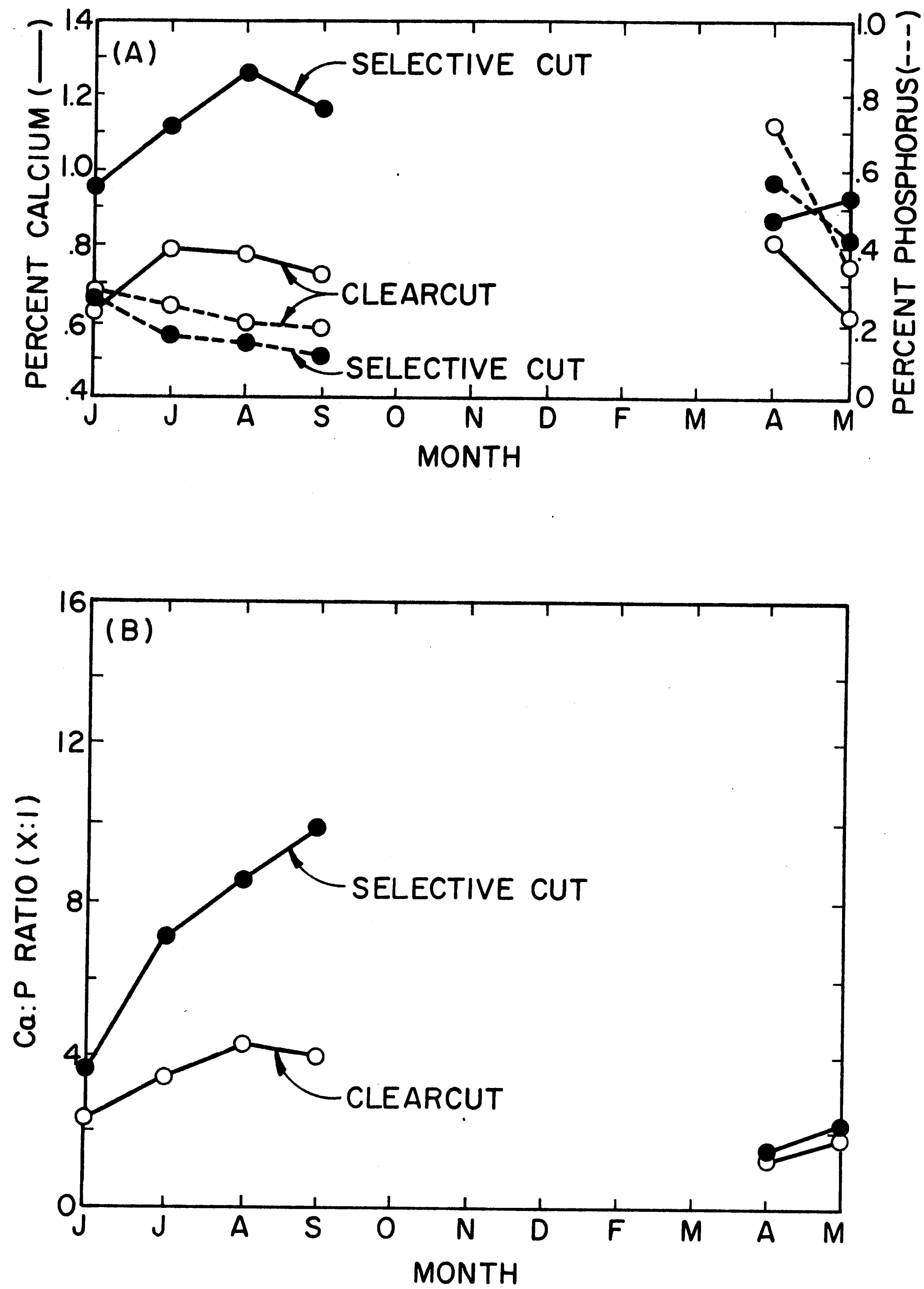


Fig. 13. Monthly trends in (A) Ca and P, and (B) Ca:P ratio of American beautyberry leaves

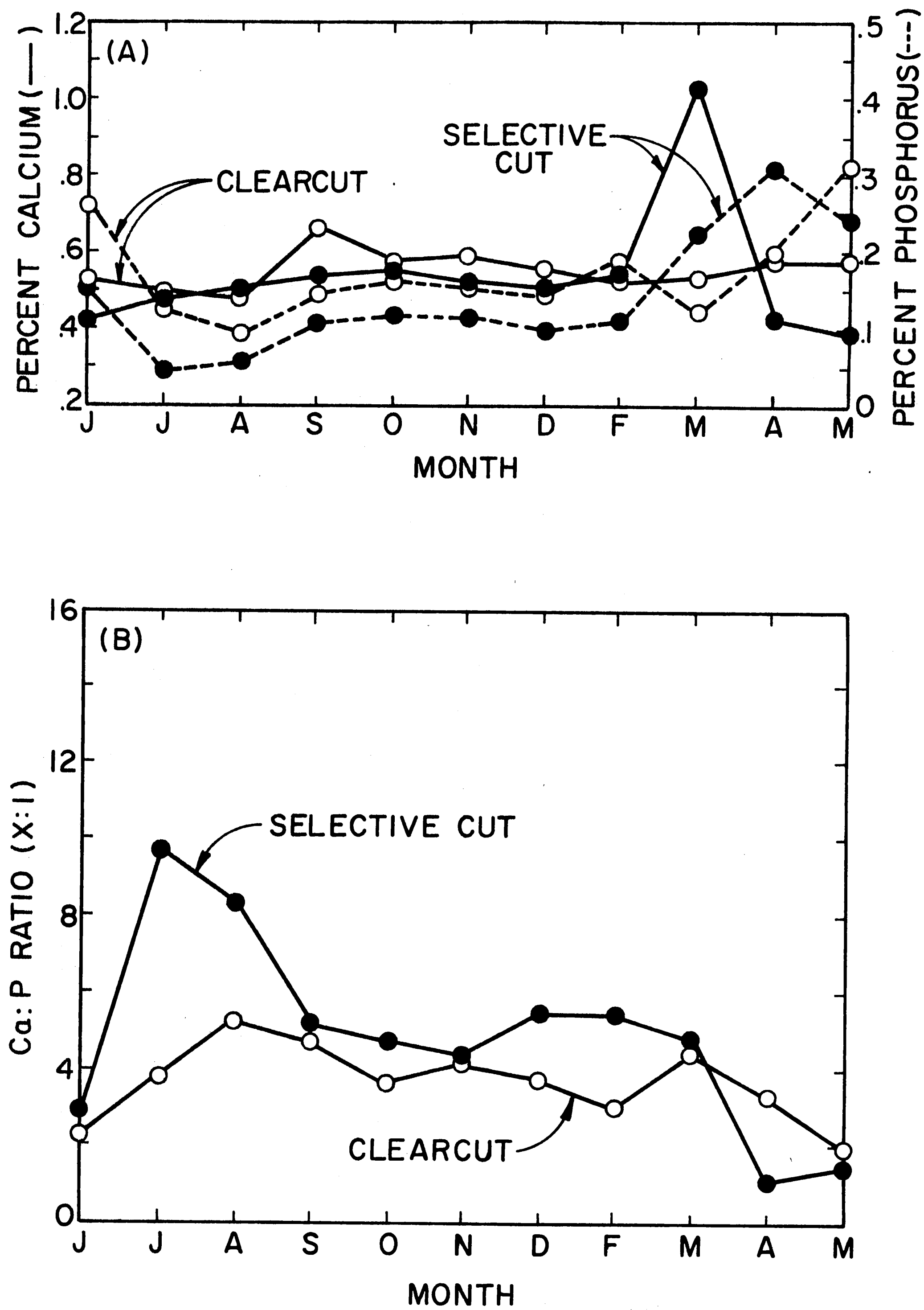
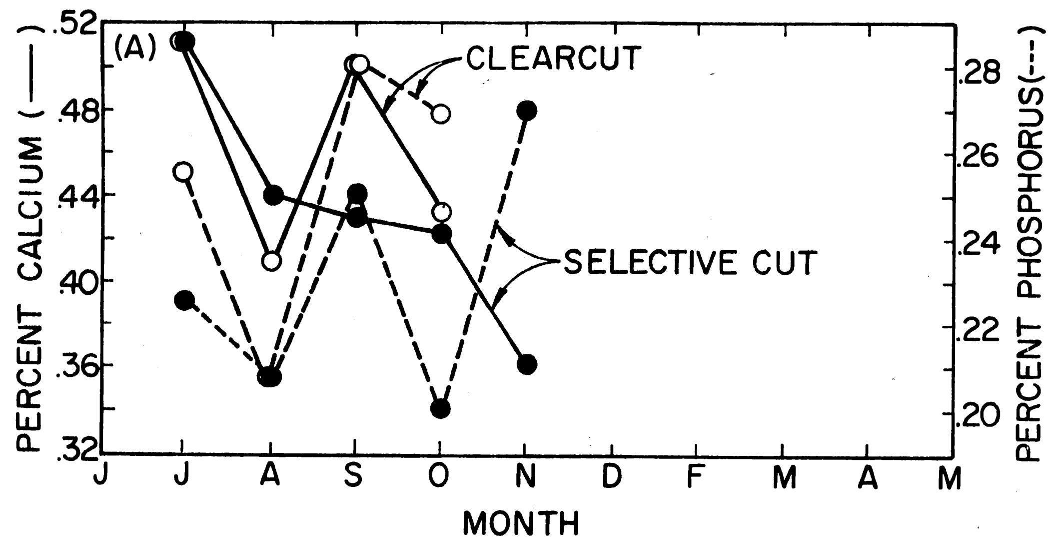


Fig. 14. Monthly trends in (A) Ca and P, and (B) Ca:P ratio of American beautyberry stems



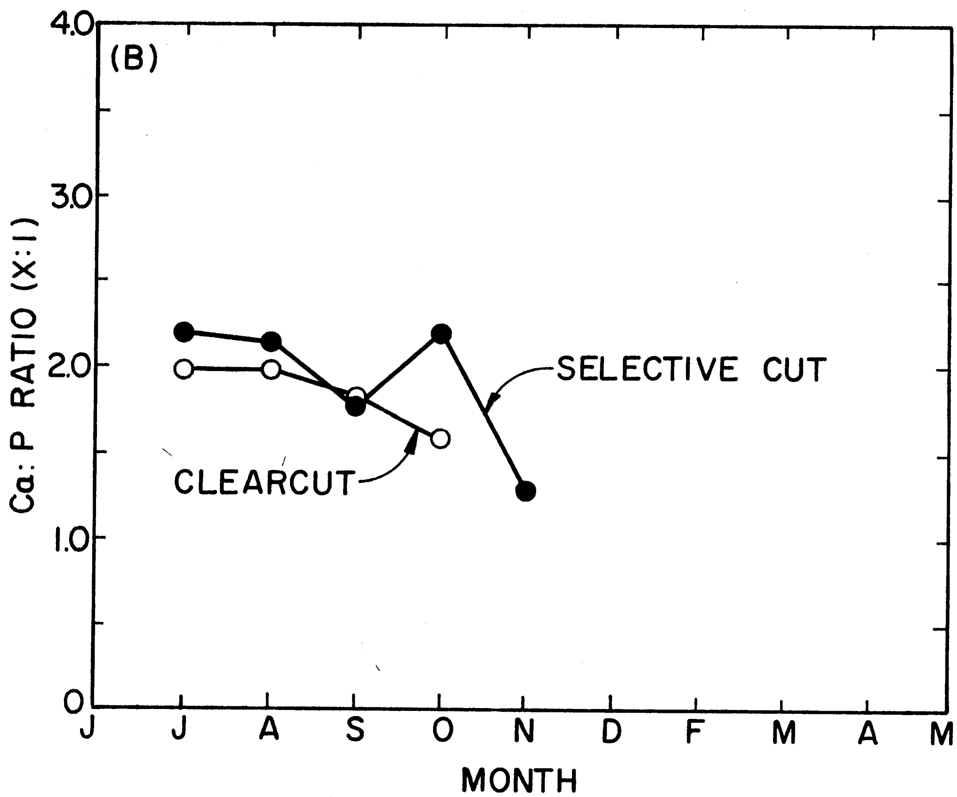


Fig. 15. Monthly trends in (A) Ca and P, and (B) Ca:P ratio of American beautyberry fruit

Phosphorus values in fruit ranged from 0.21 percent to 0.28 percent in clearcut and from 0.20 percent to 0.27 percent in selective-cut (Fig. 15A).

Ca:P ratios in beautyberry leaves ranged from 1.1:1 to 4.1:1 in clearcut and from 1.6:1 to 9.8:1 in selective-cut (Fig. 13B). Ratios in stems ranged from 1.8:1 to 5.3:1 in clearcut and from 1.4:1 to 9.6:1 in selective-cut (Fig. 14B). Fruit ratios ranged from 1.6:1 to 2.0:1 in clearcut and from 1.3:1 to 2.2:1 in selective-cut (Fig. 15B). Ratios in all plant parts in both treatments were relatively low compared to other forages analyzed. In large part, this was due to the low calcium values of this species.

Crude protein values in beautyberry leaves ranged from 9.99 percent to 29.22 percent in clearcut and from 10.91 to 25.77 in the selective-cut (Fig. 16). Levels in both treatments exceeded the minimum recommended protein level of 6 to 7 percent (French et al. 1955) for all months. Crude protein content was higher in spring.

Crude protein values in stems ranged from 3.77 percent to 8.96 percent in clearcut and from 3.74 percent to 9.95 percent in selective-cut (Fig. 17). In both treatments an increase in crude protein levels occurred in late spring and early summer.

Crude protein values in fruit ranged from 5.36 percent to 8.81 percent in clearcut and from 7.10 percent to 8.96 percent in selective-cut (Fig. 18). Levels were generally stable and met recommended minimum protein levels for deer forage (French et al. 1955).

IVDMD values in beautyberry leaves ranged from 48.51 percent to 63.01 percent in clearcut and from 41.99 percent to 50.30 percent in selective-cut (Fig. 16). In both treatments, the greatest

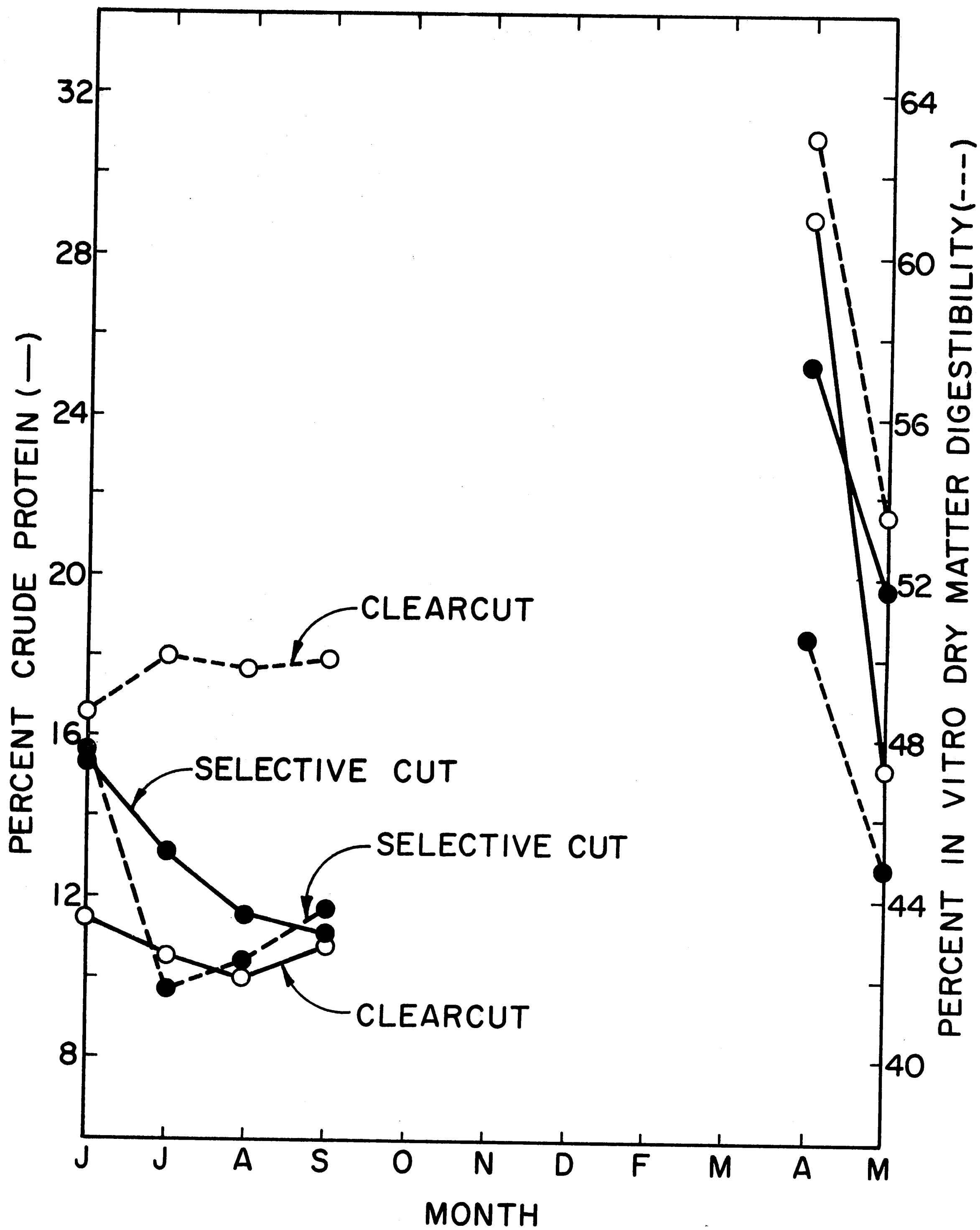


Fig. 16. Monthly crude protein and in vitro dry matter digestibility trends of American beautyberry leaves

