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A SURVEY OF MOISTURE DAMAGE IN SOUTHERN NEW ZEALAND BUILDINGS

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ACKNOWLEDGEMENTS

The authors would like to thank Mr D Frame for his valuable contribution in conducting much of the inspection work in the second stage of this report. Thanks are also due to the Invercargill City Council and to the Southland County Council for their interest and assistance. Special thanks are due to the homeowners who willingly made their houses available for our investigations, often at some inconvenience.

This report is intended for researchers working in the field of moisture-related problems in buildings, designers and Local Authorities.

A SURVEY OF MOISTURE DAMAGE IN SOUTHERN NEW ZEALAND BUILDINGS

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REFERENCE

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KEYWORDS

From Construction Industry Thesaurus, BRANZ edition:

Cavity walls; Condensation; Damage; Dampness; Failure; Ground water; Liquid content; Masonry; Moisture barriers; New Zealand; Restoring; Roofs; Thermal insulation; Timber; Ventilation.

ABSTRACT

This report describes two surveys of moisture damage in buildings (mostly residential) in Otago and Southland, 1978-1982. The first survey was a collation of routine enquiries received by BRANZ advisory service during a one-and-a-half-year period. Some 40% of the 87 cases recorded involved severe wintertime roofspace condensation. The second survey, acting on a diagnosis that related this problem to moist subfloor air migrating to cold roof spaces, was a comparative review of three different remedial measures applied to 10 selected cases.

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INTRODUCTION

This report describes a series of projects to investigate moisture-related problems in buildings, mostly houses and flats. Although the investigations were carried out in Otago and Southland, the problems encountered are found throughout New Zealand.

It was recognised in the late 1970s that there was an increase in reports of cases of serious moisture damage in roof-spaces and that these could not be a result of rain entry.

A detailed catalogue was made of all case reports received by BRANZ in Otago and Southland over a 1 1/2 year period during 1978 and 1979, which were related to any form of moisture problem. In total, 87 reports were catalogued and subsequently analysed. From this analysis it was deduced that the observed roof space moisture damage was a result of subfloor moisture evaporation.

A field study, designed to test this explanation and simultaneously to show the relative effectiveness of various remedial actions, was carried out over an 18 month period from March 1982 to August 1983.

PART 1: A SURVEY OF CASE HISTORIES

Method

A first step to identifying the cause or causes of the increase in roof-space condensation was to review a broad set of reliable case histories. A suitable set of cases was available, based on enquiries made through the BRANZ Advisory Service.

For this review, cases were chosen from BRANZ records if they met all of the following criteria:

- They occurred in the Otago/Southland region
- A written report was available, citing address, date and case details
- The report included mention of moisture, mould and/or rot
- They occurred between 1 May 1978 and 31 August 1979 - thus covering a period of two winters and an intervening summer.

There were 87 cases in total complying with these criteria, drawn from an area containing some 88,000 houses, with an average construction rate of 1400 per year over the past 30 years. A few of these cases were trivial, or were reporting the absence of a problem, but have been retained for completeness. In a few cases, the results of remedial actions were available, but frequently there was no follow-up report from the enquirer. In addition to these 87 documented cases, some 80 to 100 verbal enquiries concerning moisture control were also received for the region in the same period.

The location, date, and brief details of each case are listed in the Appendix. Figure 1, illustrating the number of enquiries received each month, shows as expected that most moisture problems arise in winter, but that a small number continue throughout the year. Figures 2 and 3 illustrate typical cases of moisture damage most commonly encountered by BRANZ up to that time.

Results

Table 1 presents in summary form the general nature of each of the 87 cases, classified according to the diagnosed source of moisture. The most commonly reported problem was in roof spaces, but problems in external walls, and in subfloor timbers were also common.

The 11 cases described in Table 1 as "internal" refer to problems such as mould growth on walls, ceilings, or in cupboards, condensation on indoor surfaces, or paint flaking. There were six cases where excess construction moisture had produced staining of paint and finishes, usually with mould, and had caused swelling of adhesives and stopping. There were three reports of inspections which revealed an absence of any problem, two of these commented on the excellent state of preservation of quite old foil-insulated floors. The remaining cases include rain entry, and one case of a defective hot water cylinder vent discharging into a roof space.

In the 35 cases where roof space condensation occurred (40% of all the problems examined), the effects of the condensation were extreme and severe. Figure 4 shows a typical example. The roof spaces were commonly observed to have heavy deposits of condensate over the entire roof underlay, with upwards of 50% of purlins or rafters dripping wet, and remaining in this condition for extended periods. This condition was ultimately observed to be common in roofs of masonry veneer houses, and as Table 2 indicates, is particularly related to open veneer construction.

Below are four extracts from typical site reports. These are verbatim, and are given partly to show the nature and individuality of each report, partly to illustrate recurring themes in these eyewitness reports:

> Case 3:
>
> "...inspected one of these homes today which had only been built in the last 4 $^1/_2$ years, water was literally running from the bottom 200 mm of the block veneer work and also from the building paper adjacent to the framing. Again, no venting at all had been allowed for below the subfloor structure. Mould was forming on the underside of the flooring and the joists were starting to show signs of deterioration, white fungus was growing on any loose timber that had been left under the house and had started to climb up on the cardboard pile boxes...".
>
> (Note: "Cardboard pile boxes" refers to boxing made from cardboard, for casting the concrete piles of the house. They are usually left in position).

Air movement up the veneer cavities can cause chilling of the internal linings of the exterior walls with consequent growth of mould, as for example in Case 36:

> "...there was severe mould growth in wardrobes and on the particleboard floor, all related to moisture under the home.
>
> "On our recommendation, extra vents were placed in the foundation and veneer venting was closed off. Polythene was laid on the ground under the whole area of the house and sealed to the foundation and piles. Over the 12 months, pretty well all mould has disappeared...

The roof condensation problem is illustrated by comparing cases 38 and 39, both houses built in the same locality and inspected on the same day:

> Case 38: "A home which had been constructed for approximately 7 years, was on a standard continuous, concrete foundation block veneer, corrugated iron roof approximately 25° pitch.
>
> "The problem here was that the vents were above the line of the sleeper plates and there was considerable mould growth in the lower wall areas. The ceilings were insulated, but at no point in the roof were there any signs of condensation. This house had the cavity completely closed at the soffit intersection...".
>
> Case 39: "A house which had been built for approximately 12 years, continuous concrete foundation and brick veneer, corrugated iron roof with a very low pitch. The venting in this place was in the concrete foundation well below the line of the sleeper plates but the whole of the roof structure - purlins and building paper had ice and condensation literally running off all members. The ceiling had been insulated with macerated paper..."

The wall and foundation details of these houses are not very different, except for the fact that in Case 38 the veneer cavity was closed off at soffit level, but in Case 39 it was open.

Discussion

The most commonly diagnosed cause of failure (61 cases, 70% of all cases reported) was moisture from wet subfloor soil.

The physical cause of roof-space condensation has been deduced as the movement of moist air from the subfloor space to the roof space, with consequent condensation occurring on the roof cladding especially during clear nights. Most masonry veneer construction provides a path for this air movement and smoke-trace testing during some inspections has clearly shown that such air movement frequently takes place.

Further supporting evidence is available from:

- The exceptions in Table 2. There were two cases of veneer walls without roof condensation, but inspection showed that the veneer cavities in these cases were closed off. There were two further cases of open veneer cavities and partly traditional roofs with condensation, but another part of each of the roofs was of skillion type with no access for moist air streams, and these parts showed no moisture accumulation.

- The reaction to remedial work. The nature and consequence of remedial action taken is known for three cases only. In one case ceiling insulation was removed. In two others, improvements to subfloor venting and closure of the veneer cavity effected a complete cure which was confirmed by a subsequent inspection 12 months later.

- Calculation. Simplified calculation indicates that this process could supply a nightly condensation rate of up to 150 g/m² to the building paper, with some daytime re-evaporation.

There was frequent comment in the site reports regarding the prevalence of excess subfloor moisture. Comments were frequently made on the lack of adequate vents, and the fact that many commercial vents have less than 15% opening; the incorrect positioning of vents so that the path of air flow was obstructed by timber; the building of paths so that they obstructed vents; and the planting of vegetation in front of vents.

Summary, Part 1

From a review of case histories of 87 buildings over a 2-winter period, 40% were found to be severely affected by roof space condensation in winter time. This has been diagnosed to be the result of moist air from the subfloor space migrating into roof space, usually via masonry veneer cavities, to condense during clear nights.

A further 30% were found to be affected by excess subfloor moisture acting directly on subfloor timber, or on the lower part of walls.

PART 2: A SURVEY OF REMEDIAL WORK

Having deduced a physical cause of these roof-space moisture problems, the next step was to test it. The method used was to select a number of houses affected, to apply in each of them one of several remedial treatments, and to observe the results over 12-16 months. To allow for the possibility of abnormal weather during the observation period some "control" houses were included.

Sample of houses

A sample of 10 Invercargill houses known to be affected by roof-space moisture was chosen from a plentiful supply. The choice was somewhat arbitrary, being made from the group of houses for which information on this problem was currently being sought from the local bodies in the area. Care was taken to select groups with gabled and hipped roofs, and to pair these for different treatments.

Remedial Treatments

The treatments applied to the houses were:

a. to block the veneer cavity at eaves level
b. to block the veneer cavity at floor level
c. to cover the ground below the floor with polyethylene film.

The methods of carrying out these modifications were selected with a view to their possible commercial application later. Cavity blocking at eaves level was done by lifting part of the roof, and nailing hardboard strips over the top of the frame, in line with the building paper. Gables were more difficult to treat, but hardboard closers were used here also, applied from within the roof space. Cavity blocking at floor level was carried out with polyurethane foam spray, or with bitumen impregnated foam strips. Covering of the ground with polyethylene film was preceded by some smoothing and raking, and the sheets were lapped and taped to each other and to the foundations and piles. These measures were necessary to achieve a tidy finish, and are considered to have been of more importance for that purpose than for technical success.

These procedures are illustrated in Figures 5 and 6.

The cost per house (1982) averaged under $NZ400 for supplying ground cover, compared to $NZ300 for closing the veneer cavity at the bottom and $NZ800 at the top.

Monitoring Programme

The 10 houses in the main sample were selected and inspected in March/April 1982. The remedial work was carried out at the end of April 1982, and the formal monitoring programme began in May 1982.

Full inspections of each house were made monthly through the winter to September 1982, and two-monthly over the summer. In January 1983, two houses which had been used as controls during the first winter, and two others where the first treatment failed, were treated by covering the ground beneath the house with polyethylene film. In six of the ten houses, inspections ceased in March 1983, but in the remaining four inspections reverted to monthly from March 1983 through to the peak of winter in July 1983. A summary of the inspection history of the 10 houses is given in Table 3.

One person was engaged on a contract basis to carry out all inspections, to achieve a more consistent standard of assessment. An inspection report form was designed for record purposes, and is illustrated in Figure 10. In addition, photographs were taken by the inspecting contractor as he saw fit.

For each inspection, both observational and measurement records were taken. Timber moisture contents of the various sections of structure were taken in a representative number of positions (5 or more) using standard commercial meters and the inspector was requested to report the highest, lowest, and most common reading for each section. Roof space temperatures were read from in situ mercury-in-glass thermometers which remained in position for the entire programme. Relative humidities in the roof spaces were obtained from uncalibrated portable hygrometers which were positioned for random periods to equilibrate, and their readings must accordingly be given less weight. From time to time, 30-day temperature/humidity pen recorders were placed into one or other of the roof or subfloor spaces.

Results

The moisture contents for each of the ten houses, recorded at each inspection are illustrated in Figures 8 and 9.

Houses 1-4

These four houses all received the same treatment of covering the subfloor ground. All four responded in almost the same way.

At the time of selection in March 1982, although few moisture contents were recorded, all roof space timbers were regarded as "dry" by experienced observers.The mean m.c. was thought to be in the vicinity of 15%. However, by the time of applying ground cover (end of April) many of the roof spaces and all the subfloor spaces were relatively moist, with high (20-30%) moisture content in many locations. In all four houses, an immediate or slightly delayed drying stage began, in both roof spaces and floor spaces, and continued throughout the following winter and spring months. During the following summer the lower moisture contents remained, as expected. The following autumn period was not monitored.

