summer, communities of Salsicornia occure (1). Species of the communities of the Trifolium maritimum are well suited to the establishment of pastures on these areas and by draining the soils to remove excess water and using ecotypes resistant to flooding and salinity such as Phalaris arundinacea, P. tuberosa, P. arundinacea var. tuberosa hybrids, Festuca arundinacea, T. saccharata, Agrostis stolonifera var. maritima, Trifolium spp., Lotus decumbens, Medicago spp., Melilotus spp., Tetragonolobus siliquosus var. maritimus and certain exotic species, such areas could be used for cattle production. Under irrigation it is possible to maintain leys or pastures of Lolium multiflorum, L. rigidum, Trifolium pratense, T. repens var. ludovic, T. fragiferum, T. alexandrinum and T. resupinatum.

Complementary research

The preliminary research inspired by studies of autecology and plant sociology can be extended to more precise experimental work. Resistance to increasing salinity and to different ionic combinations can be studied in water cultures and in special substrata. Plant-phenomenon studies in relation to dry weight could result in an assessment of certain dynamic properties of the system, as has been done in phyto-plankton research (3). Studies of artificial communities established under defined conditions of environment and with control of competition utilization and manuring can materially assist our understanding and use of different pasture types.

Problems in the exploitation of grasslands in the Mediterranean region appear complex, but the methods discussed above offer an overall view of them and provide a scientific basis for their solution. Ecological study of interactions between the three components of the system, namely, soil, plant and animal, can bring better understanding of the problem and help also to achieve maximum production within a given environment.

Importance of dew

Dew is very important for the establishment of pastures in areas of low rainfall and high atmospheric humidity. In March 1955 an assessment was made of the importance of dew on the littoral of Almeria. In this region, dew can cause a superficial leaching of saline soils, allowing invasion by oligotrophic communities (e.g. Tillana maritima, Trifolium suffocatum, Riccia vivace com­

d' especes muscosa, systeme Matthiola unulata, forSsages vivaces, mais proble'm in
in bien adaptées au milieu. Les caractéristiques exigées d'une plante

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mentary precipitation which may amount to several hundred mm per year, resulting in sustained pasture production and countering the accumulation of salinity in spring.

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PAPER 14A/4

PLANT ECOLOGY AND PASTURE PROBLEMS IN THE MEDITERRANEAN PROVINCES OF SPAIN

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Summary. Fodder production is an ecological problem in which the soil/pasture/animal system must be regarded as a whole. Animals can change the environment, modify the soil and alter the balance of competition among grassland plants. This concept has been developed in the studies in Eastern Spain reported in this paper. In the Mediterranean climate of dry summers and cold, wet winters, stands of perennial herbaceous species are difficult to maintain, but there is no paucity of species well suited to the environment. The characteristics required of a perennial herbaceous plant include rapid development after the first onset of autumn rains, with growth continued into the following early summer after the cessation of rains, and resistance to grazing.

From the results of observations of plants grown both as species plants and as members of a plant community, it is suggested that types could be selected from existing wild material which could form the basis of new cultivars.

The 'dehesa' grasslands of Spain are discussed. These are basically park-like grasslands interspersed in forests, could benefit from this supplementary precipitation which may amount to several hundred mm per year, resulting in sustained pasture production and countering the accumulation of salinity in spring.

Résumé. La production de fourrage est un problème écologique dans lequel le système sol/pasture/animal doit être considéré comme un tout. Les animaux peuvent changer l'environnement, modifier le sol et changer l'équilibre de concurrence entre les plantes d'herbages. Ce concept a été développé dans les études dans l'est de l'Espagne et rapportées dans la présente communication. Dans le climat méditerranéen, comportant des été secs et des hivers froids et humides, il est difficile d'entretenir les prairies d'espèces fourragères vivaces, mais il existe de nombreuses espèces bien adaptées au milieu. Les caractéristiques exigées d'une plante fourragère vivace com­

placent un développement rapide après les premières chutes de pluies automnales, avec une croissance se poursui-
In climates with dry summers and rainfall mostly confined to the cold season, it is difficult to maintain pastures of perennial species, and deep-rooted plants which can tolerate the summer sun must be sought. In deeper and moister soils, salinity occurs in summer and this must be borne in mind when selecting ecosystems. The rapidity of germination after warm rains in autumn has to be ascertained, and these ecosystems which show rapid development must be selected. Experience has shown that it is possible to grow many Meditarranean ecosytems of Dactylis glomerata, Hordeum bulbosum, Phalaris tuberosa, Festuca arundinacea, Hedysarum coronarium, Lotus corniculatus, Lotus edulis, and many others at these times of the year. Such fertilizer treatments favour the rapid growth of grasses without adversely affecting legume growth. Suitable rates of applications of 150-300 kg superphosphate applied in September, followed by applications of 50-100 kg ammonia nitrosulphate (30% N) and 50-150 kg KCl after every substantial fall of rain in autumn (this is normally 2 or 3 such falls in this season); it is not advisable to apply fertilizers in winter.

There is a particular need for detailed studies of the Spanish 'dehesa', which are park-like grasslands with scattered, overgrown oaks. These range in type from grasslands not subject to any special culture and which are the result of clearing areas under evergreen oaks or wild olive shrubs, to sown pastures in either natural or planted woodlands. Such pastures of this kind may be suitable for planting with almond or olive trees or such species as Ceratonia siliqua, Phelipea spp., Robinia pseudoacacia, and Quercus spp. (8). Post-river deep root systems and which cast relatively light shadow may be expected to buffer edaphic fluctuations, retard the summer uptake of nutrients from the top-soil and prevent excessive concentration of salts in the soil during summer. It is possible to establish and maintain pastures cheaply by clearing undergrowth and thinning out the trees (leaving such species as Quercus ilex, Phelipea spp., or Robinia pseudoacacia with appropriate grasses) and using such species as Medicago tribuloides, Lotus rigidum, Trifolium campestre, Trifolium fragiferum, Medicago sativa (strains resistant to nitrate accumulation) and Onobrychis sativa. In addition to these perennial there are many valuable annual species. Among perennial is it important to select for at least 4 characters: (1) rapid autumn development, (2) strong winter growth, (3) higher productivity towards the end of spring, and (4) resistance to grazing. In very dry environments with mild winters, it is possible to maintain stable pasture communitys. Cynodon dactylon is inactive in winter and seems less promising, except in particular environments. Androsolena macaeritana and Eragrostis spp. have hard, coarse leaves and are unpleasant to sheep, though it may prove possible to select varieties which are acceptable to horses. In the Mediterranean region resistance to grazing is not important. (6). Trees with deep root systems which cast relatively light shadow may be expected to buffer edaphic fluctuations, retard the autumnal uptake of nutrients from the top-soil and prevent excessive concentration of salts in the soil during summer.

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The trends for Hedysarum coronarium legys to be short-lived and to be invaded by nitrophilous species must be noted. It has been shown that in the pastures of these annual pastures and legys based on H. coronarium perennial grass mixtures must be fertilized in autumn to counteract the leaching of nutrients from the top-soil and prevent excessive concentration of salts in the soil during summer.

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