The Mushroom Journal

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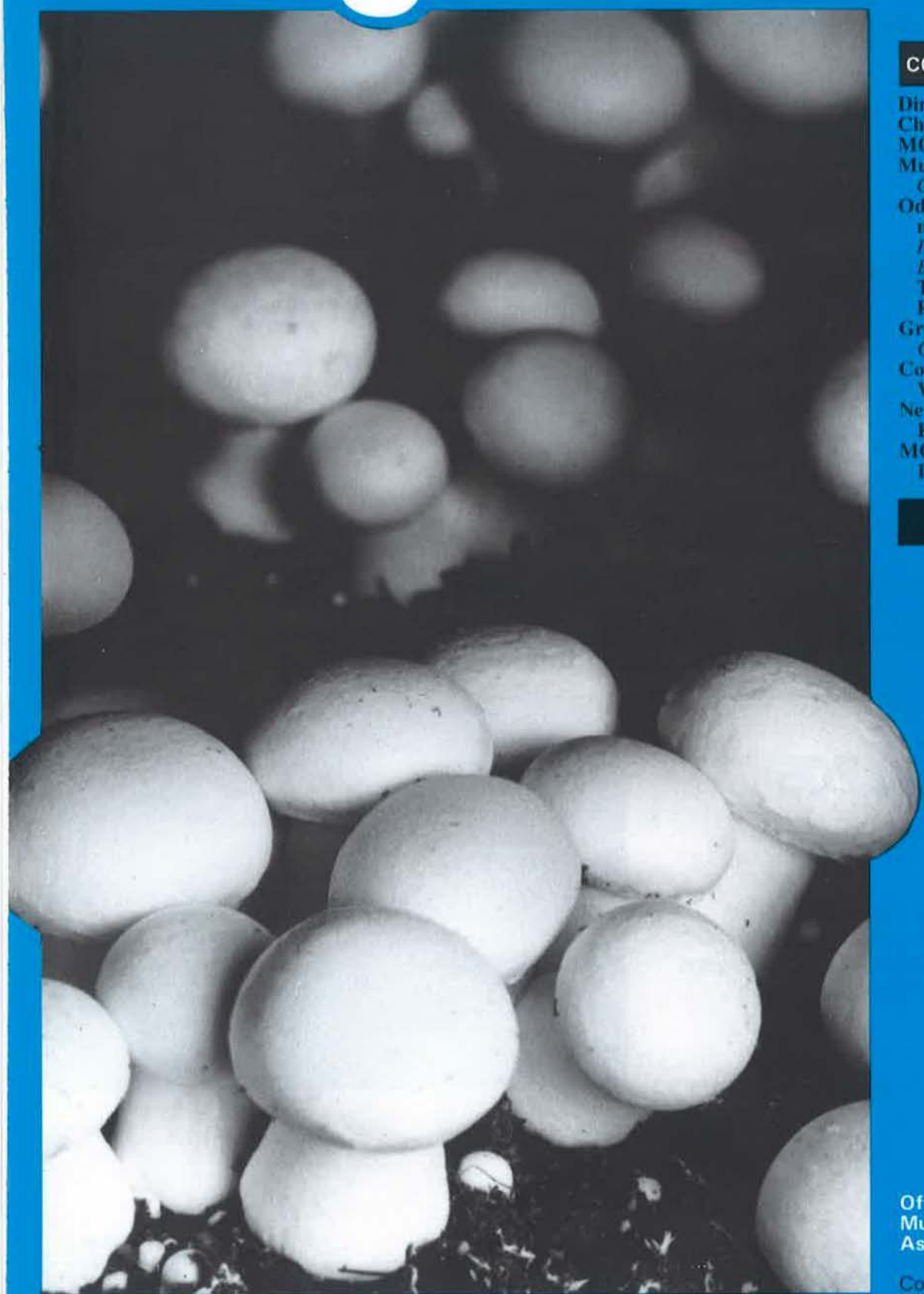

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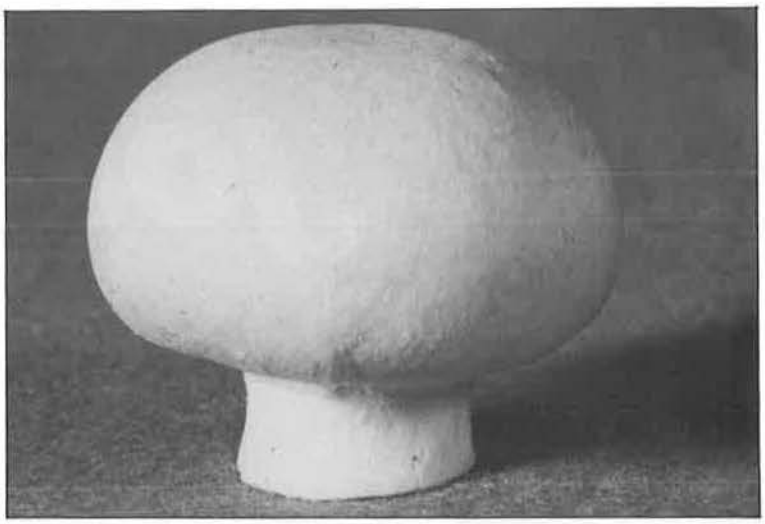

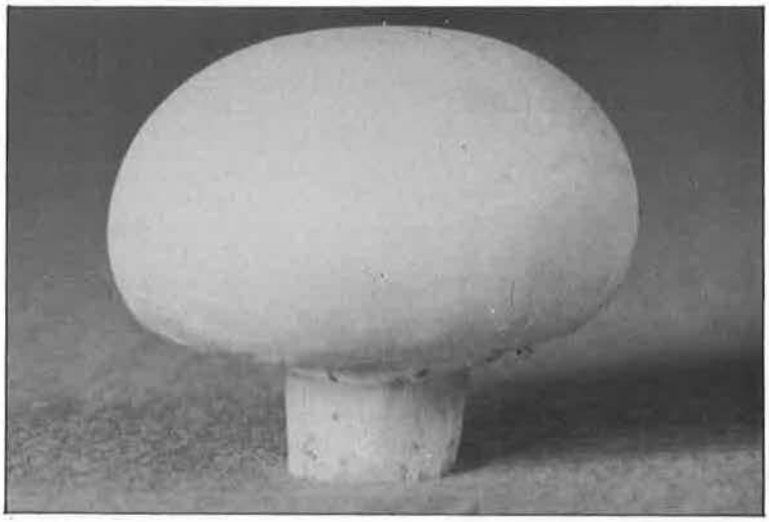

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Ken James

Looking ahead to 1989

The advantage of being a new Director is that I can only look forward to the opportunities of the next few months and years, whilst using the wealth of knowledge, experience and the skills developed by many growers, trade contacts and scientists who have already been willing to spend time discussing the industry with me. It gives me the confidence to look positively at the many opportunities and difficulties which the industry will face up to. If you read "individual growers" for industry, it brings every difficulty and opportunity back to the reality of a people industry, not a meaningless mass.

This must lead me to report a personal success by mushroom grower, Russell Howes, after a long and detailed battle to protect his mushroom growing business and a village community in Norfolk. Russell was part of a successful campaign to persuade the County Planning Authority to reject an application from a major quarry company to start extraction only 250 metres from his farm. The implications for his business, for over 20 employees and the community are obvious. Support from Peter Flegg, the Journal's Technical Editor, Dr Fred Hayes and John Fletcher of ADAS together with a supporting letter from the Association, were important elements in the case built up to oppose the application. "Hopefully an attractive valley in rural Norfolk will continue in the future as a successful community and also provide us with a living", is Russell's response to his success.

I must return to an industry scale to report a very positive and significant decision by the MGA Executive in November. There have been, and will continue to be, many discussions about the structure and the funding of research and development in the future. We know that the UK Government will continue to meet the costs of fundamental research but not what the Ministry of Agriculture calls "near market research and development". This is research, development and extension work which enables growers to carry fundamental research through into their own business.

The Executive decided to follow the lead given by the three major growers in the UK and to tell the Ministry of Agriculture that the MGA is prepared to accept responsibility for raising £100,000 each year to fund the "near market research and development", required on an industry scale. The initial £100,000 will come from the three growers and MGA reserves. The Executive expects that many growers will continue to increase their funding of confidential development projects and

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Articles submitted for inclusion in the Journal *are always welcome. Whilst the Editor cannot undertake to publish all the copy received, submissions will be acknowledged. Originals, wherever possible, will be returned to the contributor, who will also be notified as to if and when the article will appear.*

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extension work to benefit their own businesses. In this way, two of the three elements of the research, development and extension work are therefore firmly in the hands of mushroom growers. We must now expect the Government to be more positive about their fundamental research contribution, both in the resources required to maintain the people and of the facilities which are essential for the future health of our industry.

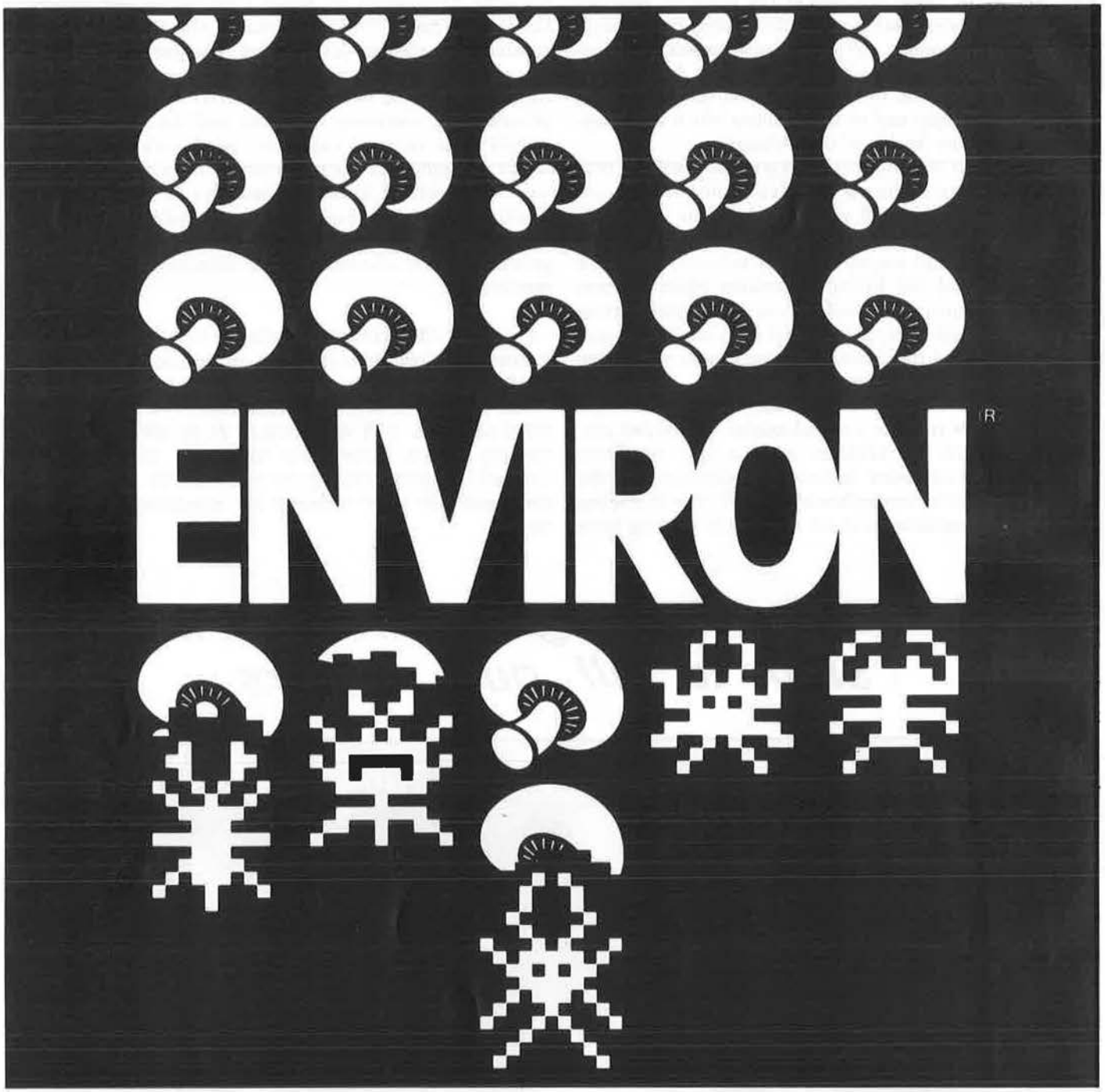
Meetings with the Ministry of Agriculture will be held in the near future to discuss this MGA initiative - we cannot afford to wait several years for decisions and in the meantime, see valuable scientific and development staff lose confidence and maybe leave our industry. I am sure that you will back this Executive decision. More information will of course be passed to you when these further meetings are held. It is salutary that Irish mushroom growers already fund their research programmes with a 50p per tonne levy on all compost used.

Research and development is of no value if your efforts and cash do not result in a sound market for the end product. The MGA PR activities make a very significant contribution to consumer interest in mushrooms and this work is likely to be strengthened in 1989. The Marketing & Publicity Committee have set up a small working party which includes a representative of the Irish Mushroom Growers Association, to devise a marketing and promotional programme aimed at ensuring that the UK market continues its volume development, but just as importantly, pays the price which will sustain growth. Attention to quality, offering the grades required by different types of customer, continuity of supply and the possibility of grower links to meet customers needs, are all subjects which will influence the programme. I am sure that growers will welcome this further initiative by the MGA and I will welcome any comments from members for I am well aware of the difficulties that the working party and growers have to overcome in this increasingly demanding market.

I suppose the greatest stimulus to overcome any difficulties we might have in trying to ensure that we take marketing seriously is to see the national food survey index of retail prices for mushrooms. The index which stood at 113 in 1979 was down to 94 by 1987. I am sure that we cannot assume that increasing yields and increased efficiency make up the whole of this reduction in price and still leave sufficient for investment in the future.

Season's Greetings from the MGA staff to all our readers

Ken sleighs them as the girls pull together into 1989. Sharon, Lucy, Amanda and Orla.



