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THE MANAGEMENT OF GRAZING LANDS IN THE WESTERN DOWNS AND MARANOA

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6.2 PASTURE COMPOSITION IN THE WESTERN DOWNS AND MARANOA REGION OF QUEENSLAND
- does it really matter?

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Introduction

Climate and land unit broadly determine the sort of pasture which will grow in south-west Queensland. This review concentrates on the more subtle controls which affect pasture composition, things such as:

- recent seasonal conditions
- spatial heterogeneity of soil, slope and large trees
- major disturbances such as fire and ploughing
- time since the last major composition change
- grazing management.

Suffice to say that pasture composition can be expressed in different ways (density, frequency, yield or abundance) each of which may be measured by several techniques (quadrats, points, clipping, rating, etc.). In south-west Queensland the major criteria to be measured are:

- basal cover
- dry matter yield
- relative abundance of key species.

That is, how well is the ground covered, how much feed is there and how common are the useful and undesirable species? For most practical purposes, annuals and seedlings of perennials are 'background noise' and can be ignored when measuring composition of long-term pasture.

The amount of quotable research/demonstration information about pasture composition from this region is very small. I will use what is available and extrapolate from surrounding regions where appropriate and provide a fairly comprehensive reading list. I will also append a table, a figure and a key which provide guides to others who wish to pursue more rigorous studies in the future. The table (Table 1) is a list of major and key species currently found in each of 16 broad pasture types from the region, plus a guide to what constitutes good, fair or poor condition. Other notes about weeds and plant cover are included. The figure (Figure 2) shows diagrammatically the adaptation of major species to clay levels and to soil acidity. My expectations, when talking about pasture composition, are as much governed by the species' comfort with current soil factors when they have moisture for growing, as they are by resistance to grazing, fire and frost.

Key soil types

Basic pasture types in the Maranoa can be broadly defined on the basis of the soil type on which they grow because the climate is very similar over the whole region except in the extreme north. I have used the dichotomous key (Key 1) to summarise my current ideas on how the broad pasture types are derived.

In settling upon these groups, I admit inadequate knowledge of the top end of the Bungil, Booringa and Taroom shires and some uncertainty about separating the Bollon gidgee country from the flat Tara brigalow lands. Sown pastures establish fairly readily in the Tara Shire on heavy clays, but will rarely do so south of Bollon; otherwise the two types of country are very similar.

Because many species are physiologically adapted to a fairly wide range of soil clay contents and pH, the pastures found on each soil type are never a unique mixture of plants, but certain species predominate. Some species do have a restricted range of adaptation, for example, spinifex and Mitchell grass. Add to this the five modifying factors mentioned at the start of this review and the task of classifying and describing pasture types in terms of their composition becomes difficult with our current knowledge.

Seasonal variation in pasture composition

Seasonal variation in composition is not easy to manage, but we do understand broad patterns of change [grasses grow more in summer (Christie 1981; Silcock *et al.* 1985) and medics and herbage flourish in winter (Clarkson 1978)] and managers largely sway with them. Vigorous winter-growing grasses seem impossible to grow in this rainfall environment; they will not survive in hot, dry summers. Annuals abound in good seasons in both winter and summer with annual grasses such as button (*Dactyloctenium radulans*) and Flinders (*Iseilema* spp.) largely restricted to the summer period. Vigorous, herbaceous, summer legumes are not common, especially in sown pastures, but many inconspicuous species exist naturally, for example, rhynchosia pea (*Rhynchosia minima*), glycine pea (*Glycine tabacina, G. canescens, G. tomentella*), *Desmodium campylocaulon, D. varians* and streaked rattlepod (*Crotalaria dissitiflora*). How much nitrogen they fix is debatable (Silcock 1988), but their feed value is high, provided they are not poisonous. These legumes occasionally have 'big' seasons and can also be very conspicuous after fires. In winter, the most conspicuous native legumes are Darling peas (*Swainsona* spp.), but annual Cooper clover (*Trigonella suavissima*) can still be found in spring on the flood plains near the NSW border. Exotic annual medics are becoming increasingly common in winter. Soil seed dynamics and softening strongly influence their presence (Silcock *et al.* 1988).

Annuals can induce big fluctuations in pasture bulk, but rarely increase basal cover significantly. Thus, they are valuable fodder and, when green, protect the soil, but they contribute little to landscape stability in the long term. Perennial grasses are the major contributors to pasture yield and to basal cover (Roberts *et al.* 1976; Silcock *et al.* 1985) and thus to pasture and landscape stability. They fluctuate less wildly in response to seasonal changes than all the other non-woody plants. Perennial grasses generally seed well from good rain in February-March (Figure 1). Thus, management can be adjusted in late summer to encourage seed set of good grass species or to discourage heavy seeding of spear and wiregrasses depending on pasture condition.

Spatial heterogeneity of plants

Within one land unit or soil type, the surface soil can vary dramatically as far as plant growth is concerned. Buffel grass grows well only under poplar box trees in mulga country (Christie 1975). Old deep-rooted eucalypts such as poplar box and silverleaved ironbark normally shelter a pasture containing more *Chloris* (windmill grass), bluegrass (*Bothriochloa decipiens, B. ewartiana*), *Paspalidium* spp. (for example, *P. constrictum*), curly windmill grass (*Enteropogon*) and legumes (for example, *Glycine tabacina, Desmodium varians, G. canescens*) than the inter-tree areas. Under these trees, wiregrasses are also less common. If the trees are pulled, the effect in and around the stumphole remains for many years, particularly on strongly duplex soils that are not cultivated. This is not to say that we should try to grow forests of big trees to discourage wiregrasses - their reduction of pasture yield is dramatic at high densities. However, I believe that in semi-arid (<500 mm mean annual rainfall) areas, the net effect of clearing trees from open woodland (<40 big trees/ha) on animal production is often negligible and certainly not economic if regrowth is significant.

Variation in soil depth with position on a slope can also be enough to change pasture composition. The pastures beside any creek differ from those unaffected by flooding, coverage with silt or salinity. When sampling a paddock, we usually deliberately skirt around creeks and ridges because they are a small (<5%) part of the total area of a paddock. However, a grazing animal is very selective about where it eats and can often produce better growth than our pasture sampling would predict for a paddock in good condition (McLennan *et al.* 1988). Selectivity to the extent of over-grazing key species and accelerated soil erosion of frontage areas can of course modify this effect. Bore drains create a similar dilemma when trying to predict animal performance from the composition of the bulk of the paddock. Green couch (*Cynodon dactylon*), watercouch (*Paspalum distichum*) and rushes are the commonest species encouraged by bore drains, partly because they are quite salt tolerant.

Spatial heterogeneity causes practical problems when fencelines have to be erected. There will always be small areas which differ from the bulk of a paddock. These cause problems when trying to adjust pasture utilisation by stocking rate alone. Consequently there are good reasons for insisting that a group of strategies be used on most large paddocks to produce optimal utilisation. Paddocks that have been completely cleared and cropped before sowing a pasture have fewer managerial difficulties because spatial variation is reduced.

Paddocks which are continuously grazed at moderate to heavy stocking rates tend to develop clumps of unpalatable species because the stock ignore those patches. This effect is particularly noticeable with stemmy wiregrasses (*Aristida* spp.) on any country, for corkscrew grass (*Stipa verticillata*) on yarran and brigalow pastures and for umbrella cane grass (*Leptochloa digitata*) or lignum (*Muehlenbeckia cunninghamii*) on seasonally flooded pastures. Hence, mean pasture composition will give an indication of 'condition' of such spatially variable pastures, but only a rough measure of the animal's diet.

Ecologically, spatial heterogeneity is valuable for plant species' survival and adaptation and should not be viewed as a bad thing by pasture managers. It just requires adaptable management to keep it in balance with animal and management needs. Very mono-specific pastures such as buffel grass are not desirable because they can cause dietary imbalances like bighead in horses in good seasons. Graziers around Blackall will not normally breed sheep on buffel pastures because lambing rates are well below that of Mitchell grass country where seasonal herbage abounds. Excessive medic causes bloat problems and Darling pea can be dangerous when too common.

