DIRECTION OF DIEBACK RESEARCH FOR MANAGEMENT PURPOSES

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D.R.
Dieback
Disease
F.D.
Report
Management
P.C.
Phytophthora

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1. At the risk of some oversimplification, but to clarify terminology for purposes of the present discussion, in the broad area of dieback there seem to be -

   1.1. Disorders - attributable to physical factors and possibly to nutritional factors also.

   1.2. Diseases - attributable to pathogenic activity.

2. Research Direction for the Management of Disorders

   The main factors here seem to be such things as fire, frost, and disbalanced water relations. These will not be dealt with at great length because possible solutions are primarily a matter of manipulation of method rather than establishment of principles. Research activity will lie more in the area of applied investigations and practitioner observations rather than at more basic levels. However it is possible to suggest amongst other things -

   2.1. Fire - Possible remedies lie in the areas of implementation of an adequate suppression system and the establishment of an adequate system of strategic hazard reduction, according to well-established principles.

   2.2. Frost - The possible remedies are largely a matter of designing and implementing silvicultural systems aimed at reducing radiation and inhibiting movement or ponding of cold air masses. Selection or shelterwood type silvicultural systems in and adjacent to the cold air catchments come readily to mind. Alternatively where introduction of species alien to a particular site is being considered proper attention must be given to species selection.

2.3. Disbalanced Water Relations - Drought or water-logging may commonly be regarded as arising from some alteration to the site due to felling or clearing practice in indigenous stands. In eucalypt plantations these problems will also occur if unsuitable species or unsuitable densities are employed. Manipulation of stand density seems to provide the remedy to some extent in either case. Selection of species is particularly relevant to drought (Carne, 1967) and where eucalypt plantations are being established, there is wisdom in avoiding extensive monoculture (Carne, 1973).

3. Research Directions for the Management of Forest Disease

3.1. Turning now to the more complex dieback diseases attributable either to insect or to soil-borne organisms - because of the greater complexity of the disease situation greater efforts will be required to determine the aetiology of the diseases as well as to implement management practices designed to control them. The financial aspects of the costs of researching and implementing practicable control measures in relation to the benefits of control are particularly relevant.

3.2. The cost items are a relatively simple matter of accounting and budgeting, but the benefits vary very substantially according to the particular management objectives and will include many intangibles such as recreation and amenity values as well as in the case of National Parks the value of protecting indigenous ecosystems (Weste, 1973). This is a particularly sensitive area as no options are open and control must be absolute in its own right.

4. Management requires these economic appraisals at policy level to determine priorities and to generate resources, as well as at operational level where budgeting and technical guidelines are also needed. Broadly, in sequence of time, the directions of research to meet these management requirements are seen as -

4.1. Determination of the present extent, location and rate of development of the disease.

4.2. Prediction of the maximum potential of the disease in terms of both time and area if allowed to develop unchecked.

4.3. Estimates of the value of the resource being protected in relation to the financial loss and costs of research and control.

4.4. Appraisal of the effectiveness and feasibility of control measures on an operational scale.

This is a very tall order as these items have to be considered in terms of the inter-actions between site, pathogens and hosts. But for the purposes of implementing initial action successive approximations based upon the best information available at any time are vastly superior to no information at all in view of the lengthy time scales involved. In the meantime hygiene measures as a prudent partial holding action are a relatively cheap way of ensuring that the disease situation is not needlessly exaggerated (Hopkins, undated, Veitch, 1973).

5. Determination of the Extent, Location and Rate of Development of the Disease.

5.1. Considerable progress has been made in this regard using ground inspection (N.S.W. 1973) and a combination of ground inspection and various photo mapping techniques as reported in most of the papers. Scale and type of photography are particularly important, but considering that in such areas as W.A. photo mapping has been in progress since 1956 and substantial areas of the more difficult vegetation types where ground mapping is also difficult still remain unmapped, progress in this basic requirement cannot

be regarded as satisfactory. Further work is required in the application of multi-spectral imagery and perhaps, where all else fails, the development of photo sampling techniques using very large-scale photography (W.A. Forests Dept., 1972, unpublished).

5.2. Attempts to determine the rate of development of diseases or even to establish a uniform and meaningful terminology have to date been inadequate. Expression of rate of spread in linear terms may be a useful index for research purposes but is meaningless in management, whereas expression in terms of percentage of infected area suffers the disability of a constantly changing base. Rate of development is crucial to management in planning utilisation of timber from infected areas and in organising possible control or rehabilitation measures. In W.A. initial photo-monitoring (F.D. 1972 unpublished) of key strips using photography dating back to 1941 has indicated overall increases in infected area of the order of 4 per cent per annum, but varying widely according to time and locality. These approximations have provided a valuable basis for some sort of management planning which unfortunately falls far short of what is ultimately desirable. Firmer estimates of rate of development are essential for internal purposes as well as to relate diseases to the overall context of land management.

6. Determination of Ultimate Potential of the Disease

6.1. So far we have a somewhat blurred picture of what has happened but we do not have any indication of what might happen. The distribution pattern of diseases is fairly wellknown where it can actually be seen. Papers from Victoria, Tasmania and W.A. indicate this, but the fact that new infections occur clearly indicates that additional susceptible areas are exposed to infection and we need to know how many and what extent. A growth loss in regrowth stands before

disease symptoms become visible has been indicated (Felton and Bird, undated) and site conditions leading to the deterioration of old growth may carry over to induce similar symptoms of disease or disorder in regrowth on the same area (Felton, 1972).

6.2. The propensity of particular sites to disease is vitally significant to future resource management and particularly to flora conservation. The interrelationships between the occurrence of disease and such physical factors as roads, streams and rainfall have been examined (Batini, unpublished) and a more comprehensive ecological site classification of disease susceptibility is being developed in W.A. (Havel pers. comm.) Undoubtedly similar techniques are being developed elsewhere.

