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Scientific Straitjacket

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The Scientific Straightjacket

The Power Structure of Science and the Suppression of Environmental Scholarship

by
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Dissident scientists in communist countries receive wide publicity for their causes. But what of cases of suppression in the West? How do those who challenge the scientific establishment fare? And why have environmentalists become the chief target of those who seek to preserve the status quo?

Inscribed across the facade of the Sydney University School of Physics are the names of twenty or so famous scientists: Archimedes, Roger Bacon, Copernicus, Kepler, Galileo, Newton and others. As a result of their scientific achievements, such illustrious forebears commanded respect; through their authority and prestige in scientific matters, they influenced the direction of scientific research. Or so the standard image of scientific 'greats', as portrayed in textbooks and the media, would suggest.

But what is the relation of the image of the eminent scientists of past eras to the present generation of scientific elites who hold positions of power in large research organisations around the world? Setting aside the question of the actual status of past elites, there is no doubt that a vast change in the organisation of scientific research has come about in the past few decades. This transformation may be called bureaucratisation, industrialisation, or the shift from 'little' science to 'big' science. Even if it were ever the case in the past, it is doubtful that the leaders of the scientific community today exert power primarily through their authority on scientific matters alone.

Suppression of Scientists

Table 1 lists a number of instances of suppression from Australia and New Zealand involving individuals who have been engaged in research or teaching relating to environmental issues. There is little documentation of the scale of suppression in the scientific and academic communities, and most of the cases came to my attention through personal contacts. For example, within the Australian National University, where four of the ten cases originated, there is no straightforward or easy way to determine the existence of academic suppression. However, there are several reasons to believe that cases such as those in Table 1 are only the tip of an iceberg.

In a survey of evidence about suppression of dissident scientists, Manwell and Baker conclude that such suppression is much more widespread in the west than generally acknowledged.[15] But, they note, cases in the west receive very little publicity compared to the great attention focussed on dissidents in communist countries. For example, it was only as a result of his personal case and the publicity it received that Manwell was informed of over one hundred cases of suppression in the English-speaking world.[16]

It is well known that there were wide-scale sackings and harassment of scientists and academics in the 1940s and 1950s, especially in the US.[17] The large scale of this activity is often forgotten, as are the long term effects of this attack on nonconformist scholarship. Just as important is the low level of awareness of the political suppression which has continued since then.[18]

As well as political beliefs, suppression is often closely connected with struggles with organisational vested interests, and with disputes over the validity of different types of knowledge and ways of acquiring it — that is, paradigm disputes.[19] A mixture of political, organisational and paradigm aspects in suppression cases is quite common.[20]

Most scientists prefer to avoid public controversy concerning their own research and teaching. This means that it is difficult to find individuals willing to have their cases presented as in Table 1. I know of several other suppression cases in which those involved do not wish publicity for personal or career reasons. There are also many cases in which suppression is a likely possibility but in which there is insufficient evidence to make a firm public case.

For these reasons it seems reasonable to infer that publicised cases are a small fraction of total cases.[21] Furthermore, since some types of suppression receive more publicity than others, it is highly likely that outright attempts to sack dissidents (as in the cases of Coulter, Evans and Manwell) are greatly outnumbered by non-tenured positions not being renewed; by failures to hire and promote; and by particular types of environmental research and teaching simply not being initiated in the first place.

At a more fundamental level, suppression merges with inhibition. As clearly expressed by C. Wright Mills years ago in relation to university teachers, "the deepest problem of freedom for teachers is not the occasional ousting of a professor, but a vague general fear — sometimes politely known as 'discretion', 'good taste', or 'balanced judgment'. It is a fear which leads to self-intimidation and finally becomes so habitual that the scholar is unaware of it. The real restraints are not

Table 1: Cases

Table 1. Instances of suppression from Australia and New Zealand involving individuals engaged in environmental research or teaching.

CASE 1: *Name* Dr John Coulter
Position Surgical Research Officer, Institute of Medical and Veterinary Science, Adelaide (1959-).
Background (a) Outspoken on numerous and diverse environmental issues, such as the impacts of environmental chemicals (1956-).
(b) As a researcher in IMVS, started on his own initiative (1977-) a routine service for testing substances for mutagenic properties.
(c) Prepared a report on the hazards of ethylene oxide (ETO) as a sterilant, and gave this to ETO workers as well as to the appropriate IMVS Committee (16 April 1980).
(d) Posted on IMVS noticeboards copies of the ETO report and related correspondence with the Director of IMVS (8 May 1980).
Action (a) Letters of complaint to IMVS from chemical companies.
(b) Environmental mutagens testing unit closed by IMVS on 30 June 1980.
(c) Letter of rebuke from Director of IMVS for releasing ETO report to workers (23 April 1980).
(d) Instruction from Director of IMVS to not make available material dealing with the affairs of IMVS to any staff member without express approval from the Director (9 May 1980).
(e) Coulter dismissed from IMVS (30 June 1980).
Status Unresolved (September 1980).
Reference (1)

CASE 2: *Name* Dr Jeremy Evans
Position Senior Lecturer, Human Sciences Program, Australian National University (1973-).
Background Taught in environmentally oriented Human Sciences Program (1973-).
Action Reappointment and review committees recommended that tenure be denied (1979).
Status Tenure decision postponed until 1982.
References (2), (3)

CASE 3: *Name* Dr John Hookey
Position Senior Lecturer, Faculty of Law, Australian National University (1971-1974).
Background Introduced (1972) and taught first Australian undergraduate course in Environmental and Natural Resources Law, at Australian National University.
Action Indication that tenure would be denied (1973).
Status Resigned (1974) pending completion of internal appeal to take up appointment as Public Hearings Commissioner in Federal Department of Environment and Conservation; subsequently Commissioner, Redcliff Environmental Inquiry, and Presiding Commissioner, Fraser Island Environmental Inquiry.
Reference (4)