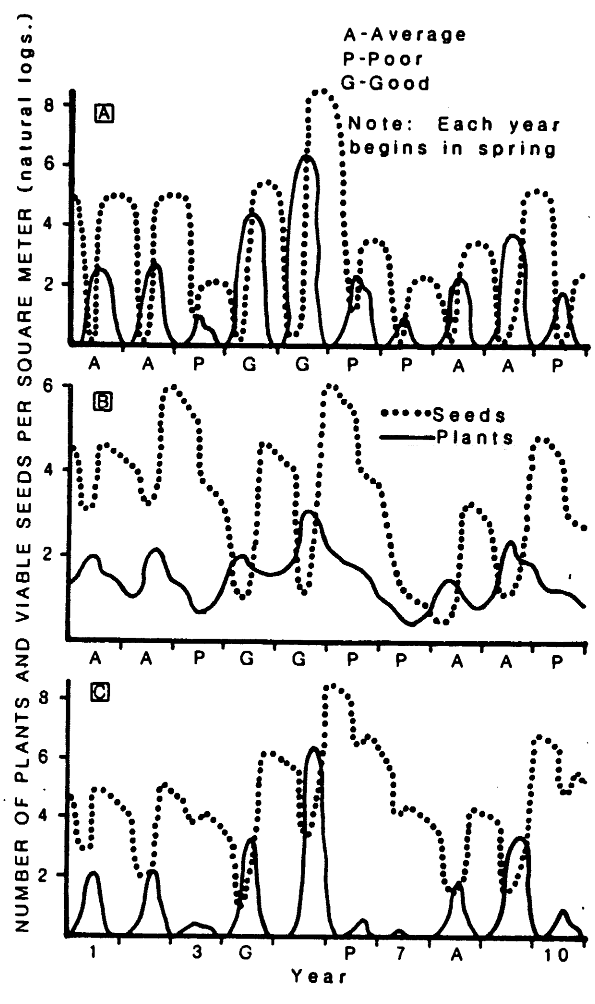

Figure 1. A stylised diagram of changes in seed and plant populations over a similar range of seasonal conditions on:
- A annual Sorghum spp.
- B Esk black spear grass
- C button grass.

Source: Silcock *et al.* (1988)

Major disturbances

Fires, droughts, floods and plagues are inevitable. They can sometimes change pasture composition radically, at other times little change will occur, this is in line with state and transition theory (Westoby *et al.* 1989a). We can predict the outcome of some events, for example, fire stimulates wattles to germinate, prolonged flooding kills Mitchell grass. Even more likely is our ability to say afterwards why some change has occurred, although it could not be predicted with any certainty because other climatic events at the time play a big role, for example, frosts, heatwaves, locust plagues (Westoby *et al.* 1989a,b). The main thing to know is that a big change has occurred and to adapt paddock management appropriately. This is where the skill/art (?) comes in! For instance, if Mitchell grass around Dirranbandi is killed by a flood, seedlings will soon emerge afterwards if the stand has seeded in recent years. If you do not rest the paddock immediately and allow the seedlings to establish, there is a good chance that you will lose the grass for many years, if not forever because its seed is not highly dormant (Silcock *et al.* 1990). Cattle should be used rather than sheep for the next few years to nurse the grass back. Of course, you may only want medics and herbage to come back, but I would question the wisdom of such an objective in that region.

There are times when masses of undesirable seedlings emerge after a fire or drought, for example, wattles, wiregrasses, burrs etc. If valuable perennial grasses still exist then strategic flogging may be in order to setback the invaders, if they are palatable. For unpalatable woody weeds, summer spelling to encourage grasses may be needed to beat seedlings or to build up a fuel load for a later fire. This type of management depends on first being able to recognise key species, and then knowing whether they are weeds, whether they are strongly perennial, and their palatability (Figure 2). If you can know your pasture plants to that extent, then management options are more clearly identified. Unfortunately, for many plants in this region we do not yet have this knowledge but Figure 2 is a proposed start. Documentation is only available from regions adjoining your Maranoa area: mulga and Mitchell grass in the west (Orr 1980, 1981; Silcock 1986), sown brigalow pastures to the north, and windmill grass pastures in New South Wales (Michalk & Herbert 1978). Fortunately extrapolation about identity and perenniality is fairly safe, but aspects of weediness and palatability are not as safely assumed.

Fire

Fire is most effective when used on shrubby plants (up to 5 m tall) or to alter proportions of annual herbs. Most large tree species are only temporarily setback by fire while shrubs have the entire canopy burnt and, if not killed, most resume growth from near ground level (Anderson *et al.* 1988). Hence the effects on them of burning are prolonged. Annuals respond or are setback due to effects on seed loads and germination conditions. Unfortunately the interaction with climate is large and a predictable outcome on annuals unlikely. Johnston and Carter (1986) have attempted to simulate the economics and feasibility of using fire for shrub control on mulga country at Charleville with very discouraging results, but based on very scanty data. There is always a good chance that wattles and cassias could increase dramatically after fires in areas where they exist already. Herbaceous legumes are usually more obvious and vigorous after a fire, particularly native ones in woodlands. I have no data on the effect of fire on regeneration of medics nor any good insights, but sown pasture grasses are quite tolerant. Sullivan and Pressland (1987) found that pasture regeneration was not affected by infrequent fires on mulga country and that its effect on shrubs was species specific. The shrubs they treated are rare in the Maranoa.

Anderson *et al.* (1988) gives a good summary of guidelines to be followed when using fire to manage pastures.

Severe drought

Woody shrubs are only rarely killed by the most severe droughts, while perennial pasture plants have an accelerated death rate during these events, especially if heavily grazed. Hence pastures take a while to recover from severe drought, especially the basal area of crowns of grasses. There is a flush of available nitrogen into the system and annual plants usually abound after a drought breaks. However, perennial grasses and woody weeds can also regenerate *en masse* after droughts if conditions suit them.

The net effect of drought breaking rains can vary dramatically depending on time of year and the type of rain (heavy storms or a prolonged soaking from a big rain depression). Grasses generally will not regenerate from a winter break of a drought, but weeds will, especially burrs (*Sclerolaena* spp.). Queensland bluegrass and many wiregrasses will emerge *en masse* in spring and autumn, but so too will medics and *Psoralea tenax* (emu foot). A knowledgeable grazier's response to such relief rain, as after fire, depends on seeing what comes up and what condition the pasture is in.

Basal cover of grasses builds up only slowly after a bad drought despite a big foliage cover. So, if basal area is very low, 2-3 years are needed before that will recover adequately (Silcock & Smith unpub.). During a prolonged run of dry seasons, deep taprooted dicots, for example flannel weeds (*Sida* spp.), tend to increase in proportion to grasses in pastures because they can expand their crown without needing wet surface soil (Silcock 1980).

Prolonged flooding

Prolonged flooding affects only a few pasture types and normally kills only plants that are completely submerged. We know that curly and hoop Mitchell grass (Hall 1982) and buffel grass (Anderson 1974b) are killed by prolonged flooding while browntop (*Eulalia aurea*) and Bambatsi panic (*Panicum coloratum*) are tolerant. Medics will not survive deep stagnant floods. Sands (1983) found flooding was detrimental to green panic (*Panicum maximum* var. *trichoglume*), Indian bluegrass (*Bothriochloa pertusa*) and purple pigeon grass (*Setaria incrassata*) but not to Bambatsi or angleton grass (*Dichanthium aristatum*).

Plague locusts

You cannot generalise on the effects which locusts (grasshoppers) have on pasture because some are not very selective feeders, although most prefer grasses. Grasshoppers appear to prefer slightly wilted grass and so stressed crops or young pastures are more at risk. In the Maranoa, a common small grasshopper is *Oedaleus australis* which eats only grass. Grasshoppers are active only in summer, so new grass pastures are always at risk in this region, while medics are not threatened. The yellow-spotted grasshopper (*Monistria pustulifera*) will not eat grass, but prefers forbs and eremophila shrubs. I say this, from experience, to highlight the subtle causes of establishment and regeneration failures which most biological agents can induce, often unnoticed. Root grubs, pathogens and caterpillars can be equally selective and destructive. Their incidence is sporadic because rainfall and temperature interact strongly on their populations via reproduction rates and parasite loads.