6.3. This type of approach is vital and must be extended in order to inject the cardinal virtue of anticipation into our rationale for disease management. Coupled with more accurate estimates of rate of spread it will allow us to obtain a truer perspective of diseases and in the meantime to adjust treatments and programmes to ensure their greater effectiveness.

6.4. Likewise we know quite a lot about the seasonal boundary conditions of temperature and moisture governing population fluctuations of P.C. (Podger, 1968) and of the eucalypt defoliating saw-fly (Carne, 1969), yet this data has not really been applied in any predictive capacity. Because of the time scale involved in forestry this is not expected to be as purposeful or positive as the Canadian work with wheat rust, yet it could help in scheduling essential works at least in vital conservational areas.

7. Economic Evaluation

7.1. Initial work in W.A. has indicated a relatively small but persistent loss in long term yield due to dieback in the jarrah forest and that the longer salvage is delayed the greater the loss of standing volume. In Tasmania a marked reduction in increment in infected regrowth stands before visible symptoms appear has been noted (Felton and Bird, undated) but this result is inconsistent with that obtained in Victoria (Incoll and Fagg, undated). No studies have as yet been carried out in New South Wales (N.S.W. F.C. 1973). Loss of height growth in eucalypt regrowth in Tasmania due to insect defoliation has been noted (Greaves, 1966) and no doubt many similar piecemeal studies have been carried out elsewhere. However it is not yet possible to produce comprehensive estimates of loss of standing timber and production potential due to lack of basic information relating to the extent and rate of disease development. This is a major omission as indicated previously in this paper.

7.2. The fact that dieback symptoms have recurred in regrowth growing on sites where the old growth had been affected is cause for concern and the marked similarity between dieback in the Brisbane Ranges and in Western Australia (Podger and Ashton, undated) together with the casually observed similarity between gully dieback in Tasmania and the early stages of dieback in W.A. indicate serious concern for the future of existing and regrowth eucalypt stands.

7.3. Other possible economic implications have been listed (Weste, 1973) and this list could be extended, however some assumptions such as that the loss of forest cover is invariably detrimental to water supply may be questioned.

7.4. The various philosophies of cost benefit studies are beyond the scope of this discussion and will not be considered, yet it is true to say that because of the observed progress of dieback in W.A. no occurrence elsewhere should be treated lightly and that until we have a more comprehensive and factual estimate of the ultimate potential of dieback diseases to impair forest production and diminish other resource values we are not really in a position to judge the amount of effort required in research and control, nor to generate the necessary finance.

8. Appraisal of the Feasibility of Economic Control Measures

8.1. Detection is the basis for control. Improved detection methods at least for P.C. have been developed (Malajczuk and Bowen, 1973) yet these do not entirely solve the problem of broadscale detection and baiting techniques cannot always be regarded as consistent or positive. Detection of visual symptoms in the ground flora related to site susceptibility may prove equally reliable and certainly cheaper. For this reason greater attention should be given to the ecological aspects of both site and possible indicator species.

8.2. Quarantine measures are costly and difficult to apply other than in extremely limited localities. The looser hygiene measures as implemented in W.A. and proposed for implementation in Victoria, are regarded as purely delaying tactics. They are also difficult to implement and by design they are not intended to be absolute. Log salvage is a matter of minimising loss rather than a control measure, and the intensive management activities proposed in W.A., (Hopkins, undated) are an attempt to make the best of a difficult situation.

8.3. Cultural methods such as thinning and fertilising may not be conclusive, other measures such as soil fumigation, soil drenching and reduction in quantities of host material are costly and likely to be applicable only in restricted areas of special value. Broad-scale commercial application of insecticides is likely to have environmental repercussions and silvicultural measures (Carne, Greaves and McInnes, undated) could be preferable. However most of these techniques are likely to be irrelevant where conservation of native flora is the prime objective as they are likely to damage the existing vegetation. To date no really satisfactory physical or control measures have been developed at operational scale and the alternative possibilities of biological control are well worth investigation (Malajczuk and Bowen, 1973).

8.4. Screening of alternative species for disease tolerance is primarily a matter of rehabilitation although it might lead to a measure of long term control. Laboratory results and field trials at least in the younger age classes have reached a relatively satisfactory level despite some anomalies between laboratory and field results. In view of the forestry time scale early establishment of field trials is vital if results are to be available for future management and large scale field experimentation with a wide range of susceptible and tolerant species (N.S.W. F.C., 1973) is regarded as a relatively cheap and valuable shotgun approach, especially in localities where a single pathogen may not be the sole cause of the disease.

9. Possible Directions for Basic Research

9.1. So far we have been dealing primarily with applied work in the fields of protection, rate of development, site susceptibility, economic evaluation and

physical and mechanical control, together with the need to collate presently available information into a comprehensive story for management purposes. Obviously on the assumption that dieback is a disease of substantial importance whatever its cause, much of the applied work can only be significant if it is soundly established on more basic investigations.

9.2. From the management viewpoint the following are seen as the most profitable lines of research investigations at this stage -

1. Development of improved techniques for micro-scale detection, as a basis for routine sampling.

2. Classification of site susceptibility to disease and determination of rate of development relevant to each major site.

3. Development of possible biological controls through rhizo sphere manipulation or investigation or antagonistic organisms.

4. Determination of survival and dispersal mechanisms on residual affected sites where both level of pathogen and food supplies are low.

10. In conclusion I hope that these comments will at least stimulate profitable discussion and help to integrate the many aspects of the dieback problem already known into a consolidated basis for determination of future action both in the fields of management and research.

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