Houses 5-6

These two houses, one with gable and one with hipped roof, were both treated by closing the veneer cavity near floor level.

The responses differed quite markedly, with the roof space of house 5 remaining at relatively high moisture contents throughout the winter, and that of house 6 drying out as rapidly and as positively as in houses 1-4. Both roof spaces were dry during the summer.

Both floor spaces remained at high moisture content through the entire programme, summer as well as winter. Moisture content scarcely dropped below 20% at any time, and in a number of places remained over 25% for lengthy periods.

Houses 7-8

These two houses were treated by blocking the veneer cavity at eaves level, and neither appeared to gain any value from the treatment. Moisture behaviour through the winter was typical of the many untreated houses in the district.

In both houses, roof space moisture contents rose to very high levels in winter and remained at those levels for most of the winter. The wettest timbers were those closest to the roof: purlins, rafters, joists - in that order. There were common sightings of extensive visibly wet areas within the roof, with the inspector estimating that 50% of all purlin surfaces and 20% of rafter surfaces were wet or dripping. Roof underlay over most of the roof was reported visibly wet or dripping on several successive monthly visits. Both roof-spaces dried out to the same state as the the other eight during summer.

In both subfloor spaces the timber remained at very high moisture content, at or close to 30% at all locations, summer and winter.

There was a prompt and permanent change in behaviour when the ground under these two houses was covered, during the summer. All subfloor timber m.c. began immediately to fall, by some 2% - 3% per month, to at least 10% below their previous level, where they remained. During the following winter, the roof space moisture content rose, but substantially less than in the previous winter. Visibly wet patches were seen once, in one house, and then only briefly. Otherwise, timber, ceiling insulation, and roof underlay were all reported as "warm and dry to touch", through the winter.

Houses 9-10

These two houses received no treatment for the first winter observation.

The moisture behaviour was of the same kind, but less severe than houses 7 and 8. Again the subfloor timber moisture contents were persistently very high, with no change between summer and winter.

The installation of subfloor ground cover during the summer period had the same dramatic effect as in houses 7 and 8.

Discussion

The most significant feature of these results relates to timing. For example, it is more significant that the m.c. of some part of one house persistently declines after some event, than that another house has higher or lower value at that time. It should be borne in mind that with any set of field observation such as this, there is normally a certain scatter of observations, and a single observation out of pattern may not mean much.

The following features are noted:

- The level of timber moisture content in many of the roof and floor spaces of these houses was persistent and severe, over 25% for long periods. Moisture contents below 20% are typically regarded as satisfactory, whilst timber above 25% is regarded as being prone to decay e.g., BS 5268 Part 2: (1984).

- The principal sources of roof-space moisture in these houses was confirmed to be the subfloor ground. Isolation of that source produced unmistakable coincident and major changes to both subfloor and roofspace moisture content.

- Covering subfloor ground with polyethylene film was a promptly effective treatment for both roof and floor space moisture in every case (8 out of 8).

- Closing veneer cavities, at either top or bottom, was sometimes effective and sometimes ineffective.

- Although not part of the designed survey, one particular case of moisture damage inspected during the survey is of very special interest. One reason for this interest is that the house description differed widely from the usual for this problem, a second reason is that it had a sound vapour barrier in the ceiling.

  This house had weatherboard cladding and galvanised mild steel sheet roofing, and yet had severe roofspace condensation similar to that associated here with masonry veneer. This problem was reported to have existed for nine years. One of the commonly-advanced hypothesis for roof-space condensation problems is the absence of a ceiling vapour barrier - e.g., see Chap. 10 of the IHVE Guide, Book A. At the time of inspection (early July 1982) the ceiling vapour barrier was still in remarkably sound condition, and yet it had clearly not helped control the moisture problem.

  A brief inspection showed that although there were no veneer cavities, subfloor air could and did pass readily to the roof space, via an attached garage open to both. The ground was promptly covered with polythylene film. Within two weeks all visible water in the roof space had disappeared, and in one further week all materials were apparently dry.

- Occupant reaction was decisive, and revealing. The survey did not include a questionnaire, but the inspecting contractor reported occupant comment voluntarily.

  From the time any ground cover was placed, occupant comment in every case switched from negative ("cold", "difficult to heat", "condensation on windows") to positive ("warm and dry", "house much easier to keep warm"). In virtually all other cases, with other remedial treatments, the occupants were not too impressed, even when the timbers were drying satisfactorily.

  This qualitative result is thought to be important, but an explanation has not been verified. The consistency of the comments makes it clear that there is a real underlying cause of this reaction. Normally however, one would expect that a drier house would imply lower relative humidity, and that in turn would imply a sensation of cooler conditions, not warmer. It is thought that the cause may be that floor and/or wall surfaces were in fact being kept moist by wet subfloor conditions, and become cooled by evaporation when indoor heating is used.

- All roofs dried out to a similar level in summer.

CONCLUSIONS

1. Some 65-70 cases of moisture damage per year were investigated by BRANZ in the Otago/Southland region during the observation period, from a region containing some 88,000 houses with average construction rate of 1400 per year over the past 30 years.

2. A large proportion of these cases related to severe wintertime roof-space condensation.

   This condition has been shown to be a consequence of airborne moisture from the subfloor region to the roof-space, usually via open masonry veneer wall cavities.

3. Excess subfloor moisture was also found to be a common fault, with moisture content of subfloor timber at very high levels for extended periods. This was attributed to a combination of wet ground, inadequate vent openings, and obstruction of vents.

4. Both roofspace and subfloor excess moisture problems could be rapidly and inexpensively controlled by covering the subfloor ground with polyethylene film. Other methods of control were found to be unreliable.

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Source of Moisture	Subfloor/ Floor	Wall	Roof	Internal	Other	Total
Construction Moisture	-	5	1	-	-	6
Ground Moisture	-	-	-	-	-	61
Indirect	-	11	35	-	-	46
Direct	15	-	-	-	-	15
Rain	-	2	-	-	-	2
Vapour	-	-	-	-	-	0
Other	1	-	2	11	4	18
Total	16	18	38	11	4	87

Table 1: Moisture damage - location of problem and source

		Yes	No	Don't know	Total
Roof Condensation Observed	Yes	34	2	2	38
	No	2	26	21	49
	Total	36	28	23	87

Table 2: Moisture damage - presence of open veneer cavity

EVENT	HOUSE NO. 1	2	3	4	5	6	7	8	9	10	YEAR
Pre-inspection	30 Mar	18 Mar		19 Mar	30 Mar	30 Mar	19 Mar	5 Apr	26 Mar	31 Mar	
Ground covered	29 Apr	27 apr	3 May	29 Apr							
Bottom veneer cavity blocked					30 Apr	26 Apr					
Eaves veneer cavity blocked							20 Apr	21 Apr			
1st report	3 May	27 Apr	3 May	1 May	2 May	26 Apr	20 Apr	21 Apr	24 Apr	24 Apr	
Leaking waste pipe fixed				1 May							
2nd report ("weather warm")	10 Jun	10 Jun	11 Jun	2 Jun	11 Jun	12 Jun	10 Jun	2 Jun	2 Jun	11 Jun	
Ventilation rate measured								2 June			1982
Clothes drier discharge moved					11 Jun						
Oil-fixed central heating fitted						Jun					
3rd report ("very cold")	12 Jul	12 Jul	12 Jul	12 Jul	12 Jul	13 Jul	14 Jul	12 Jul	12 Jul	12 Jul	
4th report	9 Aug	12 Aug	9 Aug	9 Aug	10 Aug	10 Aug	12 Aug	10 Aug	10 Aug	12 Aug	
Laundry overflow	Aug										
Ventilation rates measured		12 Aug		12 Aug			12 Aug			12 Aug	
5th report ("very wet")	13 Sep	13 Sep	10 Sep	10 Sep	13 Sep	13 Sep	11 Sep	11 Sep	10 Sep	10 Sep	
"Extra heating for patient"							Sep				
6th report ("very wet")	12 Nov	10 Nov	10 Nov	8 Nov	8 Nov	10 Nov	12 Nov	12 Nov	8 Nov	12 Nov	
Minor roof leaks fixed								12 Nov			
7th report	13 Jan	12 Jan	12 Jan	12 Jan	12 Jan	13 Jan	30 Jan	12 Jan	12 Jan	12 Jan	
Roof nail leaks fixed	13 Jan										
Ground Covered						Jan/Feb	Jan/Feb	Jan/Feb	Jan/Feb		
8th report	8 Mar	7 Mar	7 Mar	7 Mar	7 Mar	1 Mar	7 Mar	8 Mar	7 Mar	8 Mar	
9th report							6 Apr	5 Apr	5 Apr	5 Apr	
shower leak fixed										5 Apr	1983
10th report							7 May	7 May	7 May	7 May	
11th report							10 Jun	10 Jun	10 Jun	10 Jun	
roof nail leaks fixed										10 Jun	
leaking window blockwork fixed										10 Jun	
alterations, roof open								Jun-Jul			
12th report							17 Jul	17 Jul	17 Jul	17 Jul	
house exterior painted										17 Jul	
Final inspection	22 Aug	21 Aug	21 Aug	21 Aug	21 Aug	-	21 Aug	22 Aug	-	-	

TABLE 3. HISTORY OF EVENTS FOR 10 HOUSES

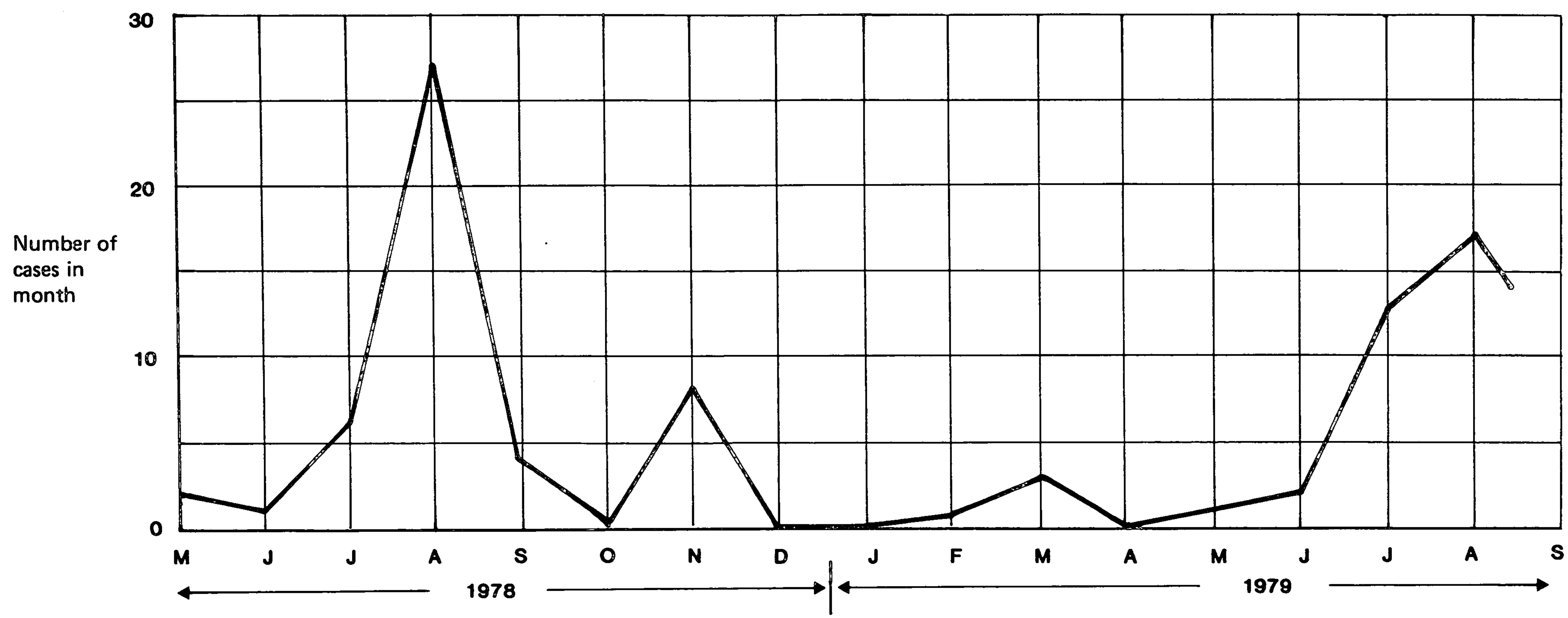


FIGURE 1: ANNUAL DISTRIBUTION OF MOISTURE PROBLEMS REPORTED

Figure 2 : Mould growth near corner due to inadequate wall insulation.