Pests

Many pests defoliate trees and shrubs severely or cause tip dieback, but rarely threaten the life of woody plants, for example, sandalwood hawkmoths, psyllids on poplar box, cicadas on mimosa (*Acacia farnesiana*). Hence, they do not significantly alter woody weed populations in my opinion. Stem borers are much more likely to kill woody plants in a semi-arid climate than leaf defoliators. The turkeybush grasshopper (*Monistria discrepans*) is the only insect that I know of in SW Queensland that can kill significant areas of shrubs (*Eremophila gilesii*), by ring-barking twigs (Burrows 1973). I have seen evidence recently of soil insects eating off the roots of young purple pigeon grass plants, causing big dead areas in a stand. Scarab beetle larvae and false wireworms could be to blame, but we do not know for sure in this case. The one exception historically was the initial effect of blue green and spotted aphids on medics and lucerne in the late 1970s (Passlow 1977a, 1977b). This could be repeated on other species in future. Breeding of aphid resistant cultivars of medics and lucerne has reduced the impact of aphids in the foreseeable future, but not on the susceptible common, cutleaf and woolly burr medics (*Medicago* spp.) or the native Cooper clover (*trigonella suavissima*) found along the Culgoa River. Woolly aphids and coccids can quietly damage the crown of grasses such as Rhodes grass (*Chloris gayana*), but I know of no major problems in the Maranoa from them. Coccids have damaged occasional buffel (*Cenchrus ciliaris*) and other grass seedlings in pot trials on mulga soil at Charleville, so they cannot be ignored.

Nematodes are more common on sandy soils and can seriously damage the roots of tap-rooted plants like lucerne. We have no good data on the relative importance of nematodes in the Maranoa, but I know Bullamon lucerne (*Psoralea eriantha*) is untroubled by rootknot nematodes while siratro (*Macroptilium atropurpureum*) is badly damaged at Charleville.

Diseases

Diseases seem less likely to modify pasture composition in the Maranoa than pests, especially in native pastures. Root and crown diseases are so insidious that we may miss them and thus underrate their effect. Leaf rust is rarely seen on siratro in the region and anthracnose is also unimportant on stylos in this region so far.

Galvanised burr stands (*Sclerolaena birchii*) can be markedly damaged by a little leaf type disease which is transmitted by an eriophiad mite (Everist *et al.* 1976). This stunts the growth of mature plants and its occurrence is sporadic in time and location and of little economic consequence, I believe. In pots in glasshouses, damping off can be a serious problem with lucerne and clovers as well as *Desmanthus virgatus* and *Schmidtia papphoporoides*. How serious these diseases are in the field is unknown, but they cannot be ignored and could significantly affect pasture establishment, and thus, composition. Our problem is a complete lack of research and detailed field observations by experts to monitor the incidence of such potential problems.

Ploughing

The major, acute disturbance man subjects pastures to is the use of the plough. The effects on composition are usually dramatic. Buffel grass is the only valuable (sown) pasture species that I can think of whose growth and density can be increased by a light ploughing which is then called renovation (Graham & Daniels 1986). Green couch grass generally increases its presence in cultivation paddocks over time and, as such, has serious weed potential in the Maranoa. Mitchell grass, white spear (*Aristida leptopoda*) and wiregrasses are generally severely damaged by ploughing. Disc and blade ploughing offers real scope for reducing most *Aristida* populations provided other follow-up grazing management or sown pasture establishment is used. Severed *Aristida* and *Stipa* roots do not regenerate readily from the damaged crown, even in moist pots.

Unfortunately ploughing pasture country almost inevitably results in big increases in non-grass weeds. The worst examples in the Maranoa are flaxweed (*Pimelea trichostachya*) on sandy soils, Mayne's pest (*Verbena tenuisecta*) on sandy and hardsetting duplex soils and saffron thistle (*Carthamus lanatus*) on all soil types. Other more ephemeral weeds are black rolypoly (*Sclerolaena quinquicuspis* var. *muricata*), soft rolypoly (*Salsola kali*), Maltese cockspur (*Centauria melitensis*), galvanised burr (*Sclerolaena birchii*), goathead (*Emex australis*) and turnipweed (*Rapistrum rugosum*). Turnip weed is well grazed by cattle and the others slowly diminish with time since last disturbance.

The biggest dilemma cultivation presents to normal grazing land in the Maranoa is the lack of positive direction taken by the pastures once cultivation ceases. Rarely are pastures deliberately sown into abandoned cultivation in the region; so nature takes its course. The outcome on most soils is a poor, weedy pasture of uncertain composition. Unpalatable Yabila grass (*Panicum queenslandicum*) may come in on Downs country (Bisset 1960), but fortunately Queensland bluegrass (*Dichanthium sericeum*) and burr medic are common components of most abandoned black soil and brigalow country cultivation within a few years (Silcock unpub.). On hardsetting poplar box duplex soils, good perennial grasses do not return readily. Windmill grasses (*Chloris truncata, C. divaricata*) initially dominate, but quickly fade away during a drought. On the red earths, woolly burr medic (*M. minima*) and cutleaf medic (*M. laciniata*) may come in, but again strong perennial grasses are slow (4-5 years) to return. Silky umbrella grass (*Digitaria ammophila*) commonly exists early on sandy surfaced soils, but it also goes out quickly in a drought leaving weeds and wiregrasses to make a relentless increase under selective non-grazing. *Aristida lignosa* is a particularly stalky wiregrass that does this on sandy red soils west of St George. Further south and around Chinchilla, cypress pine sands are commonly overrun by sand burr (*Cenchrus incertus*) after cultivation and it causes serious long-term management problems thereafter.

Of all the major disturbances possible, with their potential to radically alter pasture composition, only cultivation is completely under our control. Yet its potential advantages for controlling brigalow and other woody weeds (Norton 1966) is often nullified by lack of resolve in re-establishing perennial pasture grasses afterwards. I see this as a major problem in the whole of the Maranoa region, least so on brigalow country where cropping is most feasible.

Time

Time cures all! Unfortunately, the scale can be so great in the case of soil and semi-arid vegetation damage that human memory may be inadequate to appreciate the improvements. Once soils and vegetation in this region are severely damaged, it may take several human lifespans to return them to a productive state.

The rate of improvement is greatest on self mulching clays and deep, loose sands which can quickly regain original surface soil condition. However, even for them the enemy from below, salt, can have devastating long-term effects in some areas. Changes in soil structure and salinity will have marked effects on pasture composition, but we have little documented data for this region. Reclamation of scalded, alluvial brown soil north of Bollon, using pondage banks, produced initially only an increase in size and density of existing species rather than a change in composition. The same occurred in northern New South Wales (Rhodes 1986). Other studies in the Warrego Region (Silcock & Beale 1986), using exclosures for over 15 years, showed that changes in pasture composition over time on hard-setting soils are very slow where removal of domestic stock was the only treatment. Only when a friable surface returned to the soil or several centimetres of sand accumulated against an obstacle, did desirable perennial grasses begin to return.

The other general effects of the passage of time on pasture composition are due to the tying up of available soil nitrogen in the vegetation. The proportion of pioneer species and annuals decreases and that of perennial grasses and woody plants increases (Burrows 1980) because they need less available soil nitrogen and phosphorus each season to make good growth. Herbaceous perennial legumes are much less prominent in very stable grassy pastures than in disturbed areas in this region. Their presence is apparently not controlled primarily by levels of available nitrogen. The annual medics also seem to be influenced most by disturbance and encouraged by it. At present we do not know exactly how much grass should be left at the end of summer for optimal medic growth next spring.

My current data show that those perennial grasses which establish early in the post-cultivation or post-clearing phase gain a very great and prolonged advantage, however fortuitous or scattered their initial colonisation is. Thus, I believe it is crucial to get desirable species established as early as possible after major disturbances such as clearing or cultivation. A sparse, early stand which is allowed to seed freely and then is sensibly grazed, will often produce a very acceptable pasture after 3-4 years. Conversely, if weedy species and wiregrass are controlled well initially, they take much longer (maybe a factor of 3 times) to become a serious problem (if at all) in the future.