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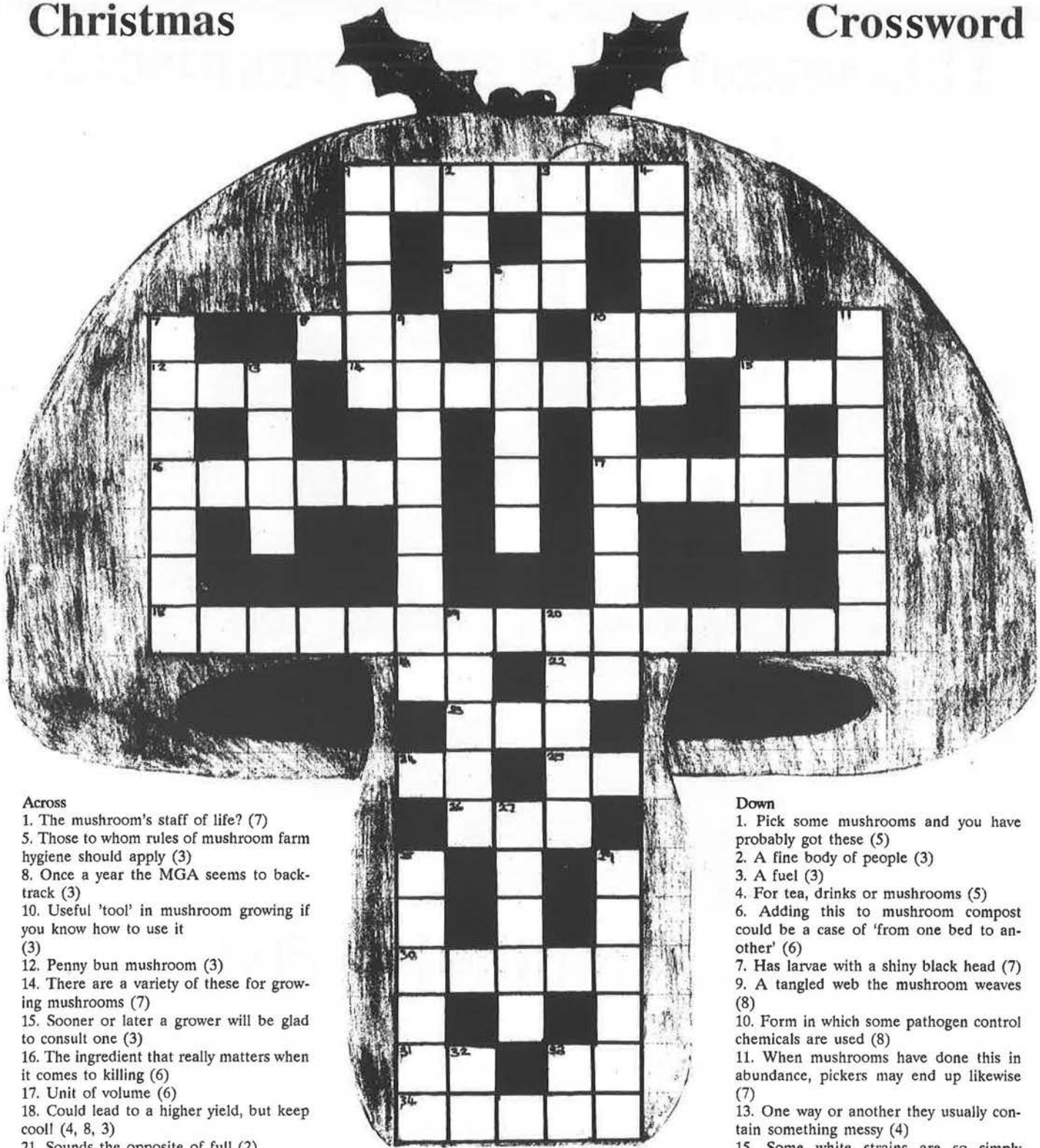

Across

1. The mushroom's staff of life? (7)
5. Those to whom rules of mushroom farm hygiene should apply (3)
8. Once a year the MGA seems to backtrack (3)
10. Useful 'tool' in mushroom growing if you know how to use it (3)
12. Penny bun mushroom (3)
14. There are a variety of these for growing mushrooms (7)
15. Sooner or later a grower will be glad to consult one (3)
16. The ingredient that really matters when it comes to killing (6)
17. Unit of volume (6)
18. Could lead to a higher yield, but keep cool! (4, 8, 3)
21. Sounds the opposite of full (2)
22. Measurement sounding like an important compost ingredient (2)
23. Brought together with Stateside connotations (3)
24. Group of insecticides (2)
25. Initially Agaricus bisporus (2)
26. Carries more weight in Brussels than in London? (3)
30. Well, hardly ever (5)
31. Somewhat wider than 23 across (2)
33. Symbolic element, essential for mushroom growth (2)
34. Known to increase in the telling (5)

Hope you enjoy doing the competition.

Correct answers in the next issue. **Peter Flegg**

Down

1. Pick some mushrooms and you have probably got these (5)
2. A fine body of people (3)
3. A fuel (3)
4. For tea, drinks or mushrooms (5)
6. Adding this to mushroom compost could be a case of 'from one bed to another' (6)
7. Has larvae with a shiny black head (7)
9. A tangled web the mushroom weaves (8)
10. Form in which some pathogen control chemicals are used (8)
11. When mushrooms have done this in abundance, pickers may end up likewise (7)
13. One way or another they usually contain something messy (4)
15. Some white strains are so simply named (4)
19. A mushroom stands or falls by this (5)
20. Blotch may make growers want to do this to their mushrooms (5)
27. Mushrooms this colour are no cause to celebrate with 'bubbly' (5)
28. Cognomen of international diarist (6)
29. Made up of many hyphae with like directional intent (6)
32. Multilingual source of information on mushrooms (2)
33. A smaller and shorter part of 17 across (2)

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Sinden Award Nominations

Members are invited by the Sinden Award Committee to send to the MGA Secretariat names of those they think should be considered for the Award this year.

The Award is made each year to someone who has made an outstanding and practical contribution to the British Mushroom Industry in research, development or advisory work, at research institutes, universities, the advisory service or in the industry.

Please send your nominations for the Award before 31st January, 1989, accompanied by the reasons for your choice (not more than 100 words please). Nominations will be kept in force for a total of three years.

Please take a few moments to let us know who you think should receive the accolade of the industry's most prestigious award. Please see inside back cover for nomination form.

Sinden Award Winners.

1976	**F.C. Atkins**, OBE. (Deceased)	1982	**P.J. Vedder.**
1977	**N.W. Hussey**, OBE, BSc, PhD, FIBiol.	1983	**H.J. Tschierpe**, PhD.
1978	**R.L. Edwards**, BSc, PhD, CChem, FRSC, MIBiol.	1984	**J.T. Fletcher**, BSc, PhD.
		1985	**G. Fritsche**, PhD.
1979	**W.A. Hayes**, BSc, PhD, NDD, MIBiol.	1986	**Peter Stanley-Evans**
1980	**L. Jacobs**, BSc, MSc, PhD, MIBiol.	1987	**T.F. Figgis**, BSc. (Deceased)
1981	**P.B. Flegg**, BSc,CChem, MRSC, FIBiol.	1988	**John A. Peaker**

MGA News Roundup

- The Research and Development Committee met in November, at Wrest Park, Silsoe, the home of the Institute of Engineering Research Station. One of our members,Ray Samp, who I know will not mind if I call him "The American at Blue Prince", looked out over the magnificent gardens leading down to the lake and the elaborate decorations and paintings within the mansion where our meeting was being held, and was heard to comment "gee, can this really be a Government research station"? All I can say is that it was within these surroundings that the R & D Committee made the recommendation to the Executive on R & D funding which I have commented on in my Director's Notes.
- On the 2nd and 3rd of November, 40 participants visited the Kuhn Farm Indoor Composting Plant in Basel, Switzerland. This will be reported in a later issue together with a technical report from Richard Gaze of ADAS.
- On the 15th of November, 1988, the SEII area met in Beaconsfield, Bucks, chaired jointly by Norman and Chris House. Paul Perrin from ADAS was in attendance and gave a report on the indoor composting plant in Switzerland.
- A new area has been set up in Scotland and the first formal meeting will be on the 2nd of December, in Edinburgh.

Diary Dates 1989

10th-12th January -BGLA Exhibition, NEC Birmingham.

21st March - Annual General Meeting, Stratford Upon Avon

14th-15th April -HERE Exhibition, and Conference Centre, Livingston, Edinburgh

5th-7th May - British Food and Farming 1989, Hyde Park Exhibition, Hyde Park. London

9th-11th May - 2nd International Fresh Produce Fair, NEC, Birmingham

19th-22nd May - Tecno-Mico Exhibition Verona, Italy

16th-19th July - 8th North American Conference Calgary, Alberta

27th-29th September - MGA Annual Conference, Viking Hotel, York.

6th-7th October - HERE Exhibition, Concorde Sports Centre, Sheffield.

6th-10th Nov - ISMS International Symposium on Mushroom Biotechnology, Nanjing, China

LOOK

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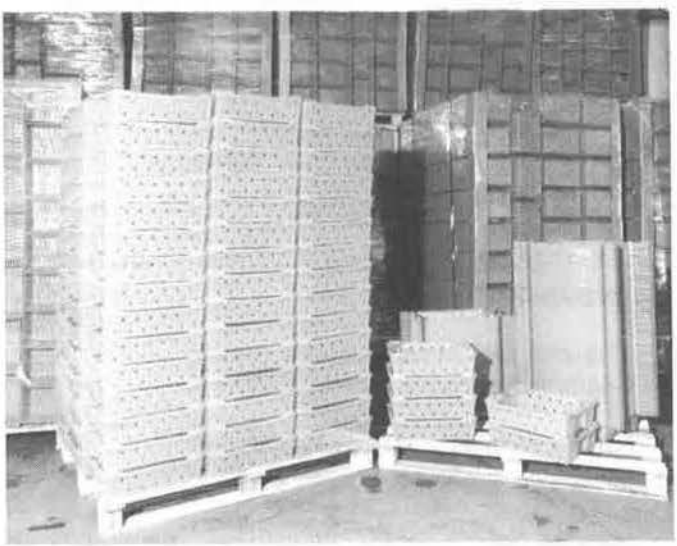

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Book Review

'Mushroom Wife' or 'Mushroom Mum'

by **Geoff Ganney**

I've enjoyed sitting around the tea table at 'Winterpick' discussing mushrooms on so many occasions in the late 1960s. Joan Barton as a mushroom mum has been hiding her talents as a writer. The biographical account of establishing a successful business, albeit mushroom production, in the trying years following the last war makes compulsive reading. Hardship, interspersed with humour and Joan's reflections on her deep-rooted religion, embodies a true continuing family effort to build, maintain and develop their mushroom business.

At times bankruptcy faced the Barton family, early on when massive eelworm infestation was only cured by spending the last £100 on a steam boiler. Then the European epidemic of what was later found out to be virus in the mid 1960s, followed by massive *Verticillium* problems in the mid 1970s. This at a time when the company had recently expanded and financial strains allowed little leeway for mushroom disease outbreaks. Joan's clear description of how Hugh decided to control the problem by individual hand control starting at 5 am every morning typifies the man's determination. 'The first month's work nearly killed him, as he examined every mushroom *in situ* - and usually threw away half of them - but he was on the right track and slowly he realised the incidence of *Verticillium* was decreasing'.

Such incidents clearly indicate how hard the gaining of knowledge was in those early days and why the importance of the MGA with it's contact with other members is continually referred to. Research has always been seen as so important by the Winterpick growers and the reflection of hard won battles in the early years highlights why. The honour of Hugh becoming Chairman of the MGA in 1974 and later Treasurer, to Joan and the Barton family is touchingly covered in two chapters. But more than this, the importance of the MGA and Hugh's dedication to its causes is felt throughout the book.

Many reading the early chapters will reflect on their own degrees of hardship in building up a business such as mushroom growing in the pioneering days. Joan's account of raising a large family while selling mushrooms to London day trippers outside the 'Black Swan' at Pease Pottage late into the evening, only to be up early picking the next day, reflected the happiness of effort. How many children today would revel in Christmas presents of brand new 'Welligogs'! or having a shilling to spend at the local jumble sale?

Sadness arrived in 1956. 'This year decided to hit the family hard. One after the other three of the children succumbed to polio - the dreaded polio - and for three months we lived a nightmare we've never forgotten'. Joan's religious dedication was of such great importance during these harrowing times, her chapters on 'Logic and Religion' are deeply thought provoking, being an important part of daily life based on a family following of true Christian belief. As is the influence of many, many friends and mushroom people who all in their own way had a part to play in the development of Winterpick mushrooms over forty years. Relationships to staff are best summarised in the opening verse of the 'Cobbins' singers at the 1970 Christmas party.

Dear Mr Barton
What shall we do?
The Elsan's overflowing
And we want to use the loo
Ernie cannot empty it;
His cesspit's full right up.
Oh, Mr Barton, you had better hurry up.

Expansion came through 'Cobbins' a small traditional farm and Henfield a green field site where the theme of quality was developed by building a most modern crop preparation area designed to feed cased trays back to the Winterpick farm. One of Beeching's closures resulted in a railway tunnel venture which coupled with 'grow your own kits' was to be short lived. But continued enthusiasm for developing the business with the boys now firmly in control, resulted in the purchase of Firsland's, a large poultry farm, next to the Henfield site. Joan points out 'it took all our money' but would allow development for the future. Expansion, of course, brought other problems, perhaps unexpected, in the form of a law suit against compost smell that resulted in a guilty, proven case, but as Hugh points out, his company has a licence to smell!;

Joan's sense of humour is brought out in many parts of her book but none more than when the, 'Mushram' broke loose and chased picker Dot around the farm! A subtle quip, quickly picked up, from the forklift driver, 'You on heat then Dot?' summed up what must have been an hilarious event.

Being less involved in a business now firmly being guided by the younger Bartons, has allowed time to travel the world. When not missing aircraft, Joan and Hugh met up with many mushroom growing friends in various parts of the globe, which is one of the satisfying aspects of this industry. A far cry from the beginning when Joan was making motor cycles jump over hedges, being wooed with cocoa and cheese sandwiches or double de-clutching huge lorries along unsuitable roads.

The courage found in Joan and Hugh Barton that is simple to say 'was in creating Winterpick' but is much, much more with dedication to family, friends, employees and the mushroom industry.