CASE 4: *Name* Dr Philip Keane
Position Lecturer in Botany, La Trobe University (1975-).
Background Published an article (5) in a national weekly newspaper (January 1977) about the spread of cinnamon fungus in Victorian forests.
Action Chairman of the Forests Commission of Victoria applied great pressure on the University's Chancellor, Acting Vice-Chancellor and the Deans of Science to take action — nine letters written and hand-delivered between 3rd and 24th February 1977 (6).
Status Unchanged by events. The University Council was informed of the attacks and the appropriate officers (Chairman of Department, Dean of School of Biological Sciences) resisted all pressures and strongly rejected the allegations made. The Chairman of the Forests Commission was further informed that all Australian University Statutes are framed to allow staff to speak publicly on controversial issues thereby preserving academic freedom.
Reference (7)

CASE 5: *Name* Dr Robert Mann
Position Senior Lecturer, Department of Biochemistry, on secondment to Centre for Continuing Education (1976-), University of Auckland.
Background A founding teacher (1974-) of the Environmental Studies programme; publicly active on issues of nuclear power, nuclear weapons, 2,4,5-T, etc.
Action Dismissal proceedings initiated (1977) by University of Auckland after letter to Vice-Chancellor

so much external prohibitions as control of the insurgent by the agreements of academic gentlemen''.[22]

The incidence of suppression in the environmental area is almost certainly greater in government and industry than in academia, especially when cases of inhibition are included. Academics generally have much greater freedom — in that their jobs are less immediately threatened — to carry out research on and speak out on controversial topics. Because of this, academics are also more likely to speak up when attempts at suppression are made, though this is seldom enough. Dissidents in government or industry generally keep quiet, learn a new set of standards, or quietly exit. Especially in industry where few voice criticisms and stay around to tell about it.

Incompetence Rarely a Factor

Is there an underlying reason for suppression in the environmental and other areas? One answer is that the grounds given for dismissal, non-renewal and the like are themselves valid. A detailed assessment of this would require full documentation of each case, hardly possible here. Suffice it to say that purely academic or scientific judgements are almost always insufficient as an explanation. In almost every case in Table 1, the research output or teaching performance of the individual under threat was well above average, and in several cases the research or teaching records were outstanding.

For example, the outstanding teaching performance of Evans has been widely acknowledged[2]; Manwell's publication record placed him in the top one per cent of comparable scientists[10]; Smith, in the few years since submitting his Ph.D. thesis, has an enviable publication record. A similar pattern has been noted in cases of political suppression, in which shortcomings of ability, competence or performance have been sufficient to justify suppression in only a tiny proportion of cases[23] Indeed a study of all contested dismissals in the period 1916-1970 reported in the *American Association of University Professors* Bulletin found that ''in only 13 of the 217 dismissal cases was there even a suggestion of incompetence in either their teaching or research''.[24,25]

The cases as listed in Table 1 are only outlines. In almost every case, further details and information show even more clearly that the suppression is illegitimate by normal scientific and academic criteria, and that efforts at suppression are more systematic and sustained than first meets the eye. For example, at the time of the Routley case, several scientists in different organisations were threatened with dismissal or other reprisals for merely giving the Routleys publicly available information and references to public documents.

of Suppression

from Head of Department of Biochemistry (no grounds given).
Status Dismissal efforts renewed 1979; University Council proposed further probation and implied cancellation of accumulated leave entitlement.
Reference (8)

CASE 6: *Name* Professor Clyde Manwell
Position Professor of Zoology, University of Adelaide (1970-).
Background Sent letter (co-author, C.M.A. Baker) to newspaper criticising aspects of the South Australian government fruit-fly spraying programme (1971).
Action (a) Dismissal proceedings initiated by senior Professor of Zoology (1971).
(b) Australian Research Grants Committee grant cut off (1972).
Status (a) Proceedings dropped (1975).
(b) Grants not resumed (1980).
References (a) (9); (b) (10)

CASE 7: *Name* Mr Peter Rawlinson
Position Senior Lecturer, Zoology Department, La Trobe University (1967-).
Background Involved in a series of radio and television interviews critical of the activity of the Forests Commission of Victoria, especially with regard to the spread of cinnamon fungus (January and February 1977), at the time being an elected member of the Conservation Council of Victoria Executive and their spokesperson on forestry issues.
Action Chairman of the Forests Commission of Victoria applied great pressure to the University's Chancellor, Acting Vice-Chancellor and the Deans of Science to take action: nine letters written and hand-delivered between 3rd and 24th February 1977.
Status Unchanged by events. The University Council was informed of the attacks and the appropriate officers resisted all pressures and strongly rejected the allegations made. The Chairman of the Forests Commission was further informed that all Australian University Statutes are framed to allow staff to speak publicly on controversial issues thereby preserving academic freedom.
Reference (7)

CASE 8: *Name* Mr Richard Routley
Position Senior Fellow, Philosophy Department, Research School of Social Sciences, Australian National University (1971-).
Background Wrote a book (co-author, Val Routley), *Fight for the Forests* (11), which was critical of Australian forestry planning and practice. Publication by Research School of Social Sciences arranged (1972).
Action (a) ANU Vice-Chancellor suggested that printing should not proceed unless book was given to the Head of the Forestry Department at ANU, to be revised in accordance with his comments (1973).
(b) R. Routley barred from using Forestry Department library (1974).
Status (a) Three editions (1973, 1974, 1975) of book published and sold out; strong interest in book continues (1980), but funding for further editions or reprints unavailable.
(b) Bar dropped (1974).
Reference (12)

CASE 9: *Name* Mr David Smith
Position Ph.D candidate, Forestry Department, Australian National University (1974-).
Background Ph.D thesis showed inadequacies in current procedures for evaluating effectiveness of pesticides (1977).
Action Two of three examiners rejected Ph.D thesis (1978).
Status Unresolved (1980); working elsewhere (1978-).
Reference (13)

CASE 10: *Name* Dr Peter Springell
Position Principal Research Scientist, Commonwealth Scientific and Industrial Research Organisation (1953-1976).
Background Scientific research undertaken and published on environmental topics; criticism of CSIRO for lack of environmental research (1974-1976).
Action Refusal to allow papers to be published through CSIRO; attempts at dismissal and transfer (1974-1976).
Status Resigned from post (1976); working elsewhere.
Reference (14)

Environmentalists Singled Out?