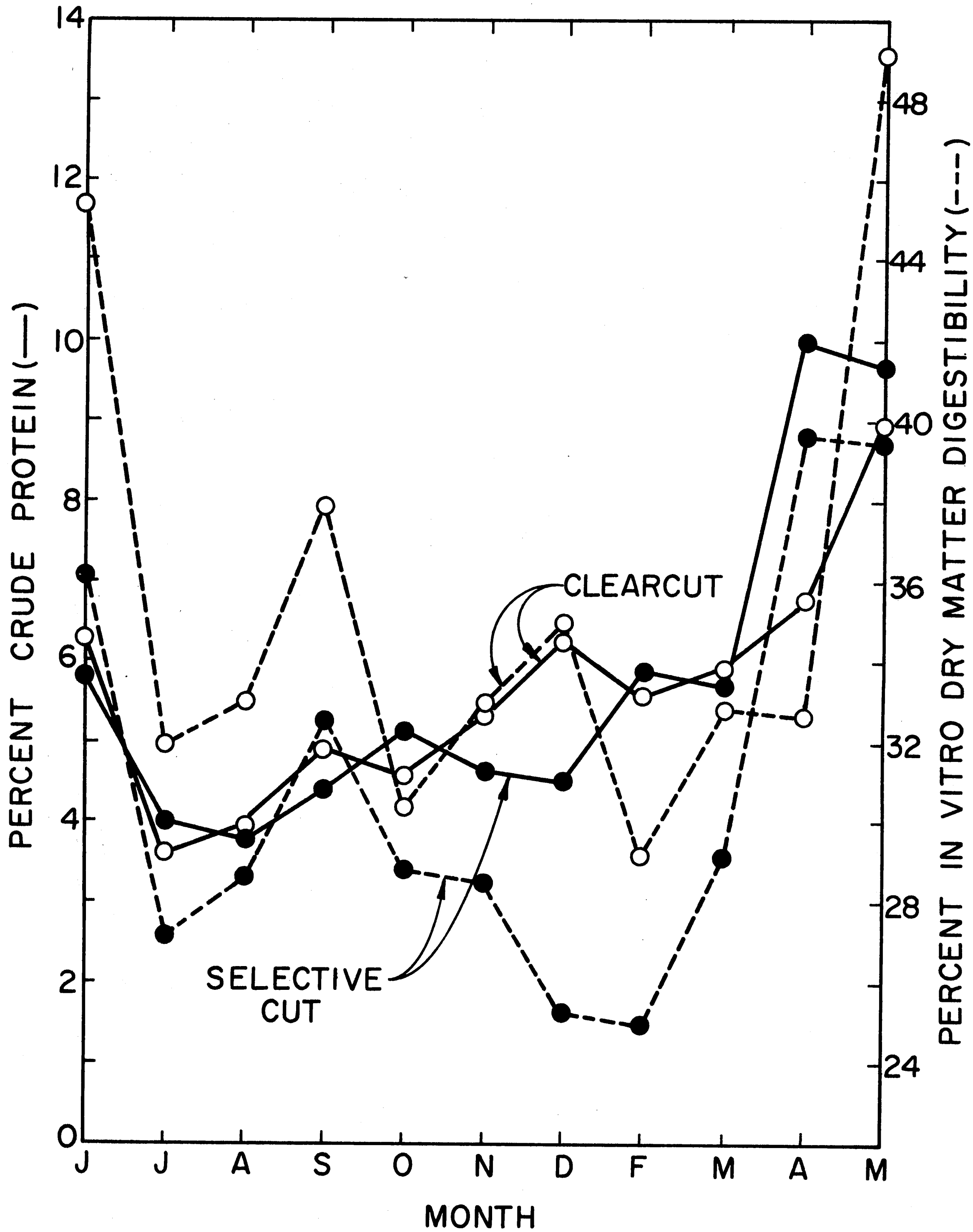


Fig. 17. Monthly crude protein and in vitro dry matter digestibility trends of American beautyberry stems

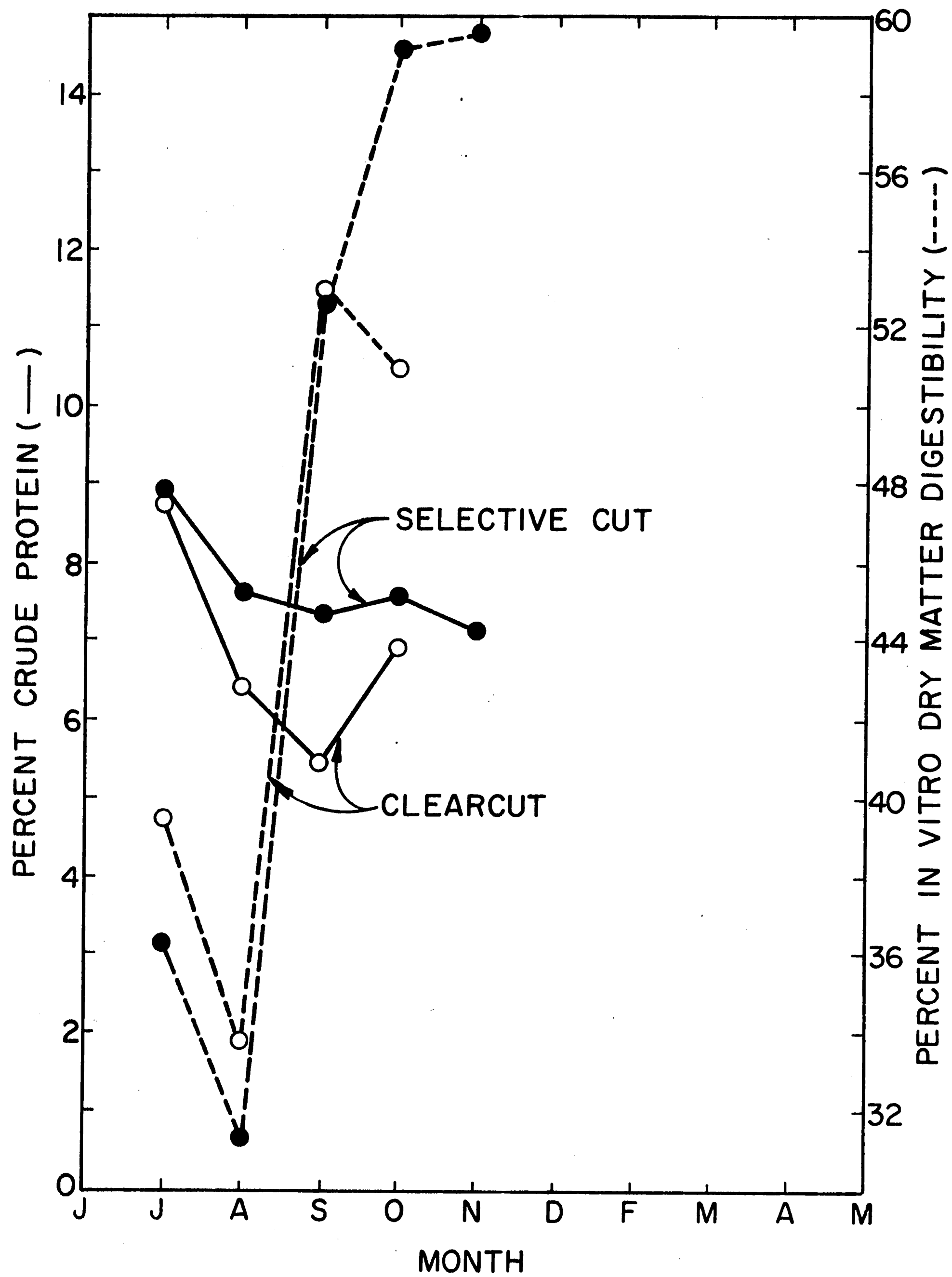


Fig. 18. Monthly crude protein and _in vitro_ dry matter digestibility trends of American beautyberry fruit

digestibilities occurred in the spring.

IVDMD values in stems ranged from 29.48 percent to 49.09 percent in clearcut and from 25.08 percent to 39.86 percent in selective-cut (Fig. 17). Digestibility values were greatest in the spring and early summer.

IVDMD values in fruit ranged from 33.98 percent to 52.92 percent in clearcut and from 31.64 percent to 58.75 percent in selective-cut (Fig. 18).

IVDMD values tended to overlap. Stems usually had the lowest digestibilities, particularly in late summer, fall, and winter. Leaves generally had the highest digestibilities; however, in September, October, and November, fruit digestibilities exceeded those of the leaves.

American beautyberry generally had lower field dry-matter values in both treatments in spring. In spring, American beautyberry leaves had a higher phosphorus level, lower Ca:P ratio, and higher crude protein and digestibility values than in other seasons. Stems in the spring had a lower Ca:P ratio and a higher digestibility. In both treatments, fruit had stable values throughout its availability.

Leaves were generally higher in total mineral matter, calcium, phosphorus, crude protein, and digestibility than stems.

In comparing American beautyberry leaves from the two treatments, a larger spread in calcium and phosphorus percentages occurred in the selective-cut. This led to a higher Ca:P ratio in leaves in the selective-cut (Fig. 13B). Crude protein levels in leaves were higher in the selective-cut, except in April (Fig. 16). IVDMD values in American beautyberry leaves were higher in the clearcut (Fig. 16).

The Ca:P ratio in stems was only slightly higher in the selective-cut (Fig. 14B). Neither treatment showed consistently higher values of stem crude protein (Fig. 17). American beautyberry stem IVDMD values were generally higher in the clearcut (Fig. 17).

Fruit of American beautyberry was available for analysis during five months of the study period. Values for all nutrient parameters analyzed fluctuated greatly between the two treatments (Figs. 15A, 15B, and 18).

Sweetgum

Leaves and stems within each treatment were separated for monthly nutritional analyses after field dry-matter values were determined. Leaf-fall occurred in November in both treatments. Spring leaf-out occurred the following April. Results of monthly nutritional analyses are presented in Table 8.

Field dry-matter values ranged from 29.37 percent to 49.54 percent in clearcut and from 21.52 percent to 47.62 percent in selective-cut. Lower field dry-matters occurred in the spring in both treatments and increased through the year.

Total mineral matter values in sweetgum leaves ranged from 3.64 percent to 6.59 percent in clearcut and from 5.27 percent to 7.82 percent in selective-cut. Total mineral matter values were lowest in late spring and early summer and increased through the year until leaf-fall occurred. This was true in both the clearcut and the selective-cut.

Total mineral matter values in stems ranged from 3.83 percent to 6.50 percent in clearcut and from 4.34 percent to 8.31 percent in selective-cut. Fluctuations in mineral values occurred in each

Table 8. Comparison of monthly nutritional values, in percent dry matter, of sweetgum (*Liquidambar styraciflua* L.) from clearcut and from selective-cut areas

Nutritional Parameter	Area and Plant Part	1974 June	July	Aug.	Sept.	Oct.	Nov.	Dec.	1975 Feb.	March	April	May
Field Dry Matter	C	38.69	42.74	46.40	48.90	49.54	43.33	44.74	46.67	39.36	29.37	36.48
	S[a]	30.51	37.50	38.79	35.95	39.47	44.00	47.62	46.15	36.72	21.52	27.15
Total Mineral Matter	L C	3.64	5.21	4.98	6.44	6.59	---	---	---	---	4.73	3.69
	S	5.76	6.16	6.97	7.82	7.68	---	---	---	---	5.66	5.27
	S[b] C	6.50	3.88	3.83	4.61	6.14	5.08	4.23	5.27	5.26	5.32	4.94
	S	7.46	4.75	5.14	5.39	4.99	5.62	4.34	4.36	5.63	8.31	5.13
Calcium	L C	0.88	0.89	0.89	1.22	1.20	---	---	---	---	0.70	0.71
	S	1.49	1.26	1.23	1.45	1.56	---	---	---	---	0.99	0.95
	S C	1.16	1.06	1.08	1.49	1.72	1.43	1.19	1.49	1.45	1.33	1.01
	S	1.60	1.20	1.26	1.60	1.60	1.65	1.14	1.27	1.59	1.37	0.96
Phosphorus	L C	0.20	0.11	0.14	0.22	0.35	---	---	---	---	0.36	0.18
	S	0.16	0.12	0.12	0.20	0.19	---	---	---	---	0.27	0.20
	S C	0.15	0.15	0.12	0.12	0.16	0.16	0.16	0.18	0.16	0.14	0.28
	S	0.13	0.07	0.08	0.13	0.09	0.16	0.14	0.14	0.14	0.24	0.15
Ca: P Ratio	L C	4.4:1	8.1:1	6.4:1	5.5:1	3.4:1	---	---	---	---	1.9:1	3.9:1
	S	9.3:1	10.5:1	10.3:1	7.3:1	8.2:1	---	---	---	---	3.7:1	3.6:1
	S C	7.7:1	7.1:1	9.0:1	12.4:1	10.8:1	8.9:1	7.4:1	8.3:1	9.1:1	9.5:1	3.6:1
	S	12.3:1	17.1:1	15.8:1	12.3:1	17.8:1	10.3:1	8.2:1	9.1:1	11.4:1	5.7:1	6.4:1
Crude Protein	L C	8.21	7.83	8.74	10.04	9.58	---	---	---	---	18.61	9.83
	S	10.11	9.40	8.96	9.26	7.99	---	---	---	---	14.69	9.39
	S C	3.74	2.72	2.94	3.92	5.20	7.02	6.42	6.78	6.83	6.24	5.25
	S	3.45	2.47	2.78	3.52	3.97	4.74	4.50	5.02	6.25	8.80	5.59

Table 8 (Continued)

Nutritional Parameter	Area and Plant Part	1974 June	July	Aug.	Sept.	Oct.	Nov.	Dec.	1975 Feb.	March	April	May
In Vitro Dry Matter Digestibility	L C	34.01	25.84	28.05	31.04	33.64	---	---	---	---	47.73	36.37
	S	45.45	40.41	34.81	46.63	42.46	---	---	---	---	46.36	45.23
	S C	34.53	24.69	25.40	31.09	31.84	35.39	34.26	34.78	31.85	42.26	43.35
	S	34.02	26.91	25.92	30.41	27.23	32.98	31.53	30.63	29.58	45.03	41.21

C = Clearcut

S[a] = Selective-cut

L = Leaves

S[b] = Stems

--- = Plant part not available

treatment during the year.

Calcium values in sweetgum leaves ranged from 0.70 percent to 1.22 percent in clearcut and from 0.95 to 1.56 percent in selective-cut (Fig. 19A). All values exceeded the recommended calcium percentage of 0.30 for deer forage (Magruder et al. 1957). In each treatment, calcium values increased from spring through leaf-fall.

Calcium percentages in stems ranged from 1.01 percent to 1.72 percent in clearcut and from 0.96 percent to 1.60 percent in selective-cut (Fig. 20A). Mineral values in each treatment varied considerably during the year.

Phosphorus values in sweetgum leaves ranged from 0.11 percent to 0.36 percent in clearcut and from 0.12 percent to 0.27 percent in selective-cut (Fig. 19A). Sweetgum leaves contained the recommended phosphorus level of 0.25 percent (Magruder et al. 1957) for deer forage in October and April in the clearcut and in April only in the selective-cut.

Phosphorus values in stems ranged from 0.12 percent to 0.28 percent in clearcut and from 0.07 percent to 0.24 percent in selective-cut (Fig. 20A). Highest levels of phosphorus occurred in each treatment in the spring. Only the sweetgum stems collected from the clearcut in May contained the recommended phosphorus level (Magruder et al. 1957).