New South Wales experience is that wiregrass (*A. ramosa*) can be controlled by strategic flogging (Lodge & Whalley 1985) but that African lovegrass (*Eragrostis curvula*) and coolatai grass (*Hyparrhenia hirta*) cannot (Robinson, pers. comm.). The good wiregrass result depends upon the increase in wallaby grasses (*Danthonia* spp.) which are not common in the Maranoa. We have not done comparable trials in the Maranoa to test this idea.

Grazing management

Grazing management normally produces only subtle changes in pasture composition in the short term, but at critical times its interaction with any of the other factors mentioned before, can produce dramatic short-term effects (Westoby *et al.* 1989b).

Sown pastures

The most dramatic change likely is the elimination in the first growing season of an annual species which was prevented from seeding. Annual snail medics are particularly susceptible to this when grazed by sheep. Wynn cassia (*Cassia rotundifolia*) has also failed in the region when it failed to set seed (after a late germination) before the first frost. Perhaps if such plants were sown with only half the seed scarified there could be a chance to return the next year.

Work by Clarkson (1989) and Lloyd and Weston (pers. comm.) shows that a good long-term density of annual legume pasture depends upon building up a big seed reserve in the soil, preferably in the first year after sowing. Just how many seeds/m² are needed is not known yet. Work by Fitzgerald (1989) on the northern slopes of New South Wales shows that each species of annual legume may have to be managed differently to ensure good persistence. All should be lightly grazed after germination, but then some persist better if continuously grazed during the winter while others do best if spelled at certain times. The amount of summer grass present in autumn also affects each species of clover differently. So we need to get data for our cultivars in our environment to be sure of our recommendations for annual legume management.

Sown grass pastures will all run down over time as available soil nitrogen is mopped up (Robbins *et al.* 1986). However, that does not automatically mean a change in percentage composition. There will usually be a drop in basal cover after 2-3 years, but that can still fluctuate with seasonal rainfall. Only buffel grass and Bambatsi panic seem capable of producing truly permanent pastures in a wide range of areas. Controversy continues over the permanence of most purple pigeon grass pastures and, under grazing, all the others either fade away or are too new to judge, for example, premier digitaria (*Digitaria smutsii*) and hatch creeping bluegrass (*Bothriochloa insculpta*). In Table 1, I have indicated the sort of contribution I would consider necessary for a sown pasture to be regarded as being in good or fair condition. Basal cover should be at the high end of the range in the higher rainfall areas and much lower in the Balonne Shire.

Native pastures

Native pastures make up the vast majority of pastures in the region (Weston *et al.* 1981). Many may not produce spectacular animal production, but given how ancient and leached our soils are by world standards (Coventry & Williams 1989), that is all we can expect. We know from experience that the best native species are rarely beaten in the long-term by unfertilised exotic pasture plants in the Maranoa (exceptions burr medic and buffel). We also know that if we consistently over-stock, unpalatable wiregrasses and woody weeds increase. However, unpalatable species inevitably increase under continuous grazing in the absence of intervention by other factors such as herbicides, fire, flood or famine. By heavy stocking we are simply removing the option of fire and increasing the bad effects of droughts.

Native pastures are a big mixture of grasses, woody plants and non-grass herbs. The proportions fluctuate with seasonal conditions and with disturbance. A grazier's task is to keep those changes within acceptable bounds so that his stock are healthy and his country is healthy. Society's role is to see that his bank account is healthy at the same time - this seems to me to be the real issue in the Decade of Land Care!

The pristine or 'original' state of native pastures is not necessarily the best for animal production (Wilson & Tupper 1982) nor is it often realistic (or easily defined) for grazing land. However, my Table 1 does give guidelines on what a good native pasture should contain on various soils in the region. A fire-induced climax community needing burns every few years is hardly realistic in the Maranoa, but may have existed in some northern areas in the past. The other factor which allows significant variation in botanical composition without detriment to pasture condition or animal production is that 'grass is grass' provided it is green and eaten. Leaf of windmill grass is just as good as buffel grass leaf. On a similar note, rhynchosia pea leaf is of similar feed value to lucerne leaf and is not known to cause bloating. Agronomically there are big differences between the species just quoted which makes their value as sown pasture species very different, but in an existing mix they are all valuable to stock (McLennan *et al.* 1988).

The big differences in feed value lie between (a) grasses and non-grasses (Silcock 1988); (b) between green grass and dead grass; and (c) between grass leaf and grass stem (Hacker & Minson 1981). Botanical composition does become important when pastures differ widely in the proportion of either (a), (b), or (c) or in the total amount of each, for example, due to dense timber. Wiregrasses have a notoriously low proportion of leaf to stem and stem is much less digestible. Frosted or senescent grass leaf has less than half the digestibility of green leaf while differences between comparable species in fresh green leaf digestibility are normally of the order of only 5-10% (spinifex and irongrass excepted).

Grazing management to encourage leafiness, or more legumes as opposed to grasses, is thus a more potent tool in influencing animal nutrition than management aimed at replacing 10% of Mitchell grass with (say) buffel grass. Most potent by far are the effects of rainfall and frosts. Nevertheless, a pasture consisting of 90% whitespear or wiregrass is greatly inferior to one of 90% Mitchell grass or mulga mitchell (*Thyridolepis mitchelliana*) because intake of digestible dry matter (palatability x digestibility) would probably be 50% less. We have no data on which I can sustain this assertion, but that is the sort of ballpark figures I believe we are dealing with.

Summary

Basically, pasture composition alters due to different rates of plant death and recruitment amongst the component species. There is so much we do not know and will not know about pasture composition until we take a close look and collect data. Critics can always point to this deficiency, but they have no credible data either. We will get some surprises when we begin to collect detailed data on how plants cope with this environment, but rarely will that knowledge offset the inertia due to existing soils and climate.

I can quote examples where an undescribed ant species at Charleville chewed off, each dawn, the shoots of buffel grass seedlings at ground level as they emerged from the soil. If I had not been there on my hands and knees 2-5 days after the rain, I would have concluded that the seed had not germinated, but been amazed that it had not because I knew it was viable. Likewise, a supposedly carnivorous beetle harvested dozens of buffel seeds coated in phosphate fertiliser and chewed out the seeds. Is it really a carnivore or does the fertiliser act like a saltlick? Pure science and close observation will enable us to explain, in future, the previously unexplained, but we will still need to do applied science to answer the important management questions that this meeting is addressing.

We can make some very useful pronouncements now about the effect and importance of pasture composition to the Maranoa region that, in the main, will stand the test of time because soils and climate will not change significantly in the context of their effect on plant growth. The harder you 'push' your country the more sophisticated your management needs to be to avoid serious pasture and landscape damage.

Does pasture composition matter? YES.

Specific questions answered

What are the relevant pasture types in the region?

Table 1 answers this.

What is the species composition of each of the pasture types?

We have insufficient data to answer this question in any detail. Table 1 lists key species but does not give proportions because we do not know how much is in good, fair and poor condition.

What are the major causes of changes in pasture composition and how does pasture composition change?

The paper has dealt with this in some detail.

What management is recommended for optimum pasture composition?

The paper has discussed this in general terms. This question can only be handled adequately by addressing problems paddock by paddock on site.

What can I do about it if I want a change?

Manipulate animal type, stocking rate, season of grazing and, where appropriate, use fire or cultivation or herbicides. At present we lack documented evidence of any pasture management system which rapidly shifts pasture composition in a predictable direction in this region.

What further information is needed? In order of priority.

1. We need a wider survey of the botanical composition of the major pasture types in the region. Then we need to know how the major species react to fire, flood, drought and defoliation and how readily they regenerate from seed.
2. We need to know how to keep a good balance of perennial grasses and annual medics using simple management. This will require well controlled grazing studies to test hypotheses, for example, will strategic flogging after a burn reduce wiregrass dominance?
3. Controlled burning trials are also needed to see if the sandalwood understorey in eucalypt woodlands can be largely eliminated by this method. The alternative is removal of all trees which seems too severe in areas like the Bollon red earths.
4. Trials to control lignum (*Muehlenbeckia cunninghamii*) and timber on the coolibah flood plains around Dirranbandi are needed. We have tried goats with limited success but learned a lot in the process, for example, initial stocking rates must be very high to ensure all regrowth is grazed in the first month after clearing.