In cases in which no clear reasons for the suppression action were given, there was a lack of scientific or academic justification for the action. But there are suggestive alternative explanations. It is reasonable in Mann's case to imagine that his public activities as an environmentalist played some role in the initiation of dismissal efforts. And those familiar with Hookey's career would be disinclined to accept that the action taken against him was a result of poor teaching or research, given his initiative in introducing the first Australian undergraduate course in environmental and natural resources law, his publication of papers on Aboriginal land rights and his participation in Papua New Guinea land rights cases [26,27].

It might be claimed that suppression in the area of environmental research and teaching is not unusual, since suppression is common in all areas of research and teaching. No doubt this is true in a general sense. But as noted before, available evidence suggests that suppression is closely connected with political beliefs, organisational vested interests, paradigm disputes and combinations of these. Each of these factors helps make the environmental area a prime one for suppression. Environmental scholarship is often seen as linked to the 'politics' of the environmental movement; environmental scholarship often presents a challenge to established practices and policies of powerful organisations; and environmental scholarship often challenges the dogmas of various scientific disciplines.

The data presented here suggest an explanation for suppression of scientists based on an understanding of the power structure of science. Suppression *does* occur in a wide range of areas of scientific research and application, from anthropology to engineering to zoology. Tellingly, it occurs most frequently in areas such as environmental studies where opportunities arise for teaching and research which provides a threat to vested interests either inside or outside the scientific community.

The Scientific Elite

There is a considerable literature documenting the existence of an elite group within the scientific community which is characterised by high productivity in scientific research, a high degree of professional recognition of its intellectual achievements, a high degree of internal interaction and clustering at a few select institutions, and a high degree of influence over the professional activities of non-elite scientists [28,29]. This group may be called the *cognitive* scientific elite, because as usually studied it is concerned mainly with academic

scientists and with activities relating to the production of scientific knowledge.

It is also possible to focus on a group which may be called the *political* scientific elite, that group of scientists with the greatest political power (both within and without the scientific community) to influence government and corporate policies and to influence developments in the scientific community. The power of this elite is manifest in the promotion of research in certain areas and its restraint in others; in the creation or closing of research institutions; in the hiring or dismissing of staff; in the allocation of funds from specific research projects and in the setting of policies for scientific journals and texts[28 30]. It is clear that there is a considerable degree of overlap between the membership of the cognitive and political scientific elites, as well as a degree of overlap between the activities and characteristics of the two[31]. The cognitive and the political scientific elites are linked in another important way. Leaders of the scientific research community often attempt to use their political power to control what counts as scientific knowledge and how it may validly be obtained and verified, and vice versa .[32 33]

Most studies which treat aspects of the political scientific elite either do not address the question of the advantages and disadvantages of the existence of an elite, or tend to emphasise the functional uses of the elite, as presently constituted, to the scientific community and society as a whole[34]. Few studies challenge the view, common among scientists who support the present organisation of the scientific community, that leading scientists are in positions of power due to their superior scientific abilities and achievements, and therefore are the best people to make decisions about the functioning and development of scientific research and the scientific community.

In one of the few studies of the political scientific elite, Mulkay[28] argues that scientific elites mediate between working research scientists and powerful groups, notably in government and industry, which have an interest in influencing the direction and content of scientific research. In Mulkay's view, then, the scientific elites serve to protect the working scientists from these outside, non-scientific influences.

The object here is not to provide a detailed critique of these views, but rather to present an alternative, partly supplementary perspective. But it may be useful to mention some inadequacies of the views referred to above. First, it has not been demonstrated that there is a correlation between rising within the scientific hierarchy and the making of productive and equitable decisions about scientific priorities. Second, the positions of political power accessible via a scientific career often attract individuals interested in personal aggrandisement[35]. Third, the strong vested interests which most scientific elites have in their reputations and in the perpetuation of particular types and styles of scientific research often lead to scientific*or public interest[36]. These second and third points are seldom taken into account in studies of the scientific elite. Finally, attention mostly has been focussed on justifying, explaining or at most reforming the structure of the current scientific elite. Little attention has been focussed on the possibilities for alternative structures.

According to Mulkay's view, the main source of direct suppression of scientists would be from government and industry. Although this is indeed a primary source of suppression, I argue below that leading scientists and academics have taken an active role in many suppression efforts. More generally, it may be argued that the politics of the scientific community is characterised by what Haberer calls 'prudential acquiescence'[37]. For example, German scientific leaders under Nazism adopted a course of accommodation rather than opposition to outside political direction.

Rather than speak of the scientific elite structure, it is a useful generalisation to speak of the scientific power structure, recognising that a power structure has many levels rather than a single elite versus all the rest. Springell in Table 1 was fairly senior in the scientific hierarchy and hence suppression came from scientists and administrators who might reasonably be called elites. But in the case of Ph.D. candidate Smith, suppression was initiated by lower level scientists, though higher in the hierarchy than Smith.