Figure 3 : Built-up ground causing subfloor flooding.

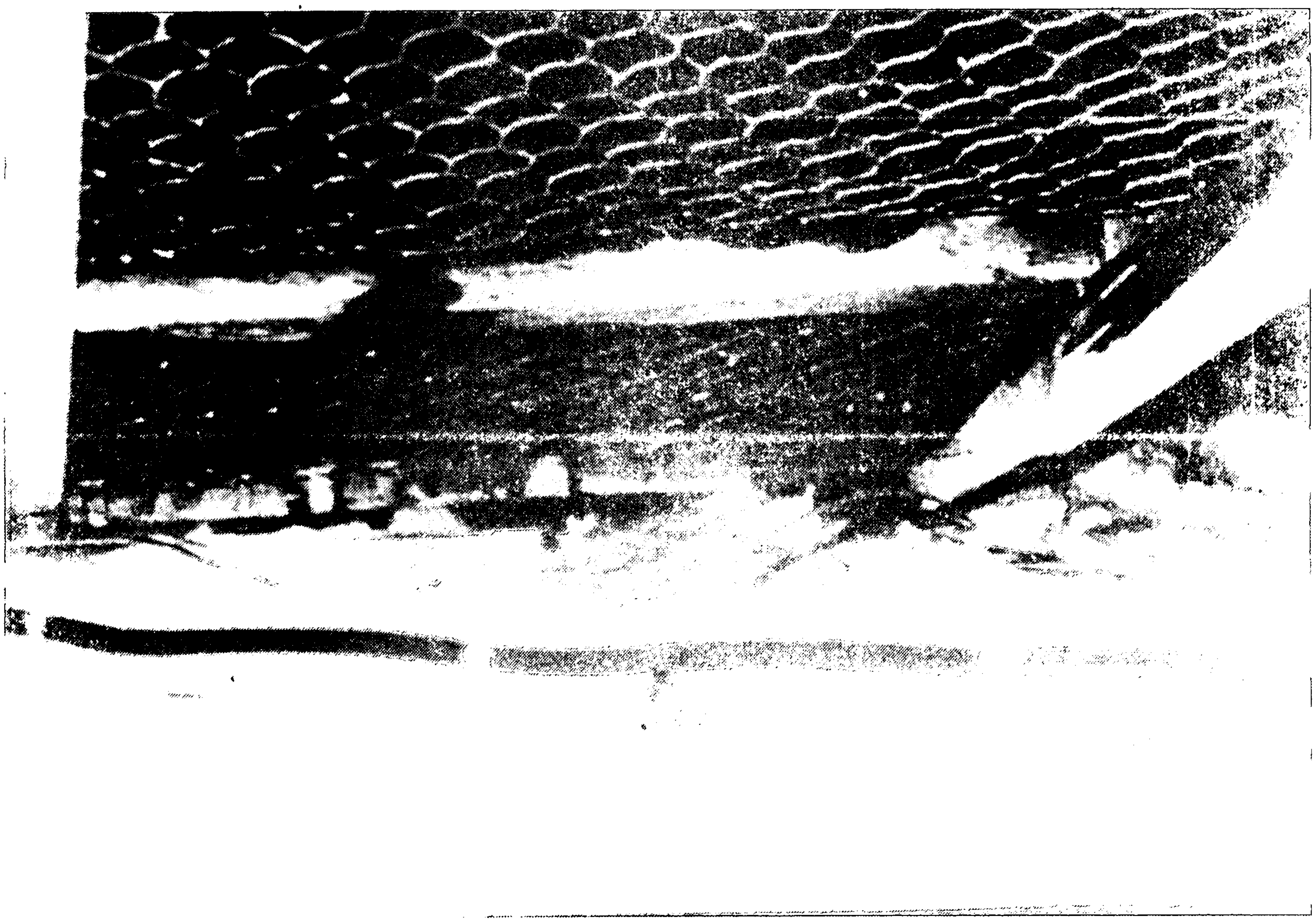


Figure 4 : Roof condensation with fibreglass insulated ceiling, from subfloor moisture (dark timber patches are wet).

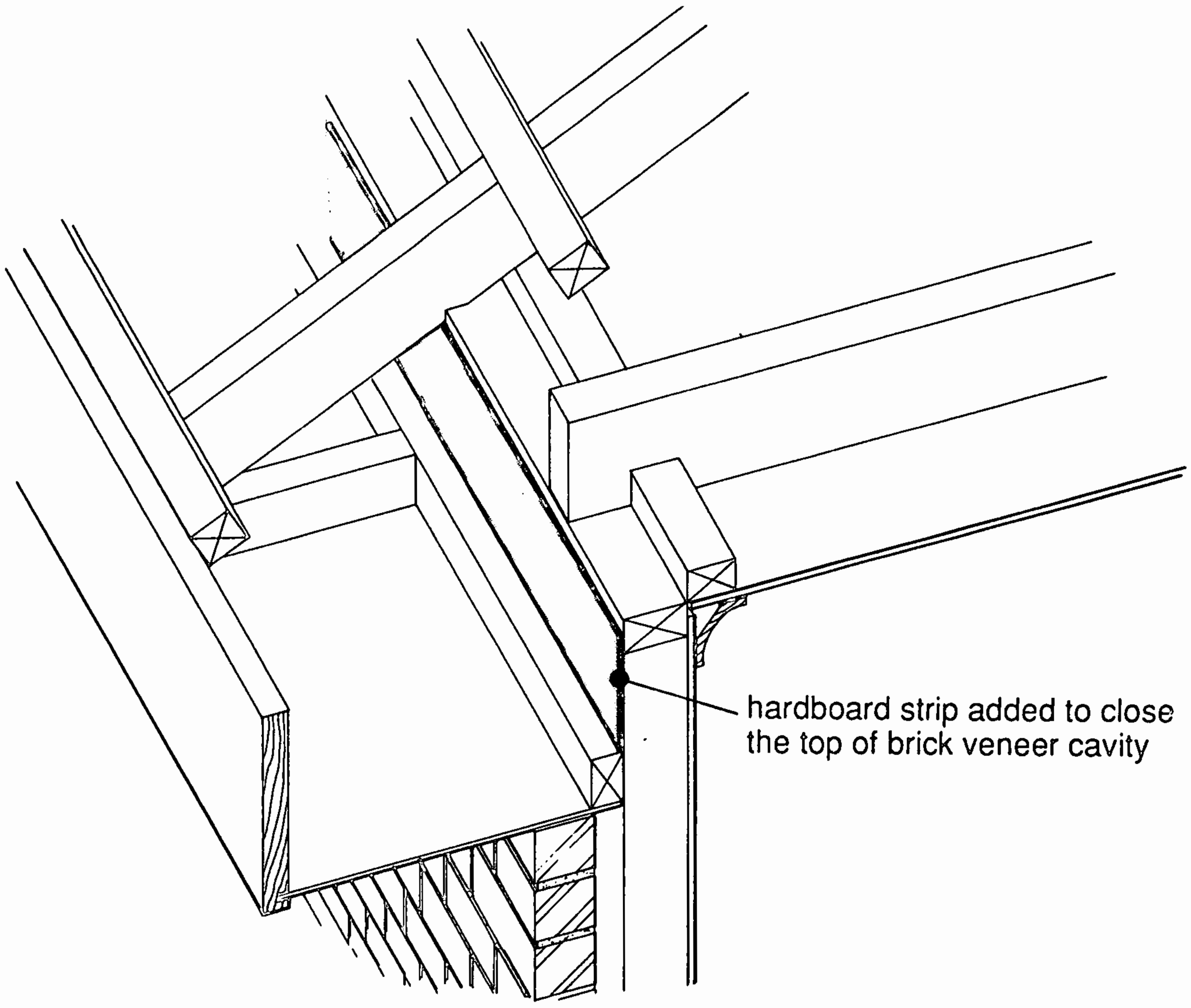


Figure 5 : Method of blocking eaves.

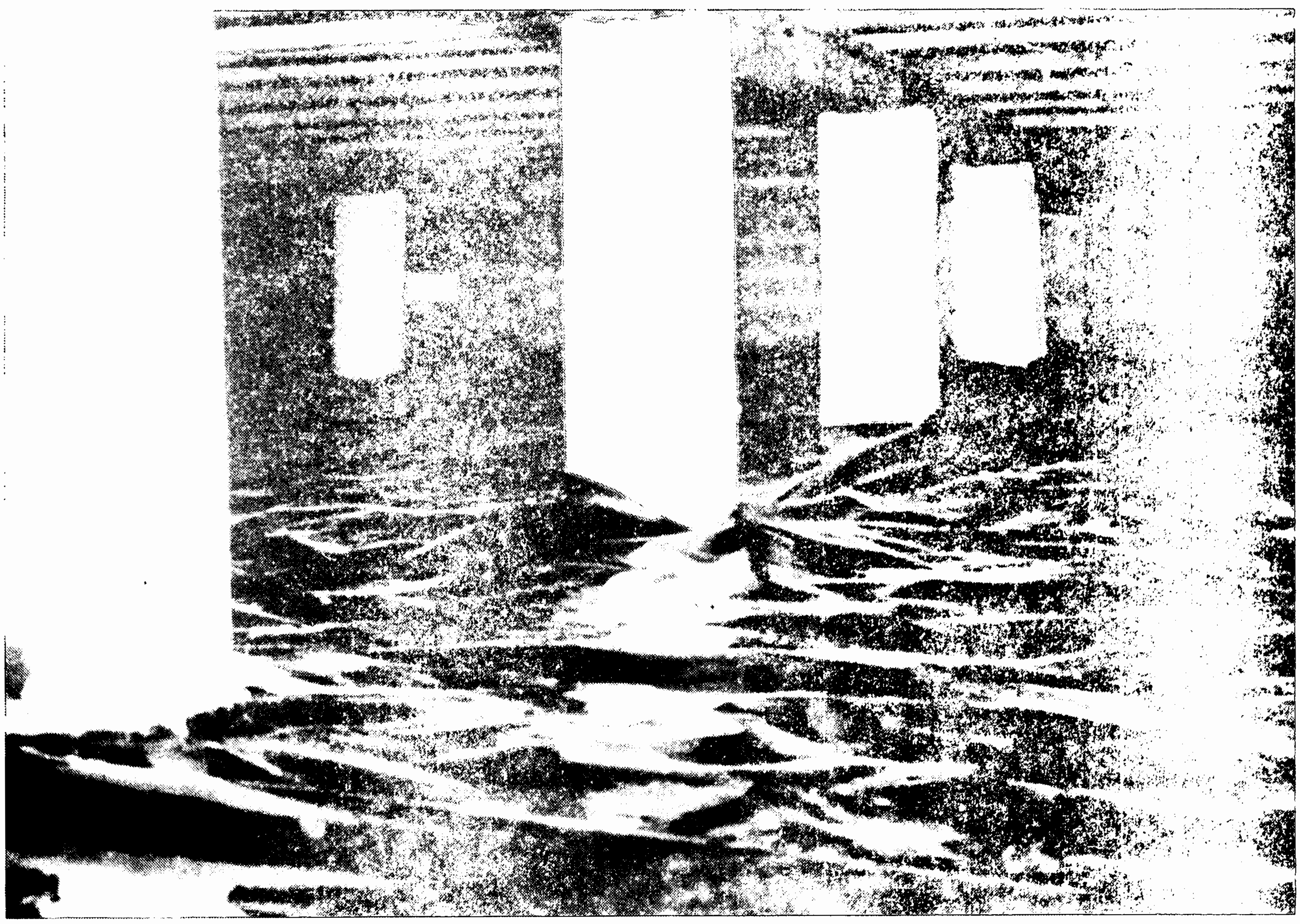


Figure 6 : Method of covering ground.