Table 1. Suggested key parameters for 17 Maranoa pasture types showing good, fair and poor pasture condition.

PASTURE A BASALT HILLS

	Condition class		
	GOOD	FAIR	POOR
Erosion status	no gullies	small gullies	deep gullies
Basal area (%)	> 3	1.5 - 2.5	< 1.5
% Key perennial grasses	> 70	30 - 60	< 25
% Perennial *Aristida*	< 5	10 - 20	> 30
% Canopy cover woody weeds	< 20	30 - 50	> 60

Key perennial species: *Dichanthium sericeum, Bothriochloa bladhii, Panicum decompositum, Cymbopogon refractus, Digitaria divaricatissima, Rhynchosia minima.*

Undesirable herb plants: *Aristida leptopoda.*

Main woody weeds: *Acacia victoriae*

PASTURE B RIDGES

	Condition class		
	GOOD	FAIR	POOR
Erosion status	sheet	rills & sheet	gullies
Basal area (%)	> 1.0	0.5 - 1.0	< 0.5
% Key perennial grasses	> 65	30 - 60	< 20
% Perennial *Aristida*	< 20	30 - 70	> 80
% Canopy cover woody weeds	< 40	50 - 80	> 90

Key perennial species: *Ancistrachne uncinulata, Thyridolepis xerophila, Paspalidium gracile, Panicum subxerophilum, Eragrostis lacunaria, Eremochloa bimaculata, Cleistochloa subjuncea, Calyptochloa gracillima.*

Undesirable herb plants: *Lomandra spp., Aristida caput-medusae*

Main woody weeds: *Carissa ovata, Acacia burrowii, Capparis lasiantha, Thryptomene* spp.

PASTURE C BULLOAK/BLOODWOOD

	Condition class		
	GOOD	FAIR	POOR
Erosion status	none obvious	some sheet	bad sheet
Basal area (%)	> 2.5	1.5 - 2.0	< 1.0
% Key perennial grasses	>60	30 - 50	< 20
% Perennial *Aristida*	< 30	40 - 70	> 80
% Canopy cover woody weeds	< 15	20 - 60	> 70

Key perennial species: *Bothriochloa decipiens, Themeda australis, Sporobolus elongatus, Chrysopogon fallax, Eragrostis sororia, Cynodon dactylon, Digitaria diffusa, Panicum subxerophilum, Cymbopogon refractus, Eriochloa pseudoacrotricha, Calotis xanthosoidea.*

Undesirable herb plants: *Aristida ramosa.*

Main woody weeds: *Casuarina luehmannii, Maireana aphylla, Eucalyptus exserta, Callitris columellaris.*

PASTURE D BULLOAK/RUSTY GUM

	Condition class		
	GOOD	**FAIR**	**POOR**
Erosion status	sheets	rills	gullies
Basal area (%)	> 2.0	1.0 - 2.0	< 1.0
% Key perennial grasses	> 70	20 - 60	< 15
% Perennial *Aristida*	< 20	30 - 70	> 85
% Canopy cover woody weeds	< 20	30 - 70	> 80

Key perennial species: *Bothriochloa decipiens, Eragrostis sororia, Enteropogon acicularis, Eriochloa pseudoacrotricha, Panicum effusum, Chrysopogon fallax, Panicum subxerophilum, Eremochloa bimaculata, Microlaena stipoides, Eulalia fulva, Leptochloa decipiens.*

Undesirable herb plants: *Aristida ramosa, Aristida leichhardtiana, Helichrysum apiculatum*

Main woody weeds: *Casuarina luehmannii, Acacia ixiolaena, Acacia spectabilis, Melhania oblongifolia, Eucalyptus pilligaiensis*

PASTURE E POPLAR BOX FLATS

	Condition class		
	GOOD	**FAIR**	**POOR**
Erosion status	none obvious	scalding	pedastalling
Basal area (%)	> 3.0	1.5 - 2.5	< 1.0
% Key perennial grasses	> 75	30 - 70	< 25
% Perennial *Aristida*	< 20	30 - 60	> 70
% Canopy cover woody weeds	< 10	20 - 60	> 70

Key perennial species: *Bothriochloa decipiens, Themeda australis, Eragrostis molybdea, Stipa scabra, Stipa setacea, Dichanthium affine, Sporobolus carolii, Spor. actinocladus, Chloris truncata, Chl. ventricosa, Enneapogon polyphyllus, Eragr. microphyllum, Monachather paradoxa, Fimbristylis dichotoma, Einadia nutans, Atriplex eardleyii.*

Undesirable herb plants: *Aristida ramosa, Ar. calycina, Ar. leptopoda.*

Main woody weeds: *Eucalyptus populnea, Eremophila mitchellii, Maireana microphyllum, Geijera parviflora*

PASTURE F MYALL/BAUHINIA

	Condition class		
	GOOD	**FAIR**	**POOR**
Erosion status	slight	obvious rills	bad rills
Basal area (%)	> 2.5	1.5 - 2.5	< 1.0
% Key perennial grasses	> 70	30 - 60	< 20
% Perennial *Aristida*	< 10	20 - 50	> 60
% Canopy cover woody weeds	< 10	15 - 35	> 40

Key perennial species: *Stipa scabra, Enteropogon acicularis, Dichanthium sericeum, Chloris divaricata, Eriochloa pseudoacrotricha, Atriplex semibaccata*

Undesirable herb plants: *Aristida platychaeta, Aristida latifolia, Malvastrum americanum*

Main woody weeds: *Cassia artemisioides, Eremophila mitchellii, Myoporum desertii*

PASTURE G TARA BRIGALOW

	Condition class		
	GOOD	**FAIR**	**POOR**
Erosion status	none	rills	gullies
Basal area (%)	> 3.0	2.0 - 2.5	< 1.5
% Key perennial grasses	> 80	40 - 70	< 30
% Perennial *Aristida*	< 5	10 - 40	> 50
% Canopy cover woody weeds	< 15	20 - 50	> 60

Key perennial species: *Dichanthium sericeum, Eriochloa pseudoacrotricha, Enteropogon acicularis, Paspalidium jubiflorum, Sporobolus carolii, Panicum buncei, Leptochloa decipiens*

Undesirable herb plants: *Aristida leptopoda, Juncus* spp.

Main woody weeds: *Acacia harpophylla, Eremocitrus glauca.*

PASTURE H YARRAN

	Condition class		
	GOOD	FAIR	POOR
Erosion status	slight	rills	bad gullies
Basal area (%)	> 3.5	2.0 - 3.0	< 1.5
% Key perennial grasses	> 85	20 -70	< 15
% Perennial *Aristida*	< 5	10 - 40	< 50
% Canopy cover woody weeds	< 5	10 - 30	> 40

Key perennial species: *Dichanthium sericeum, Bothriochloa bladhii, Chloris truncata, Enneapogon polyphyllus, Chloris divaricata, Eriochloa pseudoacrotricha, Bothriochloa ewartiana, Dichanthium affine, Rhynchosia minima.*

Undesirable herb plants: *Aristida platychaeta, Aristida latifolia, Aristida calycina*

Main woody weeds: nil

PASTURE I MITCHELL GRASS

	Condition class		
	GOOD	FAIR	POOR
Erosion status	none	rills	gullies
Basal area (%)	> 3.0	2.0 - 2.5	< 1.5
% Key perennial grasses	> 85	30 - 80	< 25
% Perennial *Aristida*	< 5	10 - 30	> 40
% Canopy cover woody weeds	< 5	10 - 30	> 40

Key perennial species: *Astrebla lappacea, Astrebla elymoides, Panicum decompositum, Sporobolus carolii, Dichanthium sericeum, Eriochloa pseudoacrotricha, Sporobolus pyramidalis.*

Undesirable herb plants: *Aristida leptopoda, Panicum queenslandicum, Malvastrum americanum.*

Main woody weeds: *Acacia victoriae, Acacia farnesiana*

PASTURE J TAROOM BRIGALOW

	Condition class		
	GOOD	FAIR	POOR
Erosion status	slight	obvious	gullying
Basal area (%)	> 4.0	2.0 - 3.5	< 1.5
% Key perennial grasses	> 80	30 - 70	< 25
% Perennial *Aristida*	< 5	10 - 25	> 30
% Canopy cover woody weeds	< 10	20 - 70	> 80

Key perennial species: *Dichanthium sericeum, Sporobolus carolii, Enteropogon acicularis, Paspalidium caespitosum*

Undesirable herb plants: *Aristida leptopoda*

Main woody weeds: *Acacia harpophylla*

PASTURE K COOLIBAH FLOODPLAIN

	Condition class		
	GOOD	FAIR	POOR
Erosion status	none	slight	obvious
Basal area (%)	> 2.5	1.5 - 2.5	< 1.0
% Key perennial grasses	> 70	20 - 60	< 15
% Perennial *Aristida*	< 5	10 - 25	> 30
% Canopy cover woody weeds	< 10	20 - 60	> 70

Key perennial species: *Paspalidium distans, Sporobolus mitchellii, Panicum prolutum, Eriochloa pseudoacrotricha, Danthonia tenuior, Eragrostis setifolia, Leptochloa digitata, Goodenia glauca, Marseilia* spp.