Three main aspects of the scientific power structure will be briefly discussed here: its relation to powerful groups outside the scientific community, its relation to the scientific community and its relation to scientific knowledge.[38] (see insert on page 43a)

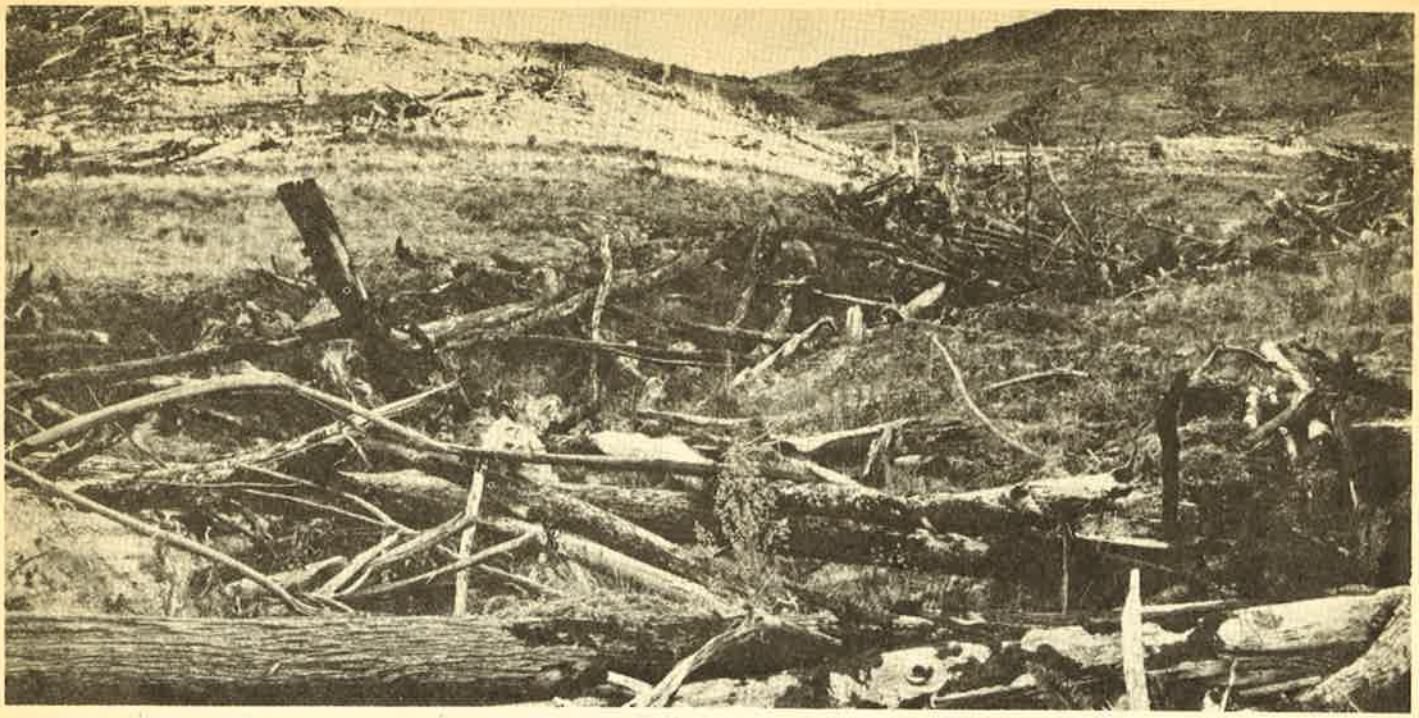
The influence of political and economic interests on the giving of scientific advice, which frequently ends up serving to justify particular policies and practices that promote the interests of powerful groups, is well documented .[36]

The patronage of leading scientists and scientific organisations by powerful non-scientific individuals and organisations is threatened when issues are taken into the domain of public debate, since the legitimacy conferred by the stamp of unanimous scientific approval is undermined. For this reason there is a strong preference among politically powerful scientists for patterns of closed decision-making[37 39]. Secrecy in scientific decision-making is the norm in the processes of allocating research grants, filling posts and making organisational policies — all areas where the influence of, and service to, powerful political and economic interests is crucial. When issues are taken to the public by concerned scientists, this often is seen as inappropriate and even contrary to proper scientific behaviour. Examples can be found in many areas, such as debates relating to nuclear power and nuclear weapons.[40 41]

The Forest Industry

The link between powerful interest groups inside and outside the scientific community helps to explain several of the cases in Table 1. In the forestry area in Australia, there appear to be strong links between university forestry departments, government forest services and research organisations, and the forest industries (timber, pulp, wood chip and other industries based on forest products). These links include informal networks of communication, professional and commercial organisations, clubs, joint conferences, consultation concerning appointments, planning and the like. These social and organisational links lead to the sharing of values and goals, which in turn influence patterns of interaction.

* priorities aligned to sources of patronage rather than in the scientific



Routley

Logged eucalyptus forest. The Australian forestry industry exercises a powerful grip on forestry research.

One example of the link between forestry researchers and personnel in the forest industries is the international organisation called the Concatenated Order of the Hoo-Hoo[42]. In Australia, the members of this social and 'service' organisation are "limited to male persons of the full age of 21 years, of good moral character and engaged in forestry, sawmilling, the manufacture of timber products, wood pulp and insulation materials derived from forest products, officials of the forestry service, forest commissions and boards, officers of timber organisations and makers of the allied industries."[43]. Despite its name and associated rituals, the Hoo-Hoo plays an important role not only in generally promoting the forest industries but in helping attune forest regulatory agencies and certain forest researchers to the interests of the forest industries.

The movement of key persons between posts in forest industries and government forest services also plays a key role in strengthening the links between the forestry industry and those who conduct forestry research. In particular there are quite a few leading figures in the government forest services who on retirement have taken positions with forest industries[44]. This interaction by personnel interchange is common in many fields beside forestry, such as nuclear power, armaments and agriculture.