'Mushroom Wife' by Joan Barton is available at a cost of £7. direct from

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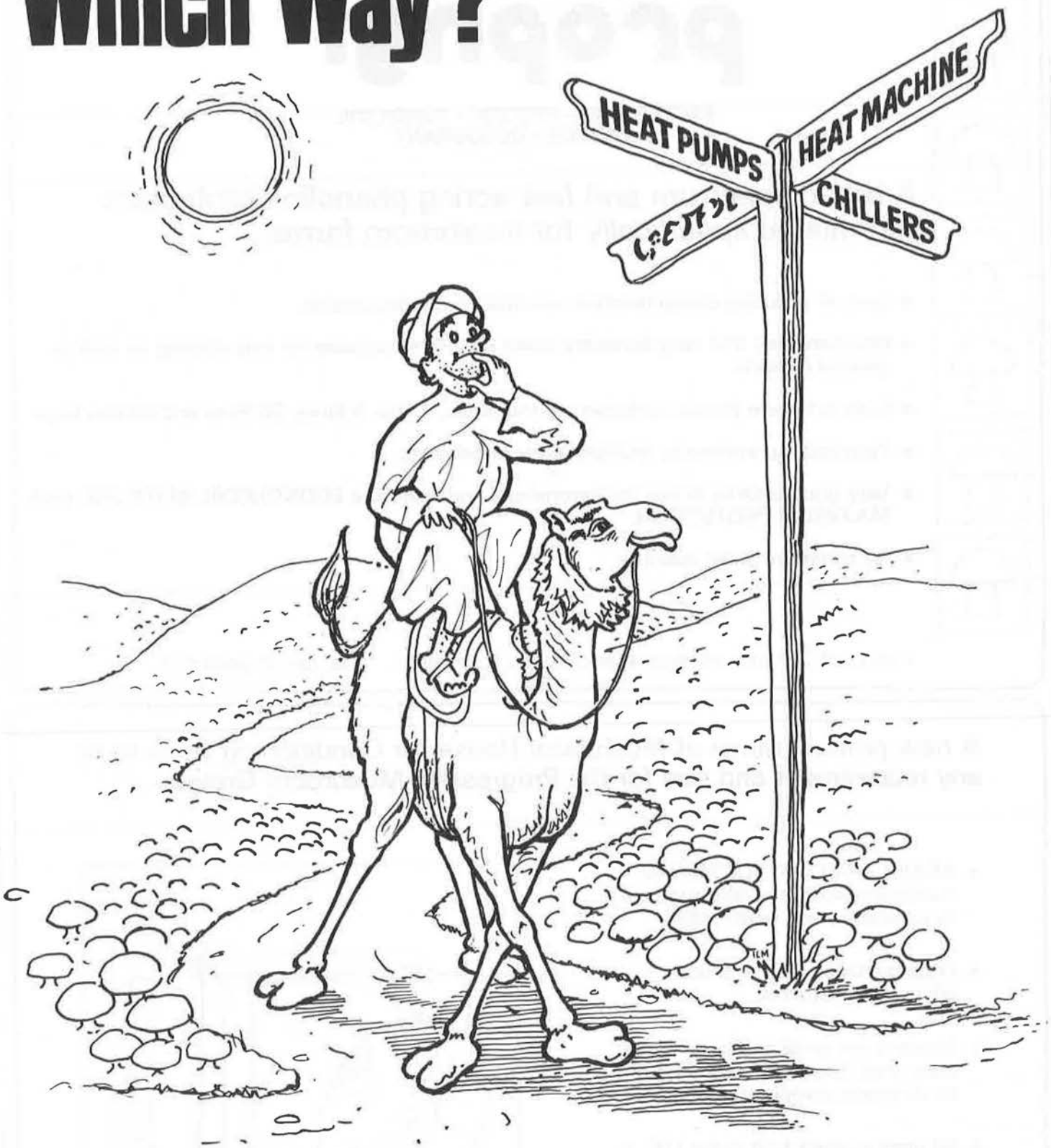

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Odours arising from mushroom composting: a review

by Frederick C. Miller and Barry J. Macauley, La Trobe University, Bundoora, Australia

The preparation of a substrate through composting is critical to the cultivation of the common commercial mushroom, *Agaricus bisporus*. Composting is normally carried out in 2 phases: Phase 1 is characterised by rapid decomposition in large outdoor stacks for 7-10 days, and Phase 2 entails pasteurisation and conditioning indoors under controlled conditions for an additional 7-10 days. Modern composting practice is still quite similar to that recommended 35 years ago by Sinden and Hauser (1953). Phase 1 composting can become a source of air pollution and nuisance odours. Currently, with the expansion of composting facilities, and with suburban populations infiltrating formerly rural enclaves, more people are being affected. In recent years, composting odours are becoming less tolerated by the general public (Anon. 1986). Odour is a serious problem facing composting operations, in that odours may necessitate investment in expensive facilities for odour containment and treatment, or may lead to site closure (Finstein *et al.* 1986). Preventing odour production through modifying processing conditions is likely to be compatible with the production of a good mushroom compost. There is no evidence of a link between the occurrence of environmental conditions leading to strong odours during composting and the subsequent growth of mushrooms.

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AJEA. PO Box 89,
East Melbourne
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Australia

Odour production in mushroom composting has not previously been reviewed as a problem amenable to ecosystem management. Presented herein is a review on odours arising from composting and related systems, with special application to mushroom composting odour problems.

Factors related to composting odours

Nature of composting odours

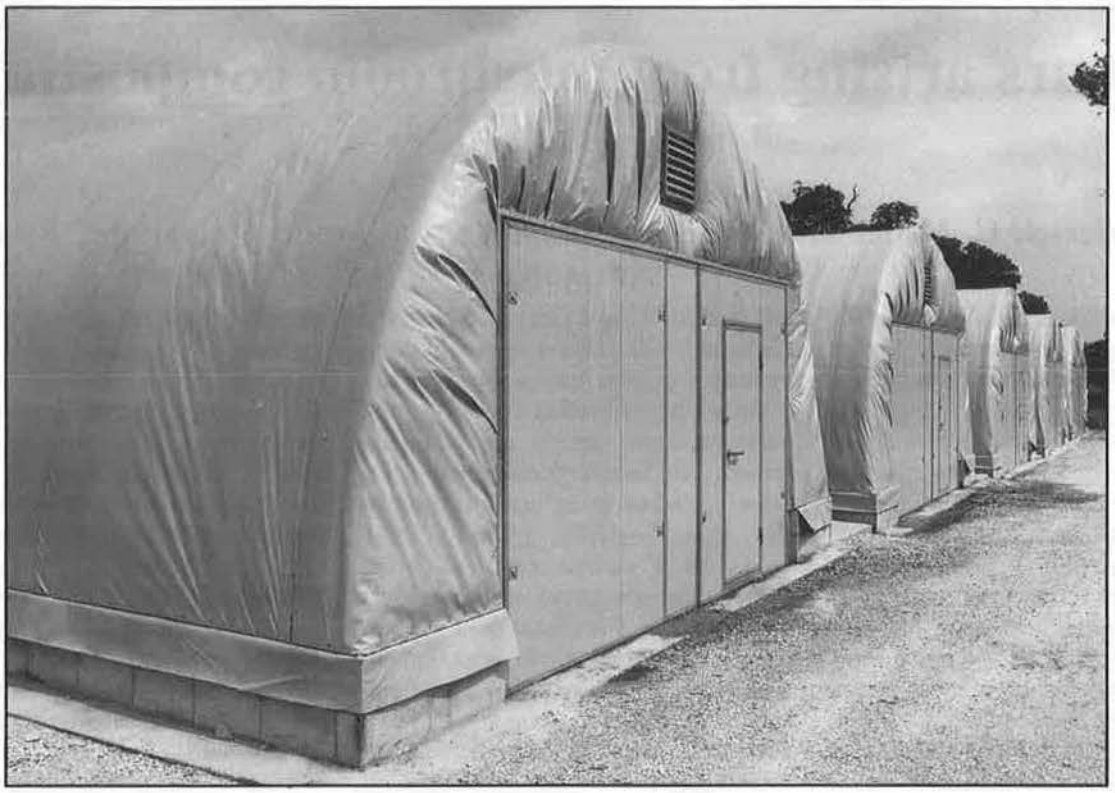
Odours are caused by the loss of organic and inorganic compounds during the composting process. These odours normally are produced through the decomposition of organic matter and are not pre-existing in the substrate; odours are a result of processing. Odours can be particulate (i.e. aerosol) in nature, as was dem-

Table 1. Some compounds implicated in composting odours, and their characteristics.

Compound	Formula	Boiling point (°C)[A]	Solubility in water[A]	Characteristic odour	Threshold odour[B] (*n*L/L)
Ethanal	CH_3CHO	20.8	Soluble	Pungent	2
Butanoic acid	$CH_3CH_2CH_2COOH$	164	Soluble	Rancid	0.28
Ammonia	NH_3	-33.4	90 g/100mL	Pungent	37
Trimethyl amine	$(CH_3)_3N$	2.9	Very	Pungent	4
3-methylindole	$C_6H_5C(CH_3)CHNH$	265	Soluble	Faecal	$7.5x10^{-5}$
Hydrogen sulphide	H_2S	-60.7	Soluble	Rotten egg	1.1
Carbon oxysulphide	COS	-50.2	50 mL/100 mL	Pungent	
Dimethyl sulphide	CH_3SCH_3	37.3	Insoluble	Foul	20
3=Dimethyl disulphide	CH_3SSCH_3	109.7	Insoluble	Foul	-
Diethyl sulphide	$CH_3CH_2SCH_2CH_3$	92.1	Slight	Foul	0.25
Methanethiol	CH_3SH	6.2	Very slight	Decayed-cabbage	1.1
Ethanethiol	CH_3CH_2SH	35	Very slight	Decayed-cabbage	0.016
1-Propanethiol	$CH_3CH_2CH_2SH$	67	Slight	Unpleasant	0.075
1-Butanethiol	$CH_3CH_2CH_2CH_2SH$	98.5	Slight	Skunk like	1.4

[A]Data are from CRC Handbook (Weast 1971).

The All Purpose Growing House



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onstrated by Hammond *et al.* (1977) in a study where pigsty odours were removed from air solely through filtration. Composting odours, however, are primarily vaporous, as the wet nature of the composting mass traps particles. Evidence that composting odours are vaporous is an observation that filtering exhaust air from ventilated composting systems is not effective (Murray and Thompson 1986).

Table 1 lists some specific compounds reported to cause odour problems. These compounds have been specifically identified from composting masses, or similar systems (Summer 1971; Francis *et al.* 1975; Lynch *et al.* 1980; Stevenson 1982; Overcash *et al.* 1983; Murray and Thompson 1986; Terasawa *et al.* 1986). It is often difficult to identify individual components of an odour by olfaction. Mixing various compounds can modify the perception of individual characteristic odours, creating unique new smells (Summer 1971). Ammonia is an especially severe problem because of the large amounts which can be released during composting. In a large Dutch facility, 2 kg of ammonia was found to be lost for every tonne (wet weight) of material composted (J.P.G. Gerrits; personal communication). Of special interest in Table 1 are the sulphide and thiol (mercaptan) compounds. In general these compounds are characterised by unpleasant smells at very low odour thresholds.

Precursors to odoriferous compounds in composting

Mushroom composts are prepared from several ingredients. Composts are usually based on horse manure (in the form of stable bedding) and/or cereal straws, such as wheaten straw. These materials are generally low in protein, containing about 0.5% nitrogen per dry weight for straw, and 0.8-1.0% nitrogen for light and heavy horse manures (Fermor *et al.* 1985). Composts containing no horse manure are known in the mushroom industry as 'synthetics'. In mushroom composting, other materials, called 'activators', are always added to increase the nitrogen content and provide readily available substrate to foster the decomposition of the relatively resistant straw, Nitrogen supplementation is also necessary to produce a finished compost that will contain approximately 2% total nitrogen, which is needed to produce good mushroom yields. Activators usually average 3-6% total nitrogen, and can comprise 20-35% of the compost dry mass in different recipes (Gerrits 1977a; Fermor *et al. 1985).* Activators added to increase nitrogen contents include chicken manure, brewers' grain, dried blood, sewage sludge, urea, and various meals, such as cotton seed or soybean meal. Similar amino acid concentrations are in poultry manure, and in oilseed meals, such as cotton, sunflower, or soybean meal (Bodwell and Hopkins 1985).

Wheaten straw is composed approximately of cellulose (40%), hemicellulose (20-35%), lignin (12-20%), and protein (4%), with ash and other materials making up the remainder (Lynch 1979; Ramasamy and Verachtert 1979; Kaul *et al.* 1981; Wood and Fermor 1981). Microbial degradation of straw under anaerobic conditions forms as products acetic acid and smaller amounts of propanoic and butanoic acids (Lynch *et al.* 1980). These acids along with other C_1 to C_6 related organic acids are classed as volatile fatty acids (Greenberg *et al.* 1985), are characterised by rancid smells, and are commonly formed during the anaerobic decomposition of carbohydrates (Kaplovsky 1951).

Gypsum ($CaSO_4.2H_2O$) is added to composts as a source of calcium to aid in the flocculation of colloids (Fermor *et al.* 1985). Gypsum also lowers pH, which reduces the loss of ammonia (Gerrits 1977b). The sulphate component may also benefit mushroom production for reasons yet unexplained. Gypsum is added to compost mixtures in large amounts, often as high as 8% of the starting mixture's dry mass (Gerrits 1977b). Sulphur in the stable sulphate form is not likely to be affected under aerobic conditions but can be readily reduced as a terminal electron acceptor under anaerobic conditions to form hydrogen sulphide. Microorganisms are almost exclusively responsible for the reduction of sulphate to sulphide, and sulphate reducers as a group can tolerate a wide variation of environmental conditions including temperature and salinity (Zinder and Brock I978).

Chicken manure is by far the most used activator in mushroom composting worldwide, including Australia (Allan and Nair 1985; Fermor *et al.* 1985), and because of its significance as a source of organic nitrogen and organic sulphur, its composition warrants a detailed consideration. Overcash *et al.* (1983)in summarising information on the protein content of 25.6% (a range of 12.5-42.5%; 19 reports) and average true protein contents of 19.4% (a range of 12-39%; 14 reports). The data of Overcash *et al.* (1983) show that practically all of the nitrogen in poultry manure is in the form of protein. Allan and Nair (1985) analysed various Australian chicken broiler manure samples for nitrogen content. Multiplying their nitrogen data by 6.25 gave average crude protein contents of 23.3% (range of 8.6-31.9%; 31 samples) for single batch broiler manure and 20% (range of 13.3-25.9%; 9 samples) for multiple batch broiler manure. While the Australian chicken manures studied by Allan and Nair (1985) are similar to the pri-

Table 2. Concentrations (% w/w, dry matter) of cystine and methionine in poultry manure as summariesed from data compiled by Overcash *et al.* (1983)

	No. of reports	Mean	Range
Raw and dried poultry manure			
Cystine	14	0.361	0.02-1.479
Methionine	18	0.231	0.09-0.671
Poultry litter waste			
Cystine	4	0.130	0.09-0.14
Methionine	5	0.372	0.12-1.12

Amino acid concentrations are expressed as percentage of total dry solids

marily American chicken manures summarised by Overcash *et al.* (1983), the individual variations between samples are considerable. Of special importance in the protein fraction of chicken manure are the sulphur-containing amino acids. Table 2 summarises results compiled from various sources by Overcash *et al.* (1983), and shows that concentrations of cystine and methionine can be fairly high. The volatilisation of organic nitrogen and organic sulphur compounds during the decomposition of amino acids, particularly methionine, under various environmental conditions, is also well established (Freney and Stevenson 1966; Lewis and Papavizas 1970; Francis *et al.* 1975; Banwart and Bremner 1975; Banwart and Bremner 1976; Farwell *et al.* 1979). If it is assumed that chicken manure contains approximately 20% protein and of the total manure protein approximately 1.2% is cystine and 1.5% is methionine, then 1 t of chicken manure could contain 3 kg of methionine. If just 1% of the sulfur in this 3 kg of methionine were converted into methanethiol it could contaminate 5000 m^3 of air to the odour threshold (refer to Table 1). In experiments reported by Banwart and Bremner (1975) where methionine was microbially degraded in soil systems under aerobic conditions, 15- 50% of methionine sulphur was recovered as volatile sulphur compounds within a 40-day incubation period. Although cystine can also be a precursor of volatile sulphur compounds, Banwart and Bremner (I975) found that the potential for cystine to become a precursor of volatile sulphur compounds was at least 10 times less than that of methionine.