The Ca:P ratio in sweetgum leaves ranged from 1.9:1 to 8.1:1 in clearcut and from 3.7:1 to 10.5:1 in selective-cut (Fig. 19B). Ratios of Ca:P in stems ranged from 3.6:1 to 12.4:1 in clearcut and from 5.7:1 to 17.8:1 in selective-cut (Fig. 20B). The ratios in stems and leaves in sweetgum exceeded the recommended ratio of 1:2 to 2:1 (Halls

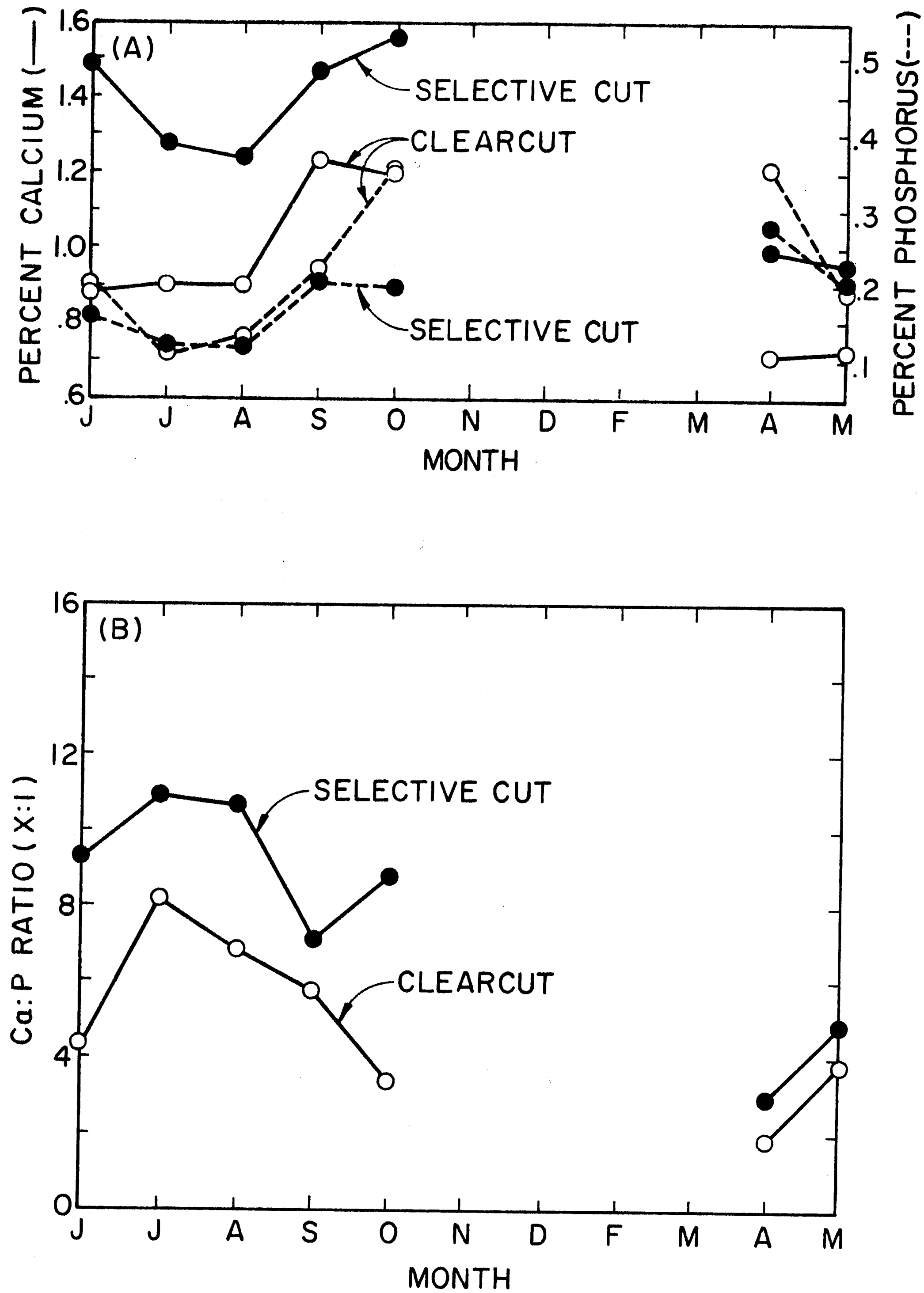
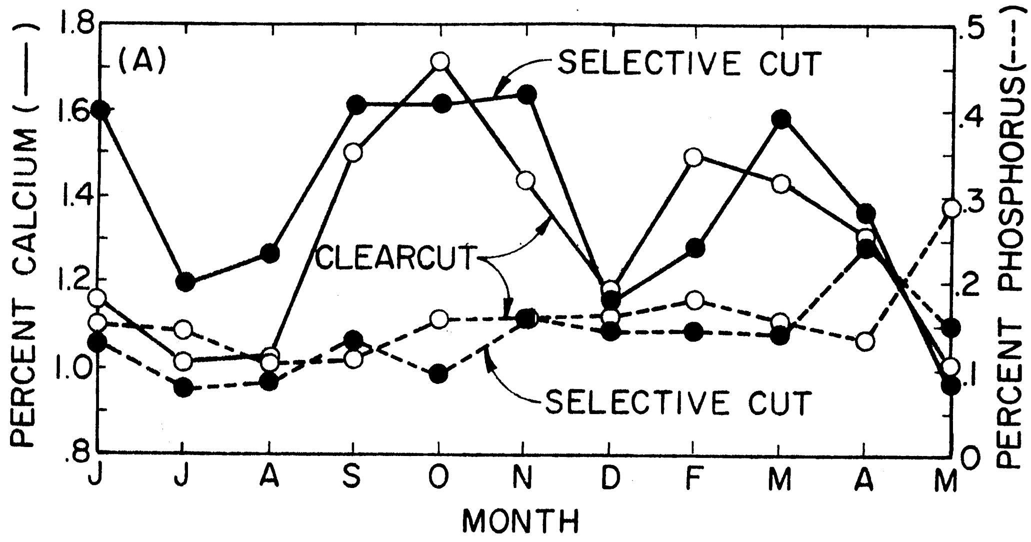


Fig. 19. Monthly trends in (A) Ca and P, and (B) Ca:P ratio of sweetgum leaves



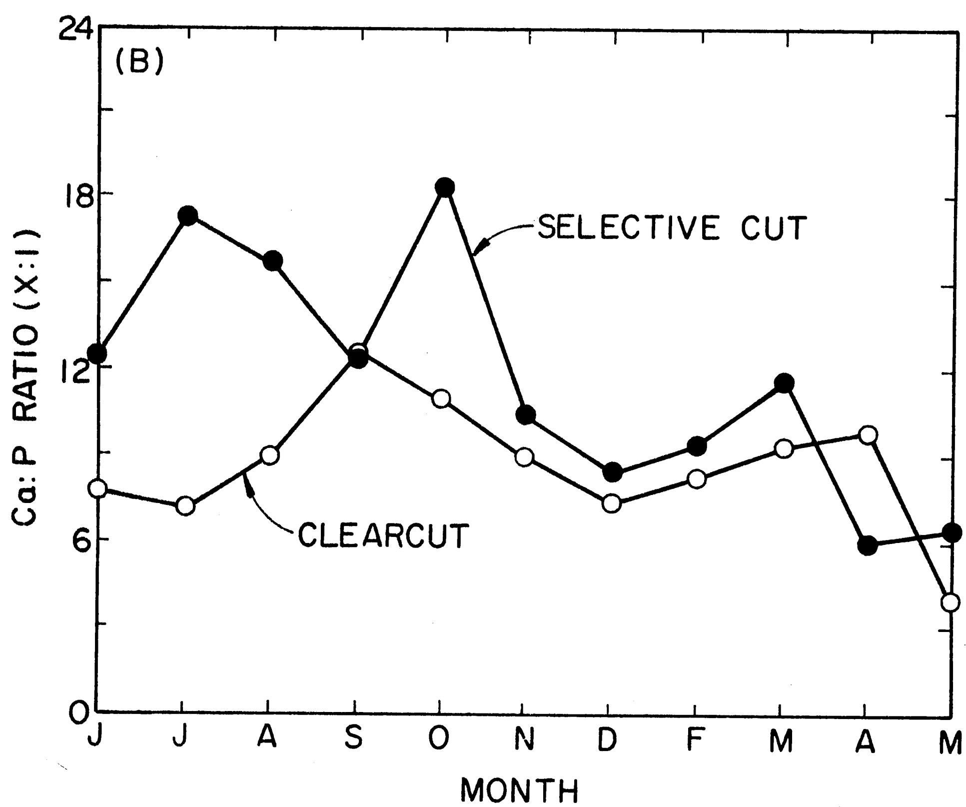


Fig. 20. Monthly trends in (A) Ca and P, and (B) Ca:P ratio of sweetgum stems

1970) in both clearcut and selective-cut, with the lowest ratios in both leaves and stems in each treatment occurring in the spring.

Crude protein levels in sweetgum leaves ranged from 7.83 percent to 18.61 percent in the clearcut and from 7.99 percent to 14.69 percent in selective-cut (Fig. 21). Crude protein levels in leaves exceeded minimum recommended requirements of 6 to 7 percent for deer forage (French et al. 1955) in all months in both treatments. In each treatment, the highest protein level occurred in April.

Crude protein levels in stems ranged from 2.72 percent to 7.02 percent in clearcut and from 2.47 percent to 8.80 percent in selective-cut (Fig. 22). In both treatments, the highest crude protein values in stems occurred after leaf-fall.

IVDMD values in leaves ranged from 25.84 percent to 47.73 percent in clearcut and from 34.81 percent to 46.63 percent in selective-cut (Fig. 21). IVDMD for stems ranged from 24.69 percent to 43.35 percent in clearcut and from 34.81 percent to 45.03 percent in selective-cut (Fig. 22). Digestibility values in sweetgum leaves and stems were higher in both treatments in the spring.

Seasonal progression in sweetgum generally showed a decrease in field dry-matter in both treatments in the spring. Sweetgum leaves in both treatments had higher crude protein and digestibility levels and a lower Ca:P ratio in the spring. Seasonal trends in stems included an increase in digestibility and a decrease in the Ca:P ratio in the spring.

Leaves, in relation to stems, were generally lower in calcium, higher in phosphorus, had a lower Ca:P ratio, and were higher in crude protein and IVDMD.

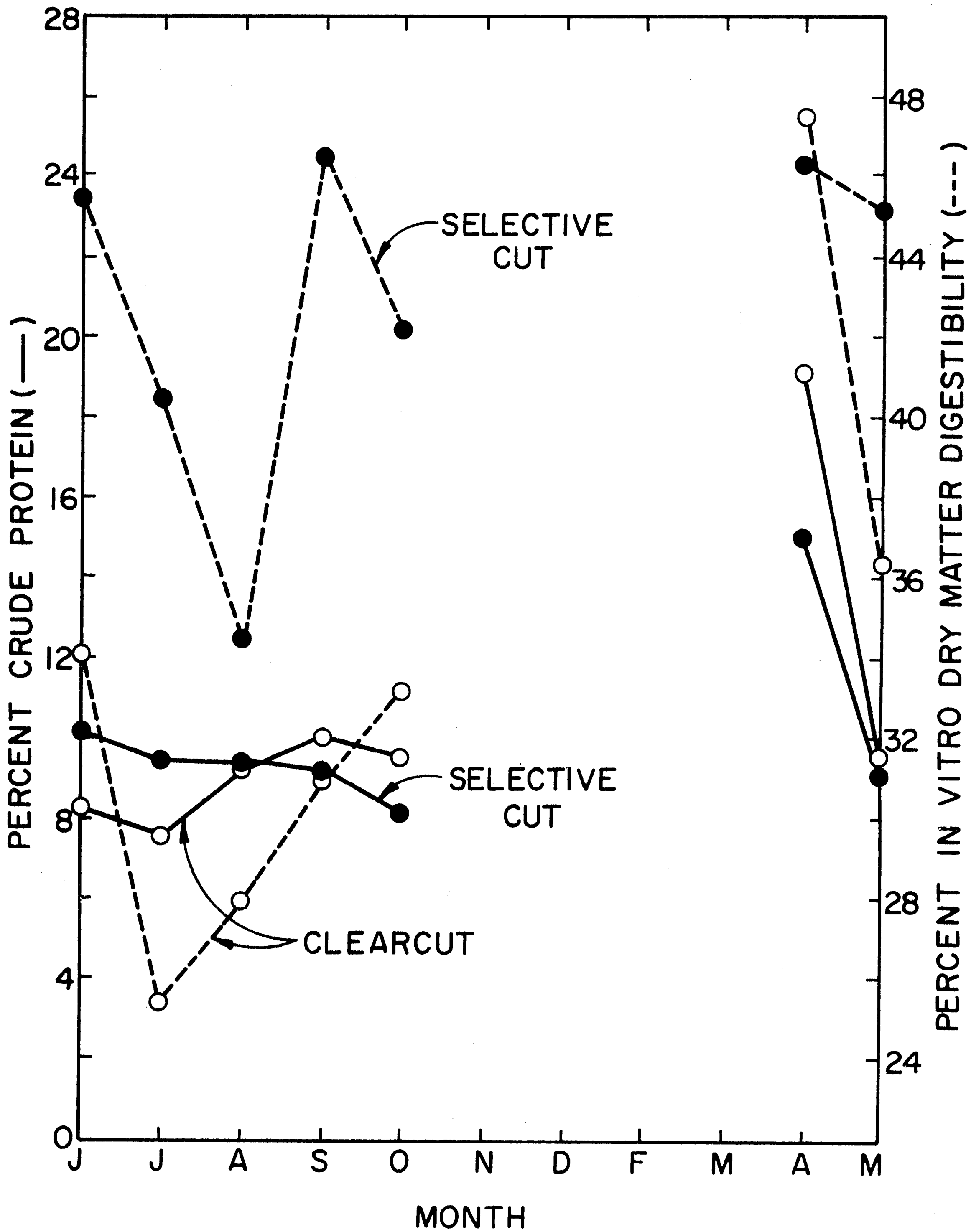


Fig. 21. Monthly crude protein and <u>in vitro</u> dry matter digestibility trends of sweetgum leaves

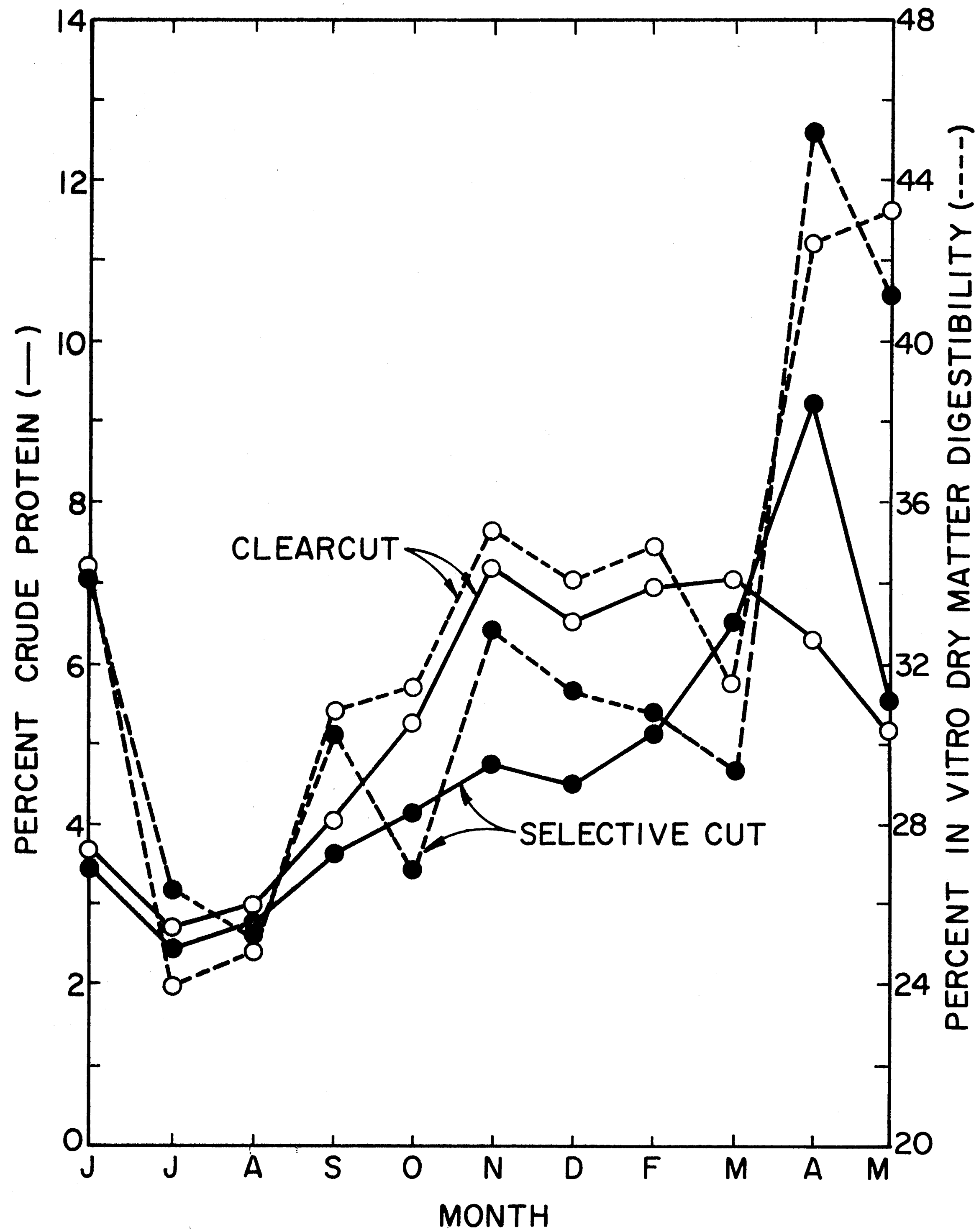


Fig. 22. Monthly crude protein and in vitro dry matter digestibility trends of sweetgum stems

Both sweetgum leaves and stems contained a higher Ca:P ratio in the selective-cut than in the clearcut (Figs. 19 and 20). Neither treatment showed consistently higher values of crude protein in sweetgum leaves (Fig. 21). Digestibility values were greater in the selective-cut (Fig. 21). In stems, crude protein levels were higher in the clearcut except in April and May (Fig. 22). Although IVDMD values varied in sweetgum stems, noticeably higher values occurred in September through March in the clearcut (Fig. 22).

Hickory Leaves

Leaves within each treatment were analyzed monthly during June through September of 1974 and from April through May of 1975. Results of monthly nutritional analyses are presented in Table 9.

Field dry-matter values ranged from 22.90 percent to 64.81 percent in clearcut and from 30.00 percent to 62.87 percent in selective-cut. Values were lowest in the spring, then increased through the year until leaf-fall occurred.

Total mineral matter values ranged from 4.65 percent to 7.73 percent in clearcut and from 6.57 percent to 8.81 percent in the selective-cut.

Calcium values ranged from 0.93 percent to 1.58 percent in clearcut and from 0.97 percent to 1.66 percent in the selective-cut (Fig. 23A). Calcium decreased in the spring in both treatments.

Phosphorus percentages ranged from 0.12 percent to 0.57 percent in clearcut and from 0.14 percent to 0.27 percent in selective-cut (Fig. 23A). The recommended phosphorus level of 0.25 percent for deer forage (Magruder et al. 1957) was met only in April in each treatment.