In many Australian states, the link between government forest services and the forest industries operates through the structure of the state and federal government bureaucracies. The state cabinets appoint senior officials in the bureaucracy, including the departmental head responsible for forestry. Due to the political influence of industry in lobbying, creating jobs locally and supplying election funds, most departmental heads are chosen to be acceptable to industry. The powers of the departmental heads are considerable. For example, in Victoria, public service regulations make it punishable with dismissal for a state government scientist to criticise the departmental head or departmental policies to three or more people or to make critical comment regarding matters outside one's field. Even if such regulations are seldom applied in practice, their presence is a strong deterrent to the voicing of dissent.

The Dangers of Speaking Out

Although in principle one can speak out in one's 'private capacity', in practice it is easy to get into trouble doing this. For example, John French in September 1976 spoke out as a member of the Native Forests Action Council about the spread of cinnamon fungus in Victorian forests, but was reported in a newspaper article as speaking in his capacity as a government scientist in the CSIRO. A correction was later published, but French also received a letter of concern from the Chairman of CSIRO about the newspaper article[45].

The basic orientation of the government forest services and many forestry academics is to promote the exploitation of forest resources for the purposes of production and profit[46]. This orientation carries over into the research of government and university foresters, where the criteria for valid and useful knowledge, and how it may be obtained, are influenced by the interests of the forest industries. In other words, the paradigm for many forest researchers is, to put it bluntly, based around ensuring that forests exist primarily for the forest industries.

Anyone who challenges this view — who criticises the way foresters manage the forests, or who promotes an alternative use of forests — is apt to be attacked by the powerful forestry interest group. Indeed, I have been informed of a considerable number of cases of suppression in the forestry area. Access to most jobs in forestry work is directly influenced by the powerful forestry interest group; hence most of those suppressed are hesitant to have their cases publicised. Indeed, the only cases which could be presented in Table 1 — Keane's, Rawlinson's and Routley's — involve individuals not working directly in the forestry area.

Patterns of Suppression

Cases of suppression seem to follow a typical pattern. A person makes a public criticism, a critical analysis in a research document, or some other 'threat' to the forestry establishment. Leading foresters, for example in the government forest services, then apply pressure on the individual's boss to have the criticism stopped, for example by making complaints in person or by telephone, or by sending letters of complaint. Steps taken to prevent recurrence of criticism include informal comments about the individual's competence and motivations, hindering of research, blocking of appointment or promotion, and threats of dismissal. Such efforts (even when immediately unsuccessful as in the cases of Keane and Rawlinson) can by setting an example serve to reduce the future likelihood of research in sensitive areas or of public comment by others.

Besides the forest industries, some other prime sources of suppression — either directly, or indirectly via subservient government and academic bodies — are chemical industries, pharmaceutical industries, electrical industries, mining industries and automotive industries.

The Smear Campaign

One method of suppression deserves special mention: the smear campaign or the threat of it. The following excerpt from a letter by a 'distinguished organic chemist' speaks for itself:

> "I appreciate your views that it would be desirable to have independent tests on water and plants in the area to see if residues of 2,4,5-T are present.
>
> "Regretfully, however, I feel that I should not at any price undertake such tests, or indeed direct anyone in the department . . . to conduct such tests.
>
> "My reasons for this stem from my complete lack of faith in certain government people who, in conjunction with their confraternity in the commercial sphere, tried very hard in a thoroughly despicable way last year to bring discredit upon me, following my criticisms of spraying activities in SA with 2,4,5-T and with amitrole.
>
> "If any tests conducted by me or anyone in my department yielded positive results of an embarrassing nature to the same people, I fear that another smear campaign would be implemented and that rumours would be concomitantly circulated to the effect that we had 'cooked' our findings.
>
> ". . . I trust that you will understand my point of view."[47]

The links between powerful interest groups inside and outside the scientific community can also help explain the cases of Coulter, Manwell and Smith in Table 1. On a number of occasions pressure was brought to bear on Coulter because of activities undertaken in his 'private capacity'.

In 1978 the Bayer company brought an action against the Australian Broadcasting Commission, partly over remarks Coulter had made on a television programme regarding one of its products containing the mutagenic pesticide dichlorvos. The action was subsequently dropped about two years later but in the interim pressure was brought to bear on Coulter through the Agricultural Chemical Trade Association and the Director of the Institute of Medical and Veterinary Science, where Coulter worked.

In 1979 Velsicol Australia complained to the Director of the IMVS about a lecture Coulter had given, in a private capacity, to a Melbourne seminar on pesticides. Coulter had mentioned the way the parent company in the US had handled the information on the carcinogenicity of two of their products, chlordane and heptachlor[48]. By dismissing Coulter, the managers of the IMVS, whatever their reasons, certainly served the interests of corporate and government bodies which produce and regulate the use of chemicals such as dichlorvos, chlordane and heptachlor.

Concerning Manwell's case, speaking out against aspects of a government fruit fly spraying programme would hardly seem grounds for great concern. Indeed, a number of individuals had done this in Adelaide prior to the publication of Manwell's letter — but none were scientists. Manwell was a scientist working in a relevant field. His letter threatened the rationale for an existing government programme benefiting various political and administrative figures, a programme which previously had had the scientific stamp of approval. It is noteworthy that Manwell's writing of a letter to the newspaper was fiercely criticised by certain conservative South Australian parliamentarians prior to the attempt of academic suppression[9]. (In the forestry area also, criticisms by scientists, and criticisms presented in rigorous technical fashion, have induced much stronger responses than less technical criticism by non-scientists.)

In the case of Smith, the suppression took place at a much lower level in the scientific hierarchy. Here a vital factor seems to be the prevalence of a perspective underlying much research on pests, which is based on the extension of engineering concepts and linear analysis. In crude terms, this particular pest control paradigm is essentially 'biocidal': the only solution perceived to the problem of pests is applying pesticides. In this view everything else is treated as an externality of secondary importance. The generation and maintenance of this paradigm is strongly influenced by industries profiting from chemical methods of pest control and by government policies legitimising these methods[49]. Scientists steeped in this pest control paradigm may not have any direct contacts with the chemical and other industries which support and benefit from research done within the paradigm. But such scientists might well be unsympathetic to research, such as presented in Smith's thesis, which questions commonly held beliefs about effectiveness of the biocidal approach.

