FATE OF FENITROTHION IN FOREST TREES VII.

PERSISTENCE, TRANSLOCATION AND METABOLISM OF C^{14} - FENITROTHION IN CONIFERS

by

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RÉSUMÉ

On a fait une étude du devenir et de la rémanence du fénitrothion marqué au C^{14}, appliqué en serre à des semis de sapins baumiers, d'épinettes blanches et de pins gris de 4 ans. L'insecticide a disparu rapidement de la surface du tissu des conifères alors que les résidus absorbés ont été plus rémanents. L'absorption et la rémanence étaient directement reliées entre elles et étaient plus élevées pour le pin, l'épinette et le sapin selon un ordre croissant. Une étude in vitro effectuée sur des surfaces de verre a démontré que la disparition rapide du pesticide était probablement due à la volatilisation. La chromatographie sur couche mince des produits d'extraction des conifères a confirmé ce mécanisme de dissipation puisque les métabolites cycliques marqués étaient présents pour la plupart en quantités infimes (traces).

Le traçage autoradiographique a révélé la tendance du fénitrothion C^{14} à se transporter de façon acropète dans le feuillage du sapin et, à un degré moindre, de l'épinette. L'histoautoradiographie a confirmé que ce phénomène se produisait par les vaisseaux du xylème. On a conclu que ces résultats confirmaient l'aptitude à servir du fénitrothion d'insecticide endothérapique contre la tordeuse des bourgeons de l'épinette.

INTRODUCTION

Fenitrothion, (0,0-dimethyl-0-(4-nitro-m-tolyl)-phosphorothioate) has been used since 1967 in place of DDT for operational control of lepidopterous defoliators in Canadian forests. By 1975, some 21 million hectares (52 million acres) of forest had been sprayed at an average rate of 0.28 kg/ha (4 oz/acre) in an attempt to control the spruce budworm, *Choristoneura fumiferana* (Clemens) (Roberts, 1975). Initial field investigations have demonstrated rapid dissipation of fenitrothion from conifers, however, Yule and Duffy (1972) observed 10% of the material to persist at least 8 months after the spray. Recent evidence indicated that this persistent residue accumulated in balsam fir foliage in proportion to the number of applications and total dosage of fenitrothion delivered (Yule, 1974). Our previous investigation (Moody et al, 1975) demonstrated that volatilization was mainly responsible for the initial rapid dissipation of fenitrothion from foliar surfaces of balsam fir, *(Abies balsamea* (L.) Mill) and white spruce, *(Picea glauca* (Moench) Voss) grown under greenhouse conditions. After 7 days, greater persistence and absorption of the pesticide was observed in fir than in spruce and this was considered to be correlated with the systemic potential of fenitrothion in fir.

The present study was conducted with C^{14} - labelled fenitrothion to further investigate the metabolic fate, persistence and translocation of fenitrothion in balsam fir, white spruce and Jack pine *(Pinus banksiana* (Lamb)). The in vitro experiment described in our previous study was repeated with C^{14} - fenitrothion on glass cover slips. The present study took advantage of basic radiotracer methodology (liquid scintillation counting (LSC) and autoradiography) to back up the previously reported data (Moody at all, 1975) based on gas chromatographic (GC) analyses, and to further elucidate the mechanism involved with pesticide translocation in conifers.

MATERIALS AND METHODS

(1) Culture of Tree Seedlings

Four year old seedlings of balsam fir, white spruce, and Jack pine were collected in the autumn of 1975 from the Ontario Ministry of Natural Resources nursery at Kemptville, Ontario. These were held in the greenhouse for approximately two months until the current buds had flushed out. Six healthy specimens of each of the three species were selected and set up in an area enclosed by plastic sheeting. Environmental conditions were adjusted to 22°C, 50% relative humidity, and a 12 hour photoperiod supplied by fluorescent "daylight" tubes (≈ 200 lux).

(2) Chemicals and Solvents

C^{14} - ring labelled fenitrothion (specific activity 10 mCi/mmol) by Dr. R. Duffy (University of Prince Edward Island). Purity was confirmed by liquid scintillation counting (LSC) and thin layer chromatography (TLC). The solvents used for extraction were glass distilled. A simulated field formulation was prepared with 10% C^{14} - fenitrothion, 1% Atlox 3409, 1% Arotex 3470, and 88% distilled water (v/v). This emulsion was diluted prior to application so that the final activity would be 7.6 µCi/ml, the optimal concentration (≈200 ppm) established by our previous investigation.