Table 9. Comparison of monthly nutritional values, in percent dry matter, of hickory leaves (*Carya* spp.) from clearcut and from selective-cut areas

Nutritional Parameter	Area	1974 June	1974 July	1974 Aug.	1974 Sept.	1974 Oct.	1974 Nov.	1974 Dec.	1975 Feb.	1975 March	1975 April	1975 May
Field Dry Matter	C	55.21	57.52	63.28	64.81	---	---	---	---	---	22.90	49.47
	S	43.12	54.62	62.87	61.90	---	---	---	---	---	30.00	41.94
Total Mineral Matter	C	6.37	6.44	7.16	6.67	---	---	---	---	---	7.73	4.65
	S	7.13	8.47	8.26	8.81	---	---	---	---	---	6.57	6.76
Calcium	C	1.46	1.09	1.51	1.58	---	---	---	---	---	1.17	0.93
	S	1.46	1.58	1.66	1.61	---	---	---	---	---	0.97	1.42
Phosphorus	C	0.14	0.12	0.22	0.16	---	---	---	---	---	0.57	0.12
	S	0.17	0.16	0.17	0.14	---	---	---	---	---	0.27	0.20
Ca: P Ratio	C	10.4:1	9.1:1	6.9:1	9.9:1	---	---	---	---	---	2.05:1	7.8:1
	S	8.6:1	9.9:1	9.8:1	11.5:1	---	---	---	---	---	3.6:1	7.1:1
Crude Protein	C	10.52	8.91	9.01	8.40	---	---	---	---	---	22.88	9.34
	S	11.96	11.32	11.06	9.66	---	---	---	---	---	14.55	12.45
In Vitro Dry Matter Digestibility	C	38.72	36.99	35.04	33.98	---	---	---	---	---	45.47	34.38
	S	42.66	35.94	37.14	34.00	---	---	---	---	---	43.86	42.77

C = Clearcut

S = Selective-cut

--- = Plant part not available

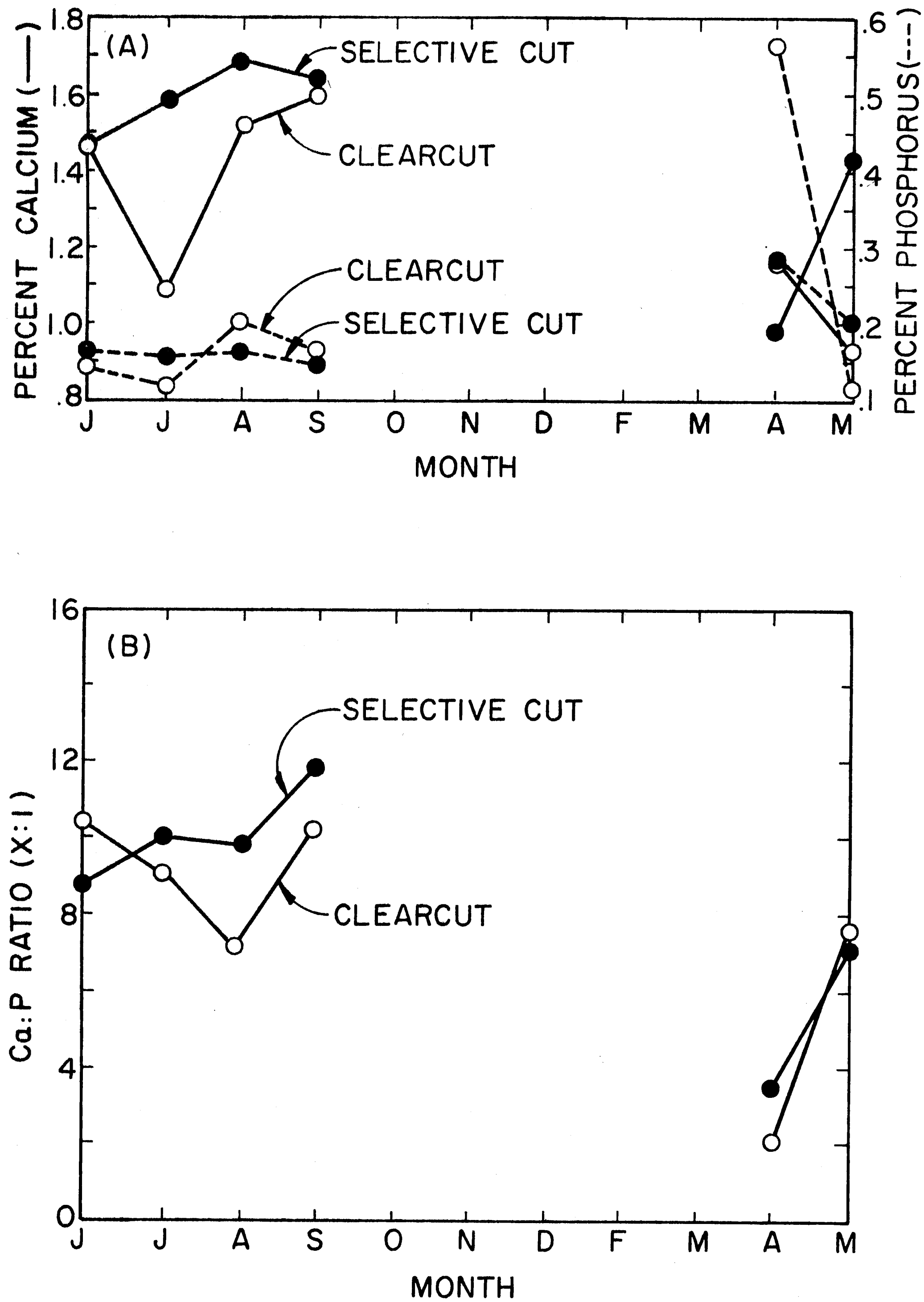


Fig. 23. Monthly trends in (A) Ca and P, and (B) Ca:P ratio of hickory leaves

Ca:P ratios ranged from 2.05:1 to 10.4:1 in clearcut and from 3.6:1 to 11.5:1 in selective-cut (Fig. 23B). The Ca:P ratios exceeded in all cases the recommended Ca:P ratios suggested for deer forage (Halls 1970).

Crude protein levels ranged from 8.40 percent to 22.88 percent in clearcut and from 9.66 percent to 14.55 percent in selective-cut (Fig. 24). The highest protein levels in both treatments occurred in the spring. Protein levels were consistently higher in the selective-cut in all months with the exception of April. Protein content decreased from spring through winter in both treatments.

IVDMD values ranged from 33.98 percent to 45.47 percent in clearcut and from 34.00 percent to 43.86 percent in selective-cut (Fig. 24). The greatest digestibility values occurred in both treatments in the spring.

Seasonally, in both treatments, the lowest field dry-matter values occurred in the spring, then increased as the year progressed. In addition, lower Ca:P ratios, increased crude protein content, and increased IVDMD occurred in spring growth.

The nutritional parameters measured fluctuated to such an extent between the two treatments that no significant differences were noted with the exception of protein levels which were generally higher in the selective-cut (Fig. 24).

Nuttall Wildindigo

Leaves and stems of Nuttall wildindigo were composited within each treatment monthly. This legume was analyzed from June through August of 1974. Results of monthly nutritional analyses are presented in Table 10.

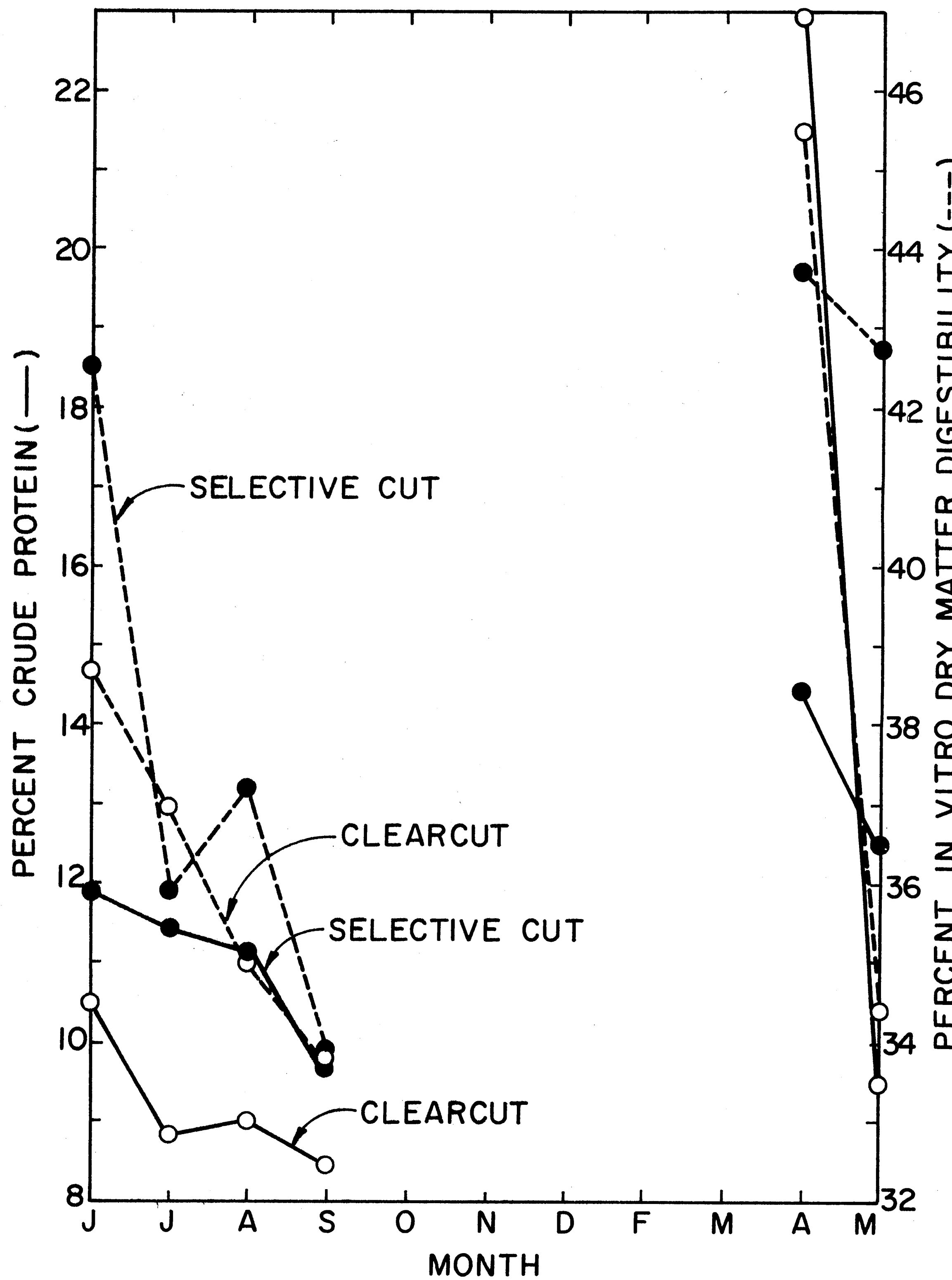


Fig. 24. Monthly crude protein and *in vitro* dry matter digestibility trends of hickory leaves

Table 10. Comparison of monthly nutritional values, in percent dry matter, of Nuttall wildindigo (Baptisia nuttalliana Small) from clearcut and from selective-cut areas

Nutritional Parameter	Area	1974							1975			
		June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Feb.	March	April	May
Field Dry Matter	C	47.01	75.74	75.00	---	---	---	---	---	---	22.86	43.00
	S	37.34	58.75	90.00	---	---	---	---	---	---	19.59	31.82
Total Mineral Matter	C	3.50	4.42	3.86	---	---	---	---	---	---	5.79	3.82
	S	4.21	4.15	3.85	---	---	---	---	---	---	6.40	4.45
Calcium	C	0.93	1.12	1.19	---	---	---	---	---	---	0.60	0.74
	S	0.83	0.80	1.04	---	---	---	---	---	---	0.65	0.71
Phosphorus	C	0.13	0.05	0.06	---	---	---	---	---	---	0.46	0.19
	S	0.14	0.08	0.06	---	---	---	---	---	---	0.29	0.13
Ca: P Ratio	C	7.2:1	22.4:1	19.8:1	---	---	---	---	---	---	1.3:1	3.9:1
	S	5.9:1	10.0:1	17.3:1	---	---	---	---	---	---	2.2:1	5.5:1
Crude Protein	C	14.96	11.10	12.53	---	---	---	---	---	---	29.20	16.33
	S	16.38	14.32	14.15	---	---	---	---	---	---	26.55	19.48
In Vitro Dry Matter Digestibility	C	41.94	36.96	36.28	---	---	---	---	---	---	49.09	41.22
	S	48.13	43.27	35.41	---	---	---	---	---	---	51.39	56.02

C = Clearcut

S = Selective-cut

--- = Plant part not available

Field dry-matter values ranged from 22.86 percent to 75.74 percent in clearcut and from 19.59 percent to 90.00 percent in the selective-cut. Values were lowest in the spring in both treatments and increased through summer.

Total mineral matter values ranged from 3.50 percent to 5.79 percent in clearcut and from 3.85 percent to 6.40 percent in selective-cut. Values were stable in each treatment throughout the year with the exception of April when values increased slightly.

Calcium values ranged from 0.60 percent to 1.19 percent in clearcut and from 0.65 percent to 1.04 percent in selective-cut (Fig. 25A). Calcium values were consistently above the recommended 0.30 percent level for deer forage (Magruder et al. 1957). Calcium values increased from spring through late summer in both treatments.

Phosphorus values ranged from 0.05 percent to 0.46 percent in clearcut and from 0.06 percent to 0.29 percent in selective-cut (Fig. 25A). With the exception of April, phosphorus levels were well below the recommended phosphorus level of 0.25 for deer forage (Magruder et al. 1957). Phosphorus levels decreased from spring through late summer in both treatments.

Ca:P ratios ranged from 3.9:1 to 22.4:1 in clearcut and from 2.21:1 to 17.3:1 in selective-cut (Fig. 25B). The ratios approached the recommended ratio of 1:2 to 2:1 in both treatments only in April. An increase in the Ca:P ratio occurred from spring through late summer.

Crude protein levels ranged from 11.10 percent to 29.20 percent in clearcut and from 14.15 percent to 26.55 percent in selective-cut (Fig. 26). The crude protein levels approached recommended optimum levels of

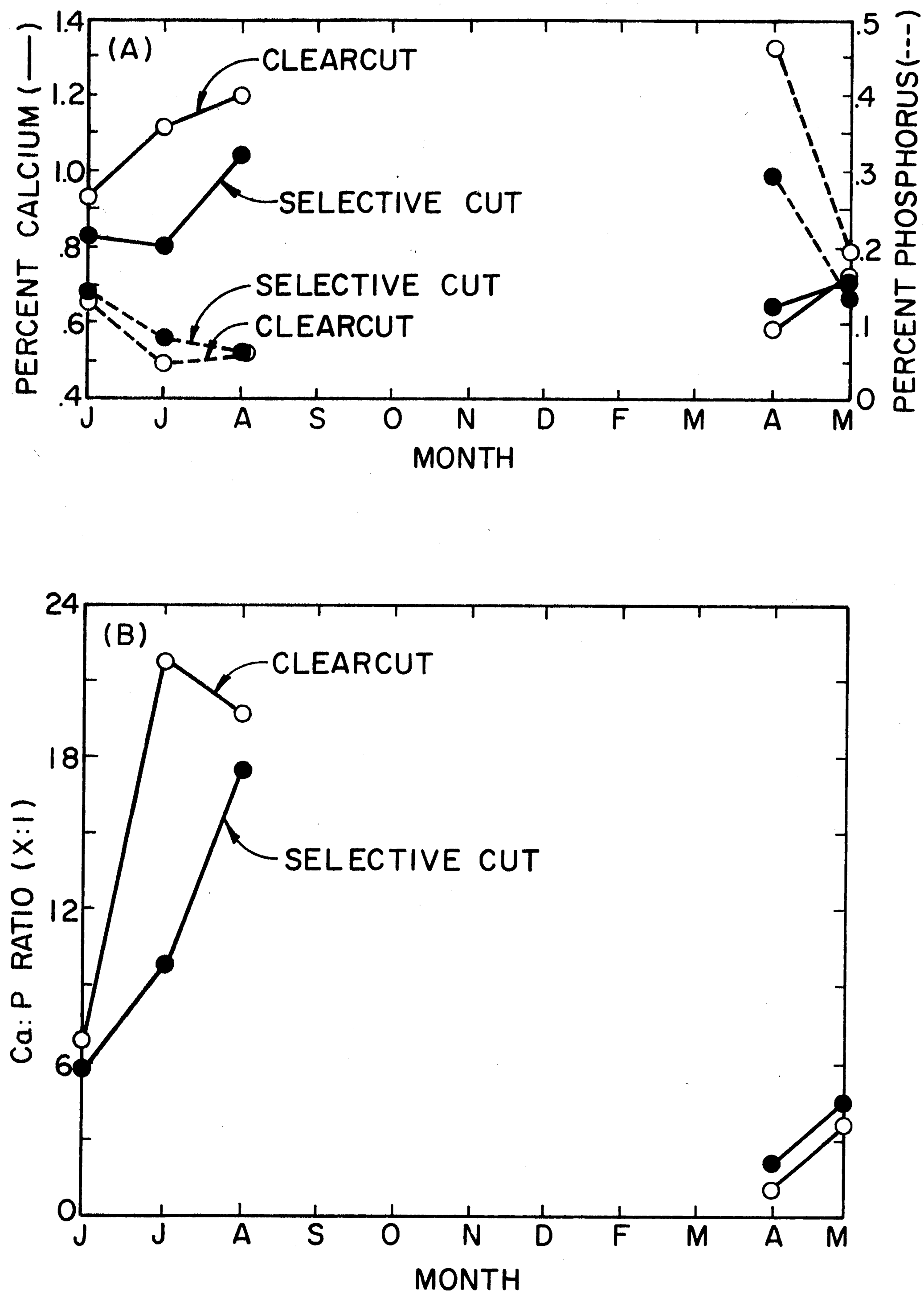


Fig. 25. Monthly trends in (A) Ca and P, and (B) Ca:P ratio of Nuttall wildindigo current annual growth