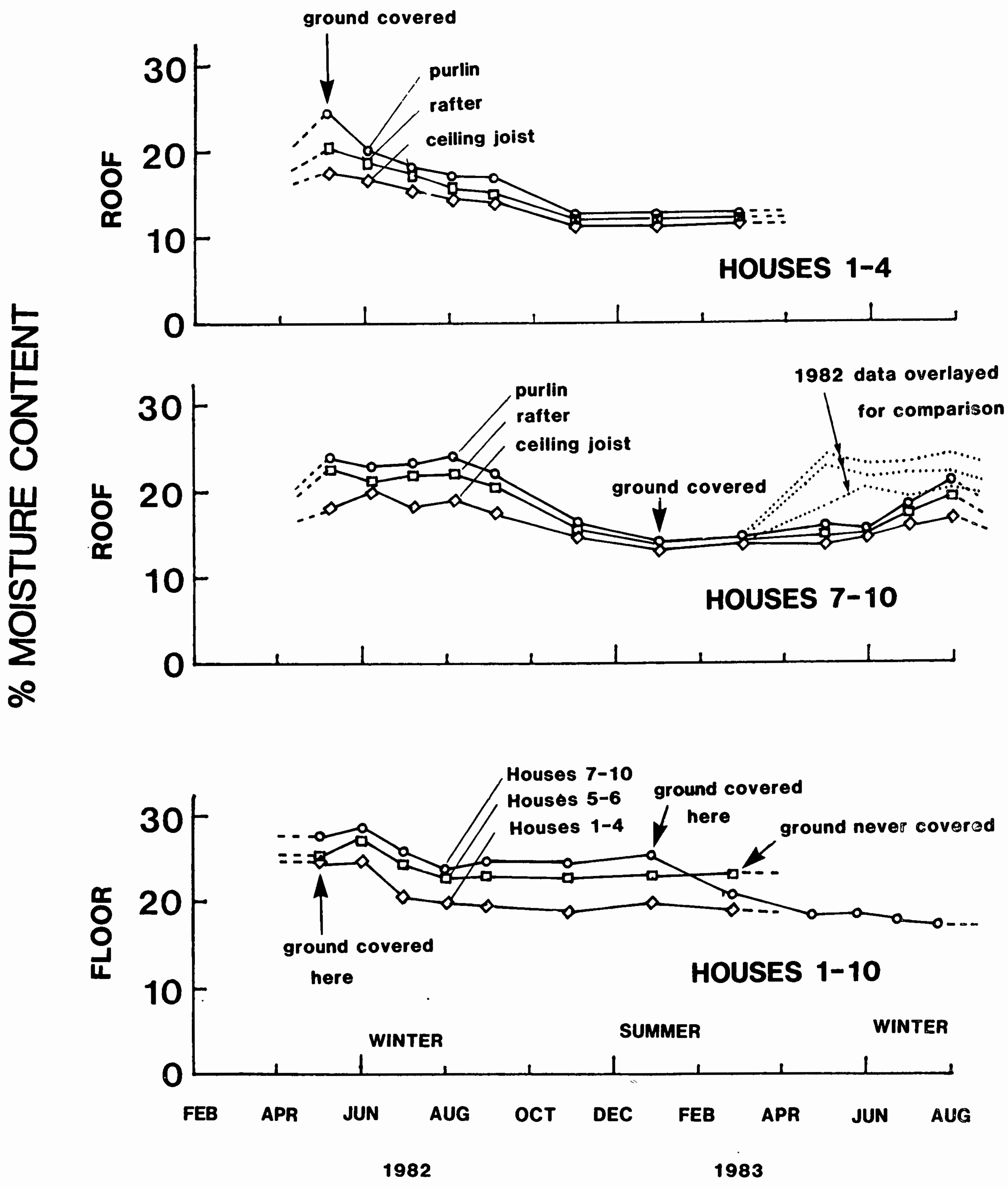
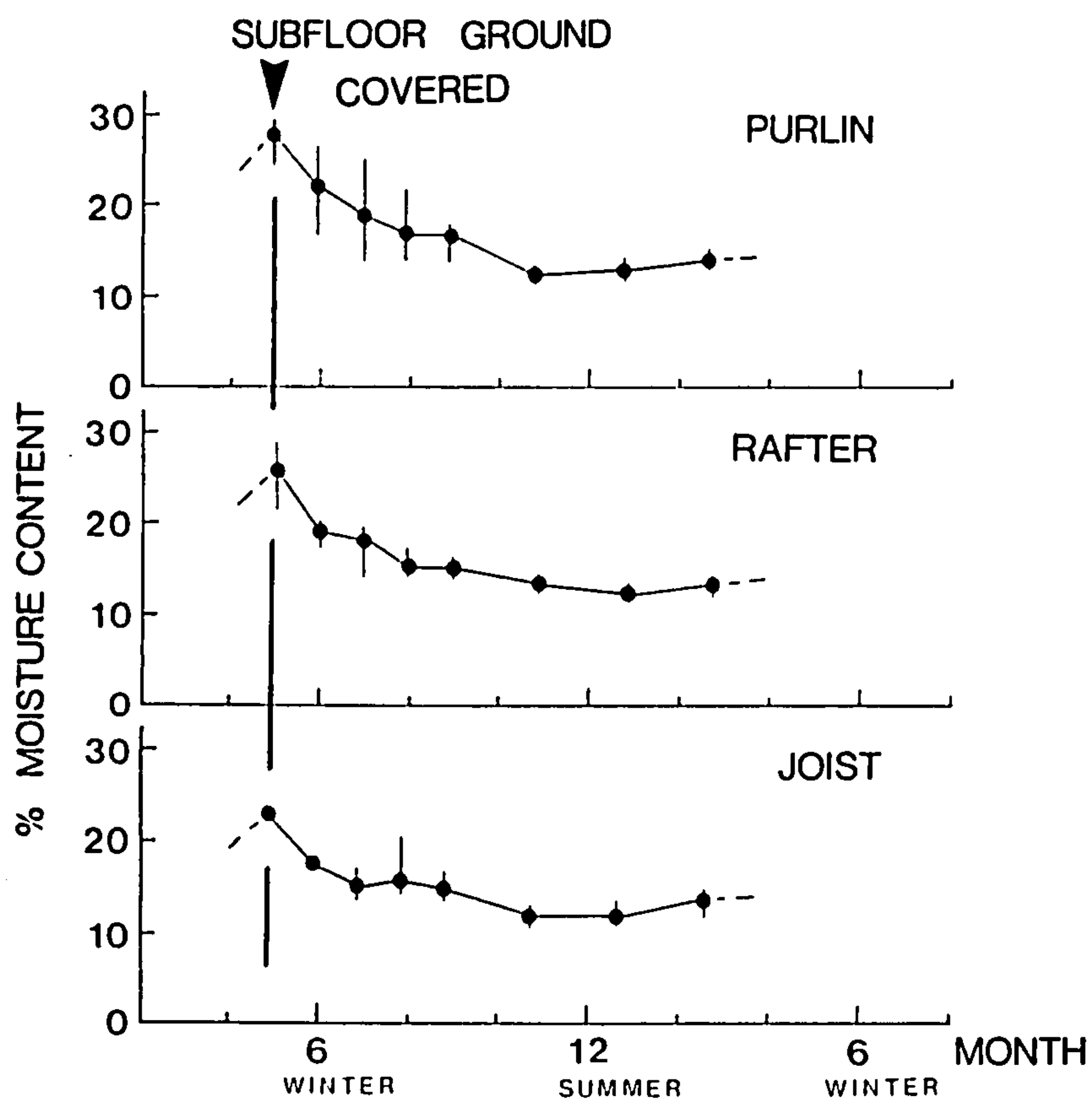
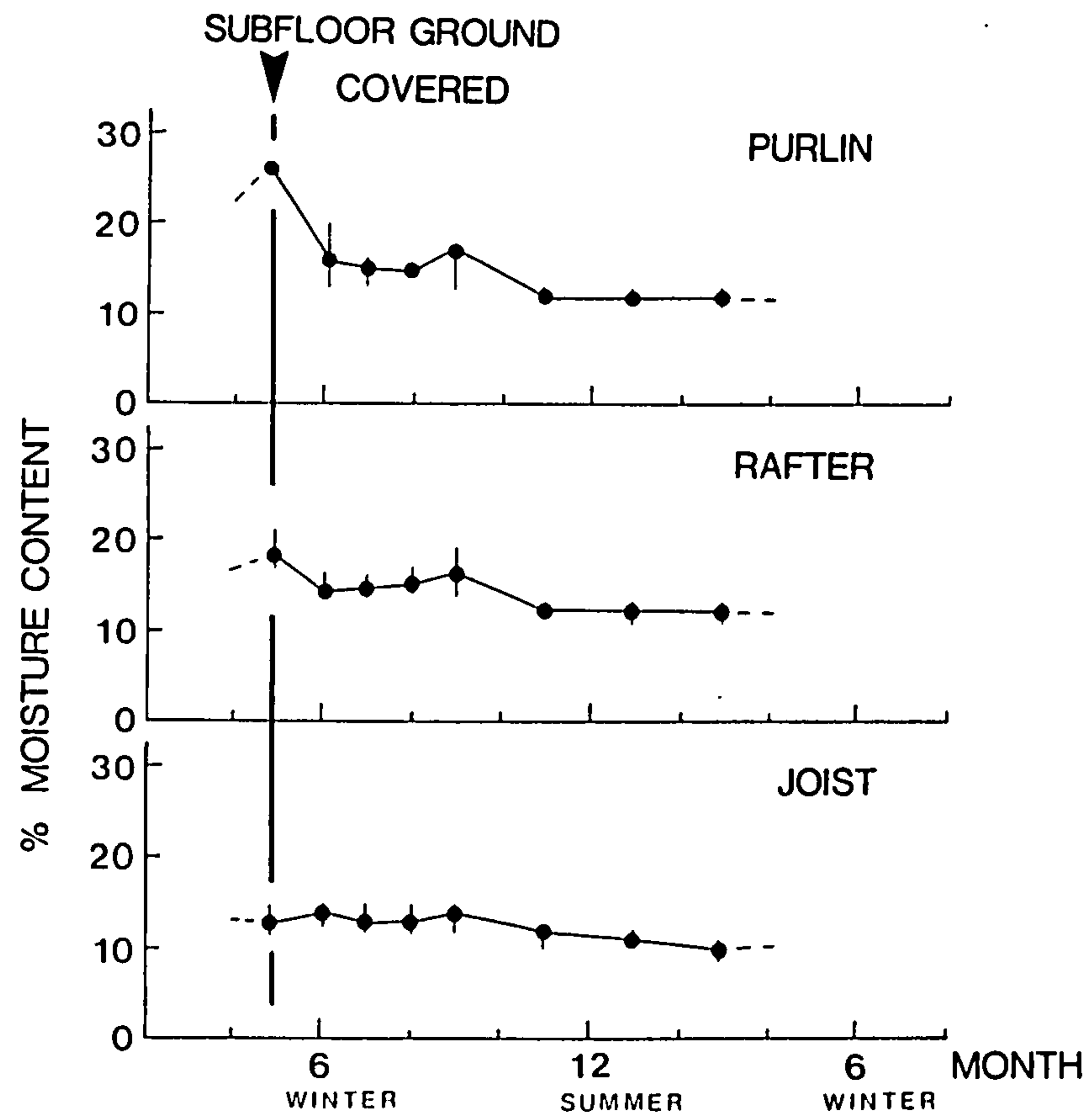