Dynamic biological and chemical reactions can rapidly inter-convert nutrients into another forms, depending on environmental conditions. Precursors of odoriferous compounds might be formed during the composting process. Even in aerobic systems sulphate can be reduced and readily taken up in situations where organic sulphur is limiting (Bruggemann and Giesecke 1967). Some farms add nitrogen in the form of urea or ammonium salts. That urea and ammonia can he rapidly converted into organic nitrogen, or vice-versa, can be inferred from studies of microbial converting capabilities (Bruggemann and Giesecke 1967; Henderickx 1967: Kelly and Stevenson 1985), and the extremely high rates of metabolic activity that can occur in composting ecosystems (Miller 1984). It has also been well established that various aerobic or facultative anaerobic bacteria can readily convert inorganic nitrogen and sulphur into sulphur-containing amino acids (Freney and Stevenson 1966; Jones 1967).

Fate of odoriferous compounds

Once formed, the compounds which cause composting odour problems can be subject to a wide range of fates. Odour dispersion and intensity depend on the odourous chemical escaping into and persisting in the atmosphere. Fates can include a combination of capture onto physical phases or solution into aqueous phases, and further biological, chemical or physical reaction.

Generally, simple organic acids are quickly metabolised to CO_2 under aerobic conditions, or more slowly converted to methane under anaerobic conditions. These compounds are not significant air pollutants except for their odour potential, and their odour potential, and their atmospheric fates have not been characterised. It can be assumed that, because of their high solubility in water and ready biodegradability, simple organic acids are rapidly removed from the atmosphere. Ammonia has an atmospheric residence time of 7 days, and tends to react with many other gaseous pollutants (Urone 1976). Natural biological emission of ammonia is so great that the amount released by industrial activity is inconsequential (Urone 1976). Once released into the air, diffusion or precipitation are the only significant factors affecting the odour potential of the volatile organic acids and ammonia.

Most of the volatile sulphur compounds implicated in odours (Table 1) have low boiling points, concomitant high vapour pressures, are slightly soluble to insoluble in water, and are very chemically reactive. Volatile sulphur compounds can be subject to various chemical reactions with free radicals and oxygen, which can be rapid enough to affect their odour potential. For example, the estimated atmospheric lifetime of hydrogen sulphide is 1 day, while for methanethiol it is only 0.2 days (Urone and Schroeder 1978). In a compost stack, hydrogen sulphide can be oxidised so rapidly upon contact with aerobic stack areas that elemental sulphur will be precipitated at the interface of anaerobic and aerobic zones (Eiker 1981). Gaseous concentrations of hydrogen sulphide decrease precipitously upon reaching aerobic stack areas, with no hydrogen sulphide being present in stack areas that contain more than 2% oxygen even though nearby anaerobic stack areas contain over 5% hydrogen sulphide (F.C. Miller and B.J. Macauley, unpublished data). Thiols and organic sulphides also spontaneously react with oxygen, at rates which fairly rapidly remove them from the atmosphere (Urone and Schroeder 1978)

Ecological factors affecting odour production

While some compounds can yield odoriferous products, other environmental factors determine the extent of the expression of this odour potential. Physical size of composting heaps or stacks, water content , and frequency of turning, tend to affect stack temperature and oxygen availability and subsequent odour production. Because of surface area to volume relationships, smaller stacks should be cooler and more aerobic owing to greater heat loss and improved oxygen diffusion. Substrate density is an important factor which expresses the amount of food energy available per unit volume; both chemical composition and physical compaction are factors. Substrate density can simultaneously affect oxygen availability, heat transfer, and effectiveness of microbial colonisation. Even biosynthisis of new products will have effects, e.g. quinones tend to react strongly with thiols preventing their release as volatiles (Stevenson 1982). Biomass size and activity area also important factors. Many odorous compounds can be utilised as substrates and thereby destroyed by a receptive biomass. The products formed by a composting system can be viewed as the historical outcome of physical fac-

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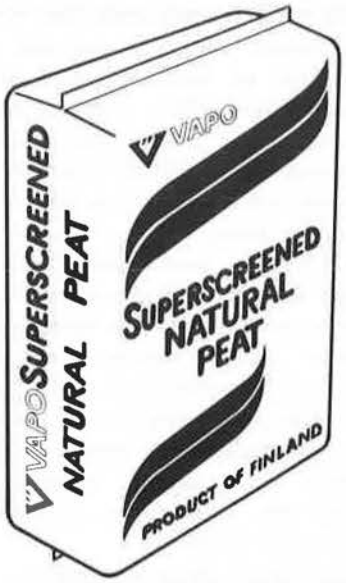

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tors, as these factors select for the responsible microbial ecosystem and induce concomitant chemical reactions.

Common to mushroom composting is production of compost temperatures in excess of 70°C (Fermor *et al.* 1985). Because of the very low thermal conductivity of the composting matrix (estimated to be <0.5 W/m.°C; Holman 1981; Miller 1984), composting temperatures should reach about 80°C in the presence of sufficient oxygen. This temperature represents the maximum that can be achieved by biological self-heating (Nell and Wiechers 1978), and is achieved semi-independently of the rate of conductive heat loss from large composting masses. The failure of temperatures to exceed 80°C in a composting mass also indicates an absence of significant chemical self-heating (Nell and Wiechers 1978).

As temperature increases, the volatility of odorous compounds increases, while the solubility of these compounds in water decreases. Solubility of oxygen in water also decreases with increasing temperature. Temperatures in excess of 60°C in sewage sludge composting have led to greater odour problems than when lower temperatures (<60°C) have been maintained (MacGregor *et al.* 1981). As both microbial species diversity (Strom 1985) and biomass, as reflected by activity (Miller 1984), are reduced with temperatures above 60°C, net losses of volatile nutrients should occur with increasing temperature. Populations which could immobilise nutrients would be reduced by thermal kill. Burrows (1951) found that losses of nitrogen as ammonia were reduced when composting temperatures were kept below 60°C. Belkin *et al.* (1985) demonstrated that a non-biological sulphur reduction occurred above 80°C in anaerobic systems, with rates increasing with increasing temperature and pH, and that non-biological sulphur reduction was partially dependent on the presence of an organic substrate. They found that, even at 75°C, sulphides were produced within 48 h of incubation.

Oxygen availability will largely determine what reactions might occur and whether the products of chemical and biological decomposition will tend to be oxidised or reduced. Oxygen availability is itself a complex parameter since in a composting matrix, gradations of oxygen exist, not only in different zones, but between the cores and outer surfaces of particles, and oxygen diffusion into particles is as important as macropore oxygen concentration (Miller 1984). Macropore space is the void space between particles or aggregates, while microspore space is the void space within particles or aggregates. Additionally, oxygen availability within a composting mass is a function of the rate of oxygen utilisation. When other environmental conditions limit activity, interstitial oxygen concentrations can remain high because of a lack of biological activity using oxygen (Miller *et al.* 1983). Oxygen availability can also determine the different types and concentrations of volatile sulphur compounds that can be produced through decomposition (DeLaune *et al.* 1981; Beard and Guenzi 1983). Waterlogged systems with poor oxygen exchange release more volatile sulphur compounds than do systems with good oxygen exchange (Banwart and Bremmer 1976).

It is axiomatic that elements tend to be conserved in ecosystems in specific proportions (Atlas and Bartha 1987). Generally, the C:N:S ratio in stable organic fractions, such as humus, is approximately 100:7:1 (Stevenson 1982). In poultry manure the C:N:S ratio can be 100:18:2 (Banwart and Bremner 1975). If activators such as poultry manure are applied in excess, nitrogen and sulphur will become mobilised. Banwart and Bremner (1975) reported that, during decomposition, poultry manure had a significantly higher loss of volatile sulphur than did 7 other animal manures that they studied with higher C:S ratios. Whether a substrate nutrient is available to excess or deficit, however, depends not just on the total amount, but also the form of the nutrient. Reinersten *et al.* (1984) found that the initial decomposition of wheaten straw was not limited by nitrogen when nitrogen concentration was 1.13-0.79% because most of the carbon was unavailable; the ratio of nutritionally available carbon to nitrogen was maintained at 10:1. Summarising earlier work, Gerrits (1977a) concluded that if the initial nitrogen content in a mushroom compost was lower than 1.5% the final nitrogen content would increase during Phase 1, but if it was higher it would decrease during Phase 1. The more surplus nitrogen, the more nitrogen would be lost directly as ammonia. This was true for stable bedding and synthetic composts.

Factors related to substrate availability can induce physical changes within the composting matrix that can in turn be selective. Wheaten straw is composed primarily of complex carbohydrate which is not readily available for microbial nutrition. In contrast, composting activators are concentrations of readily available substrates in the forms of proteins, fats and carbohydrates. Increasing the amounts of activators in a composting mixture will increase the available nutrition and thereby stimulate metabolic activity, increasing the likelihood of oxygen limitation or, alternatively, excessive temperature achievement. Other types of effects can be pH changes due to ammonia release, or drying of the compost as a consequence of metabolic heat output.

Finally, the biomass itself can sequester and thereby form a substantial store of nutrients. Under optimal conditions, a large biomass can be maintained which can take up and immobilise a large amount of nutrients. Additionally, the assimilation efficiency of different classes of microorganisms will affect nutrient fate. Fungi can assimilate 30-40% of carbon metabolised, while aerobic bacteria assimilate 5-10% and anaerobic bacteria only 2-5% (Alexander 1977). Temperature can greatly affect the species diversity of the microbial community (Strom 1985) which, in turn, can affect the nutritional requirements of the overall community (Alexander 1977). If environmental conditions change from optimal to distinctly suboptimal, the amount of viable microbial biomass will decrease. Suboptimal conditions would be an environment too hot, too dry, anaerobic, or of unfavourable pH, or nutrients depleted

or imbalanced, or the accumulation of toxic products. With a decrease in the total biomass, nutrients that were immobilised within cells would be released back into the environment (Stevenson 1986); these nutrients could then contribute to odours.

Reduction of odours

Many odours blamed on composting are not due to composting as such. At many facilities, material storage, waste water management, and other activities associated with composting can cause significant odour problems, but are not composting odour problems *per se*. Addressing the actual sources of odours at a composting facility should be the first step in solving odour problems.

A salient issue in the control of composting odours is odour treatment versus odour prevention. The solution of specific odour problems may be best addressed by odour treatment, prevention, or a combination of both. Odour treatment and odour prevention are conceptually dissimilar approaches which lead to different consequences. Odour treatment is primarily a physical/ chemical approach which requires the removal of odoriferous compounds through the use of various types of air scrubbers, static filters, or biofilters. Odour prevention is a biological approach to process control which avoids creating odoriferous compounds, achieved through judicious use of nutrients in the initial starting mixture, and/or controlling the ecological conditions under which the composting occurs. From an engineering viewpoint odour treatment is attractive, in that familiar chemistry and engineering practice can be employed, based on a pre-existing, well-established body of information. Solubility, vapour pressure, reactivity, and related information can be used to evaluate the effectiveness of different alternative standard physical/chemical treatment processes. From a scientific viewpoint, odour prevention is attractive because prevention can be incorporated into other fundamental improvements of the composting process. Odour prevention is fraught with a greater degree of uncertainty than treatment because it requires a biological solution, but ecological control also offers the possibility of a more elegant and economic solution to odour management. It has been proposed by Diaz (1987) that research on process control may be more beneficial than money spent on extensive application of odour control equipment.

Odour treatment

Odour treatment requires some control and containment of contaminated air, manifest as either trapping air through vacuum-induced ventilation or containment of the composting process. Some facilities use vacuum-induced ventilation of compost piles to contain odorous air for further treatment (Murray and Thompson 1986). Greater containment is offered by carrying out traditional composting inside of a building, and treating the very large air flow volumes required to maintain worker safety. High levels of containment are offered by in-vessel systems, in which composting occurs within reactor vessels. Completely contained in-vessel systems are becoming more commonplace in waste treatment composting because of the advantages they offer in process air containment and treatment options (Walker *et al.* 1986). Progressing from simple outdoor systems to in-vessel systems, capital costs escalate 5-10 fold, and flexibility of process control greatly decreases because of constraints on handling composting materials (Finstein *et al.* 1987).

Compounds that can be responsible for odour problems are not easy to treat owing to their high volatilities and, for many compounds, low solubilities in water (Table 1). These qualities limit the effectiveness of water spray units, or wetted filter systems. Chemical treatment improves odour removal; for example, Murray and Thompson (1986) treated exhaust air with a scrubbing system using a sulphuric acid scrubber to remove ammonia followed by a sodium hypochlorite stage for oxidising reduced sulphur compounds. Chemical scrubbing systems, using ozone, hypochlorite, or permanganate can be effective, but this type of treatment is expensive (Murray and Thompson 1986). Significant reduction in odours can be achieved through biofiltration (Van Der Hoek and Oosthoek 1985; Logsdon 1987), but this generally requires large filter areas and more sophisticated management. Trapped odorous compounds might still require further treatment before disposal, along with any treatment chemicals and their residues. An additional difficulty in treating odours is the corrosive effects of compounds such as ammonia: hydrogen sulphide, and organic acids, which can rapidly damage many common construction materials. Volatile sulphur compounds can rapidly deteriorate ferrous and non-ferrous metals, concrete, paints, and other materials (Nriagu 1978).

Odour prevention

Prevention strategies are primarily process management strategies, with all of the inherent difficulties of controlling a complex ecosystem. Constant vigil is required to maintain process control. Variations in initial materials could cause poor control of nutrient levels unless analytical work was carried out before composting. Controlling ecological conditions requires a more sophisticated understanding of composting, along with monitoring and process control equipment. A bonus of control strategies, however, is that mushroom yields can be improved through better process control, if the control of odours is developed in conjunction with producing a good compost.

Further research is required on the reduction of odours by developing processes and compost formulations that are compatible with producing a good compost for mushroom production. Given the complex and still somewhat obscure requirements of mushroom cultivation, it is hard to predict the effects of composting process changes on mushroom production. Optimum environmental conditions for mushroom composting have not been well established, mainly because of the difficulties of controlling the ecosystem, and the lack of related research.

Lower temperature achievement ($<60^{\circ}C$) in the composting process should reduce odours (MacGregor *et al.* 1981; Finstein *et al.* 1986). For example, at a sewage sludge composting facility in Sussex County, New Jersey, U.S.A., odour problems, once severe enough to cause the facility to suspend operations, were

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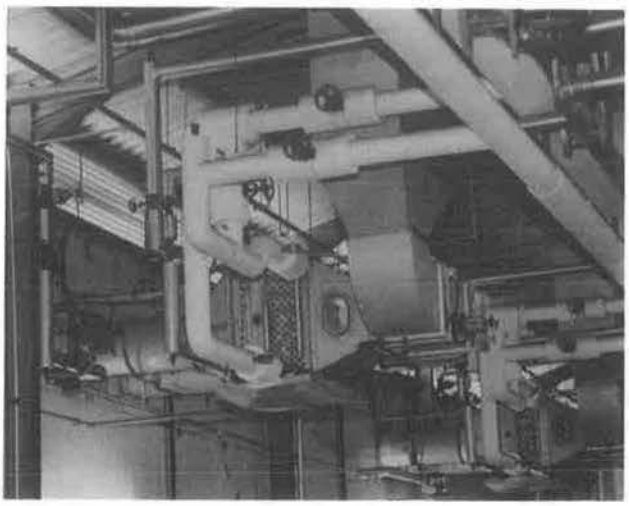

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economically controlled to levels publicly acceptable by modifying process control (Cerenzio 1987; Finstein *et al.* 1987). Ventilation, the rate of which was determined by a temperature feedback control system, was used to provide oxygen and to control temperatures (Finstein *et al.* 1985). By using ventilation to control temperature, well-oxygenated conditions were assured because it requires approximately 9 times more air to remove heat (at an exit temperature of 60°C) than to meet stoichiometric oxygen requirements (Finstein *et al.* 1986). By restricting temperature achievement to a ceiling of 60°C, rates of biological activity were greatly increased over previous operations, and odour emissions were greatly reduced.