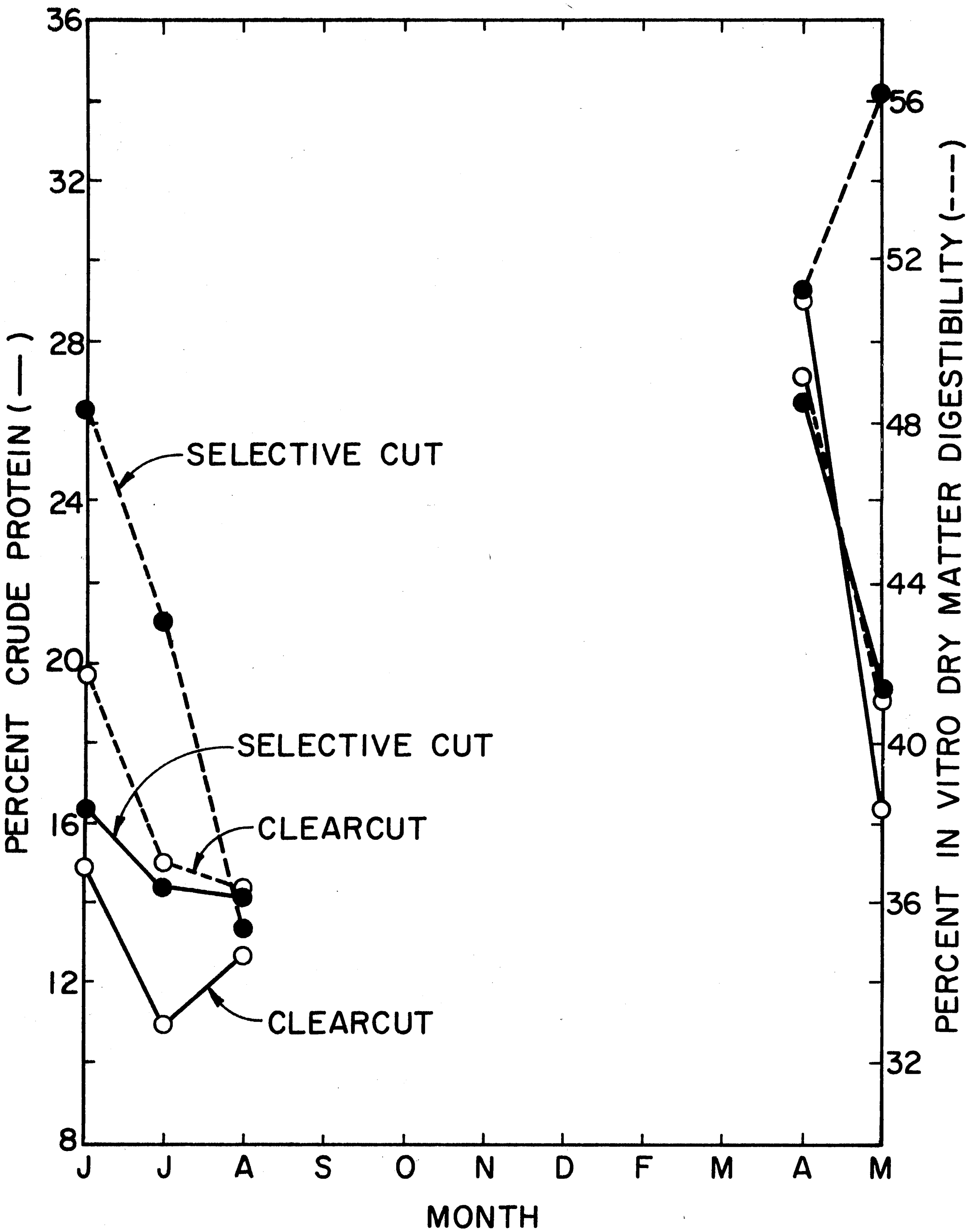


Fig. 26. Monthly crude protein and in vitro dry matter digestibility trends of Nuttall wildindigo current annual growth

levels of 13 to 16 percent (French et al. 1955) in both treatments throughout the sampling period. Crude protein content decreased from spring through late summer.

IVDMD values ranged from 36.28 percent to 49.09 percent in clearcut and from 35.41 to 56.02 in selective-cut (Fig. 26). The high digestability values in each treatment occurred in the spring.

A difference was noted between the treatments with respect to calcium and phosphorus percentages and the Ca:P ratio. The clearcut had a larger spread between calcium and phosphorus percentages than the selective-cut. This led to an increased Ca:P ratio in the clearcut (Fig. 25B). Crude protein levels were generally higher in the selective-cut except in April (Fig. 26). Digestibility values were higher in the selective-cut except in August (Fig. 26).

Species on the Clearcut Treatment

Seven plant species were analyzed from the clearcut area only. These species were: woolly panic grass, broomsedge, highbush blackberry, St. Andrews cross, smooth sumac, winged sumac, and blackgum. The plant parts and the amounts of these species analyzed are listed in Table 1.

Flowers of St. Andrews cross were present in June, July, and August, and thus were included in the monthly composited sample of leaves and stems within each treatment. In addition, some fruit was always present on the plant, and was included in the monthly sample.

Results of monthly nutrient analyses for the plant species collected from the clearcut are presented in Tables 11 through 17.

In the plants analyzed from the clearcut, field dry-matters were

Table 11. Comparison of monthly nutritional values, in percent dry matter, of broomsedge bluestem (*Andropogon virginicus* L.) from clearcut areas

Nutritional Parameter	1974							1975			
	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Feb.	March	April	May
Field Dry Matter	39.11	39.25	36.50	42.81	55.25	76.00	65.70	93.97	95.11	90.96	49.09
Total Mineral Matter	4.64	3.80	4.12	3.24	3.65	3.28	3.09	2.83	2.80	2.73	4.43
Calcium	0.20	0.31	0.17	0.21	0.19	0.25	0.19	0.19	0.19	0.20	0.25
Phosphorus	0.14	0.14	0.12	0.19	0.19	0.19	0.07	0.07	0.09	0.05	0.56
Ca: P Ratio	1.4:1	2.2:1	1.4:1	1.1:1	1.0:1	1.3:1	2.7:1	2.7:1	2.1:1	5.0:1	0.5:1
Crude Protein	4.66	4.47	4.95	3.68	3.76	2.33	2.13	2.46	2.61	2.80	6.74
In Vitro Dry Matter Digestibility	39.55	36.63	35.85	34.80	27.23	14.99	14.78	17.02	26.02	24.10	40.43

Table 12. Comparison of monthly nutritional values, in percent dry matter, of woolly pancium (*Panicum lanuginosum* Ell.) from clearcut areas

Nutritional Parameter	1974							1975			
	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Feb.	March	April	May
Field Dry Matter	38.73	51.55	52.69	37.88	44.19	43.37	33.93	44.64	27.78	23.91	41.67
Total Mineral Matter	8.52	11.56	9.74	9.02	8.04	8.72	10.13	9.14	10.25	9.88	6.76
Calcium	0.31	0.56	0.40	0.48	0.46	0.45	0.39	0.39	0.48	0.39	0.28
Phosphorus	0.18	0.18	0.14	0.19	0.20	0.20	0.25	0.25	0.31	0.38	0.21
Ca: P Ratio	1.7:1	3.1:1	2.9:1	2.5:1	2.3:1	2.3:1	1.6:1	1.6:1	1.5:1	1.0:1	1.3:1
Crude Protein	5.21	5.59	5.23	7.82	7.44	7.00	7.52	10.30	10.41	12.30	5.67
In Vitro Dry Matter Digestibility	45.09	43.71	36.08	38.83	41.00	41.44	45.15	45.16	53.80	52.64	42.24

Table 13. Comparison of monthly nutritional values, in percent dry matter, of highbush blackberry (*Rubus ostryifolius* Rydb.) from clearcut areas

Nutritional Parameter	Plant Part	1974							1975			
		June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Feb.	March	April	May
Field Dry Matter		44.32	47.12	49.09	45.37	46.88	53.41	57.27	59.38	35.71	27.78	35.13
Total Mineral Matter	L	3.31	3.21	3.19	2.59	3.80	4.20	---	---	3.00	2.26	2.29
	S	3.60	2.75	2.69	2.66	2.64	3.29	3.25	3.07	3.14	3.35	3.18
Calcium	L	0.74	0.78	0.78	0.94	1.10	1.04	---	---	0.43	0.53	0.60
	S	0.69	0.66	0.78	0.79	0.87	0.75	0.93	0.85	0.92	0.69	0.89
Phosphorus	L	0.10	0.07	0.07	0.08	0.09	0.09	---	---	0.42	0.17	0.15
	S	0.12	0.08	0.07	0.09	0.11	0.17	0.11	0.16	0.40	0.18	0.15
Ca: P Ratio	L	7.4:1	11.1:1	11.1:1	11.8:1	12.2:1	11.6:1	---	---	1.0:1	3.1:1	4.0:1
	S	5.8:1	7.5:1	11.1:1	8.8:1	7.9:1	4.4:1	8.5:1	5.3:1	2.3:1	3.8:1	5.9:1
Crude Protein	L	8.24	7.47	7.60	7.74	6.72	5.48	---	---	11.82	11.01	8.71
	S	3.82	3.87	4.24	4.77	5.41	5.93	5.47	7.59	2.16	3.08	1.00
In Vitro Dry Matter Digestibility	L	52.23	50.79	50.52	50.33	51.58	56.26	---	---	68.11	55.85	57.88
	S	18.49	21.37	22.46	24.01	25.09	32.14	32.11	37.60	33.13	31.97	32.30

--- = Plant part not available

Table 14. Comparison of monthly nutritional values, in percent dry matter, of St. Andrews cross (*Ascyrum hypericoides* L.) from clearcut areas

Nutritional Parameter	1974 June	July	Aug.	Sept.	Oct.	Nov.	Dec.	1975 Feb.	March	April	May
Field Dry Matter	49.81	46.91	52.33	40.63	47.96	60.00	63.04	70.91	51.95	38.64	50.00
Total Mineral Matter	2.77	3.53	2.50	3.19	3.47	3.15	2.91	2.58	3.03	4.13	3.20
Calcium	0.44	0.49	0.48	0.59	0.38	0.56	0.53	0.52	0.56	0.55	0.56
Phosphorus	0.16	0.14	0.15	0.23	0.23	0.23	0.23	0.20	0.28	0.27	0.19
Ca: P Ratio	2.8:1	3.5:1	3.2:1	2.6:1	1.7:1	2.4:1	2.3:1	2.6:1	2.0:1	2.0:1	2.9:1
Crude Protein	7.07	7.97	9.01	8.76	9.46	8.64	8.10	8.82	11.93	13.99	8.82
In Vitro Dry Matter Digestibility	42.45	53.00	51.09	36.60	41.01	31.81	25.20	23.16	34.80	53.33	52.15

Table 15. Comparison of monthly nutritional values, in percent dry matter, of smooth sumac leaves (<u>Rhus glabra</u> L.) from clearcut areas

Nutritional Parameter	1974 June	1974 July	1974 Aug.	1974 Sept.	1974 Oct.	1974 Nov.	1974 Dec.	1975 Feb.	1975 March	1975 April	1975 May
Field Dry Matter	44.65	47.18	69.12	39.02	48.65	---	---	---	---	18.83	36.44
Total Mineral Matter	6.35	4.80	5.45	5.08	6.34	---	---	---	---	5.87	4.25
Calcium	1.16	1.03	1.34	1.43	1.70	---	---	---	---	0.61	0.72
Phosphorus	0.23	0.20	0.26	0.30	0.43	---	---	---	---	0.71	0.25
Ca: P Ratio	5.0:1	5.2:1	5.2:1	4.8:1	4.0:1	---	---	---	---	0.9:1	3.0:1
Crude Protein	10.67	8.78	9.74	9.81	5.70	---	---	---	---	26.70	10.40
<u>In Vitro</u> Dry Matter Digestibility	54.43	53.77	53.77	55.67	54.14	---	---	---	---	72.06	56.13

--- = Plant part not available

Table 16. Comparison of monthly nutritional values, in percent dry matter, of winged sumac leaves (*Rhus copallina* L.) from clearcut areas

Nutritional Parameter	1974 June	July	Aug.	Sept.	Oct.	Nov.	Dec.	1975 Feb.	March	April	May
Field Dry Matter	50.40	49.01	50.76	46.79	50.19	---	---	---	---	21.23	43.45
Total Mineral Matter	3.89	3.31	3.96	2.88	3.86	---	---	---	---	5.59	2.57
Calcium	0.75	0.73	0.96	0.98	1.13	---	---	---	---	0.51	0.43
Phosphorus	0.18	0.13	0.21	0.26	0.23	---	---	---	---	0.78	0.22
Ca: P Ratio	4.2:1	5.6:1	4.6:1	3.8:1	4.9:1	---	---	---	---	0.7:1	2.0:1
Crude Protein	9.58	7.62	9.04	9.34	6.34	---	---	---	---	30.93	11.35
In Vitro Dry Matter Digestibility	54.43	52.58	49.00	50.93	50.42	---	---	---	---	60.52	56.11

--- = Plant part not available

Table 17. Comparison of monthly nutritional values, in percent dry matter, of blackgum (*Nyssa sylvatica* Marsh.) from clearcut areas

Nutritional Parameter	Plant Part	1974 June	July	Aug.	Sept.	Oct.	Nov.	Dec.	1975 Feb.	March	April	May
Field Dry Matter		42.80	48.15	51.45	48.21	55.56	38.78	50.00	50.00	47.37	21.79	34.39
Total Mineral Matter	L	3.38	3.88	4.43	4.94	5.39	---	---	---	---	5.10	3.57
	S	3.70	3.62	3.75	2.96	3.79	3.28	3.49	3.50	3.70	7.12	4.90
Calcium	L	0.63	0.83	0.78	0.98	1.16	---	---	---	---	0.55	0.37
	S	0.84	0.95	0.91	1.02	1.09	0.78	0.96	0.98	1.03	0.83	0.73
Phosphorus	L	0.14	0.14	0.14	0.18	0.15	---	---	---	---	0.52	0.17
	S	0.09	0.07	0.06	0.11	0.11	0.13	0.11	0.07	0.10	0.36	0.15
Ca: P Ratio	L	4.5:1	5.9:1	5.6:1	5.4:1	7.7:1	---	---	---	---	1.1:1	2.2:1
	S	6.0:1	13.6:1	15.2:1	9.3:1	9.9:1	6.0:1	8.7:1	14.0:1	10.3:1	2.3:1	4.9:1
Crude Protein	L	8.94	10.75	9.98	10.60	7.19	---	---	---	---	22.47	11.30
	S	3.43	3.34	3.02	3.71	3.94	3.94	3.60	3.74	4.37	13.92	6.04
In Vitro Dry Matter Digestibility	L	43.54	45.56	46.49	44.33	43.26	---	---	---	---	48.55	46.56
	S	35.38	29.73	33.17	28.89	30.75	31.34	27.50	29.87	32.23	61.07	44.92

--- = Plant part not available

lowest in April in all species except broomsedge. The lowest values for broomsedge were recorded from June through August (Table 11).

Ca:P ratios generally exceeded the recommended ratio of 1:2 to 2:1 (Halls 1970). However, Ca:P ratios in clearcut species were lower than ratios of species analyzed in both treatments or in the selective-cut only. Overall, broomsedge and woolly panic grass (Fig. 27), had lower Ca:P ratios than any other species analyzed in this study. St. Andrews cross had a low Ca:P ratio, particularly in the fall and winter (Fig. 28). Highbush blackberry had a high Ca:P ratio throughout the year with the exception of spring (Fig. 28). Smooth sumac and winged sumac were similar, having high Ca:P ratios except in the spring (Fig. 29). Blackgum leaves and stems generally had high Ca:P ratios except in the spring when both plant parts showed a lower Ca:P ratio (Fig. 30).

As shown in Figs. 31 through 34, crude protein levels met the minimum recommended protein level of 6 to 7 percent for deer forage (French et al. 1955), in all species throughout the year with the exceptions of woolly panic grass, broomsedge, and blackgum stems. In all species except broomsedge, crude protein levels were highest in the spring. Broomsedge protein levels remained consistent, and low, throughout the year (Fig. 31).

As shown in Figs. 31 through 34, IVDMD values tended to be greater in all species in spring. Digestibility values of St. Andrews cross (Fig. 32) increased in July, which could have been due to the presence of flower parts in the sample at this time. In all species collected from the clearcut area only, IVDMD values were generally lowest in the winter months (Figs. 31 through 34).