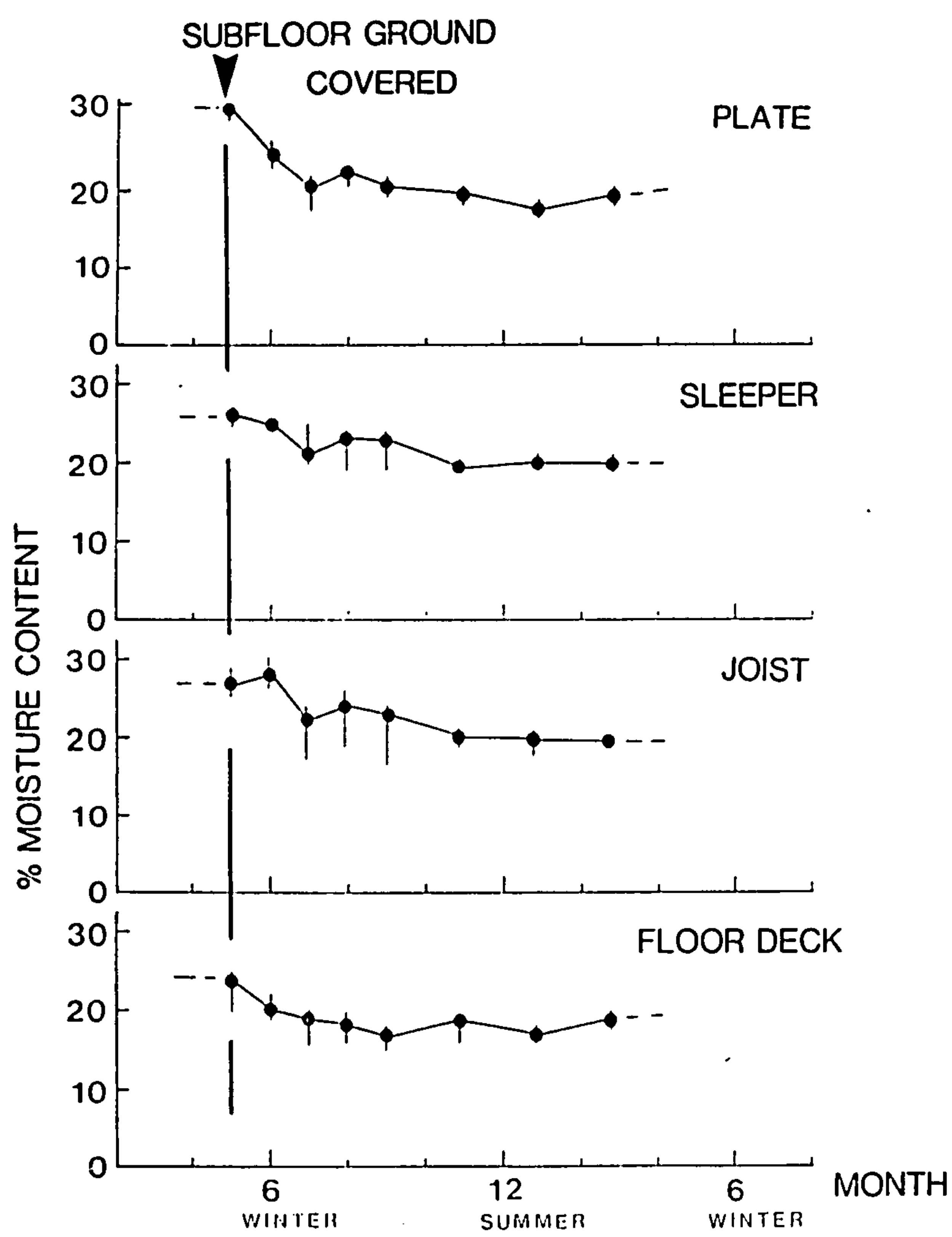
FIG. 7 COMBINED SUMMARY OF MOISTURE CONTENT OBSERVATIONS



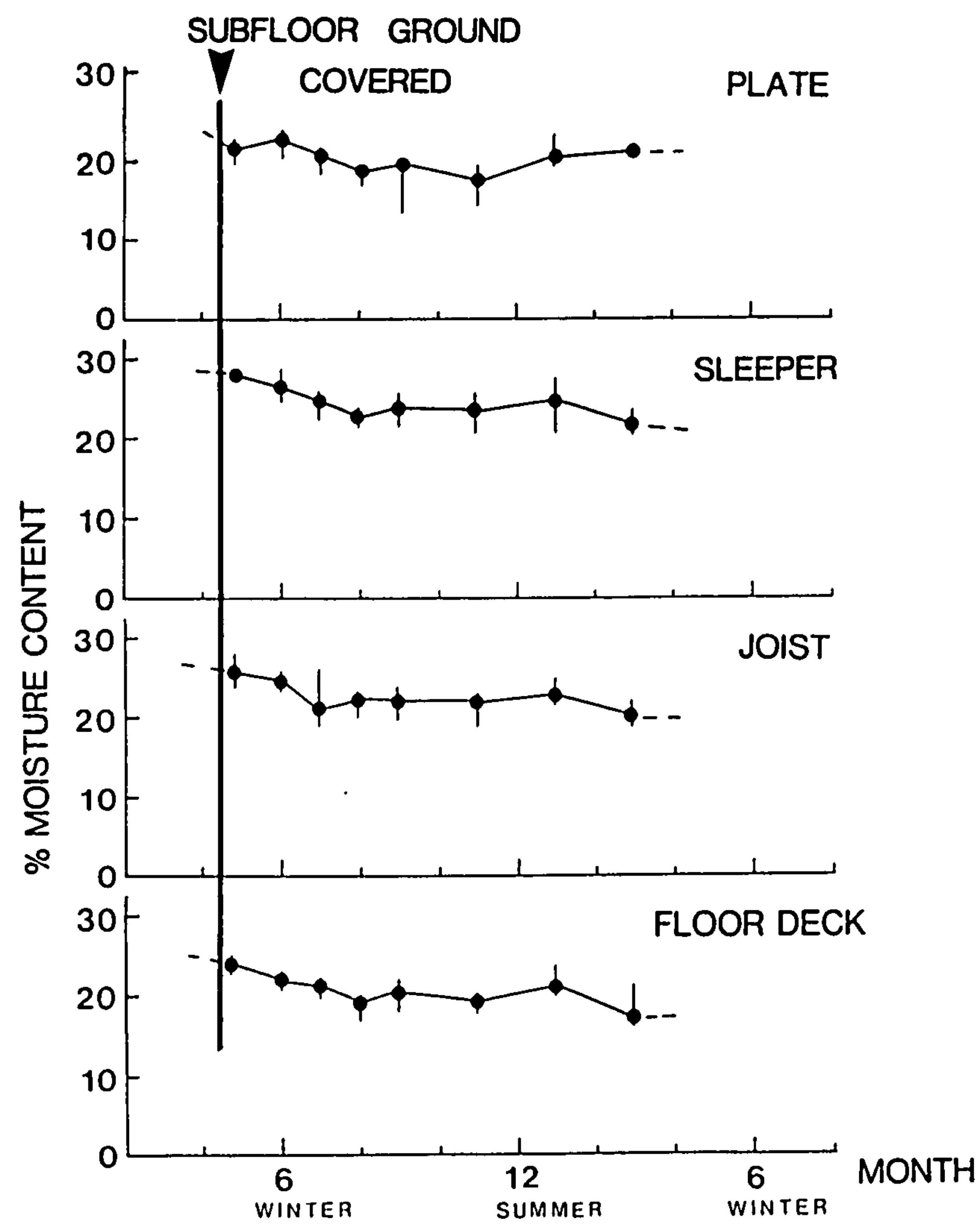
HOUSE 1 ROOF



HOUSE 2 ROOF



HOUSE 1 FLOOR



HOUSE 2 FLOOR

Fig 8 (a) : Individual m.c. observations in 10 houses.

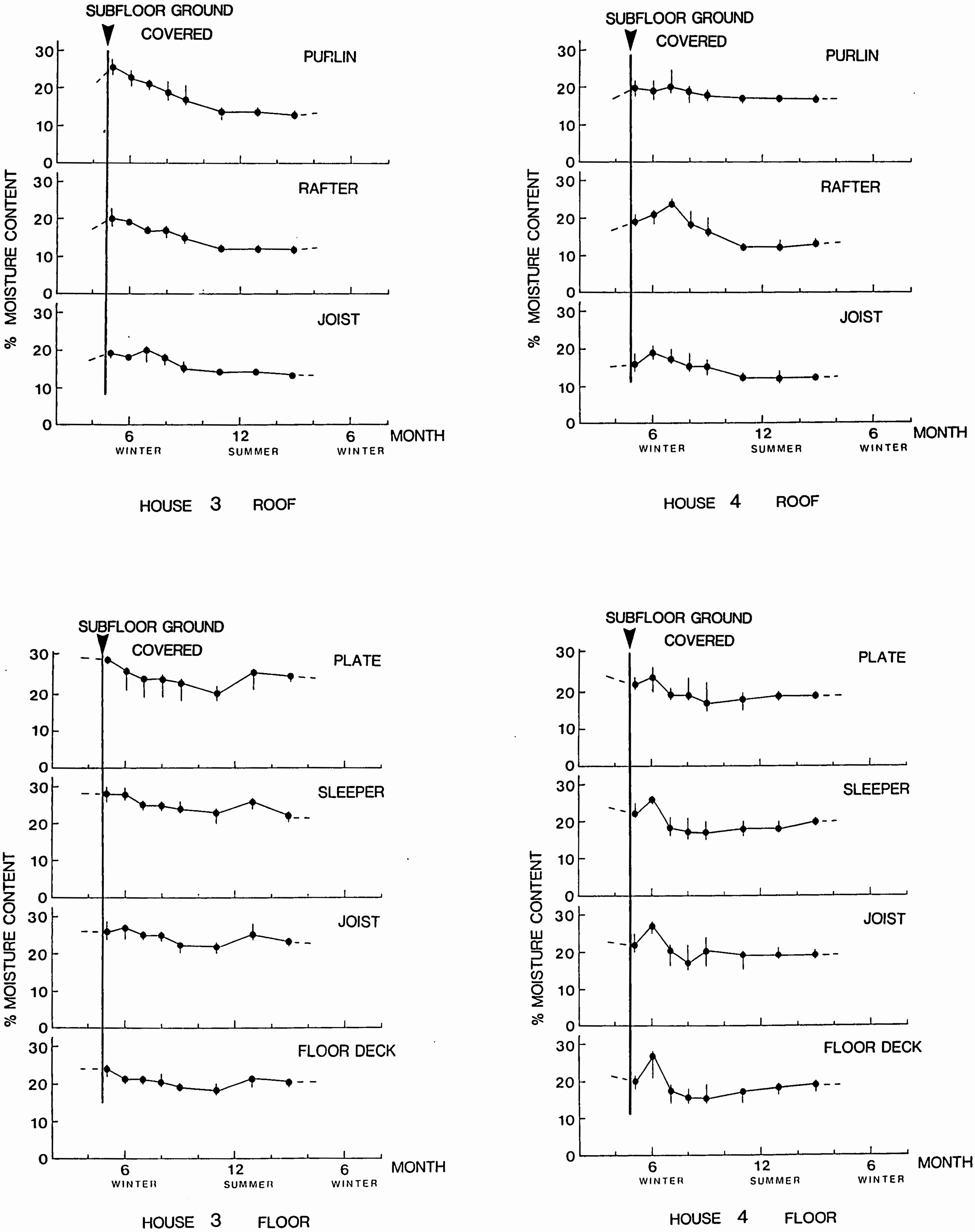


Fig 8 (b) : Individual m.c. observations in 10 houses.