Seen from the point of view of the interests of powerful non-scientific groups, the scientific power structure serves a valuable function of social control. The patronage of politically powerful scientists provides a ready means for outside interests to influence the direction of scientific research, and to obtain scientific legitimisation for preferred policies. If patterns of control over scientists were less hierarchical, such outside influence would be less easily exercised and less effective.

Areas of Suppression

Karl Z. Morgan. Although not opposed to nuclear energy, Morgan has been consistently outspoken in his criticisms of the nuclear industry's safety record. Highly regarded in the scientific community as the 'Father of Health Physics', he was part of the team which developed the atomic bomb. Later he became a director of the prestigious Oak Ridge National Laboratory. His first brush with the authorities came after he wrote a speech critical of the liquid metal fast reactor. Advance copies were siezed and replaced by an edited version. In 1980, he was relieved of his post as professor at the Georgia Institute of Technology. According to the World Information Service on Energy, "Sources close to Morgan claim that his dismissal is most probably linked to his continuing criticisms of the nuclear industry."

John Goffman and Arthur Tamplin. Presented a paper in 1969 challenging current radiation exposure standards. Attempts were made to censor a subsequent report to the American Association for the Advancement of Science. Goffman's research grant was terminated. Tamplin stayed on at the Lawrence Livermore Laboratory, "essentially a non-person." Later he resigned and moved to the Natural Resources Defence Council.

Thomas Mancuso. Regarded as one of America's most outstanding epidemiologists, Mancuso was awarded a contract by the Atomic Energy Commission in 1964 to study the effects of low-level radiation on the health of workers at the Hanford reprocessing plant in Washington State. In 1974, pressure was put on Mancuso to refute the findings of an independent study which revealed that cancer rates at the plant were five times higher than expected. Mancuso refused and his grant was terminated. His own report estimated that workers at Hanford had 26 per cent higher risk of dying from cancer and that the risks of dying from cancer of the bone marrow was increased by 107 per cent.

Irwin Bross. Funds cut off after publishing the results of a survey showing that children x-rayed in the womb had a three to four times higher chance of developing leukemia than those who had not been x-rayed.

Milton Zaret. First experienced attempts to suppress his research when he reported that microwaves, well within the current exposure limits, could adversely effect the behaviour of rats. Later he established a link between microwave exposure and the development of cataracts. His research grant from the Department of Defence was terminated and he was brusquely told that there is 'no such thing as a microwave cataract'. Zaret now alleges that he is blacklisted from receiving funds from the Department of Defence, the Food and Drug Administration and the Environmental Protection Agency. In an interview with the environmental magazine *Commonweal,* he described most government-sponsored research on the effects of microwaves as 'intelligent looks in the wrong direction'. (See *The Ecologist,* Jan-Feb 1979).

Robert Van Den Bosch. Outspoken critic of the pesticide industry. As a result he suffered frequent attempts to discredit him and to oust him from his post at the University of California — none of which were successful. In his book, *The Pesticide Conspiracy,* he described the pesticide industry as a 'mafia' with "its own lobbyists, front organisations, PR apparaatus, and 'hit men'". He also accused the industry of owning "politicians, bureaucrats, researchers, administrators, and elements of the media" and of being quite capable of breaking those who do not conform to its rules. Tragically he died in 1979.

Specialisation and Suppression

Those who rise within the scientific power structure often do so via a successful research career following orthodox research channels in a fairly narrow specialisation. The bases on which power and prestige rest within the hierarchy depend therefore on the status of specialised research within a recognised discipline. In other words, empire-building in scientific organisations tends to follow disciplinary lines[50]. It is no coincidence that the elite body the Australian Academy of Science is a group of specialists.

Disciplines and specialism themselves should not be seen as 'natural' divisions of knowledge, but as socially constructed divisions which are established, maintained or altered on the basis of social conventions and institutional arrangements[51]. Power struggles within scientific organisations thus have several facets. They involve positions within the hierarchy: struggles for appointment, promotion and research grants. They involve the nature of the hierarchy: struggles over specialism and discipline boundaries, as in the setting up of departments and courses. And they involve the standards and frameworks for knowledge: struggles over paradigms and struggles using paradigms as resources.[52]

The status of specialised research within a recognised discipline depends in part on the discipline in question being off limits or opaque to non-specialists and to the public. Only to the extent that the essence of the work in a discipline and its specialities is either a special preserve or else not readily grasped by outsiders is it possible for members of the discipline to claim exclusive rights to judge the importance of work in the discipline.

I have suggested that specialisation and disciplinary exclusiveness serve the interests of many who work in traditional disciplines, especially those who rise to positions of power within these disciplines. With this perspective, it is understandable that many scientists in traditional disciplines would be antagonistic to potentially substantial programmes relating to science which are either truly interdisciplinary or popular with students or the public. Interdisciplinary research and teaching is, by its nature, subversive to that portion of

the scientific power structure which is founded on narrow disciplinary research and teaching. Likewise, scientific programmes or ideas that involve the public in active understanding or participation are also a threat to the power structure of science, since the exclusive judgement rights over the development of the discipline are potentially challenged.

The Human Sciences Program

In recent years the environmental area has been a source of scientific research and teaching which is potentially threatening to many parts of the traditional power structure of science. By its nature much environmental research is interdisciplinary. The results of this research often offer a challenge to existing policies and practices of government and industry, and the area is one of high public concern. Such research can thus provide a threat to the hierarchical power structure of science.[53] The same strictures apply to the achievement of successful environmental education.