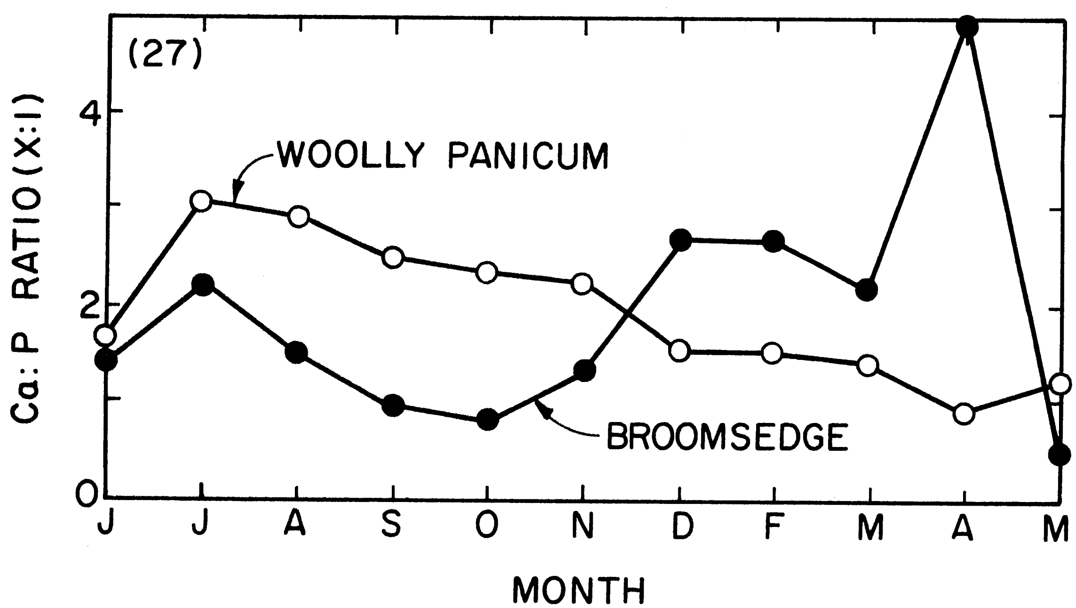


Fig. 27. Monthly trends in Ca:P ratios of woolly panicum and broomsedge current annual growth

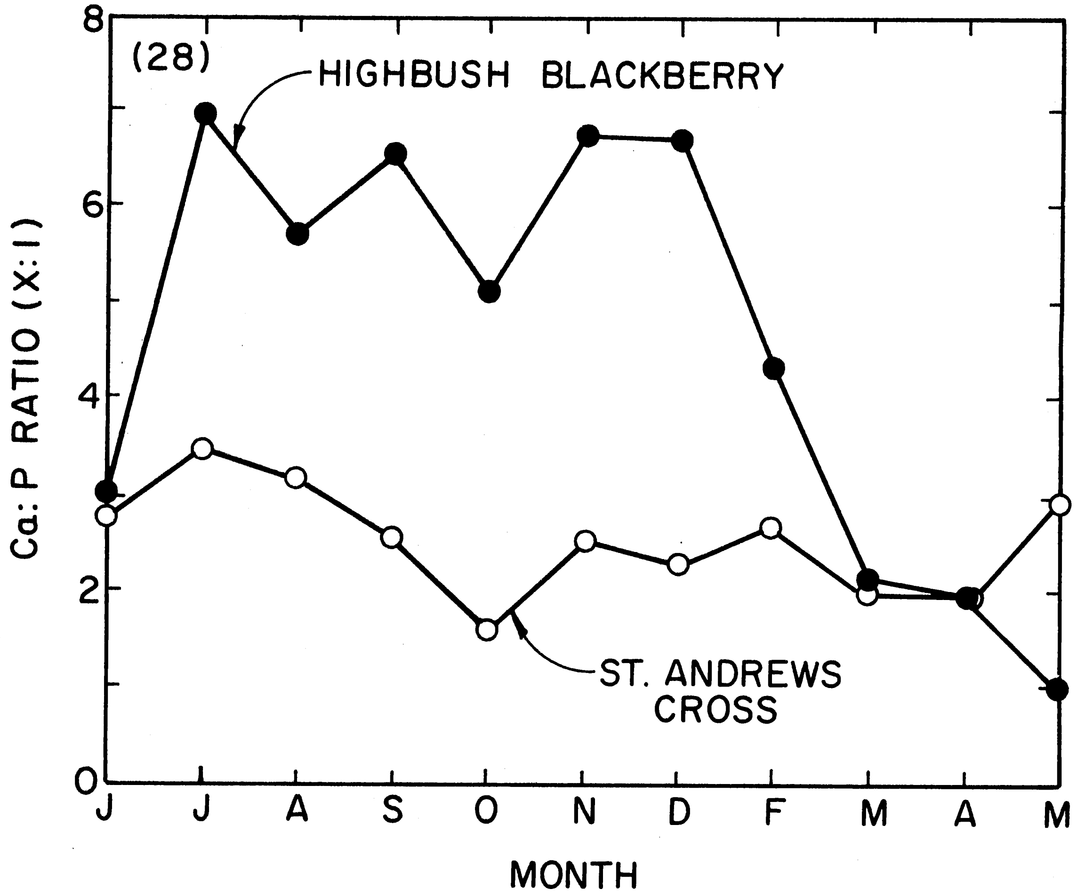


Fig. 28. Monthly trends in Ca:P ratios of highbush blackberry and St. Andrews cross current annual growth

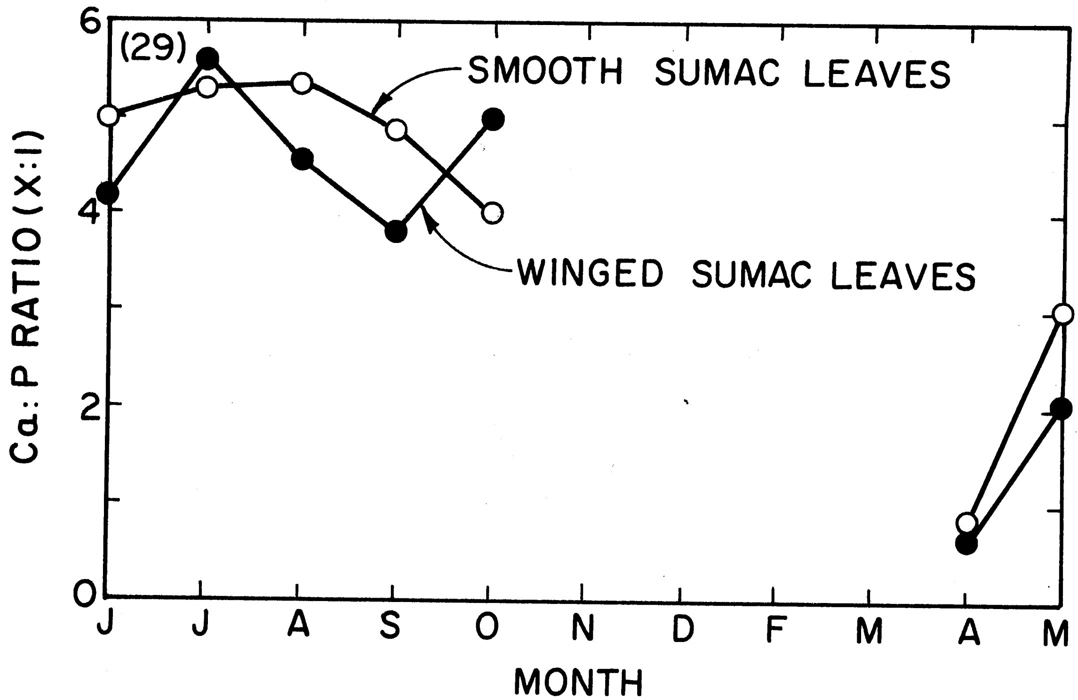


Fig. 29. Monthly trends in Ca:P ratios of smooth and winged sumac leaves

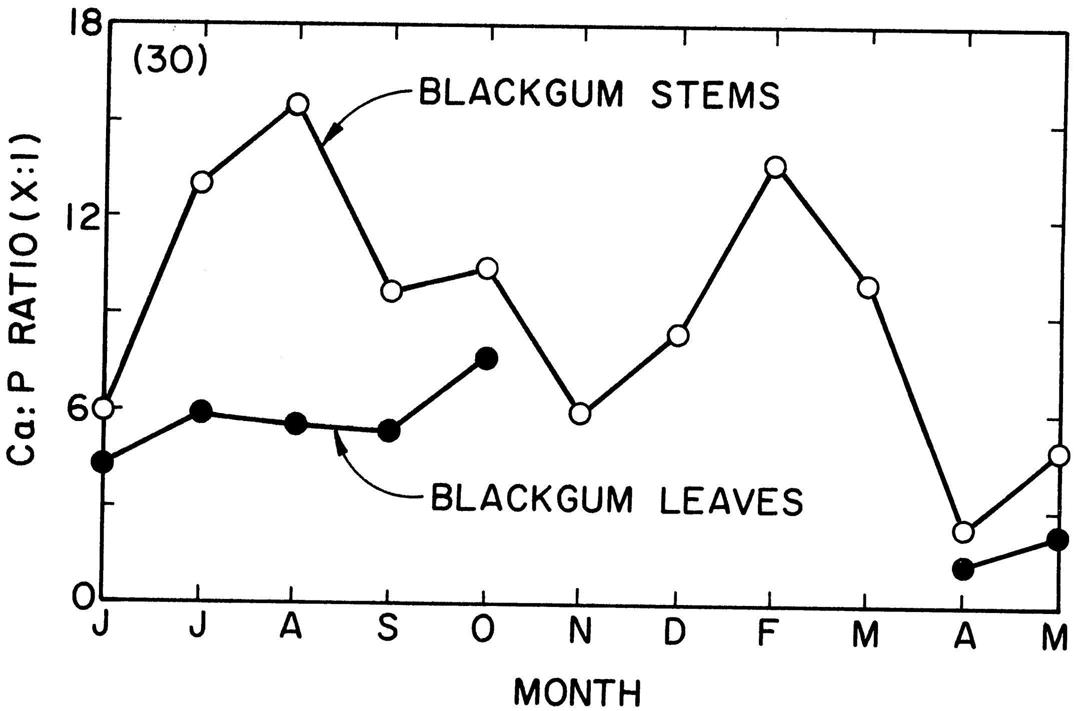


Fig. 30. Monthly trends in Ca:P ratios of blackgum leaves and stems

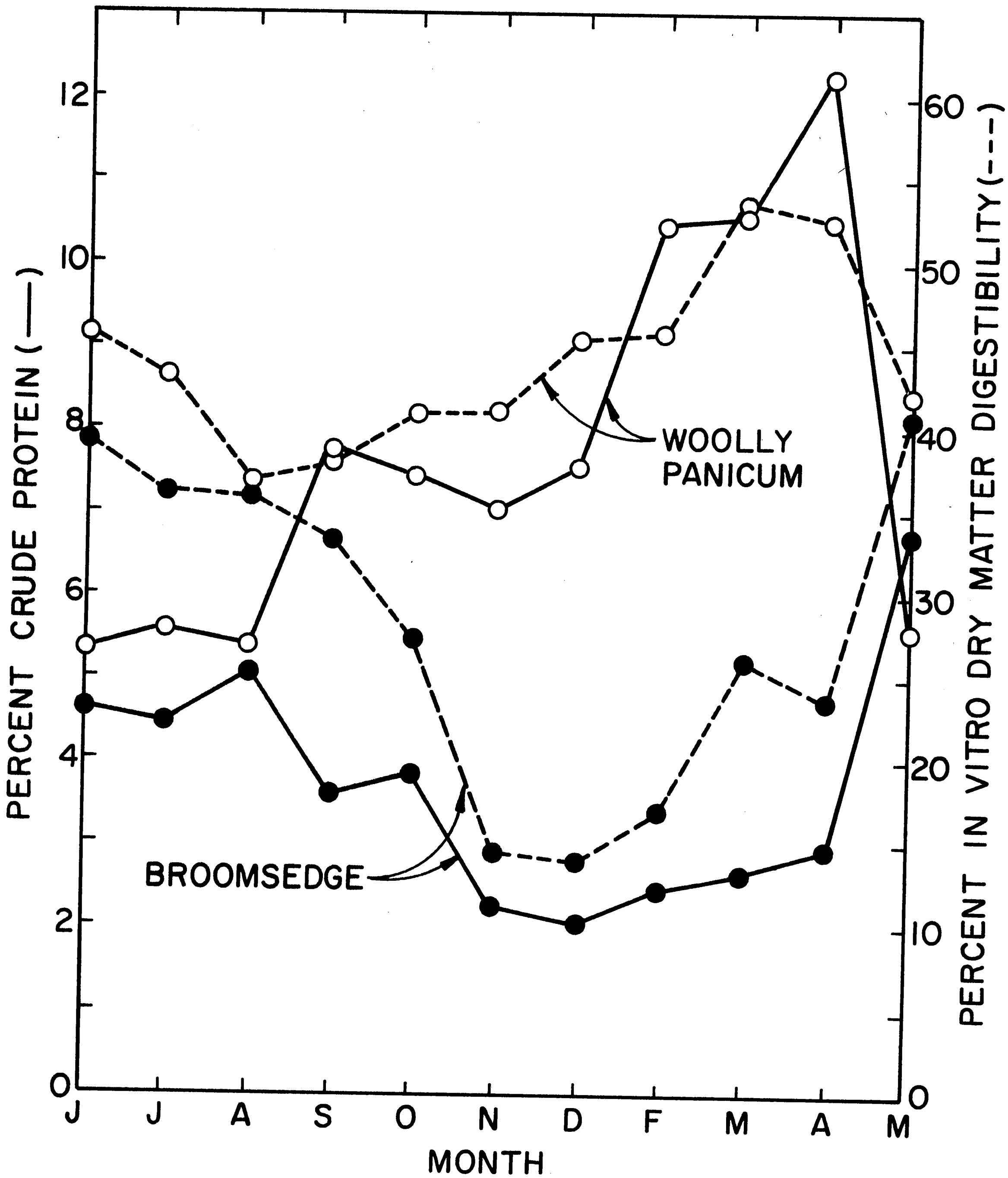


Fig. 31. Monthly crude protein and *in vitro* dry matter digestibility trends of woolly panicum and broomsedge current annual growth

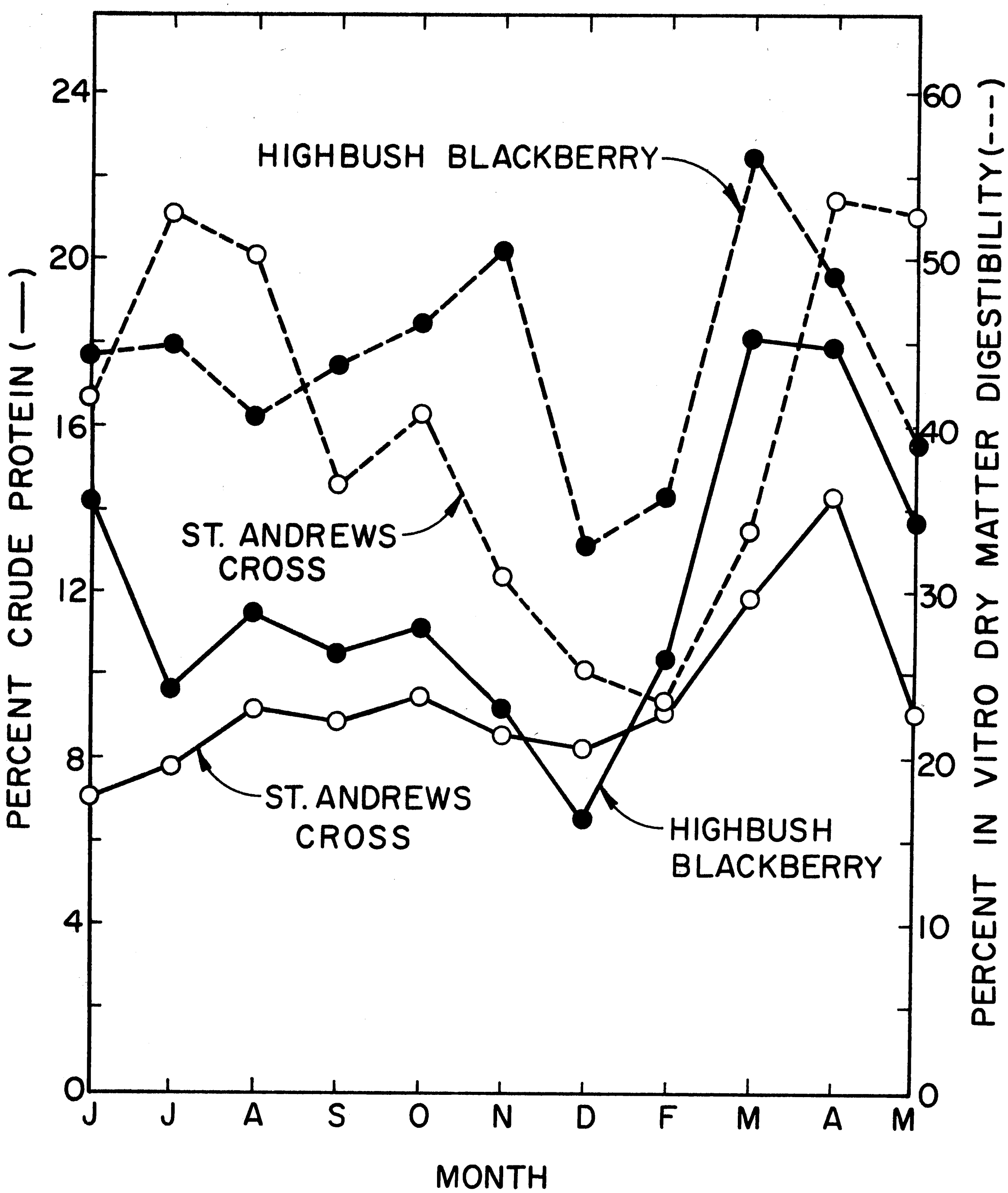


Fig. 32. Monthly crude protein and <u>in vitro</u> dry matter digestibility trends of highbush blackberry and St. Andrews cross current annual growth