(3) Method of Treatment

(a) In Vivo Plant Study

Three replicates of each of the three conifer species were employed for LSC determination of persistence. Four branches (per tree) were selected, and 0.5 ml of the C^{14} - fenitrothion formulation (7.6 µCi/ml) was carefully applied with the aid of a 3mm (1/8") brush (Grumbacher # 4116) in an attempt to obtain uniform coverage. Three replicates of each species

were also used for autoradiographic (AR) detection of the labelled pesticide. For this purpose, three branches (per tree) were selected and the formulation (7.6 μCi/ml was applied by painting 2.5 to 5 cm (1"-2") sections of either the newly flushed foliage, the older foliage or the bark tissue. This AR study was set up to determine whether the major direction of pesticide translocation was acropetal or basipetal. Plastic sheeting was used to cover the soil in the pots to prevent contamination.

(b) In Vitro Glass Surface Study

Fifty μℓ of an acetone solution of C^{14} - fenitrothion (≈ 5 X 10^4 dpm) were applied to each of 30 circular glass cover slips (Corning # 1, 18 mm) held in scintillation vial caps. Half of the caps were placed in a light-proof cardboard box. The remainder were placed on top of the box which was left in the greenhouse, exposed to the same environmental conditions specified previously.

(4) Sampling and Extraction Procedure

Separate samples of newly flushed foliage (N.F.), old foliage (O.F.) and stem tissue (S.T.), were taken at 1, 3, 7 and 21 day intervals for LSC analysis. These were individually weighed, placed in plastic "roll-top" bags and frozen in liquid nitrogen prior to being stored at -70°C. The extraction procedure followed that used previously (Moody et al 1975) except that the cleanup procedure was omitted. Each conifer tissue sample (1-5 g) was placed in a sintered glass funnel and filtered by vacuum with 200 ml of ethyl acetate. The extract was concentrated to near dryness in a rotary evaporator (35°C) and then brought up to 10 ml with acetone for analysis. The tissue was then extracted twice with ethyl acetate (100 ml each time) in a polytron sonicator (model - 1020) and the combined extracts were filtered through prerinsed Celite 545, concentrated, and brought up to 10 ml with acetone prior to analysis.

The trees treated for AR were sampled after 7, 14 and 21 days. The entire branches were individually bagged and refrigerated at - 70°C. The branches taken at 7 and 21 days after treatment were used for gross autoradiography while the 14 day samples were used for histoautoradiography.

The glass cover slips were sampled at 1, 3, 7, 14 and 21 days. Three replicates were taken on each sampling date from both the light and the dark conditions.

(5) Analytical Procedure

(a) Liquid Scintillation Counting (LSC)

All samples were analysed with a Beckman LS-100C liquid scintillation counter. Fifty µℓ aliquots of the plant extracts were dispensed into Beckman plastic scintillation vials, each holding 10 ml of Fisher scintiverse cocktail. All sample counts were corrected for quenching with the aid of a "quench curve" constructed by counting a set of C^{14} - fenitrothion standards to which had been added increasingly greater amounts of coniferous extracts. The percent counting efficiency was plotted against an external standard ratio and the resulting "quench curve" was used to correct for any loss in sample counting efficiency. This simple construction permitted omission of the time consuming "clean-up" procedure that was necessary in our previous study for GC analysis of conifer extracts.

The glass cover slips from the in vitro experiment were counted immediately after sampling simply by inverting the plastic vial caps over scintillation vials fitted with 10 ml of cocktail. The caps were screwed on and the vials were shaken vigorously prior to LSC analysis.

(b) Autoradiography (AR)

Gross autoradiography was conducted following the basic procedure outlined by Yamaguchi and Crafts (1958). Briefly, this involved

pressing blotter-paper mounted conifer branches for 2 days followed by exposure to Kodak No-Screen X-ray film for 6 weeks. Histoautoradiography was performed following the method of Prasad and Moody (1974), and involved cryostat sectioning of the untreated tissue followed by a 2 to 3 week exposure to Kodak NTB2 liquid emulsion.