These points help to explain the cases of Evans, Mann and Springell (Table 1). On the basis of information available to me, the case of Evans provides the best illustration. The Human Sciences Program in which he works has been under attack by various people, especially people in positions of power within traditional departments, from the time it was first proposed in 1970, although the Program has been vindicated in several reviews. The Program is the only one of its kind in Australia to espouse clearly the ideal of holistic education in which a number of different possible approaches to knowledge and understanding (of which science is only one) are studied, with special application to environmental issues. Predictably, some scientists have criticised the lack of a disciplinary base for the Program. Their commitment to specialist, discipline-based perspectives helps to explain their negative evaluation of Evans' research, which is actually above the average for his faculty in terms of quantity.

Antagonism to the Program was strong from some sections of the University even in the days when there was plenty of government money for nearly everyone in the universities; therefore departmental competition for resources cannot be the sole explanatory factor. The recent years of increasingly tight university budgets seem to have provided the extra pressure which led to the attempt to deny tenure to Evans, the only potentially tenurable member of the Program.

A study of environmental programmes in U.S. universities concluded that two features were necessary, though not alone sufficient, for their success:

> "1. Substantial or complete control of the faculty reward structure and
> 2. Freedom to be innovative in introducing course material, educational programs, work study programs, and curriculum requirements for degrees."[54]

Such requirements obviously conflict with the maintenance of the current scientific power structure. Therefore, it is not surprising that decision-making groups within the Australian National University have maintained a tight rein over the academic staff of the Human Science Program with regard to each of these two features.

Institutionalised Suppression

Links between powerful groups inside and outside the scientific community, and vested interests in disciplinary exclusiveness within scientific organisations, are two major features of the power structure of science which lead to suppression of dissident viewpoints. These two features should not be seen simply as bases for overt attempts at suppression such as blocking publications or appointments. The basis for suppression is institutionalised in science through the very nature of scientific research and scientific organisations.

Corporate and government bodies have an important direct influence on the nature of scientific research. This influence operates through funding of research, through availability of jobs in particular areas and industries, and through the general benefits to scientific elites for setting up research bodies that are designed not to challenge the status quo. Many funds are available for studying fossil fuels and nuclear fission, few for studying the conserver society. Lots of investment is made in microprocessors and other labour-saving technology, little is put into industrial democracy. There is plenty of research into how to make war, almost none into how to make peace. In short, existing patterns of funding for science, existing orientations of scientific organisations and current scientific paradigms all tend to discourage or suppress views contrary to the interests of powerful groups in society.

I have argued that the scientific community is based on hierarchies of power as well as status, on specialised disciplinary research and teaching and on the separation of scientific work from the public. Most leading scientists have vested interests in these aspects of science, and this can lead to suppression as in the case of Evans. But it is important to note that hierarchy, specialisation and exclusiveness in science are also valuable to powerful groups *outside* the scientific community. Specialised research is selectively useful to powerful groups who have the resources to hire experts to study and apply it; hierarchically organised scientific organisations mesh well with hierarchical organisations in government and industry; and the chopping up of the learning experience into specialist bits tends to produce scientists who do not question the premises underlying their work. Hierarchy, specialisation and the separation of scientific work from public scrutiny thus help retain the patronage of powerful non-scientific groups.

Specialised research and teaching is much less likely to lead to or serve public campaigns which might damage the interests of groups in government and industry. For example, a great deal of Japanese research of the orthodox, large-scale, discipline-based type — mostly funded by government and industry — was unable to determine the cause of Minamata disease. On the other hand, the local groups of concerned scientists, school teachers and citizens who carried out simple but insightful and wide-ranging experiments were able to trace the disease to mercury poisoning caused by industrial effluents.[55] Ui argues on the basis of cases such as this that scholars working in specialisms in traditional organisations *necessarily* stand on the side of the institutions which produce environmental problems.[56]

In the case of the Centre for Resource and Environ-

mental Studies (CRES) at the Australian National University, the traditional disciplinary approaches used and the traditional hierarchical structure of the organisation make it a very inadequate base for getting to the roots of environmental problems, as I have argued previously[57]. CRES, which was set up by elites in the academic and wider community, was from the beginning strongly oriented towards government and industry rather than to community groups or the general public. That it was also set up by these elites to carry out discipline-based research in a traditional hierarchical structure seems no coincidence.

The Human Sciences Program in which Evans teaches is an example of the holistic approach to knowledge, which involves integrating knowledge, perspectives and methods from different disciplines and world views into a unified framework. By contrast, much multidisciplinary research and teaching such as in CRES involves merely the collection together of narrow specialists from different fields. Multidisciplinary interaction of this latter type poses relatively little threat to traditional patterns of power and professional control.[57,58] This is especially the case when, as in many problem-oriented projects, the work is carried out under the aegis of one particular discipline or approach.[59]

In the above examples a strong connection can be seen between the scientific power structure's links with powerful groups outside the scientific community and the pressures within the scientific community for specialisation and discipline-based research and teaching. Indeed, it may be argued that many characteristics of the scientific community have evolved out of the community's history of interaction with government, industry and other groups. For example, the tendency of academics to avoid the limelight[60], which is part of the scientific ethos, can be interpreted as an adaptive response to avoid alienating potential sources of patronage. More generally, the process of professionalisation of science can be seen as a process of transforming the special knowledge and skills of scientists into social and economic rewards[61]. The scientific power structure would seem to be an important component in this process.

Challenges to the Scientific Power Structure

I have described how the power structure of science is sustained by links with powerful non-scientific groups, by the self-interest of those high in the scientific hierarchy and by the vested interests of the scientific community in specialised, discipline-based research and teaching. However, by no means all scientists acquiesce in these arrangements. Especially in the past decade or so, there have been increasing challenges to the scientific power structure.