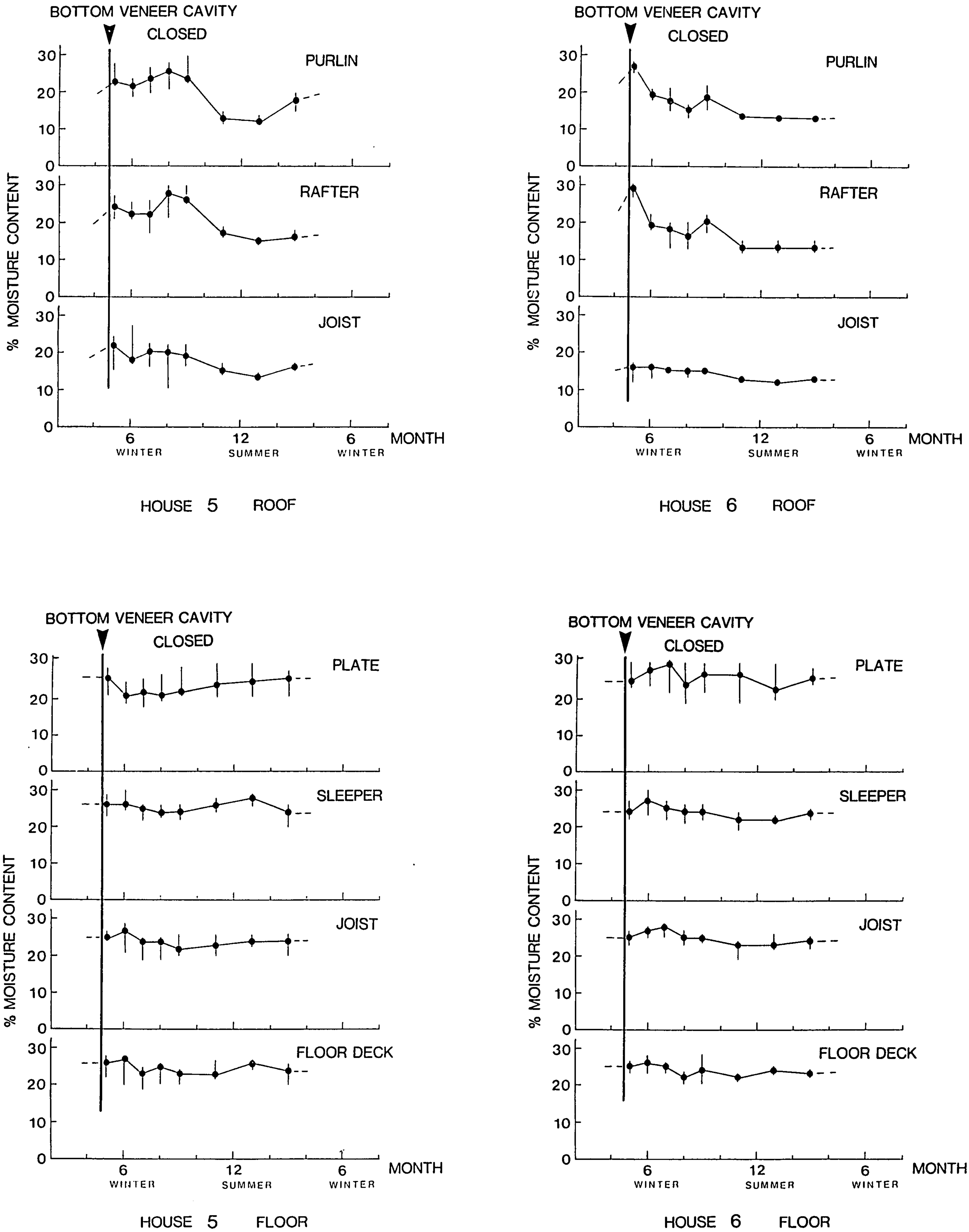
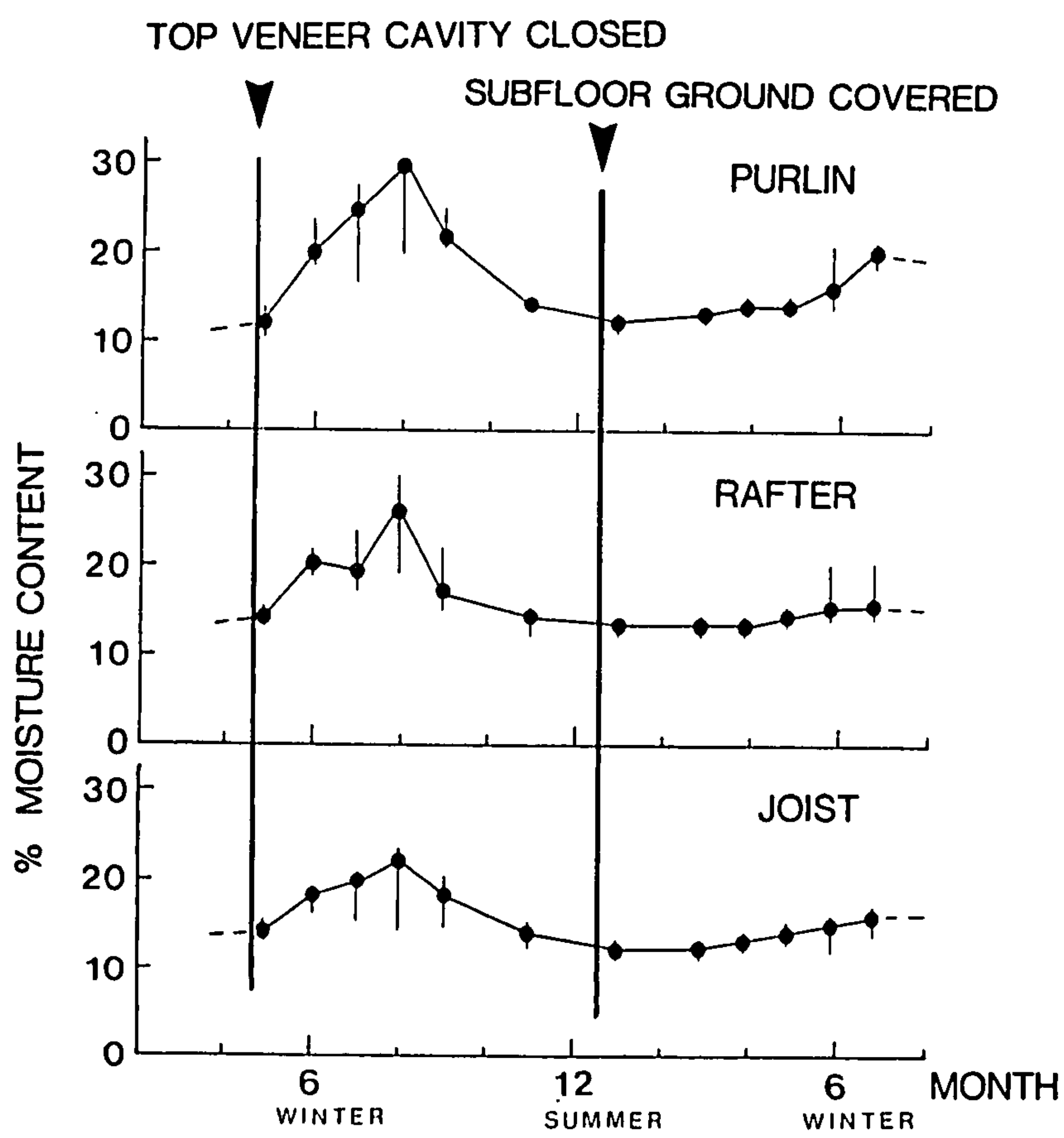
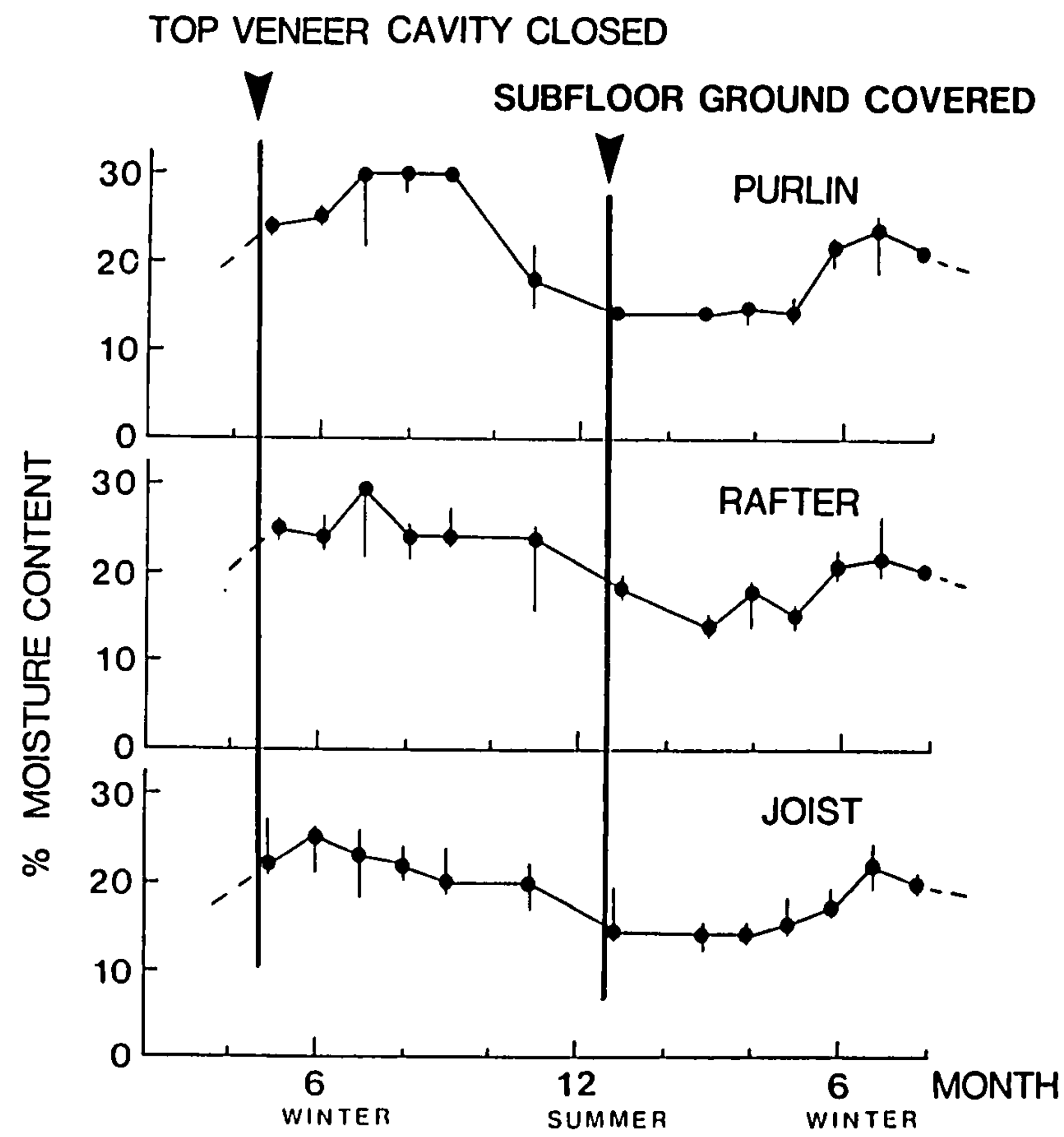