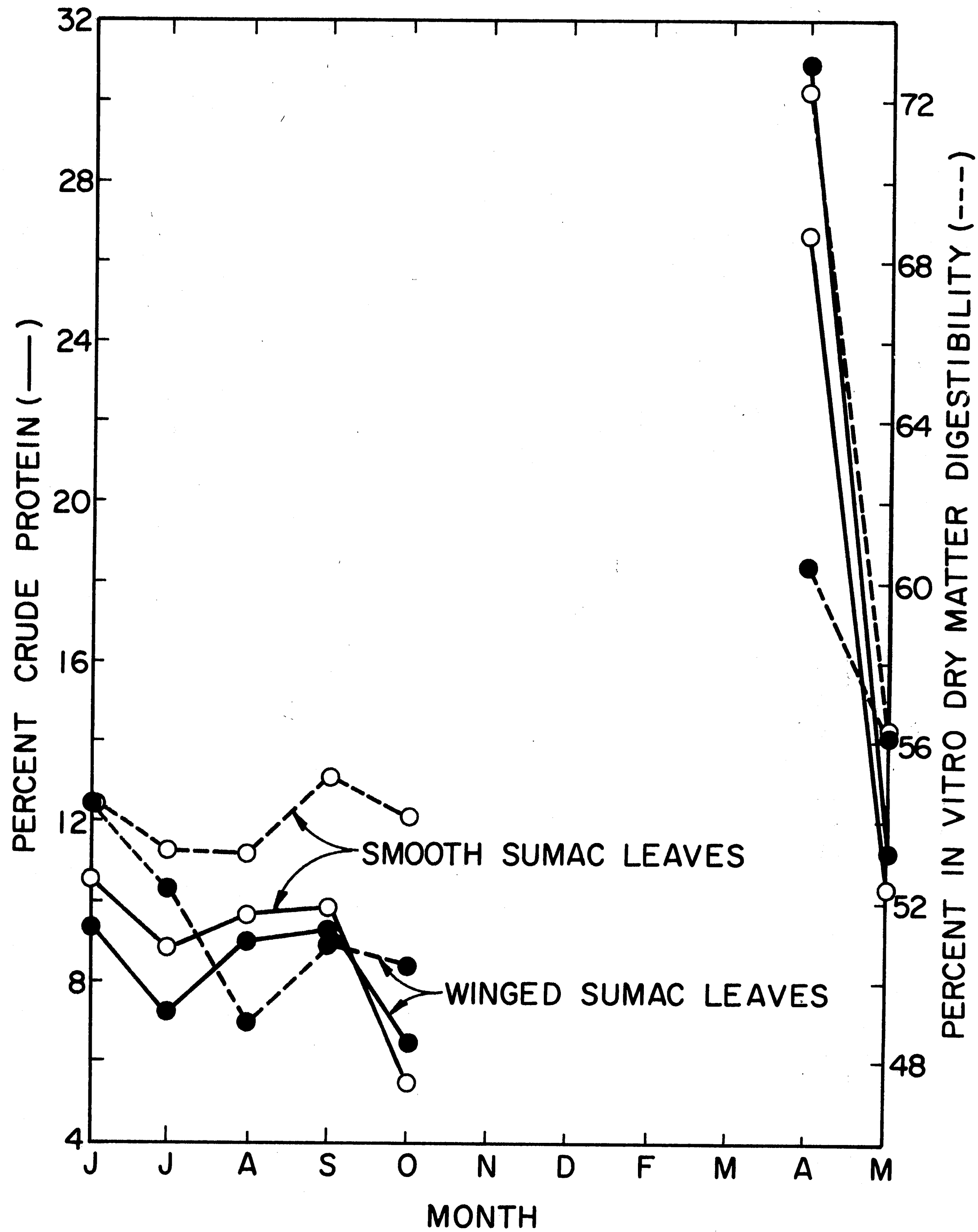


Fig. 33. Monthly crude protein and <u>in vitro</u> dry matter digestibility trends of smooth and winged sumac leaves

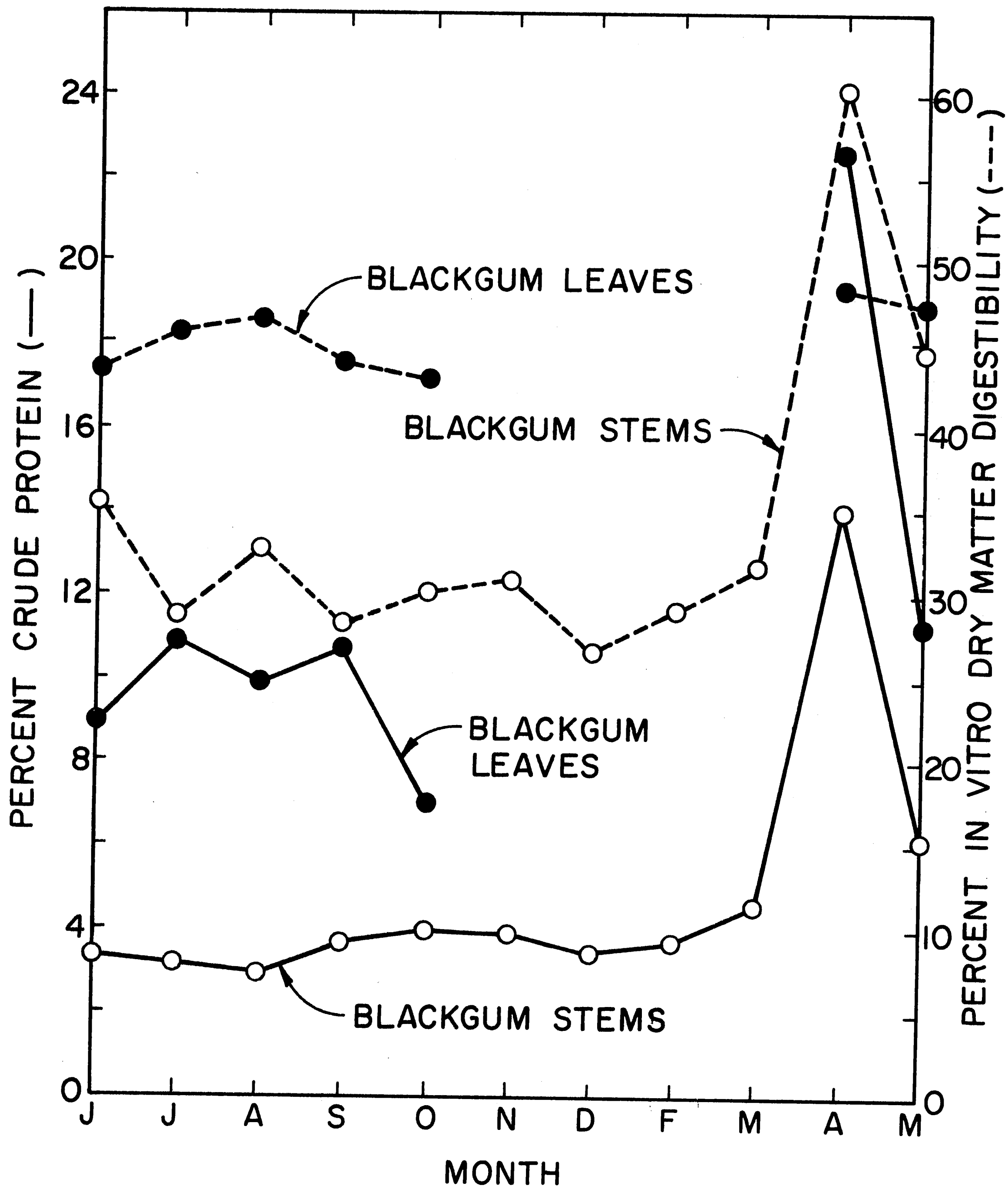


Fig. 34. Monthly crude protein and _in vitro_ dry matter digestibility trends of blackgum leaves and stems

Leaves and stems were analyzed separately in only one clearcut species: blackgum. Blackgum leaves, in relation to stems, were higher in crude protein and IVDMD and had a lower Ca:P ratio (Figs. 30 and 34).

Species on the Selective-cut Treatment

Three plant species were analyzed from the selective-cut treatment only. These species were: flowering dogwood, common deerberry, and farkleberry. The plant parts and the amounts of these species analyzed are listed in Table 1. Results of the monthly nutritional analyses for the plant species are presented in Tables 18 through 20.

In all selective-cut species, field dry-matter values were lowest in spring and highest in winter.

As shown in Figs. 35, 36, and 39, Ca:P ratios were generally high in all selective-cut species. Dogwood leaves and stems had extremely high Ca:P ratios throughout the year. The lowest Ca:P ratios for all species and plant parts occurred in the spring. In leaves and stems of dogwood and common deerberry, the highest Ca:P ratios occurred in summer (Figs. 35 and 36). Ca:P ratios in farkleberry fluctuated throughout the year (Fig. 39).

As shown in Figs. 37, 38, and 39, crude protein levels met minimum recommended levels of 6 to 7 percent for deer forage (French et al. 1955) in dogwood and common deerberry leaves and in farkleberry throughout the year. Dogwood and common deerberry stems had crude protein levels generally below the recommended minimum protein level (FIgs. 37 and 38). Protein levels were highest in the spring in dogwood and common deerberry leaves and in farkleberry. Dogwood stems were low in crude protein throughout the year, which was also true in common

Table 18. Comparison of monthly nutritional values, in percent dry matter, of flowering dogwood (*Cornus florida* L.) from selective-cut areas

Nutritional Parameter	Plant Part	1974 June	July	Aug.	Sept.	Oct.	Nov.	Dec.	1975 Feb.	March	April	May
Field Dry Matter		36.17	45.49	43.36	47.73	47.33	46.03	48.00	53.93	52.61	29.88	34.08
Total Mineral Matter	L	7.24	9.97	10.23	9.06	10.03	---	---	---	---	10.21	10.22
	S	5.00	4.71	5.01	4.71	4.78	5.74	5.53	4.91	5.73	5.88	5.62
Calcium	L	2.69	2.71	2.74	2.76	3.06	---	---	---	---	2.34	2.54
	S	1.36	1.38	1.43	1.53	1.74	1.63	1.48	1.46	1.78	1.39	1.32
Phosphorus	L	0.15	0.15	0.10	0.19	0.18	---	---	---	---	0.21	0.15
	S	0.08	0.06	0.07	0.15	0.15	0.14	0.10	0.12	0.19	0.11	0.14
Ca: P Ratio	L	17.9:1	18.1:1	27.4:1	14.5:1	17.0:1	---	---	---	---	11.1:1	16.9:1
	S	17.0:1	23.0:1	20.4:1	10.2:1	11.6:1	11.6:1	14.8:1	12.2:1	9.4:1	12.6:1	9.4:1
Crude Protein	L	9.42	9.19	8.58	9.49	9.06	---	---	---	---	12.40	10.58
	S	3.56	3.28	3.32	3.67	4.53	4.61	4.55	5.37	4.85	4.74	4.40
In Vitro Dry Matter Digestibility	L	41.72	28.53	43.16	43.47	39.20	---	---	---	---	48.96	54.64
	S	30.56	39.01	27.98	24.73	27.03	32.88	35.52	32.74	22.11	35.06	35.05

--- = Plant part not available

Table 19. Comparison of monthly nutritional values, in percent dry matter, of common deerberry (*Vaccinium stamineum* L.) from selective-cut areas

Nutritional Parameter	1974 June	July	Aug.	Sept.	Oct.	Nov.	Dec.	1975 Feb.	March	April	May
Field Dry Matter	41.92	50.00	52.03	52.27	58.00	65.38	55.26	59.52	42.05	28.64	33.15
Total Mineral Matter	4.88	5.48	4.85	4.82	5.54	4.92	3.39	4.39	4.95	6.41	5.67
Calcium	0.81	0.90	1.02	1.21	1.16	1.12	0.92	1.05	0.89	0.94	0.48
Phosphorus	0.27	0.13	0.18	0.19	0.23	0.17	0.14	0.25	0.43	0.46	0.42
Ca: P Ratio	3.0:1	6.9:1	5.7:1	6.4:1	5.0:1	6.6:1	6.6:1	4.2:1	2.1:1	2.0:1	1.0:1
Crude Protein	14.10	9.84	11.69	10.31	10.94	9.29	6.39	10.18	17.95	17.56	13.85
In Vitro Dry Matter Digestibility	44.75	44.97	40.81	43.99	45.05	50.21	33.28	36.36	56.57	49.07	38.40

Table 20. Comparison of monthly nutritional values, in percent dry matter, of farkleberry (*Vaccinium arboreum* Marsh.) from selective-cut areas

Nutritional Parameter	1974							1975			
	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Feb.	March	April	May
Field Dry Matter	39.24	50.00	50.00	44.55	43.10	53.33	58.00	70.00	37.50	26.36	34.82
Total Mineral Matter	3.82	4.04	3.58	4.34	5.11	7.04	4.34	3.81	4.84	3.72	3.47
Calcium	0.85	0.88	0.94	1.11	1.16	1.19	1.09	0.95	0.89	0.73	0.80
Phosphorus	0.12	0.07	0.07	0.13	0.33	0.09	0.11	0.14	0.39	0.22	0.14
Ca: P Ratio	7.1:1	12.6:1	13.4:1	8.5:1	3.5:1	13.2:1	9.9:1	6.8:1	2.3:1	3.3:1	5.7:1
Crude Protein	6.27	7.40	7.11	7.22	7.16	5.83	6.33	5.57	14.60	12.15	9.29
In Vitro Dry Matter Digestibility	31.20	27.61	27.73	27.13	29.43	32.36	31.98	27.92	40.96	39.29	36.37