Changes in compost formulation need to be considered within the context of process control, because the processing conditions affect the fate of the initial nutrients. Substrates that may reduce odours would have to be evaluated in relation to subsequent mushroom yield. Lowering of nitrogen and sulphur contents in the initial composting mixture should alleviate odour problems. Loss of organic nitrogen and sulphur compounds represents a loss of nutrients from the composting operation, and hence an economic loss to the grower as well as a nuisance to the neighbours.

Unlike the production of ammonia, sulphur reduction might be amenable to control of stack oxygen concentration. More aerobic stack conditions should reduce odours, especially those arising from hydrogen sulphides. More aerobic conditions, however, might not eliminate odours arising from thiols. Lowering the concentrations of sulphate might reduce odours, but would lower the activity of organisms using sulphate as an electron acceptor. The benefits of sulphate reduction is a moot issue. While subjecting the composting material to anaerobic conditions is common to many mushroom composting facilities, the avoidance of anaerobic conditions appears to be compatible with producing a good compost (T. Vestjens, of Gebr. Theeuwen Mestermenteerbedrijf b.v., personal communication).

Conclusion

Despite the problems, it is clear that a great degree of control over composting substrates (Gerrits 1977a; Fermor *et al.* 1985) and over process control is possible (Finstein *et al.* 1983; Miller 1984; Finstein *et al.* 1986; Gerrits 1987). With a better understanding of mushroom composting, this potential control can be used to solve odour problems within the economic constraints of mushroom farming.

Acknowledgments

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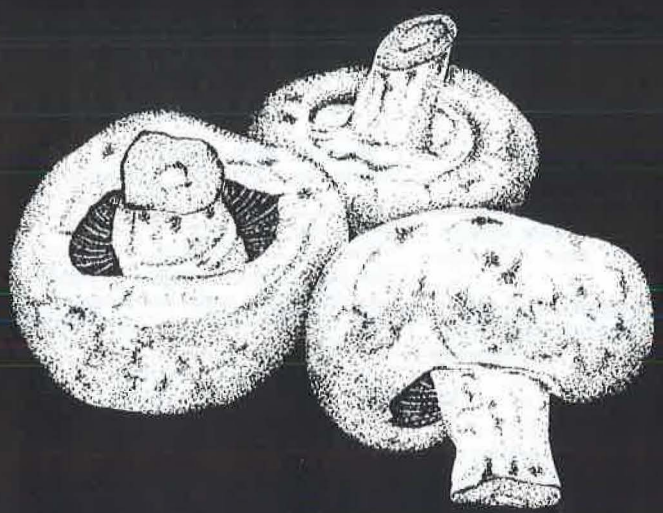

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Pesticides (Max. Residue Levels in Food) Regs.

These regulations come into operation on 31 December 1988 in respect of fruit and vegetables.

From 31 December 1988, it will be an offence to leave or cause to be left in any specified food a level of residue exceeding the maximum laid down by the regulations. These offences are unusual says the Produce Packing and Marketing Association. It was expected that the regulations would make it an offence to 'sell, possess for sale, expose for sale or offer for sale' in the manner usually employed in food law. The concept of 'leaving or causing to be left' does not appear in any other food legislation and its impact on traders at all stages in the distributive chain must be carefully considered.

The regulations also empower the Minister to seize, treat or dispose of any consignment of food, or any part of a consignment, where pesticides in excess of the maximum are found.

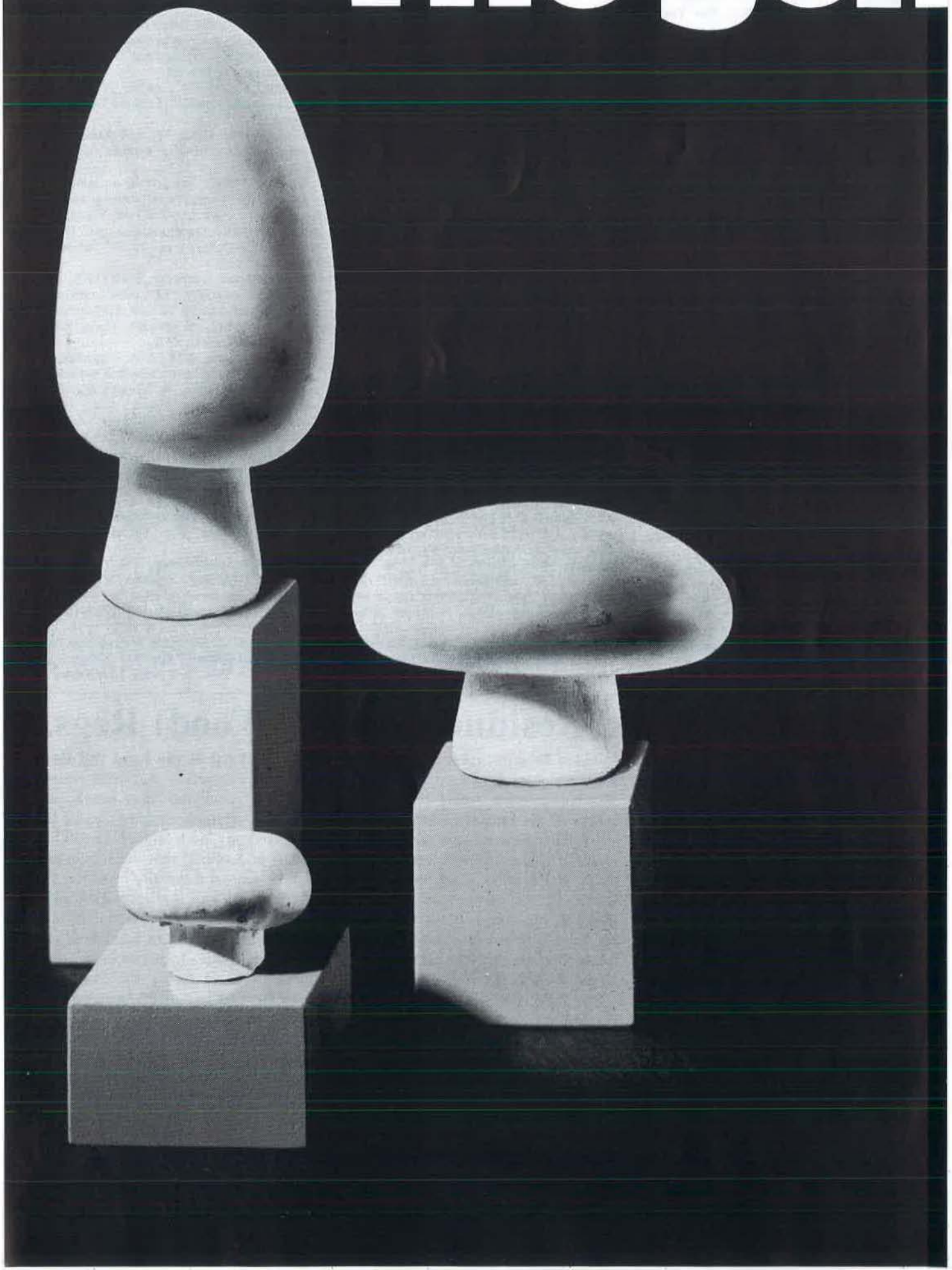
A further surprise says the PPMA is that the offence is restricted to pesticide which is 'in' food and not 'on' food. In the case of an apple, for example, the bulk of pesticide will be on the skin and only a small part may leach through the skin and be found in the flesh of the fruit.

The EEC Directives on which the regulations are based require Member States to exercise control over produce at all stages of distribution and refer throughout to residues which are 'in or on' the produce. The reason why this rather odd state of affairs has arisen is that the enabling powers for Ministers to make regulations in section 16(2) (k) of the Food and Environment Protection Act 1975 restrict them to specifying 'how much pesticide or pesticide residue may be left in any crop, food or feedingstuff.'

It is understood that the regulations will be enforced initially by officers of the Ministry and that local authorities will not be involved says the PPMA. It will still be open to local food and drugs authorities to prosecute for pesticide residues under the Food Act 1984 but that has always been possible and the new regulations do not change anything save for the fact that there are now legally prescribed maximum levels of pesticide residue.

The PPMA is of the view that the prosecution of anyone, other than the grower, for an offence against the regulations is "very unlikely indeed".

The gen



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GEOFF GANNEY'S

GROWING PAINS

1st November.

Had a dream about CACing! Coupled with CACASPing (casing at spawning with spawned casing) we were picking at day 4 from normal casing and production leapt by 60%! Unfortunately we could not harvest the crop or sell the excess production for any more money!!

Fineness of chalk giving rise to concern as it appears to be 'clogging' or is the word' 'clagging' up the pores in the sphagnum peat. Specific gravity is greatly enhanced. Breathing potential is greatly disenhanced. Areas that are distinctly anaerobic do not encourage the mycelium to grow and the question of 'casing selectivity' for rapid entry of mycelial growth has to be considered as another determined factor.

2nd November.

We had much debate on the need to clear first flushes completely to allow a more even and fast 'break back' for second flushes. 'It makes no difference was one thought'. 'It holds back the second break' implied another. 'But you could use it to stop the second break coming back too heavy', was yet another aspect of the subject. 'Well I think we get a bonus of large mushrooms that is additional to the second break', came out as the favourite opinion. Well what is the answer, if any? Surprisingly a couple of days after apparently clearing a flush, large mushrooms develop with the next flush underneath! But do you remove them at a smaller size, even though they are likely to be wet and peaty after heavy waterings, or do you let them grow out?

3rd November.

Discussing the European Collaboration Linkage of Agricultural and Industry through Research (ECLAIR) when two EEC partners join together with an industrial party (say MGA) and 50% funding of projects can be approved with community finance. Maybe some EEC partners have *enough Government funding* for their *mushroom research*? But is there an opportunity for the research committee to investigate this on behalf of UK producers.

4th November.

There must be concern about the further development of chemicals in relation to their use in the mushroom industry in the coming years. How for example will the future Sporgon's (a product used world wide in the mushroom industry) be developed. *Who will sponsor and who will investigate?*

Bonfire Night

Blank patches in first flushes reveal some evil looking compost and every indication of some eelworms being present. Wonder which came first, the bad compost or the eelworms?

Telephone call from our insurance brokers asking if we expected any fire claims in the near future.....

6th November.

Catfield Peak Heat fan collapsed breaking through the metal duct work so bringing down the control flaps and heater's batteries. Compost fell away to 42°C and for *some reason it didn't seem to convert very well!!* Having looked at the fan units rusting slowly away for years we should have guessed this might happen. Stainless steel must be a must to beat the rust.

7th November.

Q.C's report tells me mushroom stalks are not cut square! Second report informs me recruitment for pickers is slow! Another report says 'So what's new!'

8th November.

Checked through the selection of air thermometers we have been using and dismayed at the wide range against an accurate master thermometer. If they had been cheap types one could have anticipated that this would have been a possibility. 'Check when you install and regularly re-check'.

9th November.

Installed Fax machine for information accuracy between each farm, then no one can say they *'didn't know'.*

10th November.

Fax machine broke down!!

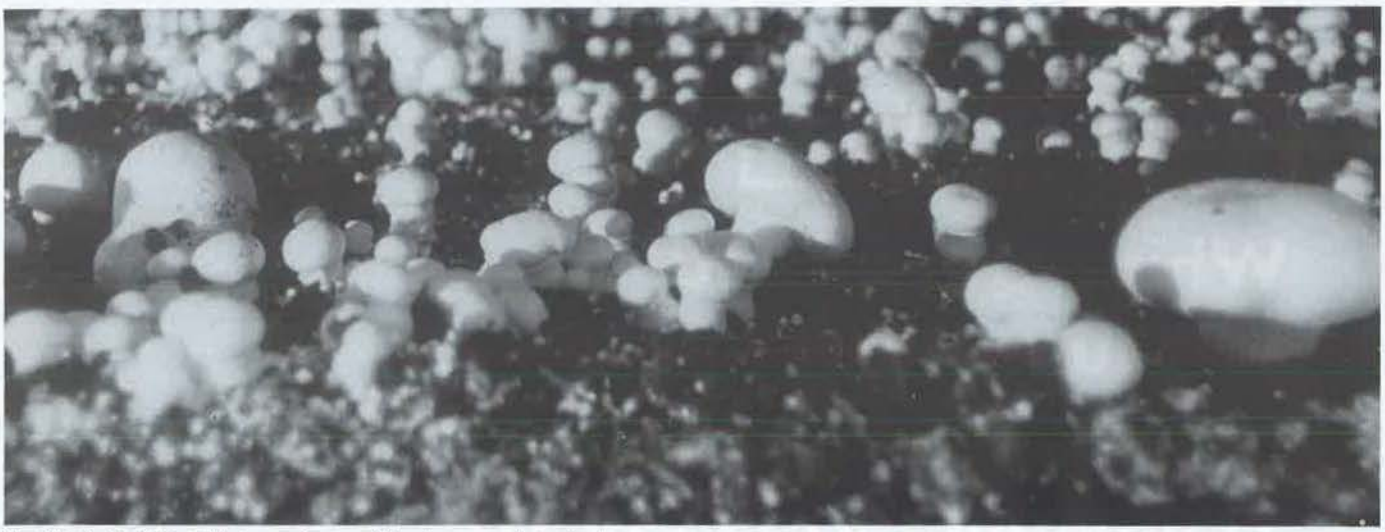

Fig 1 Tail End First Flush mushrooms 'To clear or not to clear'

11th November.

Environmentally in coming years the question of smells, chemicals or pollution will without doubt simply not be accepted from a mushroom production company. Often in this column reference has been made to establishing 'hygiene programmes' with minimal chemical usage and those that are used to be far less noxious. Suggestions of Ministry guidance in formulating such programmes for mushroom farms has drawn no response.

A very sobering experience is to take a series of black and white photographs looking from the outside into the premises called a "mushroom business'. Those unsavoury corners quickly catch the eye, as they do to the passers by! The camera does not lie and as an industry some more landscape application could be employed to good effect so lifting the image of the 'mushroom business'

12th November.

The most widely used bactericide is probably sodium hypochlorite, recommended for the treatment of bacterial blotch layers and Lambert 1955; Royse and Wuest 1980. It is rapidly inactivated and no adverse effects on mushrooms have been reported. However, this rapid inactivation is a factor which has caused variable results when used on blotched crops. (Note from *The Biology and Technology of the Cultivated Mushroom* page 275).

A note worthy of closer consideration particulary in the context of the last sentence!

13th November,

Converted some holding rooms back to growing sheds and the air movement is all over the place. Nothing like growing mushrooms to indicate air movement problems, that can not normally be measured. Now we know why they were not good holding rooms!!

14th November.