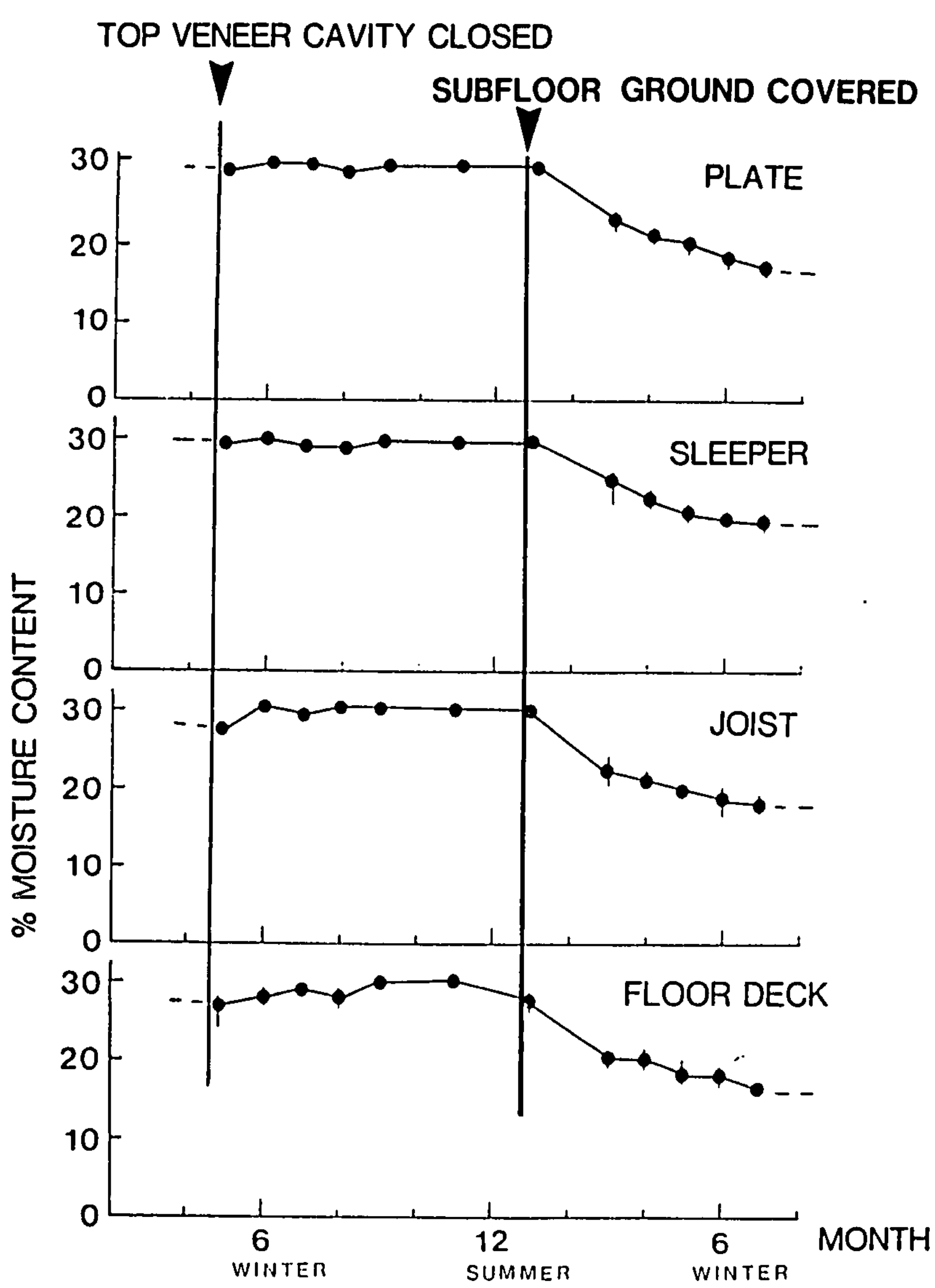
Fig 8 (c) : Individual m.c. observations in 10 houses.