Undesirable herb plants: *Eleocharis pallens*

Main woody weeds: *Eucalyptus microtheca, Acacia stenophyllum, Muehlenbeckia cunninghamii, Eucalyptus largiflorens, Eremophila bignoniflora, Teucrium racemosum.*

PASTURE L TALWOOD BOX/SANDALWOOD

	Condition class		
	GOOD	FAIR	POOR
Erosion status	slight	scalding	bad scalds
Basal area (%)	> 2.5	1.5 - 2.0	< 1.0
% Key perennial grasses	> 70	30 - 60	< 20
% Perennial *Aristida*	< 20	30 - 80	> 85
% Canopy cover woody weeds	< 15	20 - 60	> 70

Key perennial species: *Thyridolepis mitchelliana, Stipa scabra, Enteropogon acicularis, Digitaria brownii, Themeda australis, Bothriochloa decipiens, Thyridolepis xerophila, Monachather paradoxa, Panicum effusum, Chloris ventricosa, Chloris truncata, Enneapogon polyphyllus, Danthonia tenuior, Cymbopogon refractus, Glycine tabacina, Desmodium varians, Justicia procumbens, Ruellia australis, Sida corrugata, Sclerolaena convexula*

Undesirable herb plants: *Aristida ramosa, Aristida armata*

Main woody weeds: *Eucalyptus populnea, Eremophila mitchellii, Acacia deanei, Cassia nemophila, Dodonaea viscosa var. arborescens, Capparis lasiantha*

PASTURE M MULGA

	Class condition		
	GOOD	FAIR	POOR
Erosion status	none obvious	scalding	pedastalling
Basal area (%)	> 2.5	1.5 - 2.0	< 1.0
% Key perennial grasses	> 70	30 - 60	< 20
% Perennial *Aristida*	< 20	30 - 70	> 80
% Canopy cover woody weeds	< 15	20 - 70	> 75

Key perennial species: *Amphipogon caricinus, Thyridolepis mitchelliana, Stipa scabra, Thyridolepis xerophila, Eragrostis lacunaria, Eragrostis eriopoda, Digitaria ammophila, Monachather paradoxa, Eriachne helmsii, Einadia nutans , Hibiscus sturtii.*

Undesirable herb plants: *Aristida ramosa, Aristida jerichoensis*

Main woody weeds: *Eremophila mitchellii, Dodonaea viscosa*

PASTURE N CYPRESS PINE

	Condition class		
	GOOD	FAIR	POOR
Erosion status	light	obvious	obvious
Basal area (%)	> 2.0	1.0 - 2.0	< 1.0
% Key perennial grasses	> 30	10 - 30	< 10
% Perennial *Aristida*	< 30	40 - 70	> 80
% Canopy cover woody weeds	< 25	30 - 50	> 60

Key perennial species: *Cenchrus ciliaris, Chrysopogon fallax, Heteropogon contortus, Digitaria ammophila, Aristida jerichoensis, Bothriochloa bladhii, Panicum effusum, Eragrostis lacunaria, Enteropogon acicularis, Bothriochloa ewartiana*

Undesirable herb plants: *Aristida lignosa, Cenchrus incertus, Sclerolaena birchii*

Main woody weeds: *Acacia murrayana, Sida rhombifolia, Callitris collumellaris*

PASTURE O SPINIFEX

	Condition class		
	GOOD	FAIR	POOR
Erosion status	nil	sheet	gullies
Basal area (%)	> 10	3.0 - 10	< 2.0
% Key perennial grasses	> 10	3.0 - 10	< 3
% Perennial *Aristida*	< 10	30 - 60	> 75
% Canopy cover woody weeds	< 40	40 - 70	> 70

Key perennial species: *Chrysopogon fallax, Themeda australis, Eriachne aristidea, Panicum effusum, Stipa scabra, Sida filiformis.*

Undesirable herb plants: nil

Main woody weeds: *Thyrptomene hexandra, Prostanthera lithospermoides*

PASTURE P BOLLON GIDGEE

	Condition class		
	GOOD	**FAIR**	**POOR**
Erosion status	negligible	pedastalling	obvious
Basal area (%)	> 3.0	1.0 - 3.0	< 1.0
% Key perennial grasses	> 30	10 - 30	< 10
% Perennial *Aristida*	< 5	10 - 20	> 25
% Canopy cover woody weeds	< 10	10 - 30	> 40

Key perennial species: *Dichanthium sericeum, Astrebla* spp., *Cenchrus ciliaris, Eriochloa pseudoacrotricha, Sporobolus carolii, Eragrostis setifolia, Atriplex semibaccata.*

Undesirable herb plants: *Aristida latifolia, Ar. leptopoda, Ar. platychaeta, Sclerolaena birchii, Sc. muricata.*

Main woody weeds: *Eremophila mitchellii, Myoporum deserti, Eremocitrus glauca, Acacia cambagei, Maireana microphyllum.*

SOWN PASTURES

	Condition class		
	GOOD	**FAIR**	**POOR**
Erosion status	negligible	obvious	bad
Basal area (%)	> 3.0	1.0 - 3.0	< 1.0
% Key perennial grasses	> 40	15 - 40	< 15
% Perennial *Aristida*	< 10	20 - 40	> 50
% Canopy cover woody weeds	< 10	30 - 70	> 80

Key perennial species: SOWN SPECIES, *Bothriochloa* spp., *Themeda australis, Dichanthium* spp., *Sporobolus* spp., *Chloris truncata, Enneapogon polyphyllus, Monachather paradoxa, Fimbristylis dichotoma, Einadia nutans, Atriplex eardleyii.*

Undesirable herb plants: *Aristida ramosa, Ar. leptopoda, Ar. latifolia.*

Main woody weeds: *Eucalyptus populnea, Eremophila mitchellii, Maireana microphyllum, Geijera parviflora, Callitris collumellaris, Eremocitrus glauca, Dodonaea* spp., *Acacia harpophylla*

Key 1. Key to the 16 major pasture types of the Maranoa region.