Delighted to see the new Director Ken James on the Yaxley farms and to discuss numerous topics from Sales to Advertising. His keenness, lively mind and elegance of debate will be a great asset to the Association introducing a different emphases to the MGA Director's role in the future development of the Industry.

15th November.

The yield effect of sciarid larvae feeding throughout the pin head formation area must be considerable. At Catfield, having regained control again with Dimilin after spending a fortune on organophosphorus materials, large fifth flushes are being produced. Previous to this we were hardly getting third breaks. Perhaps a count of the dead pinheads per square foot would reveal much.

16th November.

Prepared the first trial shed for casing with spawn run compost! (Cathal McCanna please note this!!) Carefully checked quality of fully run material, weights of compost, casing specific gravity, casing moisture and uniformity of application. Looks good, everyone is pleased and there is much discussion on how to water and what to look for.

Personal Note:- Hope they didn't mix up any brown spawn with the material for mixing into the casing. Also concerned over any mould spores around the farm, all this timber does not help. Think I will get some polythene sacks done up into the same shed just to check out quality on bag growing.

17th November.

Very lengthy Executive meeting! Seems more and more to discuss at each meeting, or is it just that some days more is said?

18th November.

I read constantly in the *'Grower'* Magazine of substantial Irish developments in mushroom production both North and South! Are these reports in line with the quality of the 'New Scientists' report suggesting RHM made profits from mushrooms? For instance the *'Grower'* says: SAFE marketing envisage about 100 new growing farms being set up, adding about £30 million a year to Northern Ireland's already expanding mushroom industry. (3rd November) Eire's largest mushroom concern, Monaghan Mushrooms is investing £11 million over the next 3 years in creating a 'Mushroom Village' to increase their 15% share of the U.K. market. (10th November). At the Kinsealy Conference an estimated 170 new growing sheds producing £7 million in mushroom value look destined for building in 1989. The Irish Minister for Horticulture predicted a doubling of the mushroom industry in

Fig 2 The camera does not lie!

The growing voice of opinion

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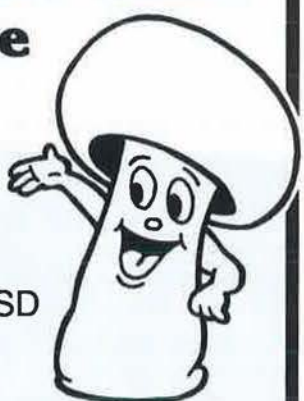

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Great British Mushroom Structures

next 3-4 years with the crop becoming as important to the economy as potatoes, wheat or sugar beet. (17th November) *Jim 4 new sheds is simply not enough!!*

19th November.

Second flush with many 'Saggy Sock' mushrooms and it looks as though the sudden surge of water has exploded the outer epidermis of the stipe.

20th November.

Reduced number of pre-wetting movements of the compost as the breakdown factor seems to have increased. Perhaps the new aerated pump back system is far more efficient so allowing more even and quicker overall wetting of the straw and manure. Explanations of the critical path analyses, recording, back checking that is required in the areas of prime base material preparation is falling onto stony ground. A meeting to discuss this in depth and the time required to do this is necessary in order to implement the systems required to gain consistent uniformity of base material.

21st November.

Decided to change the tray layout in the growing sheds in order to get people in and mushrooms out! Meant a reduction in the number of trays in each shed but at least we should now be able to handle the crop more easily. Must take care not to reduce the tray number too far or the *environment will get out of balance.*

22nd November.

Decided to put heavy watering in the crop that has been cased with spawn run compost added, growth fluffing up from the introduced material but not coming strongly enough into the base of the casing because it is too dry. How dry (wet) should it be? Normally we have our casing moisture near to field capacity and very dense. But here we need to learn if the 'Christmas Pudding' effect will give the same results?

Advert is *Sunday Times* Christmas offers 'Simply open the lid and away they grow!' Simply send £13.90p for the gourmets delight, even though we unfortunately cannot claim that these have aphrodisiac properties! After the box is exhausted place the contents in leaf mould in full shade beneath trees outside, with a little luck and the right conditions you can expect further cropping'. Yes you have it, French Oyster Mushrooms! *What is more simple than fullshade!?*

23rd November.

Growth during the past week has suddenly slowed. Picking supervisors re-estimates, which are normally on the low side, have by some miracle hit target. Most excellent pin set and development to small buttons and then a growth pause. Temperature boosts have had no effect. Decided to reduce water levels prior to second flushes this week to encourage more bed activity. No doubt with todays snowfall and hard night frosts something will trigger growth once again and all will blossom at the same time.

24th November.

First shed of spawned casing treatment progressing well with fast fluffing up of the surface mycelium and now good regrowth at the interface. Watering seems to be a case of being plentiful, but casing surface has panned. Maybe this doesn't matter?

25th November.

Discussing *Trichoderma pseudokoningii* with John Fletcher and what effect *61 million spores per gram* will cause to the mushrooms!! Don't tell me about the Cap Spotting Doc! This we can see, how do we stop it from keeping coming back? You mean burn the trays? So you don't get the problem on aluminum shelves, but we don't have any aluminum shelves! David Stanly-Evans tells me he's going back to trays, I bet he doesn't have the problem. Perhaps the ammonia levels are too low during phase II? Sure the compost is too wet, the strain's breaking down too quickly and the dumb heads pump too much goody back on to the piles. You mean water coming out during pressing is bad? Jesus Doc you better come and see us.....Happy Christmas.

27th October.

Casing mix far too fine this week and checking back on the records it would appear the mixing last week was not done by the usual operator. Once again the level of attention required was not passed down to the stand in operator so the importance of time in the mixer was overlooked. Now we will fit a time controller on the elevator to help avoid the problem in future.

28th November.

Exceptionally wet compost at spawning due in part to overwetting the pre-wet but also from the wet foggy conditions of recent weeks. Reverse condensation into the stacks has been occurring with ease and we will now have to readjust the moisture level at stacking. Thank goodness we have conventional peak heat rooms, one dreads to imagine the effects of loading such short, heavy wet compost into 'bulks'. Compression factor would be so enormous it would become impossible to blow air through the compacted structure. No doubt in changing over from conventional phase II to bulks great consideration to the type of raw materials available must be given.

29th November.

'Quality Controllers' have developed a fault, it is called 'Lazy Eyes'; 'check the Checker' or 'Eject the Rejecter'

30th November.

A typically good day! Spawning line tipper decided it preferred to tip when the trays are only half way into the cradle. More firewood!! The front drum drive on the composting machine decided it had enough of pulling heavy wet compost about and fell apart!! One of the large fridge vans took a liking to several trees along the route onto the A1 and is now self ventilating!! Having watered the spawned casing trial for the last time it is now obvious we shouldn't have done so!! Picking not completed!! Mushrooms sent out at too low a temperature!! Decided to go down to the pub; it was closed!!

Happy Christmas and a Good Mushrooming New Year to all our friends around the mushroom world.

A workload well handled

by **Peter Flegg**

How would you like to contemplate holding a farm walk for over 300 visitors and not a mushroom in sight? Ferd and Sylvia Hensby did and very successful it was too!

The afternoon began with a splendid buffet lunch at the Slepe Hall Hotel in St Ives provided by the Allied Trades. Ferd welcomed us and urged us towards the coaches waiting to drive to the main composting site and mushroom farm. A shuttle service of coaches throughout the afternoon eased the journey between the two sites.

Hensby's contact with the mushroom industry goes back well over thirty years when HEH Enterprises (Farmers) Ltd, sold manure to mushroom growers, but Hensby Compost Ltd, was not formed until 1965. Recent years have seen considerable expansion of business and increase in staff and facilities. A laboratory now provides an important quality control service for their own operation and offers compost analysis and pest and disease identification to customers and other growers.

Currently around 1,600 tonnes of phase 1 compost are produced on the main composting site each week. Ferd believes that quality is terribly important. They aim to produce an active, well-structured compost. Using wheat straw, horse manure, chicken litter and gypsum, the intention is to finish phase 1 with a compost of total nitrogen content 1.85%-2.00%, ammonium nitrogen 0.45-0.50%, pH just above 8 and a water content of 72-74%.

To achieve these objectives straw and manure are subjected to a pre-treatment and a pre-wetting before phase 1 composting proper begins. During the pre-treatment phase straw bales are broken and mixed with 250kg of chicken manure (litter) per tonne and watered at 500 litres per tonne of mixture as they are passed through a compost turner. This mixture is left in a loose heap for 2-3 days until it is ready for pre-wetting. Horse manure supplies are unloaded and loosely heaped for a day or two waiting for pre-wetting and particularly dry areas are given a spot watering.

Ferd welcoming the guests to the farm walk

Pre-wetting begins about 6 to 8 days before stacking. The main pre-wet heap is made up from the straw and chicken manure heap and the horse manure heap in the ratio of 2 to 1 and it is then watered. Some 2 to 3 days later, the pre-wet heap is turned using a tractor with fore-loader, dryish patches, particularly in summer, are again given more water.

Phase 1 compost yard, the material intended for customers who will carry out their own phase 2 operation, mostly tray growers, is sited in the yard towards the road and is given three turns. The compost to be processed by Hensby's own phase 2 tunnels is placed away from the road and turned only twice.

On day 0, the composting material is moved from the pre-wetting area and made up into long stacks (windrows) each about 2m high and 2m wide. In summer the width of stacks is reduced slightly. Each windrow contains about 100 tonnes of compost. At stacking, poultry manure is added, 40kg per tonne. Compost intended for their own tunnels also receives some granular limestone to help improve the structure.

The first turn of the compost takes place on days 2 and 3. This is when gypsum is added, 25kg per tonne of compost, and, if needed, additional water is mixed in through the turner. Generally at this stage the compost is

Geoff Ganney and MGA chairman Frank Stewart-Wood

wet enough

The second turn, days 5-6, is when customer requirements for further additives are met, for example, cotton seed meal may be mixed in, moisture content is checked and maintained at around 73%.

On days 7 to 8, the compost for Hensby's own tunnels is filled and that for customers requiring a particularly active compost, mostly those with their own tunnels, is despatched.

The third turn, for customers on the tray system, is done on days 8-9 before loading for delivery.

Ferd Hensby foresees big developments in phase 1 composting during the next five years. "Changes are being forced on us by environmental considerations", he says. The impact of environmental legislation arising both on the continent and in the UK is being evaluated by the company and recent new developments in indoor composting are being closely monitored. Phase 1 is likely to be modified to become mainly a rapid mixing of ingredients which are then moved straight into the phase 2 tunnels. Possibilities for the future, for Ferd, include the utilisation of the tremendous amount of heat produced by mushroom composts and of the gases produced during composting.

The Hensby phase 2 operation produces about 600 tonnes of compost weekly and is divided into four interrelated sections, production, tunnel management, hygiene and transport. The technical department with its laboratory facilities provides the analytical back-up for quality control. There are 20 tunnels, 12 producing 25 tonnes of compost weekly and 8 larger tunnels each producing twice that amount.

Phase 1 compost arriving from the yard is filled by swinging conveyor into the tunnels at around 800-1,000kg per square metre. At filling the compost is usually 45-50°C and is raised up to 60°C for the 'kill' once the compost temperatures have levelled out. The temperature is kept up to a maximum of 60°C for 8 hours so as to ensure that the compost is free from mushroom pathogens. The subsequent conditioning period usually lasts around 2 days during which time the compost is kept at 48-50°C. At the end of phase 2, the compost characteristics aimed at are a pH of around 7.3, a water content of 67-68%, a total N content of not less than 2.2%, but with the ammonium nitrogen not exceeding 0.04%.

A group of farm-walkers at the Hensby's

The earlier tunnel types are in the traditional Dutch style, but the more recent ones follow the design of Pat Walsh. This latter type has advantages for emptying by skid-steer front loaders.

The tunnels are equipped with modern electronic controls and a computer system has been installed to control and monitor the operation of the four latest tunnels. Ferd is somewhat equivocal about computerisation. He feels the human presence aids reliability.

He does not expect too much change in phase 2 composting in the near future, maybe a little more mechanisation, but "after all compost is compost".

The newly built mushroom farm is a logical extension to the Hensby operation. "We built the type of farm growers will be using in the future", Ferd declared. It is run as a commercial unit and Eric Vernooy, from the Netherlands, joined them as farm manager just a few weeks before the farm walk. Preferring to start from scratch, Eric had the whole farm cleaned out. Hence there had been no time to get a crop to pinning stage before the farm walk. However, as Ferd claimed during his introductory few words, there were some very good spawn runs.

There can be little doubt that by the time this article is printed there will have been a lot of mushrooms in those houses which were open for our inspection on the day.

There are 12 growing rooms, each with 305 square metres of metal shelves. Normally a double fill of 30 tonnes per room is made in alternate weeks. As the farm provides valuable feedback to the compost production unit, both spawned blocks and bulk compost are used. Eventually the plan is to use the farm to help their customers review their growing practices and to provide the means of passing on new information.

In building the farm, Ferd told me that they were looking for easy management, reduced labour requirements and thorough mechanisation. 'Hygiene is important too' he believes. "Getting the hygiene contractors in to clean all the machinery costs a fortune", he declares, "but is essential!"

Although those looking for mushrooms may have been disappointed, the weather was fine and there was much to interest on both sites. Also an excellent tea was available in the phase 2 covered area. Not only must farm walk visitors thank both Ferd and Sylvia for such an excellent effort, but let us not forget Iain Hensby and John Dashwood-Hall (Operations and Production), Brian Fairbrother, (Sales, Marketing and Customer support), David Border (Technical Department), and Gerry Barker (Finance). Especially thanks to the staff of 100 or so who must have worked very hard to give us such an interesting few hours.

Perhaps, it is with the memory of all that glittering equipment and technology in mind, we give the last words to Ferd about 'people'. An early supporter of the ATB-MGA Open Learning Scheme, Ferd believes that, "Training is the thing. We must start now to train the people for the new methods and the new technology. You do not teach people to grow mushrooms by bringing in computers".

Ted Bowman

Low Tech aids for high tech mushrooms

... Can you believe that material from babies nappies and a drain pipe could offer significant improvements in the control of air flow and the general environment within our mushroom houses! Ted Bowman, from the AFRC Institute of Engineering Research, obviously thinks so and will soon tell us how in a future issue of the Mushroom Journal, there will be an article from Ted explaining how these two mundane items of daily use in some families do play a vital part.

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The **new rate** from 1st January, 1989 is £40.87 plus VAT £6.13 = £47.00

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New Rate as from 1st January, 1989

Farm size Bed area laid down sq. ft p.a.	Subscription 1988 £	VAT 15% £	Total £
under 40,000	79.13	11.87	91.00
40,000 and over	103.08	15.46	118.54
60,000 and over	147.68	22.15	169.83
80,000 and over	215.42	32.31	247.73
120,000 and over	276.96	41.54	318.50
160,000 and over	307.73	46.16	353.89
200,000 and over	384.64	57.70	442.34
300,000 and over	523.11	78.47	601.58
400,000 and over	630.82	94.62	725.44
500,000 and over	738.53	110.78	849.31
600,000 and over	846.24	126.94	973.18
800,000 and over	1,000.10	150.01	1,150.11
1,000.000 and over	1,153.96	173.09	1,327.05
1,500,000 and over	1,384.76	207.71	1,592.47
2,000,000 and over	1,846.32	276.95	2,123.27
2,500,000 and over	2,461.76	369.26	2,831.02
3,000,000 and over	3,077.20	461.58	3,538.78
3,500,000 and over	3,692.66	553.90	4,246.56
4,000,000 and over	4,308.08	646.21	4,954.29
4,500,000 and over	4,923.55	738.53	5,662.08
5,000,000 and over	5,539.01	830.85	6,369.86

Thereafter a rate for each half million square feet

Important - All EEC members are reminded that VAT is reclaimable

THE MUSHROOM GROWERS' ASSOCIATION

Membership List 1989

Bold type indicates UK Grower Membership, *italic* Associate Membership.
The symbol (A) after a grower's name indicates Associate Grower.