(c) Thin Layer Chromatography (TLC)

The C^{14} - plant extracts were run on silica gel TLC plates (Fisher Rediplates) in a solvent system of 1:3, ethyl acetate to cyclohexane. The plates were then exposed for 2 weeks to X-ray film for C^{14} - detection, or they were sprayed with a steer liver homogenate used for detecting anticholinesterase activity (Mendoza, at al 1968).

(d) Scanning Electron Microscopy (SEM)

Balsam fir foliage was gold coated under vacuum and photographs were taken of the tissue surface in an AMR-1000 SEM.

RESULTS

Table I lists the concentration of fenitrothion in each of the samples analysed. The ppm values were calculated by simple conversions from the dpm (disintegration per minute) recorded by LSC, using the known S.A. (10 mCi/mmol) of the compound. Each tissue type (N.F., O.F., S.T.) has a value recorded for both the surface wash (W) and the tissue extract (E) which enabled a rough estimation to be made of the levels of surface (cuticular) and subsurface (subcuticular) residues present*. The percent absorbed

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* One sample taken 1 day post treatment was washed three times before extraction to determine the efficiency of this surface wash method. 79% of the total activity was in the first wash, 5% in the second, 2% in the third, and 14% was in the final tissue extract.

(% ABS) was calculated as being equal to $\frac{ppm(E)}{ppm(W) + ppm(E)} \times 100$ and the total ABS is plotted against time for each of the three species in Fig. 1 (i). The total residual fenitrothion (total ppm) was converted to percent recovery values which are plotted against time in Fig. 1 (ii) to illustrate a persistence curve for the pesticide through the 21 day sampling period. The results of the in vitro experiment are plotted in Fig. 2 which demonstrates the persistence of fenitrothion on glass surfaces under light and dark conditions. The results of the translocation studies are depicted by gross autoradiography in Fig. 3 (i - xviii) and histoautoradiography (Fig. 4 (i - ix)). Fig. 5 (i - iv) shows scanning electron micrographs of balsam fir foliage. Fig. 6 shows an autoradiograph of a TLC plate spotted with a balsam fir extract.

Table I

LSC and TLC Analysis of C^{14}-Fenitrothion Treated Conifer Tissues

Sample		Time (Day) 1* ppm	1* % ABS	3** ppm	3** % ABS	7 ppm	7 % ABS	21 ppm	21 % ABS
Fir	N.F. (W)	1.42		0.38		0.31		0.21	
	N.F. (E)	1.17	45.2	0.99(A)***	72.3	2.03(A)	86.8	1.55(A)	88.1
	O.F. (W)	2.10		2.22		0.55		0.25	
	O.F. (E)	0.44	17.3	0.82	27.0	1.37	71.4	0.67	72.8
	ST. (W)	2.82		1.40		1.24		0.85	
	ST. (E)	0.77	21.5	0.83	37.2	0.75	37.7	0.95	52.8
	Average	2.91	28.0	2.21	45.5	2.08	65.3	1.49	71.2
Spruce	N.F. (W)	1.16		0.48		0.24		0.05	
	N.F. (E)	0.25	17.7	0.63(A)	56.8	0.47(A)	66.2	0.32(A)	86.5
	O.F. (W)	3.06		1.70		0.40		0.22	
	O.F. (E)	0.52	14.5	0.66	28.0	0.86	68.3	0.37	62.7
	ST. (W)	1.47		1.15		0.78		0.52	
	ST. (E)	0.22	13.0	0.72	38.5	0.88	53.0	0.86	62.3
	Average	2.23	15.1	1.78	41.1	1.21	62.5	0.78	70.5
Pine	N.F. (W)	2.09		0.65		0.26		0.26	
	N.F. (E)	0.58	21.7	0.50	43.5	0.42	61.8	0.24	48.0
	O.F. (W)	0.53		0.29		0.13		0.08	
	O.F. (E)	0.12	18.5	0.10	25.6	0.06	31.6	0.06	42.9
	ST. (W)	2.05		1.19		0.47		0.25	
	ST. (E)	1.06	34.1	0.72	37.7	0.46	49.5	0.54	68.4
	Average	2.14	24.8	1.15	35.6	0.60	47.6	0.48	53.1

* All extracts gave a spot (Rf; 0.52) on the TLC autoradiographs which corresponded to that obtained for the standard C^{14}-fenitrothion. This spot exhibited anitcholinesterase activity after spraying with the liver spray homogenate described by Mendoza (1972).