1.	(a)	Soil less than 15 cm deep	2
	(b)	Soil more than 15 cm deep	3
2.	(a)	Soil fertile and derived from basalt (rare)	PASTURE A
	(b)	Soil infertile, not from underlying basalt	PASTURE B
3.	(a)	Impeded drainage in the soil (rushes, bulloak common, bleached zone above B horizon clay)	4
	(b)	No impeded drainage down the soil profile	6
4.	(a)	Deep A horizon, >40 cm to bleached layer (rare)	PASTURE C
	(b)	Shallow A horizon above bleached layer	5
5.	(a)	A_2 horizon >2 cm thick, B horizon not dark	PASTURE D
	(b)	A_2 horizon often thin or locally absent, B horizon red or brown	PASTURE E
6.	(a)	Strongly cracking soil surface	7
	(b)	Surface non-cracking, often sandy	11
7.	(a)	Surface soil red or brick red coloured (uncommon)	PASTURE F
	(b)	Soil surface black, grey or brown coloured	8
8.	(a)	Acid A horizon	PASTURE G
	(b)	Neutral to alkaline A horizon	9
9.	(a)	Soil fertility low to fair (uncommon)	PASTURE H
	(b)	Soil fertility good to high	10
10.	(a)	Mitchell grass country	PASTURE I
	(b)	Brigalow country	PASTURE J
	(c)	Coolibah flood plain	PASTURE K
	(d)	Gidgee country	PASTURE P
11.	(a)	Soil surface hard-setting, massive	12
	(b)	Surface soil very loose and sandy	13
12.	(a)	Eucalypt dominant tree species	PASTURE L
	(b)	Mulga the dominant tree	PASTURE M
13.	(a)	No spinifex growing	PASTURE N
	(b)	Spinifex (*Triodia* spp.) normally found (uncommon)	PASTURE O

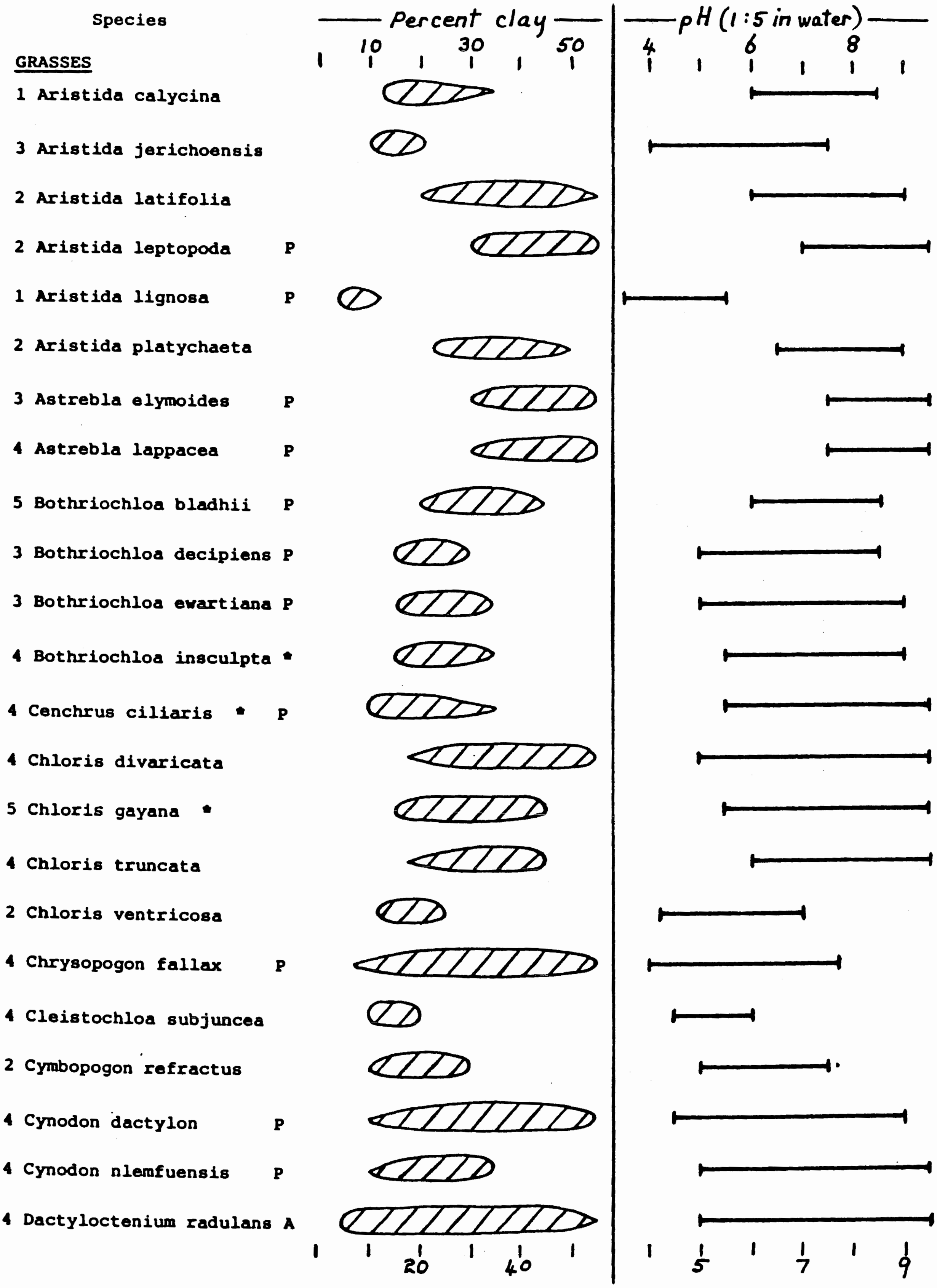

Figure 2. Field adaptation of major Maranoa pasture plants to levels of clay in their root zone and soil pH. Preceding numbers rate palatability.
* = Sown species, A = annual, P = strongly perennial, W = weed

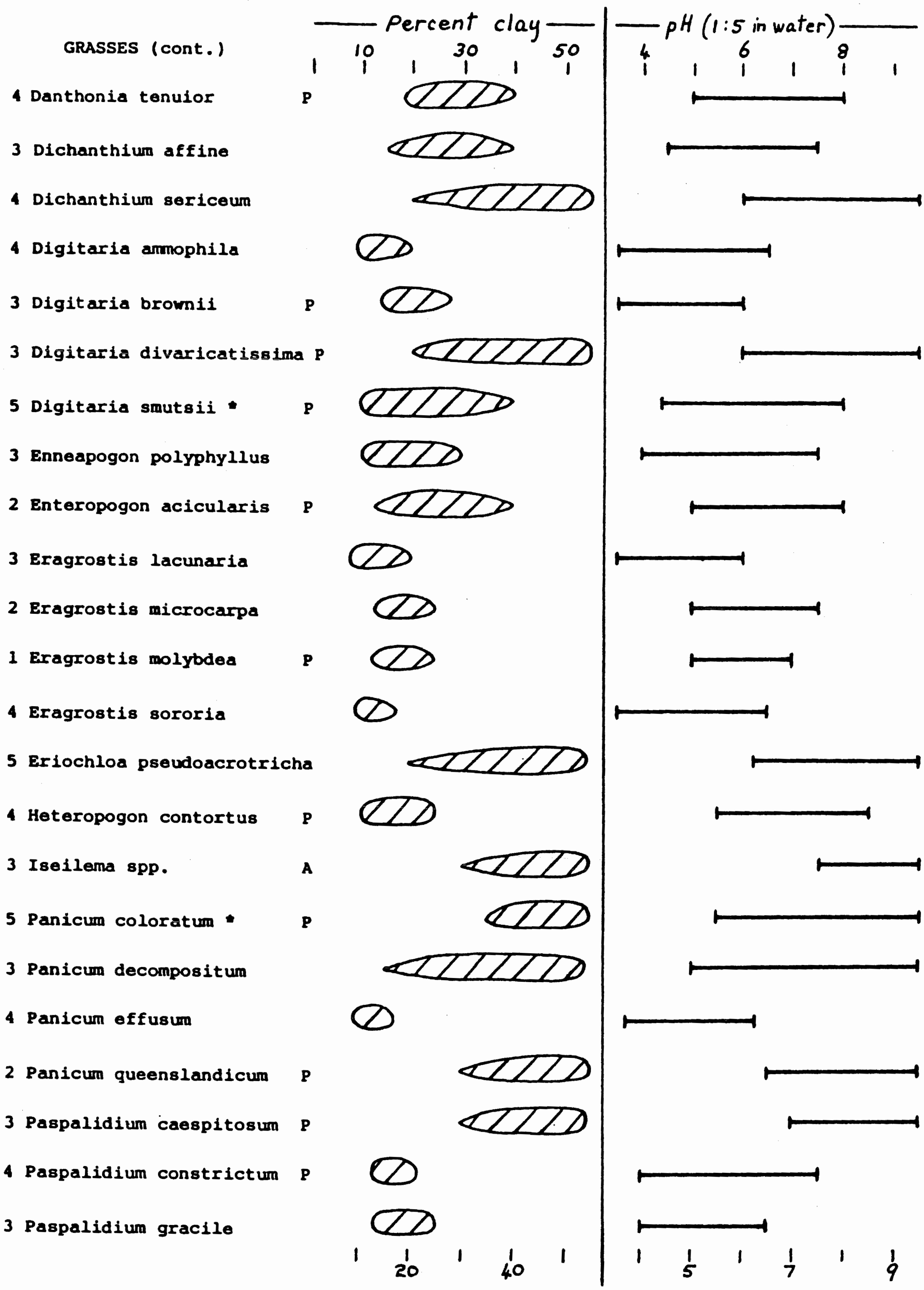

Figure 2. (cont.)