† Deceased.
* Indicates all those members who are giving financial support to the advertising fund as at November 1988.

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ARGENTINA
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Thibaud, Michel, Juncal 3540, Buenos Aires.

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Baldock, G. G. & B. L., c/o Adelaide Mushrooms Nominees Pty, Paralatinqa Road, Reynella, 5161.
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Crown Mushrooms, 163 Belgrade Road, Wanneroo 6065.
Daley, Rex J., Maguires Road, Nelson, via Riverstone, 2765.
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Department of Agriculture (The Librarian), Baron-Hay Court, South Perth 6151, Western Australia.
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Gater, D. J., 34 Constance Street, Darlington, Perth, Western Australia 6070.
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Heley, D., Mushroom Composters P/L, Post Office Road, Ebenezer, N.S.W. 2756.
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BELGIUM
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Overstijns, Dr. A. P., Provincaal Centrum Voor Land En Tuinbour, Ieperweg 87, 8810 Roeselare.
Poppe, Dr. Josef A., Union of Belgian Mushroom Growers, Van Gansbergelaan 29, B9200 Merelbeke.
Sterckx, Jan, p.v.b.a., Rumbeeksegravier 141, 880 Roeselare.
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International Food Information Service, Commonwealth Bureau of Dairy Science & Technology, Shinfield, Reading.
Palfrey, E., Coxboro' Cottage, Cookham SL6 9HR. Tel: (06285) 22456.
Regional Library, Ministry of Agriculture, Fisheries & Food, Block 'A', Government Offices, Coley Park, Reading RG1 6DT.

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Library, Canada Dept of Agriculture, Ottawa K1A 0C5.
Campbells Farm Fresh Mushrooms, T. Adlington, PO Box 606, Portage La Prairie, Manitoba R1N 3B9.
D. & W. (1976) Mushrooms Ltd, 15650-93 Avenue, Surrey B.C. V3R 9G4.
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Hort. Research Inst. of Ontario, Ontario Ministry of Agriculture & Food, Vineland Station L0R 2ED, Ontario.
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Ontario Ministry of Agriculture and Food, (W. Brown), Vineland Station, Ontario L0R 2E0.
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Eaton, F. J., Brookhouse Farm, Wirksworth Road, Duffield DE6 4AQ.
Kirk, Mr R. (A), Moorfields, Deepsick Lane, Near Calow, Chesterfield S4 5DN.
***Monk, R. S.,** Derbyshire Mushroom Co Ltd, Highfields Farm, Atlow, Nr Hulland Ward DE6 1NS. Tel: (0335) 70693.
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Harpers Hill Mushrooms (A), de Steiger, R. & C., 12 Leechwell Street, Totnes TQ5 5SX. Tel: (0803) 865588.
M.A.F.F., Starcross Sub Centre Library, Staplake Mount, Starcross, Exeter EX6 8PE.
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***Evis, P.,** Minster Mushrooms, Melbury Road, Yetminster DT9 6NA. Tel: (0935) 872909.
***Scrimgeour, J. H.,** Huntick Farm, Lytchett Matravers, Poole BH16 6BH. Tel: (0202) 622222.

EGYPT
Mahmoud, B. H., Tanta Mushroom Farm, 16 Sayad El Mirghany, Heliopolis, Cairo.

EIRE
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Beirne, J., Cordrehid, Carrick-on-Shannon, Co. Roscommon. Tel: (010) 35378 20374.
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Carbury Mushrooms (C. MacCanna), Carbury, Co. Kildare. Tel: (010 353) 40553222.
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IDA Ireland (G. Battersby), Wilton Park House, Wilton Place, Dublin 2. Tel: 602244.
International Mushrooms Ltd (M. O'Rourke), Beechmount Industrial Estate, Navan, Co. Meath. Tel: (046) 22358.
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Monaghan Mushrooms (A. Brannon), Tyholland, Co. Monaghan. Tel: (047) 82599.
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*Cranham (Commodities) Ltd, (R. C. A. Payne), Anso Corner Farm, Hempstead, Saffron Walden CB10 2NU. Tel: (079986) 220.
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*Hughes, B. N., Layer Mills Ltd, Layer De La Haye, Colchester CO2 OJ2. Tel: (020 634) 254.
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Super Pultracy Co, (Ms E. Ghafan), Doha-Qatar, PO X 8757. Tel: 806239-324384.

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Bibliothek der Fakultaet für Gartenbau u. Landeskultur D.T.U., Herrenhaeuestr. 2, 3 Hannover-Herrenhausen.
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Windmill Fruit Farm, (A), (R. Grimes), Southend, Wotton-under-Edge GL12 7PB. Tel: (0453) 842933.

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*Coates, F. (Mushrooms) Ltd, Rivelin Nurseries, Course Lane, Newburgh, Parbold, Wigan WN8 7WB. Tel: (025 76) 2061.
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***Much Birch Mushrooms,** (Mr Rosser), Much Birch HR2 8HY. Tel: (0981) 540248.
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Forest Research Institute and Colleges, (Librarian), PO New Forest, Dehra Dun 248006.
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***Parker, G.,** Bilting Mushrooms, Bilting, Nr Ashford TN25 4HA. Tel: (0233) 812631.
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Sutton Hill Farm (A), (Mr C Noble), Sutton In The Elms, Broughton Astley.

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*__Markstrip Mushrooms Ltd,__ Settlers Lodge, Roman Bank Crosses, Long Sutton, Spalding PE12 9AT. Tel: (0406) 362320.
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Retail Fruit Trade Fed. Ltd, Mrs E. A. Pretty, 108-110 Market Towers, 1 Nine Elms Grove, New Covent Garden SW8 5NS.
R. Rumbold Ltd, (H. Evans), Stands 156/157 Spitalfields Market E1. Tel: 01-247 1604.
Sainsbury, J., PLC, (Mr J. Love), Scientific Services Div., Rennie House, Stamford Street SE1 9LL. Tel: 01-921 7300.
Mr. R. Shah, Meridien Trade Corp. Ltd, 16 Grosvenor Street W1X 9FB.
P. E. Yeats & Co, (Mr. P. E. Yeats), Arch 7, New Covent Garden SW8 5PP. Tel: (01) 720 4131/4120.

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*__Beardsell, D. T. R., Ltd,__ (Mr R. R. Beardsell), 10 Cable Street, Formby, Liverpool L37 3LX. Tel: (07048) 72427.
Donnings Ltd, (R. J. Hughes), 7, 9, 11 Block A, Wholesale Fruit Market, Edge Lane, Liverpool L13 2DZ. Tel: 051-220 1947.

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Hongos de Mexico SA de CV (V. Cano), Neuvo Leon 74, Chajimalpa, Ad po postal 6663 D.F.
Zimmerman, Mr & Mrs I., Comerlializadora Poseidon, Bosque De Helechos 32, Bosques De Las Lomas, CP H 700. Tel: 570-84-91.

NEW ZEALAND
Holst, A.G., N.Z. Mushroom Industries Ltd, Box 184, Morrinsville.
Kivell, D. L. Wyvale Mushroom Farm, Kaiapo Road, Hastings, North Island.
Marshland Mushrooms, 390 Marshland Road, Christchurch 9.
Meadow Mushrooms Ltd, Spring Road, Prebbleton, Christchurch.
Ministry of Agriculture and Fisheries, The Librarian, Agricultural Library and Information Centre, Private Bag, Upper Hutt.
Mount Albert Research Centre, The Librarian, D.S.I.R., Private Bag, Auckland.
Mushroom Spawn Laboratories (Waikato) Ltd, P.O. Box 5696, Frankton, Hamilton.
Parkvale Mushrooms, Nix Road, Parkvale, Carterton R.D.2.
Te Mata Growers Ltd, (Mr Speeden), P.O. Box 137, Havelock North.

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*__Bradfield, Peter,__ Norfolk Mushrooms (1985) Ltd, Thornham, Nr Hunstanton, Norfolk. Tel: (048 525) 288.

__Cleyfield Farms,__ (A), (Mr J. Blackburne), Cockley Cley, Swaffham PE37 8AG. Tel: (0760) 721339.

Engineering Design & Production Ltd, (B. D. Woodcock), New Road, Catfield, Gt Yarmouth NR29 5BQ. Tel: (0692) 82100.

Gough Packaging Ltd, (Attn L. H. Harvey), Unigrow Works, Jupiter Road, Mile Cross Lane, Norwich NR6 6SU. Tel: (0603) 43869.

__Horning Mushrooms,__ (H. C. Boddington), Ropes Hill Farm, Horning NR12 SP13. Tel: (0692) 630292.

*__Howes, R. M.,__ Birds Farm Mushrooms, Flordon, Norwich NR15 1RN. Tel: (0508) 470200.

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__Thurlton Park Mushrooms,__ (Mr V. Watkins), White House Farm, Low Road, Thurlton NR14 6QD. Tel: Raveningham 8972.

*__Watkins, D.,__ Orchard Mushrooms, Low Road, Haddiscoe, Norwich NR14 6PJ. Tel: (050 277) 296.

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C. C. Imports, (G. R. Panter), Keepers Cottage, Kelmarsh NN6 9NA. Tel: (060 128) 630.

__Court Farm Mushrooms,__ N. A. & S. E. Brunton-Reed, Court Farm, Overstone NN6 0AP. Tel: (0604) 491447.

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***Caledonia Fresh Mushrooms Ltd,** (T. J. Hyatt), 2 Dawson Road, Port Dundas, Glasgow G1 2Q7. Tel: (041) 332 7511
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***Dumbreck, T.,** R. D. Dumbreck & Son Ltd, Edenvalley Mushroom Farm, Freuchie, Fife KY7 7EU. Tel: (0337) 57335.
E.C.L. Organics Ltd, (Mr H. Bryant), Ednam, Kelso, Roxburghshire. Tel: (0573) 24988.
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***Fenton Barns Mushrooms Ltd,** (Mr. K. Chalmers-Watson), Fenton Barns, North Berwick, East Lothian.
Five Pines, (G. & M. Anderson-Jones), Five Pines, Roshven, Lochailot, Invernesshire PH38 4NB.
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***Great Scott Mushrooms,** (Mr B. Baird), Ormiston House, Kirknewton, Midlothian EH27 8OQ. Tel: (0506) 882641.
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Highland Distilleries Company PLC, (Mr T. J. Hyatt), 106 West Nile Street, Glasgow G1 2QY.
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Royal Botanic Garden, Library, Edinburgh EH3 5LR.
Stirling Diagnostics Ltd, (D. G. Ward), Innovation Park, Hillfoots Road, Stirling FK9 4NF. Tel: (0786) 50050.
Scottish Mushrooms, (A), (Mrs. N. Toole), 19 Ranfurly Road, Bridge of Weir, Renfrewshire PA11 3EL. Tel: Bridge-of-Weir 612597.
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Wenlock Mushrooms, (K. J. G. Britzman & M. R. Smallman), 1 Dog Lane, Little Wenlock, Telford, Shropshire. Tel: (0952) 504000.

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C. & D. Nurseries, (A), (C. G. Pearson), Notlake Farm, Lower Notlake Drove, Clewer, Wedmore BS28 4JW.
***East Coker Mushroom Farm,** (S. J. Dodge), Amberley, Long Furlong Lane, East Coker, Near Yeovil BA22 9LJ.
Gill, T. J., (A), 93 Galmington Road, Taunton. Tel: (Taunton) 251768.
Swatton, A., MAFF, ADAS, Quantock House, Paul Street, Taunton TA1 3NX. Tel: (0823) 87922.
Wessex Mushrooms, (J. P. Vine & R. R. Peacock), Beer Farm, Beer Crowcome, Taunton TA3 6AJ. Tel: (0823) 480904.

SOUTH AFRICA
Maybury Mushroom Farm, P.O. Box 86, Maidstone 4380.
Meadow Mushroom Farms (Pty) Ltd, P.O. Box 169, Daleside 1840, Transvaal.
Medallion Mushrooms, Stellenbosch (Pty) Ltd, (T. Crawley), Strand Road, P.O. Box 54, Stellenbosch.
Merensky Biblioteek, The Librarian, University of Pretoria, Pretoria.
Murray, R. K., P.O. Box 1185, Hillcrest, Natal, 3650.
Mushrooms Cordon Bleu (Pty) Ltd, 1 Klopkloppe St, Birchacres, Kempton Park 1620.
Richardson, C. R., Highveld Mushroom (Pty) Ltd, P.O. Box 70422, Bryanston 2021.

Tongaat Mushrooms Transvaal (Pty) Ltd, 7th Avenue/Laan, Wynberg Ext. 1, P.O. Box 67486, Bryanston 2021.
Tongaat Mushrooms Western Cape (Pty) Ltd, (Mr M. Langston), Hooggelegen Road, P.O. Box 140, Durbanville 7550.
Vegetable & Ornamental Plant Research Institute, Private Bag X293, Pretoria 0001.

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*__Brammer, J. D.,__ Wood Farm, Bagnall, Stoke-on-Trent. Tel: (0782) 503272.
__Coach House Mushrooms,__ (A), (Mr. S. E. Powell), School Lane, Dunston, Stafford ST18 9AG.
Kind, J. B. Ltd, (Att. J. A. A. Emery), Shobnall Street, Burton-on-Trent DE14 2HP. Tel: (0283) 64631.
__New Farm Mushrooms,__ P. Mellor & Son, 85 Burton Road, Branston, Burton-on-Trent DE14 3DW.
Rumenco Ltd, Stretton House, Derby Road, Stretton, Burton-on-Trent DE13 0DW. Tel: (0283) 61211.

SUFFOLK
Aston Equipment Ltd, (Mr A. B. Fuller), 4 Chase Road, Northern Way Industrial Est., Bury St. Edmunds, Suffolk IP32 6NT. Tel: (0284) 701555.
*__Blake & Mann Mushroom Farm,__ Flixton, Nr Bungay NR35 1NR. Tel: 098 682 271.
*__Chesswood Produce (Shepherds Grove) Ltd,__ Stanton, Bury St Edmunds IP31 2BQ. Tel: (0359) 50441.
Eastern Electricity, (R. N. Lewis), Agricultural Engineer, PO Box 40, Whenstead, Ipswich IP9 2AQ. Tel: (0473) 688688.
Griffiths Contractors Ltd, (Mr S. A. Griffiths), Gazel Road, Moulton, Newmarket CB8 8SR. Tel: Newmarket 750343.
*__Hearne, Sqn. Ldr. P. J.,__ Capel Mushrooms, Capel St. Mary, Ipswich IP9 2LA. Tel: (0473) 310380.
H. E. H. Enterprises (Farmers) Ltd, Plantation Farm, Chippenham Road, Kennett, Newmarket CB8 7QJ.
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Needham Chalks Ltd, Ipswich Road, Needham Market, Ipswich IP6 8EL. Tel: (0449) 720227.
__Trimley Mushrooms,__ Trimley St. Martin, Felixstowe, Ipswich IP10 0RJ. Tel: (0394) 275346.