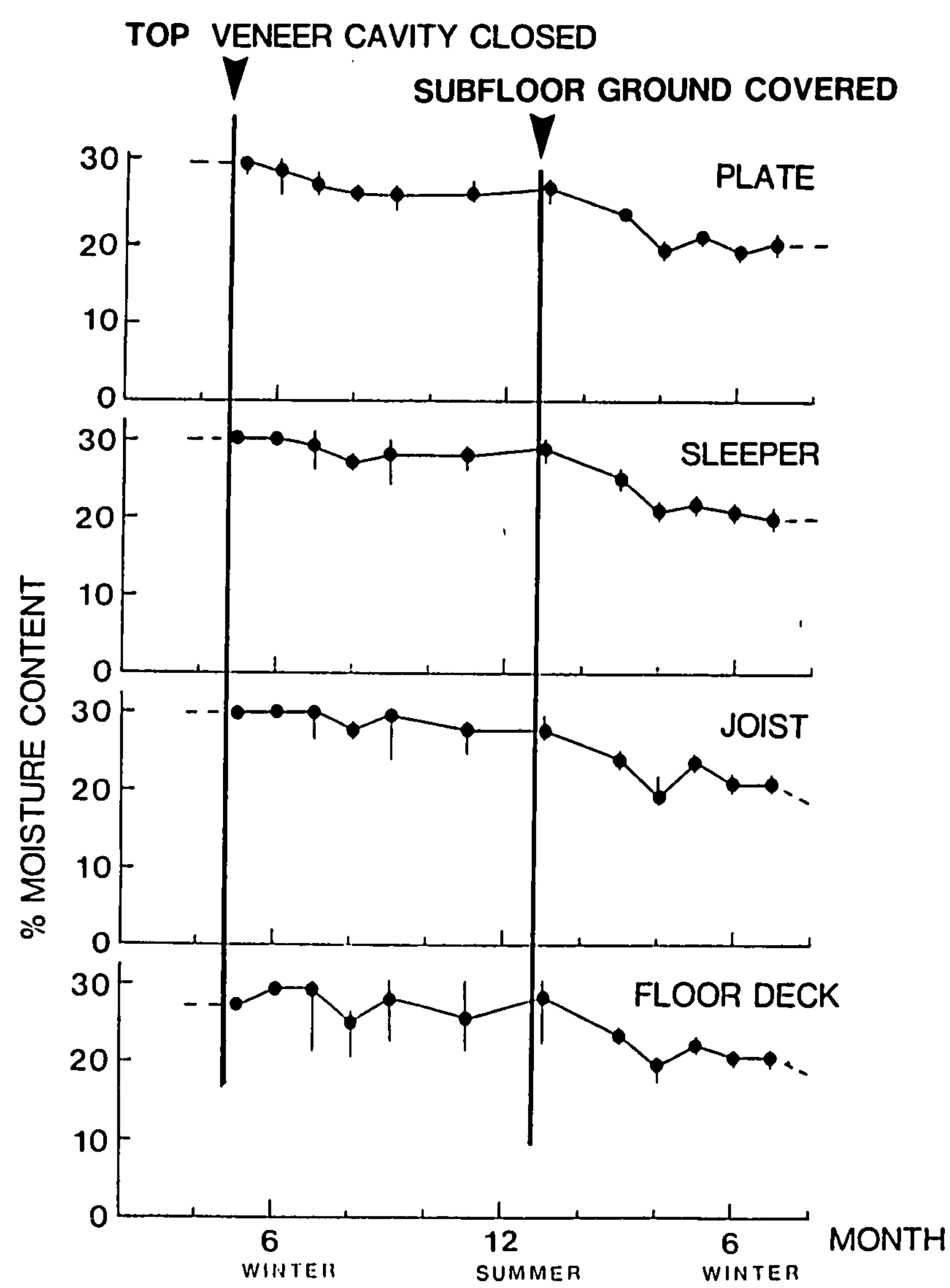
HOUSE 7 ROOF



HOUSE 8 ROOF

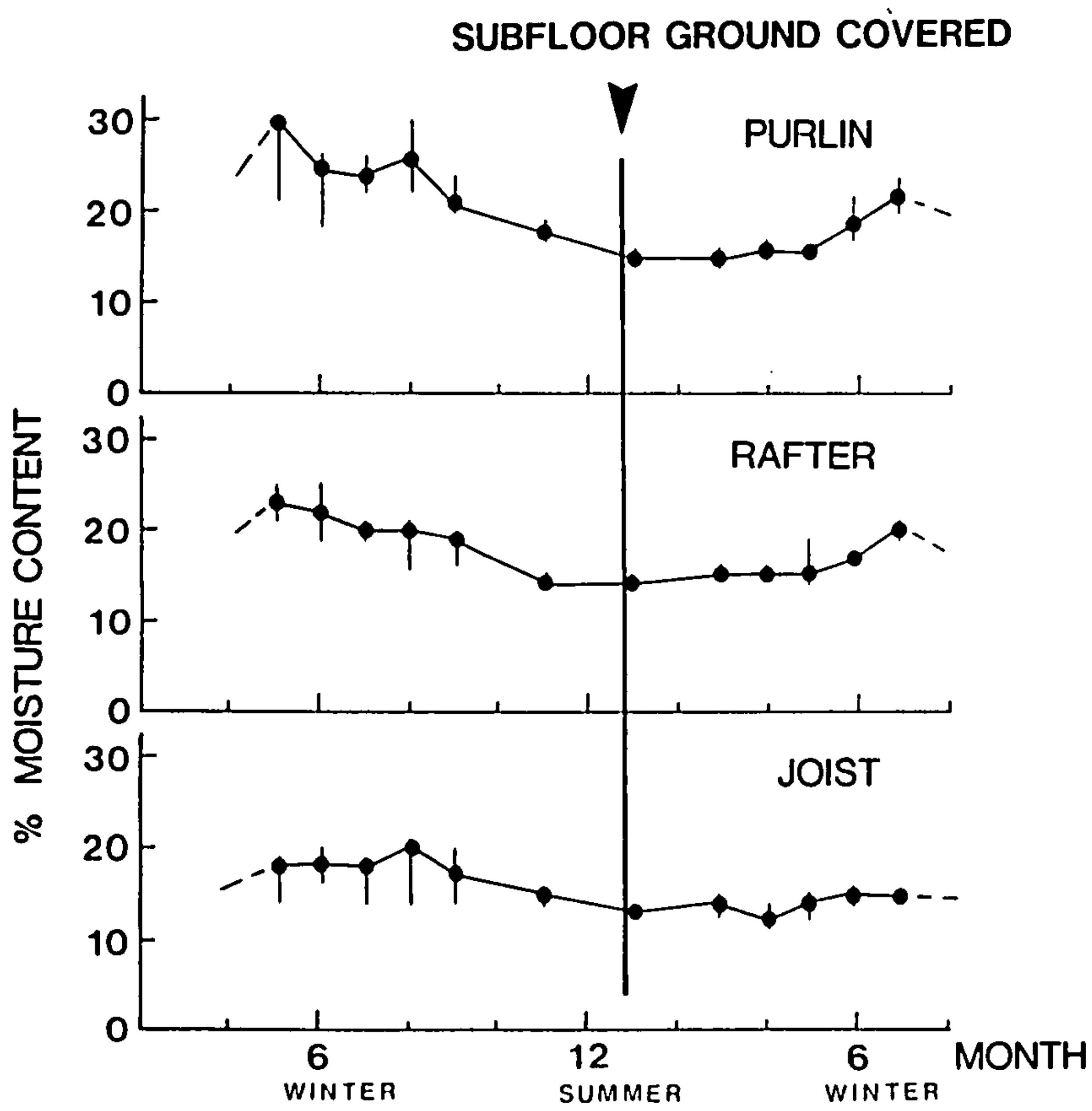


HOUSE 7 FLOOR

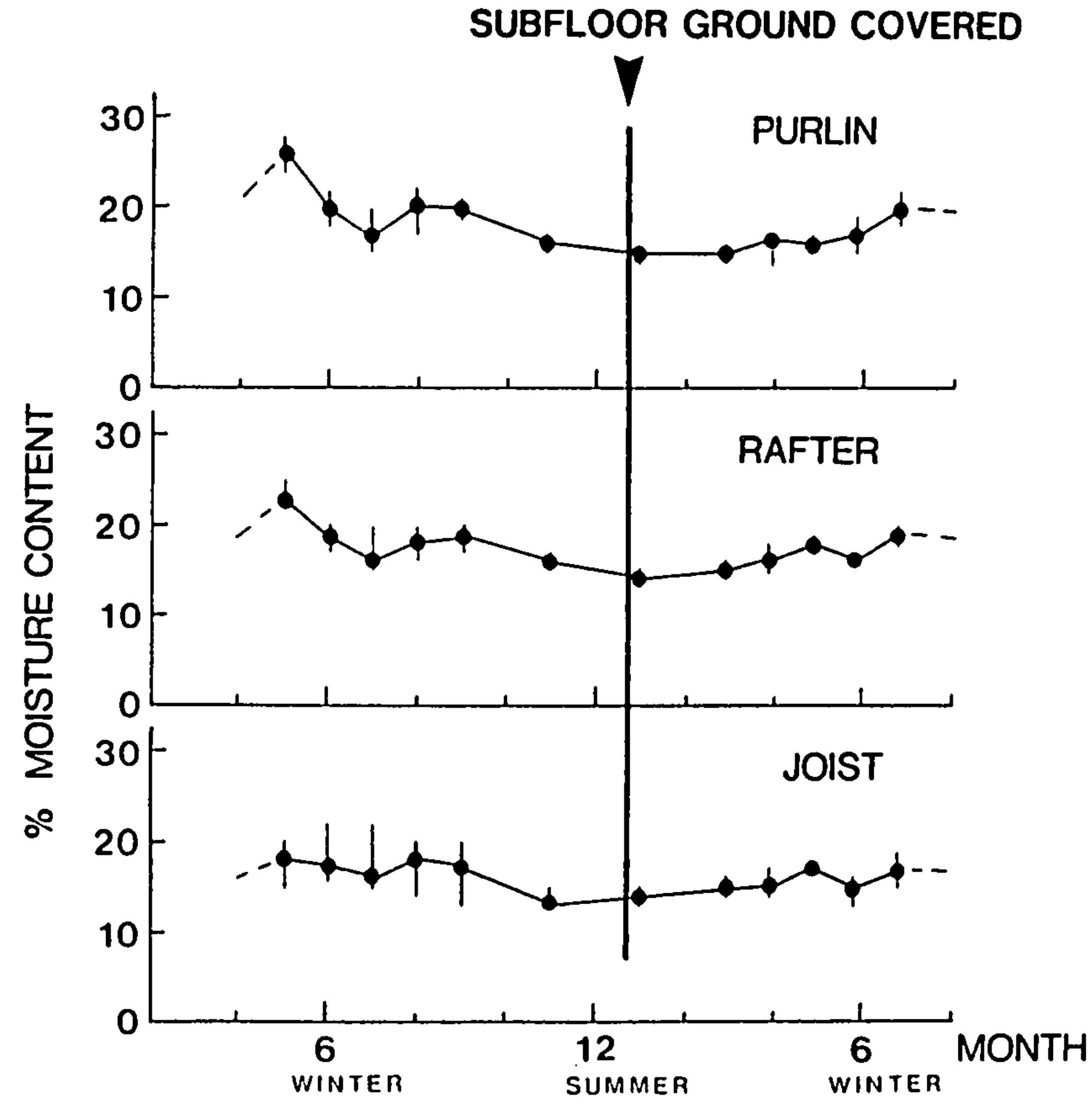


HOUSE 8 FLOOR

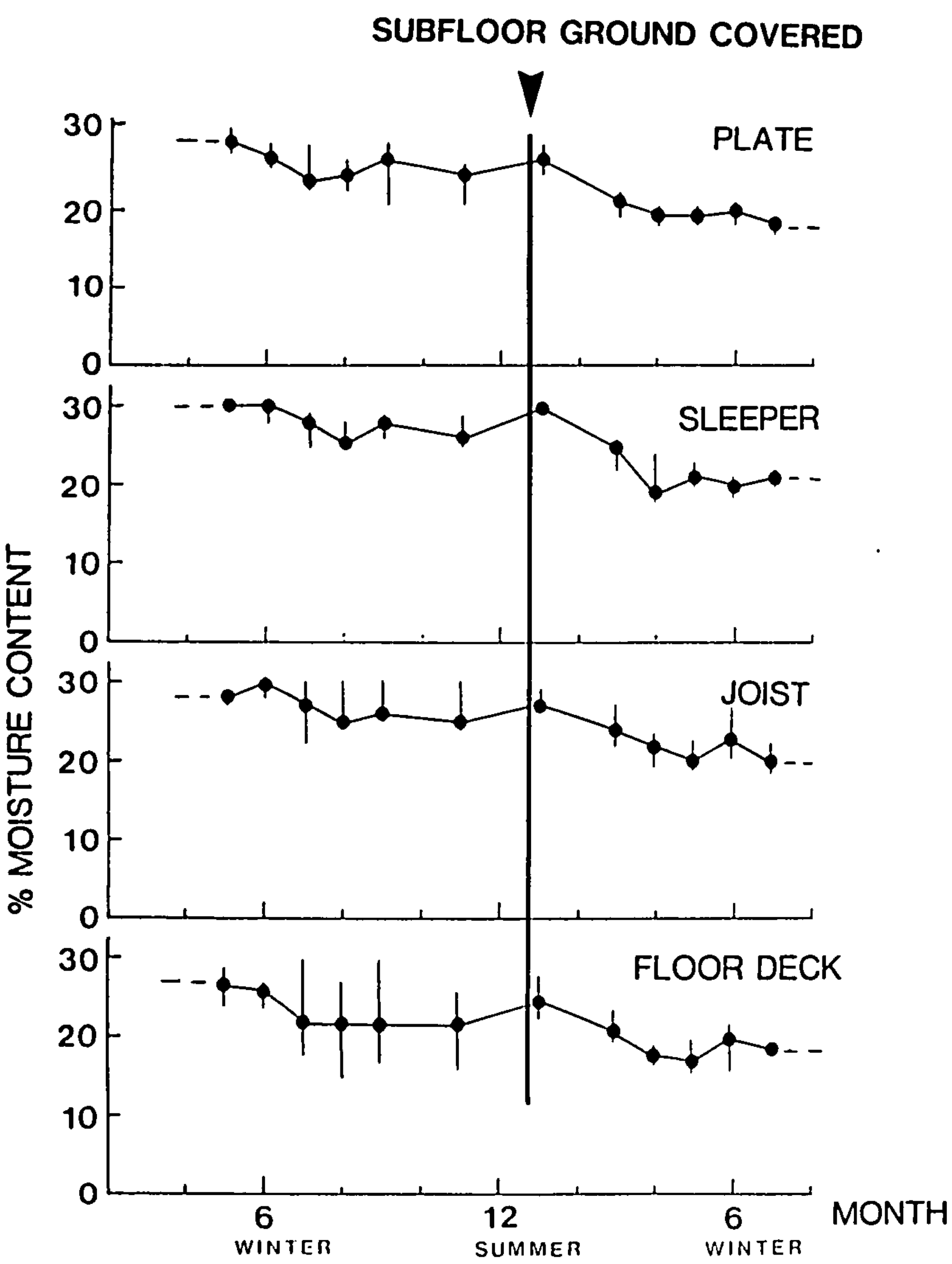
Fig 8 (d) : Individual m.c. observations in 10 houses.



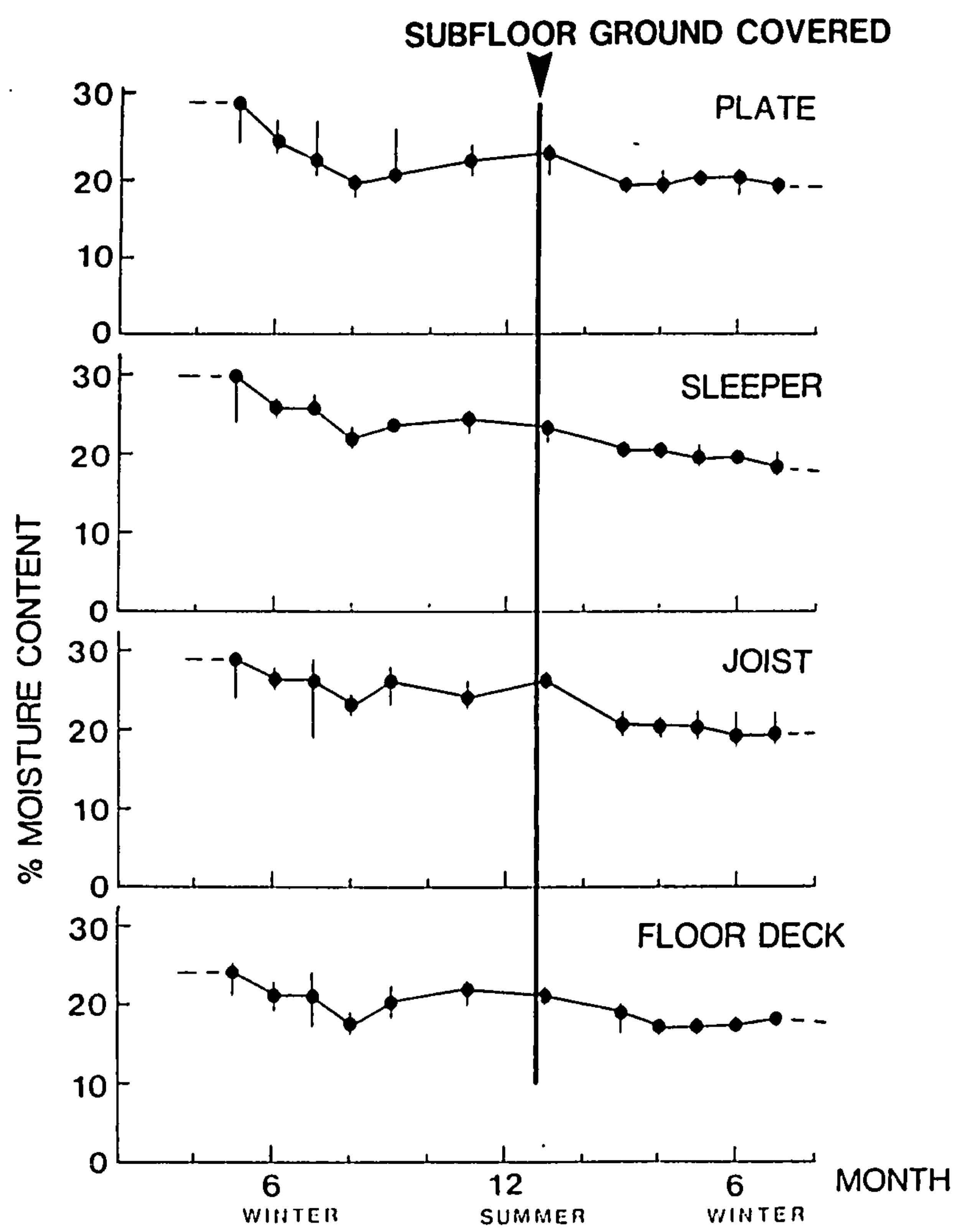
HOUSE 9 ROOF



HOUSE 10 ROOF



HOUSE 9 FLOOR



HOUSE 10 FLOOR

Fig 8 (e) : Individual m.c. observations in 10 houses.

NAME: XXXXXX INSPECTION NUMBER: 5
DATE: 13 September 1982 TIME: 4.30pm
ADDRESS: XXXXXXXXXXX

WEATHER CONDITIONS: Fine, cool 8 knot s/w wind 6/8 cloud

ROOF PURLINS: 0% VISIBLY WET
18% mc (high) 17% mc (avg) 14% mc (low)

JOISTS: 0% VISIBLY WET
17% mc (high) 15% mc (avg) 14% mc (low)

RAFTERS: 0% VISIBLY WET
15% mc (high) 15 % mc (avg) 14 % mc (low)

RIDGE: 14/15% mc. Under-purlin 14/17% mc. Batten 16/15% mc

TEMPERATURE:	Ceiling 18°C	Midway -	Ridge 19°C
HYGROMETER:	Ceiling 70%	Midway -	Ridge 72%

ROOM: TEMPERATURE 17°C HYGROMETER 82%

OUTSIDE TEMPERATURE 9°C HYGROMETER 70%

SUB FLOOR: PLATE:	22% mc (high)	20% mc (avg)	19% mc (low)
SLEEPER:	23% mc (high)	22% mc (avg)	18% mc (low)
FLOOR JOIST:	24% mc (high)	23% mc (avg)	17% mc (low)
FLOORING:	18% mc (high)	17% mc (avg)	15% mc (low)

TEMPERATURE 10°C HYGROMETER 65%

FLOORING IN HOUSE: 17% 15% 14%
MOISTURE METER
MODEL NO MA 508257

UNDERLAY dry

INSULATION: dry warm batts

COMMENTS:
- Roof space timber continues to reduce about 3%
- subfloor much the same
- inside floor moisture has reduced
- several floor boards now creaking
- owner claims beds and house feels much warmer

Figure 9: Sample Inspector's Report

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