One potent challenge to the links between powerful scientists and powerful non-scientific groups is simply public exposure of these links. Such exposure has occurred especially in controversies over issues such as the supersonic transport aircraft, nuclear power, food additives and pesticides[36]. When the public is made aware of conflicts of interests in the roles of scientists[62,63] and becomes aware of the existence of value assumptions underlying statements and advice by scientists, the ability of scientific experts to legitimise policies and practices of government and industry is greatly reduced.

Another development in this area is the creation of scientific research groups which are committed to 'public interest science' and hence less susceptible to pressures or cooption by powerful special interest groups. Examples are the Union of Concerned Scientists in the U.S., the Science Shop at the University of Amsterdam[64] and the citizen-based environmental research groups in Japan[55]. Such initiatives also tend to emphasise interdisciplinary approaches and to modify or replace the traditional hierarchies in science. One model for such efforts is the high level of community involvement in scientific research, reduction in scientific training and orientation of research to practical problems in China in the early 1970s, as described by *Science for the People*[65].

Also important in challenging the power structure of science is challenging traditional paradigms, especially when established ideas and ways of doing research and teaching are clearly linked to vested interests. Challenging paradigms is especially significant when the dispute is taken outside disciplinary boundaries and involves non-scientists.

Another set of challenges to the scientific power structure arises from attempts to change scientific organisations from within, for example, by introducing innovative interdisciplinary research and teaching programmes in areas such as alternative technology, women's studies or participatory democracy. This approach may be one of the most difficult to bring off.

The existing emphases in universities — not to mention government and industry — are predominantly in traditional subject areas, using traditional methods in traditional organisational structures. As a consequence, there is an in-built resistance to changes in such institutions from the usually narrow purposes for which they were designed.

In the area of energy and environment in the US, no holistic study programmes were established at universities before 1971. Thus the programmes followed rather than preceded the development of widespread public interest and definition of the main problems[58]. This suggests that the generation of public interest in issues and the creation of independent, citizen-oriented research groups may have a larger impact on existing scientific institutions than isolated attempts for change from within.

In the meantime, struggles do continue within scientific organisations, of which the cases in Table 1 are a sample. As noted before, many such encounters are hushed up by all concerned. However, the general interests of environmental scholarship are more likely to be served by publicity in at least some cases. Publicity is usually avoided by the individuals and groups carrying out the suppression, especially when their side of the case cannot be openly or readily justified in scientific or academic terms. Also, publicity threatens to expose the existence and methods of operation of the vested interests involved in the suppression effort. In the case of Hookey, no information about the case reached the general university community or the wider community; the individuals and organisational interests which led to the suppression were relatively undisturbed. However, the later case of Evans has generated a number of newspaper articles and letters, petitions, and support groups of staff and students. Even unpublicised cases, such as those of Hookey and Smith, can cause embarrassing divisions and conflicts within the university hierarchy. Publicity and staff or student action as in the cases of Coulter, Evans, Mann, Manwell and Springell can be a real threat to business as usual.

Incidentally, it would seem unwise for those involved in suppression cases to put heavy reliance on staff or professional organisations for support. In many suppression cases such organisations have been conspicuous by their absence. For example, when an engineer who worked for the Electricity Trust of South Australia provided public information to a newspaper, he was "severely criticised by the Institution of Engineers for saying things critical of other engineers"[66]. It seems better to look for support from individuals and groups which are in no way beholden to the groups attempting the suppression.

It would be unrealistic to expect all suppressed scientists to speak out about their cases. Those in the middle stages of a scientific career often have heavy financial or family commitments and can ill afford risking job security or promotion prospects. Those just beginning a career or with a well-established reputation often are in a better position to take risks — both in making scientific innovations[67] and in speaking out and so inviting or challenging suppression — though sacrifices may be entailed in these cases also, for example by jeopardising job prospects or losing pension benefits. But then, power structures of any kind have seldom been reformed without risk or sacrifice.

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    Dr F.R. Moulds, Chairman of the Forests Commission of Victoria, after retirement became a forestry consultant and also Chairman of Victoria's Timber Promotion Council.
    Mr N. Humphreys as Harvesting Officer of the NSW Forestry Commission in 1979 went on a world trip with a manager of Australian Newsprint Mills Limited to pick out a logging system for their Albury newsprint mill, and shortly after joined ANM as a manager.
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Material to be inserted after paragraph 3, column 2, page 36

Powerful groups outside the scientific community

Those who are high up within the scientific power structure have considerable interaction with people and organisations outside the scientific community, particularly with those in positions of power[62]. This is inevitable given the sizeable fraction of social resources devoted to science and the important role given to leading scientists in deciding its allocation. A second major source of interaction arises out of the scientific advisory apparatus, again dominated in terms of influence by the most politically powerful scientists[68]. Informal interactions are at least as important as the formal ones, though much harder to document.

Many individuals in the scientific power structure have had little or no scientific training or experience, or have lost touch with what training or experience they once had. Such individuals may suitably be called administrators. Yet many such administrators are in key positions of power concerning scientific matters, especially in government and industrial research bodies. So in actuality there is a meshing of occupational backgrounds as well as of contact and interest between individuals inside and outside the scientific power structure.

The results of the interaction between scientific and non-scientific power brokers can be seen as a quid pro quo. From powerful non-scientists, scientists receive funding, a source of jobs and some prestige. From powerful scientists, the non-scientists receive help in directing scientific research through channels selectively useful to the latters' interests. This is fairly clear in the case of government and industry, under whose direct auspices the bulk of scientific research takes place. It also applies to university research, where the influence of grant money, future job prospects and possible applications of research help channel research into areas selectively useful to powerful groups[69]. For example, Weart has concluded that leading French nuclear scientists after World War II only controlled events so long as matters moved in the directions desired by more powerful, non-scientific groups; in this context, scientists who failed to attract and maintain outside support were shunted aside for the purposes of decision-making about directions for scientific research and development[70].

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