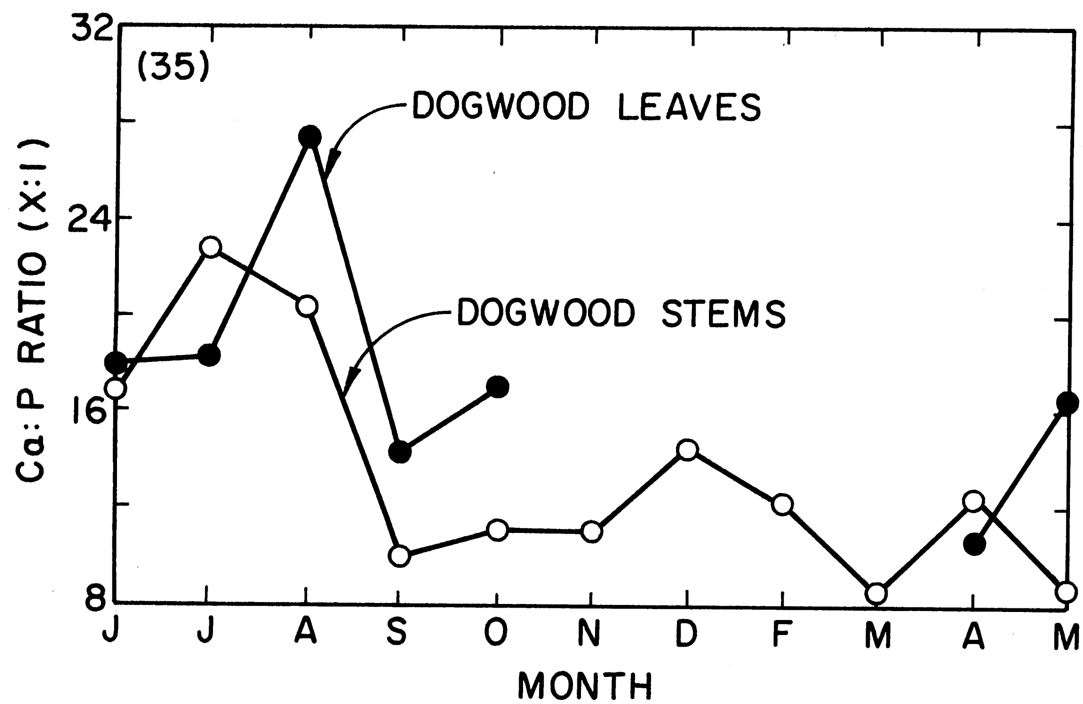


Fig. 35. Monthly trends in Ca:P ratios of dogwood leaves and stems

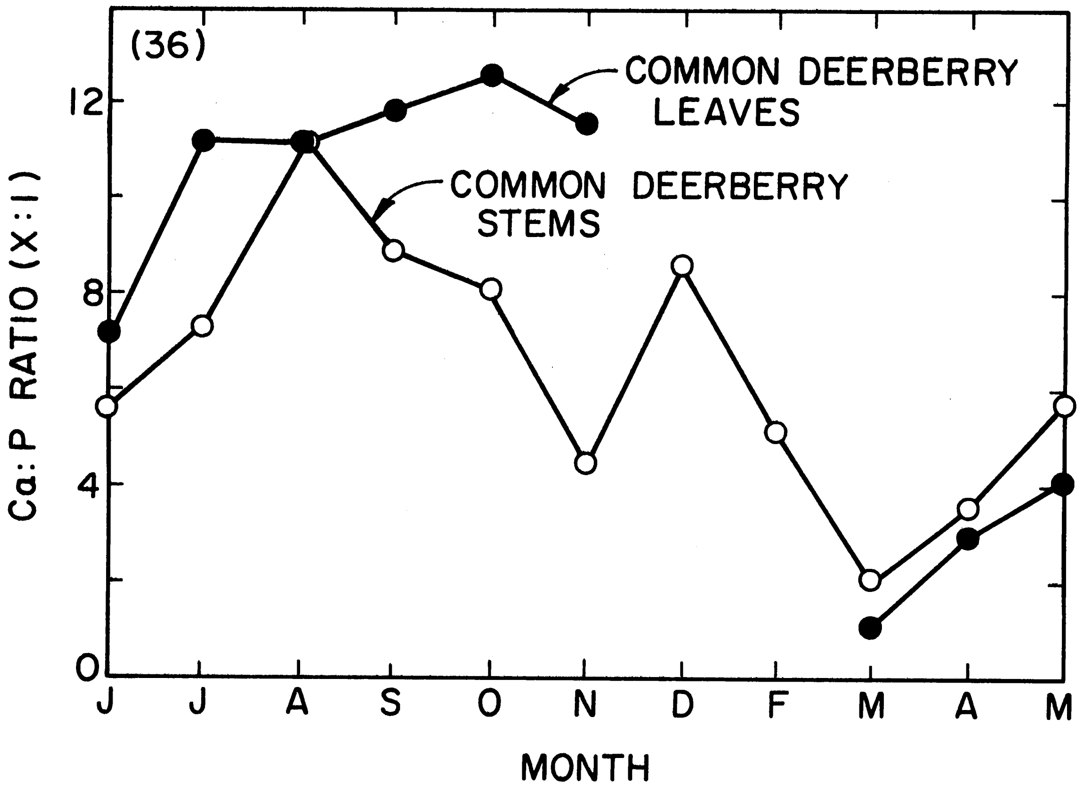


Fig. 36. Monthly trends in Ca:P ratios of common deerberry leaves and stems

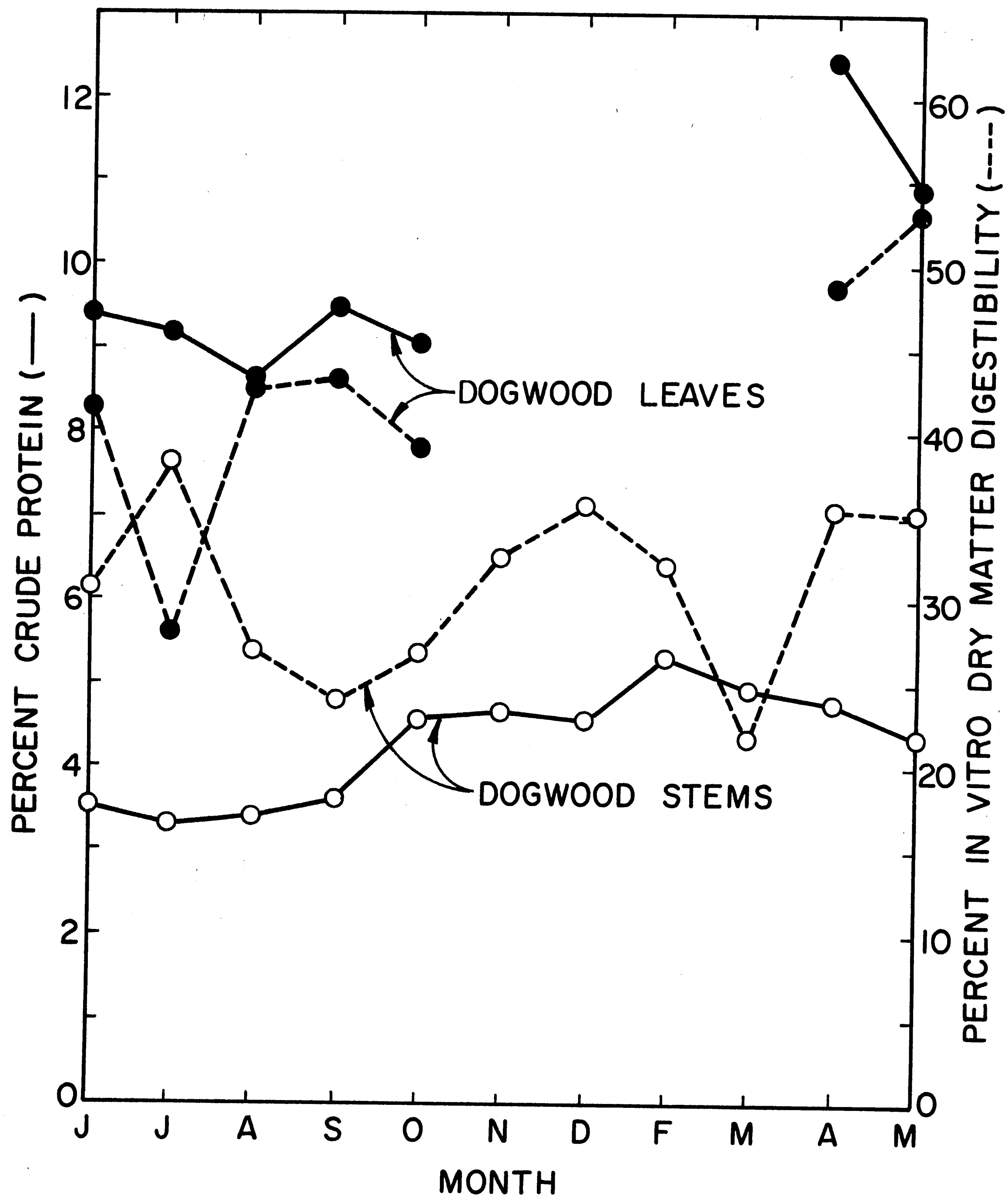


Fig. 37. Monthly crude protein and in vitro dry matter digestibility trends of dogwood leaves and stems

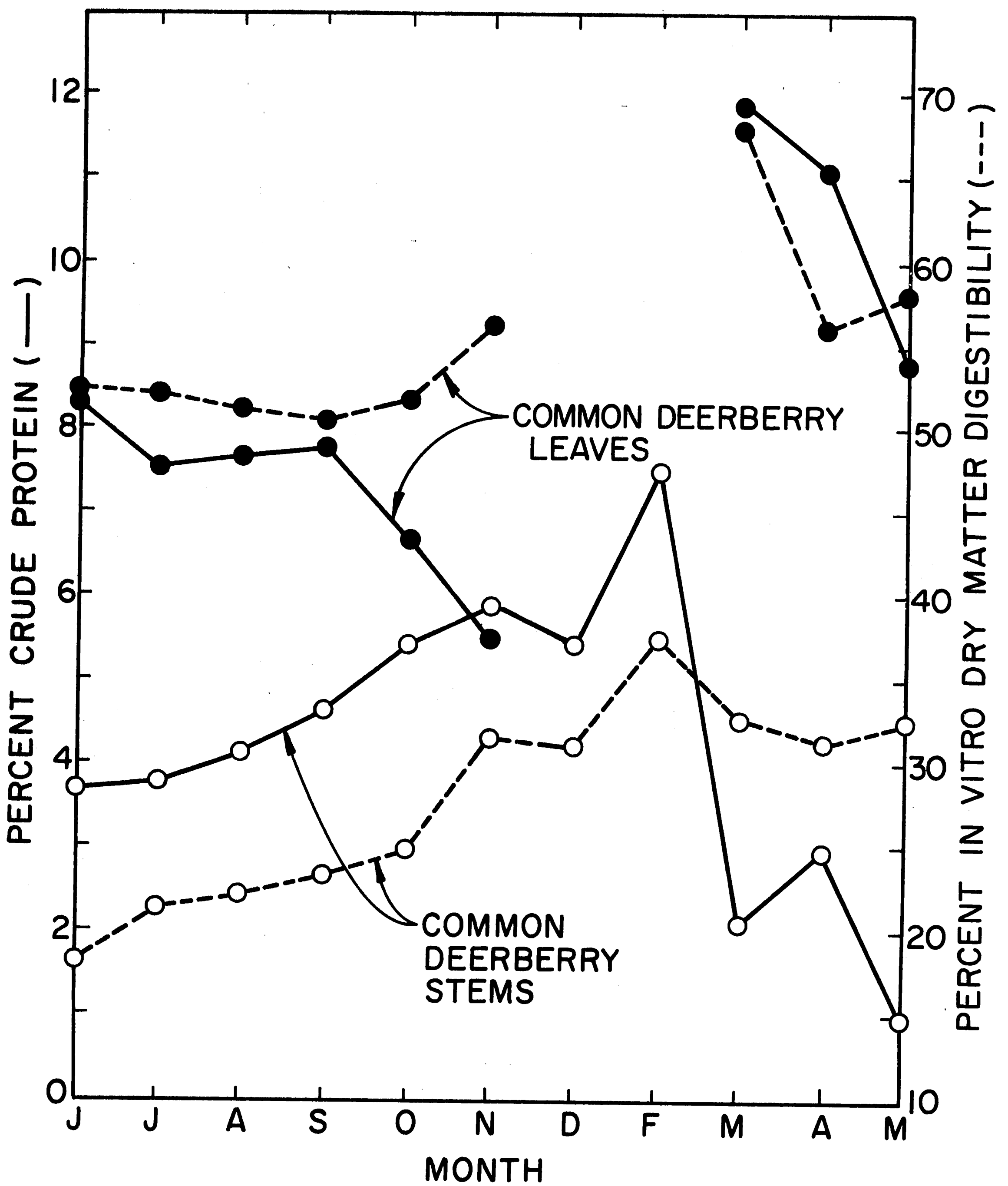


Fig. 38. Monthly crude protein and in vitro dry matter digestibility trends of common deerberry leaves and stems

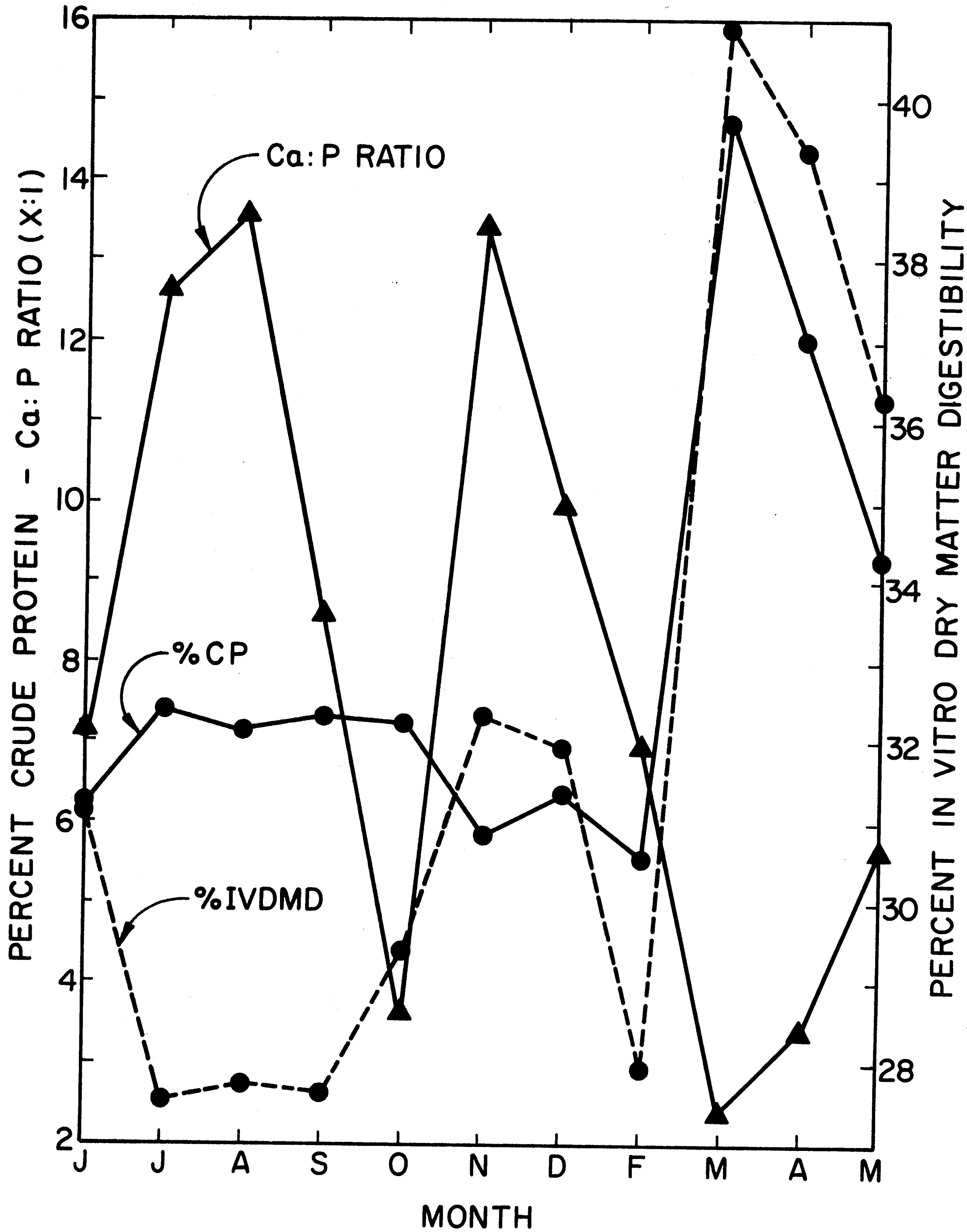


Fig. 39. Monthly trends in Ca:P ratio, crude protein, and *in vitro* dry matter digestibility of farkleberry current annual growth

deerberry stems except in February.

IVDMD values in dogwood and common deerberry leaves and in farkleberry were highest in the spring (Figs. 37, 38, and 39). Digestibility values in dogwood and common deerberry stems were highest in late fall and early winter (Figs. 37 and 38).

Dogwood and common deerberry leaves, in relation to stems, were higher in crude protein and IVDMD, and had higher Ca:P ratios (Figs. 35, 36, 37, and 38).

CHAPTER V

SUMMARY AND CONCLUSIONS

The principal objectives of this study were to determine seasonal trends in nutritional values of selected plants potentially useful as deer forage on clearcut and selective-cut pine sites in southeastern Oklahoma, and to compare the differences in nutrient content of the forages from the two treatments.

Species on Clearcut and Selective-cut Treatments

In the seven plant species collected from both clearcut and selective-cut treatments, a decrease in field dry-matter values and the Ca:P ratio, and an increase in crude protein and IVDMD occurred in spring.

With the exception of some stem components, plant species that were collected from both treatments generally contained the minimum recommended requirement of 6 to 7 percent crude protein for deer forage (French et al. 1955).

In those species in which leaves and stems were analyzed separately, leaves generally had a lower Ca:P ratio and were higher in crude protein and IVDMD.

Plant species in the selective-cut, with the exception of loblolly pine, generally had lower field dry-matter values than did those in the clearcut. This could have been due to the increased canopy coverage afforded those plant species in the selective-cut.

Crude protein and IVDMD values varied between treatments, depending on the species. Neither of the treatments, when species were compared, showed consistently higher crude protein or IVDMD (Table 21).

Of the nutrient factors analyzed, only mineral composition of plant species differed consistently between treatments. Calcium percentages and the Ca:P ratio differed noticeably between treatments. The selective-cut generally had higher, less desirable Ca:P ratios (Table 21). It appears the clearcutting practice, through removal of vegetation, may lower the amount of mineral matter available for recycling. In the study area, this removal of mineral matter favored deer by lowering the Ca:P ratio in the forage. The potential effect of this removal on vegetation in the area is not known.

The goal in meeting recommended calcium and phosphorus levels in forages is to have adequate levels of both minerals, with a proper ratio between the two minerals. To lower the calcium level may achieve a desirable ratio but does nothing to solve the phosphorus requirement of the animal. The proper goal is to increase the phosphorus level, which will in turn lower the Ca:P ratio. In this respect, fruits are generally good sources of phosphorus. A management systems providing for the maintenance of plant species which are desirable fruit producers, would serve well the calcium-phosphorus problem so often encountered in deer forages.

The particular month at which a certain nutrient factor might peak in one treatment in a species differed from the peak month for the same species in the other treatment. This is an important consideration in

Table 21. Plant species showing a consistently lower Ca:P ratio, higher crude protein content, or higher *in vitro* dry matter digestibility in treatment comparisons

Nutritional Parameter	Treatment	
	Selective-cut	Clearcut
Ca:P Ratio	Nuttall wildindigo	Winged elm Loblolly pine Common greenbrier leaves Common greenbrier stems American beautyberry leaves American beautyberry stems Sweetgum leaves Sweetgum stems
Crude Protein	American beautyberry leaves Hickory leaves Nuttall wildindigo	Loblolly pine Sweetgum stems Winged elm
In *Vitro Dry* Matter Digestibility	Loblolly pine Sweetgum leaves Nuttall wildindigo	American beautyberry leaves American beautyberry stems Common greenbrier leaves Common greenbrier stems

relation to adequate nutrient levels for white-tailed deer. If clearcut and selective-cut areas adjoin one another, the animal has available within one species, plants of varying nutritional value. This variation increases the deer's chances of obtaining a diet of adequate nutritional quality because deer appear to have the ability to select the more nutritional plant and plant parts available (Swift 1948, Weir and Torell 1959, Longhurst et al. 1968).

Species on the Clearcut Treatment

In the seven plant species collected only from the clearcut, a decrease in field dry-matter values and the Ca:P ratio, and an increase in crude protein and IVDMD occurred in spring.

With the exception of broomsedge, woolly panic grass, and blackgum stems, species in the clearcut met throughout the year, the minimum recommended crude protein requirement of 6 to 7 percent for deer forage (French et al. 1955).

Species on the Selective-cut Treatment

In the three plant species collected only from the selective-cut, a decrease in field dry-matter values and the Ca:P ratio, and an increase in crude protein and IVDMD occurred in spring.

With the exception of dogwood and common deerberry stems, species in the selective-cut met throughout the year, the minimum recommended crude protein requirement of 6 to 7 percent (French et al. 1955).

Implications Related to Clearcutting

In this study, there appeared to be a difference in species diversity and abundance between clearcut and selective-cut areas. Plants present in one of the areas were not always found in the other treatment area. When a plant species was present in both treatments, there often appeared to be a difference in the abundance of the species. Due to these differences in plant diversity and abundance between the treatments, contiguous clearcut and selective cut areas should provide deer a greater choice of forage plants.

In regard to plant nutritional quality, only Ca:P ratios appeared to consistently differ between clearcut and selective-cut areas. However, due to the fluctuations in nutritional values between the two treatments for the same plant species analyzed, adjoining clearcut and selective-cut areas should simultaneously provide deer with different nutritional qualities within the same plant species.

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