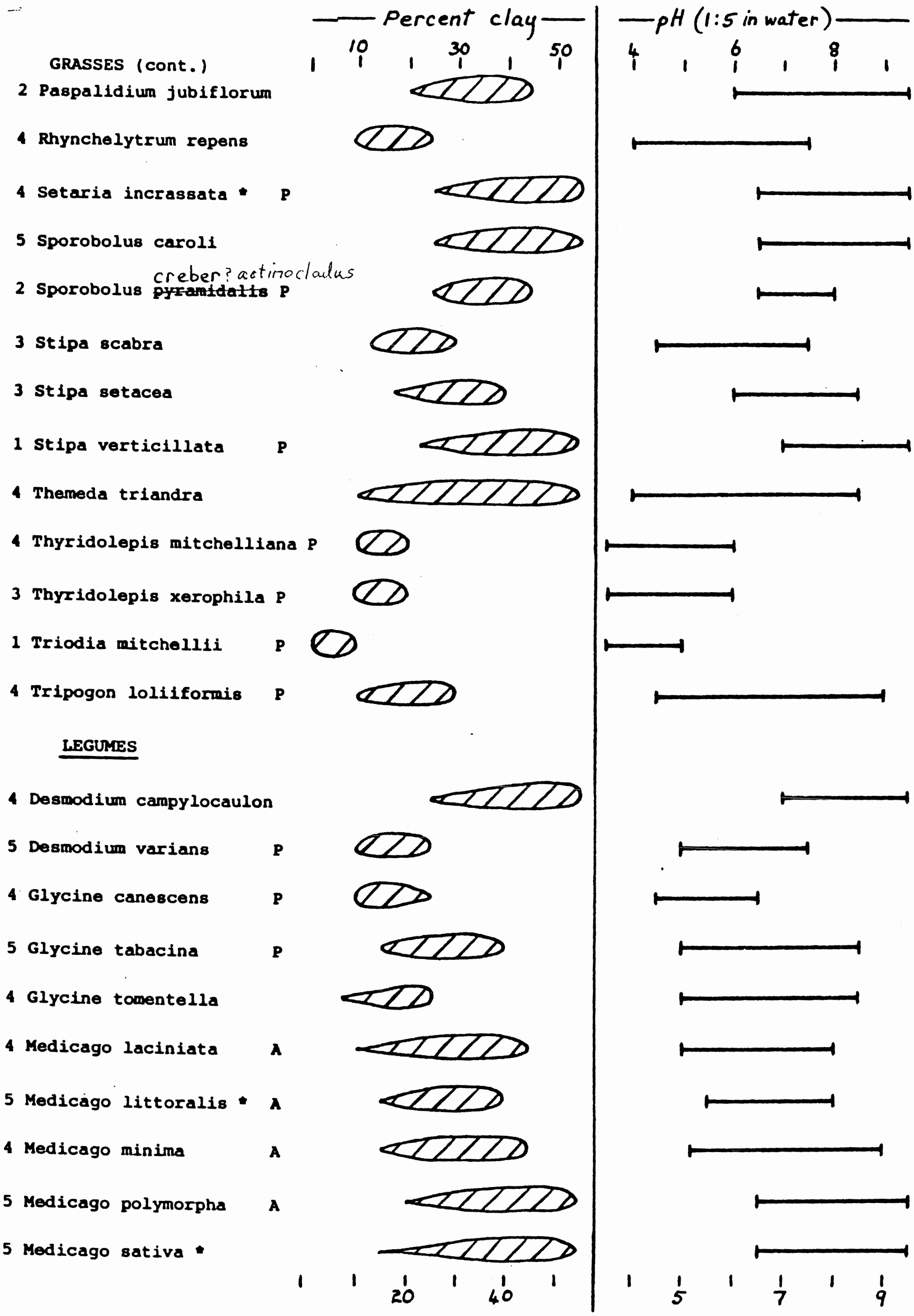

Figure 2. (cont.)

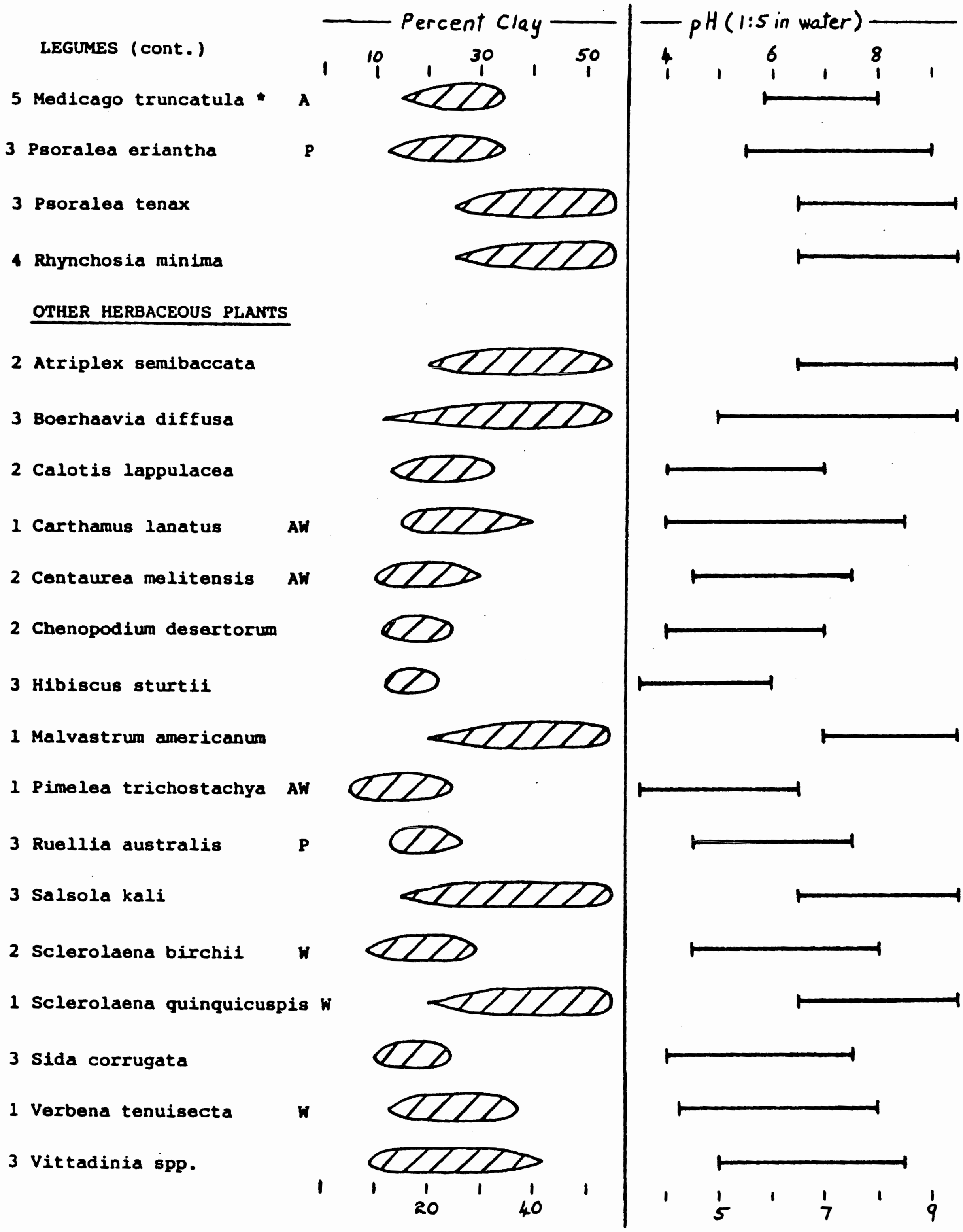

Figure 2. (cont.)

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