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__Borrow House Farm,__ (G. Batchelor), Jumps Road, Churt, Farnham GU10 2LB.
__Clockhouse Mushrooms,__ D. Tolhurst, Clockhouse Lane East, Egham TW20 8PF.
Commonwealth Mycology Institute, Ferry Lane, Kew, Surrey TW9 3AF.
Croxton & Garry Ltd, (M.. J. H. Duff), Curtis Road, Dorking RH4 1XA. Tel: (0306) 886688.
Martin, W. R., Burcros, Clarks Farm, Reading Road, Blackwater, Camberley GU17 0DP. Tel: (0252) 872241.
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*__Blue Prince Mushrooms,__ Station Road, Rustington, Littlehampton BN16 3RF. Tel: (0903) 775111.
__C.B.F. Nurseries,__ Camelia Botnar Estate Co. Ltd, (Mr N. R. Ellis), 'Ivorys', Maplehurst Rd., Cowfold. Tel; (040 386) 4486.
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*__Hammer Lane (Heathfield) Ltd,__ Farrelly, Gordon J., Hammer Lane, Vines Cross, Heathfield TN21 9HF. Tel: (043 53) 2715.
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*Salliota Ltd, (B. Howes), The Causeway, Sidlesham, Chichester PO20 7NE. Tel: (02435) 6353.
*Searles Mushrooms, (I. R. Sanford), Fletching, Uckfield TN22 3YB.
*Sampson Mushrooms Ltd, Oving, Nr Chichester PO20 6DF. Tel: (0243) 784455.
Tamplin Engineering Ltd, (Mr N. T. Tamplin), Man Road, Birdham, Chichester PO20 7BU. Tel: (0243) 512599.
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California, University of, Serials Department, General Library, Berkeley, California 94720.
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Camsco Produce Co. Inc., Evansville Farm, PO Box 169, Maidencreek Road, Blandon, Pennsylvania 19510.
Camsco Produce Co. Inc., PO Box 639, Farm Road 310, Hillsboro, Texas 76645.
Chen, Ming H., 2 Noble Road, Christiana, Pennsylvania 17509.
Delaware, University of, Serials Dept., Newark, Delaware 19711.
Del Monte Research Center, Technical Library, P.O. Box 9004, Walnut Creek, California 94598.
Franklin Mushrooms Farms Inc., P.O. Box 18, North Franklin, Connecticut 06254.
Frezzo, Emidio, Jnr., Inc., Box 226, Toughkenamon, Pennsylvania 19374.
Frezzo, James L., Frezzo Bros., Box 44, Avondale, Pennsylvania 19311.
Fuji Bio Farm, c/o Yonekyu Corp., 2219 Via Caliente, Fullerton, California 92633.
Giorgi Mushroom Co., Box 96, Temple, PA 19560. (215-926-2139).
Gourmets Delight Mushrooms Inc., Rt 1, Eden, Wisconsin 53019.
Guizzetti, Gildo, Guizzeti Farms Inc., Rd No 1, Box 87, Landenberg, Pennsylvania 19350.
Holmes, Dr James, 3390 Haas Drive Aptos, California 95003.
Illinois, University of, The Library, 1408 W. Gregory Drive, Urbana 61801.
Kinrus, Aron, 2202 Nassau Drive, Wilmington, Delaware 19810.
Kurtzman, Dr Ralph, Ph.D., 445 Vassar Avenue, Berkeley, California 94708.
Lambert, L. F., Spawn Co. Inc., P.O. Box 407, Coatesville, Pennsylvania 19320.
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Longwood Biological Laboratories, Hepburn Road, RR2 Box 475, Avondale, Pennsylvania 19311.
Maine — University of, Fogler Library, Serials Dept., Orono, ME 04469.
Mangelsdorf, J., Quincy Farms, RT4 Box 245, Quincy, Florida 32351.
Modern Mushroom Farms Inc., P.O. Box 655, Kennet Square, Pennsylvania 19348.
Monteray Mushrooms, Fresh Operations, R. & D. Department, P.O Box 189, Watsonville, CA 95077.
Montgomery, D. W., Vice-President — General Manager, Amcel Mushroom Spawn, P.O. Box 1260, San Juan Bautista, California 95045.
Mulder Enterprises Inc, (Mr D. Mulder), 29785, Los Angeles Str, Shafter, California 93263.
Mushroom Growers Co-op. Association of Pennsylvania, Box 375, Kennett Square, Pennsylvania.
Needham, Don, Needham's Mushroom Farm Inc., Box 69, Chatham, Pennsylvania 19318.
NPI, Dr R. K. Kulkarni, 417 Wakara Way, Salt Lake City, Utah 84108.
Pannell Manufacturing Corporation, P.O. Box 162, Avondale, Pennsylvania 19311.
Penford Products Ltd, 1001 First Street S.W., P.O. Box 428, Cedar Rapids, Iowa 52406.
Peterson, Jon, 2710 Cawelti Road, Camarillo, CA 93010.
Pia, Michael, Kaolin Mushroom Farms Inc., Mushroom Growing Div. P.O. Box 1037, Kennett Square PA 19348.
Pia, Richard E., 316 N, Broad Street, Kennett Square, Pennsylvania 19348.
Piantoni, A., Shelby Mushrooms, 46275 Ryan Road, Utica, Michigan 48087.
Pietro Industries Inc., (Attn. Mr Peter Alonzo, Jnr.), Schoolhouse Road, Kennett Square, Pennsylvania 19348.
Pilsbury Company, The, Technical Information Center, 311 Second St. S.E. Minneapolis, MN, 55414.
Princetown Mushrooms, (Mr Ray Samp), RR/3 Princeton, Illinois 61356.
Reinert, Dr W. R., Box 57U, Cirt, Campbell Place, Camden, NJ 08103-1799.
Rincon Mushroom Farm, 33777, Valley Center Rd., Valley Center, California 92082.
Rodwell, J. H. D., 3373 Ocean Drive, Channel Islands, Oxnard, California 930301.
Royse, Daniel J., The Pennsylvania State University, 211 Buckhurst Laboratory, University Park, Pennsylvania 16802.
San Antonio, J. P., A.R.S., Plant Genetics & Germ Plasm Institute Vegetable Laboratory, Arc-W, Admin. Bldg, N. Wing, Beltsville, Maryland 70705.
Sher-rockee Mushroom Farms (J. J. Ciarocchi), P.O. Box 190, Avondale, Pennsylvania 19311.
Snetsinger, Dr Robert, Dept. of Entomology, 106 Patterson Bldg., The Pennsylvania State University, University Park, Pennsylvania 16802.
Sno-Top Mushroom Farm, Wampum, Pennsylvania 16157.
Spawn Mate East, Attn. Lou Summerfield, P.O. Box 389, Birch Street, Kennett Square, Pennsylvania, 19348.
Spawn Mate Inc., PO Box 1990, Santa Cruz, CA 95061.
Steakmate Mushrooms, P.O. Box 818, Morgan Hill, California.
Swayne, III, J. B., Swayne Spawn Co., P.O. Box 618, Kennett Square, Pennsylvania 19348.
Thompson, F. G., Mushroom Supply Co., Toughkenamon, Chester County, Pennsylvania 19374.
United Foods, PO Box 119, Bells, Tennessee, 38006-0119.
Washington State University, Agricultural Sciences Library, Johnson Annex Room C2, Pullman, Washington 99164.
Wuest, Dr Paul J., 211 Buckhout Laboratory, University Park, Pennsylvania 16802.
Yamhill County Mushrooms Inc., PO Box 219, Yamhill, Oregon 97148.
C. P. Yeatman & Sons Inc., RR No 1, Box 477, Avondale PA 19311. Tel: 215-869-3595.

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Selsko Khozjajstven Biblioteka, Orlikov Per 3, Moscow.

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Clwyd Mushrooms, (M. Tomkins/R. Tudor/C. Lloyd-Williams), Hwlffordd Farm, Llansannan, Denbigh, Clwyd LL16 5NN.
Conwy Mushrooms, (Mr P. S. Phillips), 13 Mountain Road, Conwy, Gwyned.
Court Colman Farm (A. Thomas), Court Colman, Bridgend, Mid Glamorgan CF31 4NG.
Gilbart, John L., & Co Ltd, Wholesale Fruit Centre, Bessemer Road, Cardiff, South Glamorgan CF1 8BD. Tel: (0222) 31264.
Greenmeadow Mushrooms, (A), (C. Beasley), Bush Lane, Kilgetty, Dyfed SA68 0RB. Tel: (0834) 813190.
'H' Mushrooms, (Mr J. D. Coates), 17a The Grove, Rumney, Cardiff CF3 8HG.
The Mabinogion Mushroom Co, (A), (P. G. Perkins), 8 De-la-Beche Street, Swansea SA1 3EB. Tel: (0792) 41503.
National Library, Aberystwyth, Cardiff, Dyfed.
Plasvac Ltd, Severn Farm Ind. Estate, Welshpool, Powys SY21 7DF.
Portapax Ltd, Unit 21, Maeglas Ind. Est., Newport, Gwent NP9 2NN. Tel: (0633-21) 4455.
Robertson, M., Flatholm Farm, Penylan, Bassaleg, Newport, Gwent NP1 9RW. Tel: (0633) 680377.
Wye Valley Mushrooms (A), (Mr R. Hone), Incline Farm, Redbrook, Monmouth, Gwent NP5 4LU.

WARWICKSHIRE
Brookside Mushroom Farm, (A), S. R. Cooper, Gaydon Road, Bishops Itchington, Leamington Spa CV33 0QZ. Tel: (0926) 612320.
Dyche, Mrs M. A., (A), Hedgend, Moss Lane, Newbold-on-Stour. Tel: (0780) 987 725.
Focadi, Enzo, Harper Mushrooms, 'Four Winds', Kinton Lane, Claverdon CV35 8PP. Tel: (092 684) 2093.
Wier, J. A. C., Farm Electric Council, NAC, Kenilworth, Warwicks CV8 2LS. Tel: (0203) 58626.

WEST MIDLANDS
Albright & Wilson Ltd, PO Box 3, Albright & Wilson House, Hagley Road West, Oldbury, Worley, West Midlands B68 0NN.
Denis, John, Food Group Ltd, Smithfield Market, Wholesale Markets Precinct, Pershore Street, Birmingham B5 6UN. Tel: (021 622) 5471.
Ellis, R., Mack & J. V. White Horticultural Markets, Wholesale Markets Precinct, Pershore Street, Birmingham B5 6UN. Tel: (021 622) 4111.
Exeway Ltd, Unit 3, 1161 Chester Road, Erdington, Birmingham B24 0QY. Tel: (021 377) 6550.
Hughes, Stan, (Birmingham) Ltd, Unit 26, Smithfield Market, Pershore Street, Birmingham B5 6UN. Tel: (021 622) 3351.
Retail Fruit Trade Federation, 10 Centre Block, Wholesale Markets Precinct, Pershore Street, Birmingham B5 6UL. Tel: (021 622) 3977.
Williams, J. P. (A), 1 Dudley Road, Sedgley, West Midlands DY3 1ST.

WILTSHIRE
Ukital Spawn Ltd, (Mr K. G. M. Pointing), 11 Hazel Grove, Trowbridge BA14 0JG. Tel: (0225) 768088.

YORKSHIRE
British Library, The, Document Supply Centre, Boston Spa, Wetherby LS23 7BQ.
Fillyflash Mushrooms, (Mr N. Earnshaw), Glen Royd, South Lane, Netherton, Wakefield WF4 4HR.
***Greenhill Nurseries Ltd,** (Mr C. C. A. Spencer), 9 Hill End Road, Leeds LS12 3PT. Tel: (0532) 632438.
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Little Beck Mushrooms (A), (P. & T. Danahay), Snape Cottage, Snape, Bedale DL8 2TQ.
***Lockwood, J. B.,** Minskip Mushroom Farm, High Moor, Langthorpe, Boroughbridge. Tel: 322588.
MAFF, Block 2, Government Buildings, Lawnswood LS16 5PY.
Mag Valley Mushrooms, Turner, N. & J. Snittle Road, Hade Edge, Holmfirth, Huddersfield HD7 1RT.
***Middlebrook (Mushrooms) Ltd,** Brayton, Selby YO8 9DZ. Tel: (0757) 702114.
Monomech Ltd, Langthwaite Grange Ind. Est., South Kirkby, West Yorkshire WF9 3AW. Tel: (0977) 42985/43261.
Orgrow Mushrooms, (John Lyttle), Lees Hall Farm, Thornhill Lees, Dewsbury, West Yorkshire. Tel: (0924) 456768.
Raymond E. Rhodes (Bfd) Ltd. (Mr H. S. Savill), 1, 3, 5 & 7 St James Market, Wakefield Road, Bradford BD4 7PN.
Preece, T. F., Agriculture Building, Department of Plant Sciences, The University of Leeds, Leeds LS2 9JT. Tel: (0532) 431751.
Edwin Robinson (Sheffield) Ltd, 41/43 Wholesale Market, Parkway, Sheffield.
Roche Abbey Mushrooms Ltd, (T. E. Morrell), Roche Abbey Farm, Maltby, Rotherham S66 8NW. Tel: (0709) 812424.
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West Riding Mushrooms, (A), (C. G. Crossley), 105 Whitehall Road, Drighlington, Bradford, West Yorkshire BD11 1LN.
***Wilgro Mushrooms,** (C. E. Merson), Grange Farm, Milby, Boroughbridge YO6 9HQ.
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***Wollaston, J. H.,** All Berries Cottage Farm, Holme-upon-Spalding Moor, York YO4 4HB. Tel: (0696) 60645.

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Institut za Ratarstvo, 1, Povrtarstvo-Biblioteka, Maksima Gorkog 30, 21000 Novi Sad.

Ro Ini 'RKB Agroekonomik', Centar Za Informacije 1, Dokumentaciju, 11213 Padinska, Skela.

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While every effort has been made to ensure the accuracy of the entries, please check and let us have any necessary amendments. — **Ed.**

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Mushroom Growers' Association

Candidate Recommendation Form for

Sinden Award/Student of the Year Award

Nominated by:

Received:

On

No.

(Candidate)

Name

Organisation and position

Address of organisation

Telephone No.

Activity Area*: Grower/Adviser/Research/Development

(Recommender)

Name

Field of expertise

Organisation and position

Address of organisation

Telephone No.

Reasons for your recommendation, including a list of achievements and other information (approximately 200 words) (Do not submit publications).

If necessary continue on a separate sheet.

Student nominees should also write a short account of their work for the benefit of grower members and the Committee, and to give the Committee some idea of their future plans.

* Delete which is not applicable.