** All extracts exclusive of the 1 day samples (i.e. 3, 7 and 21 day samples) gave a faint spot at the origin (Rf; 0) which was not toxic to the liver homogenate.

*** A non-toxic, C^{14}-metabolite was detected by TLC in extracts denoted by (A) which had an RRf of 0.21.

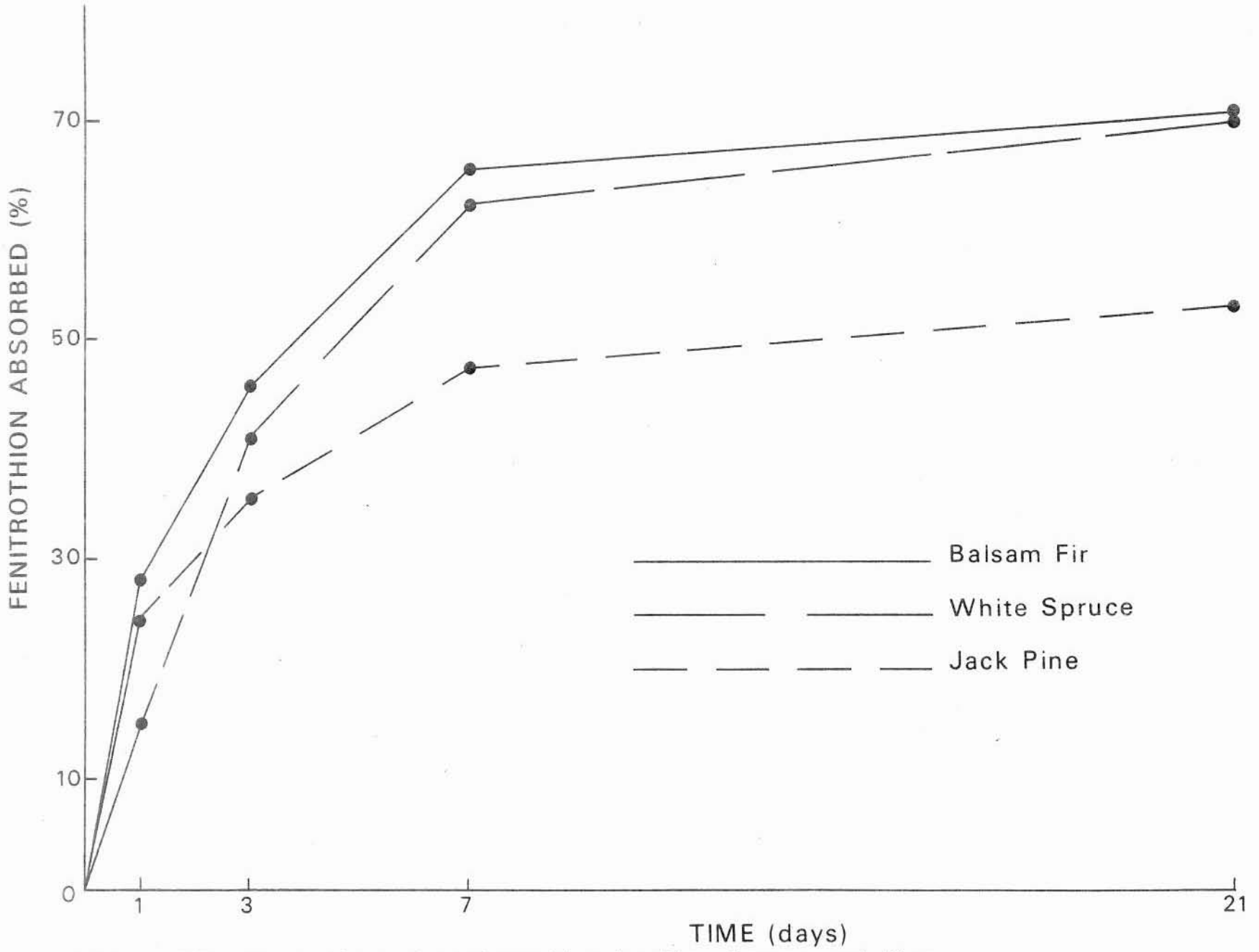


Fig. 1 (i) Absorption of Fenitrothion by Fir, Spruce and Pine.

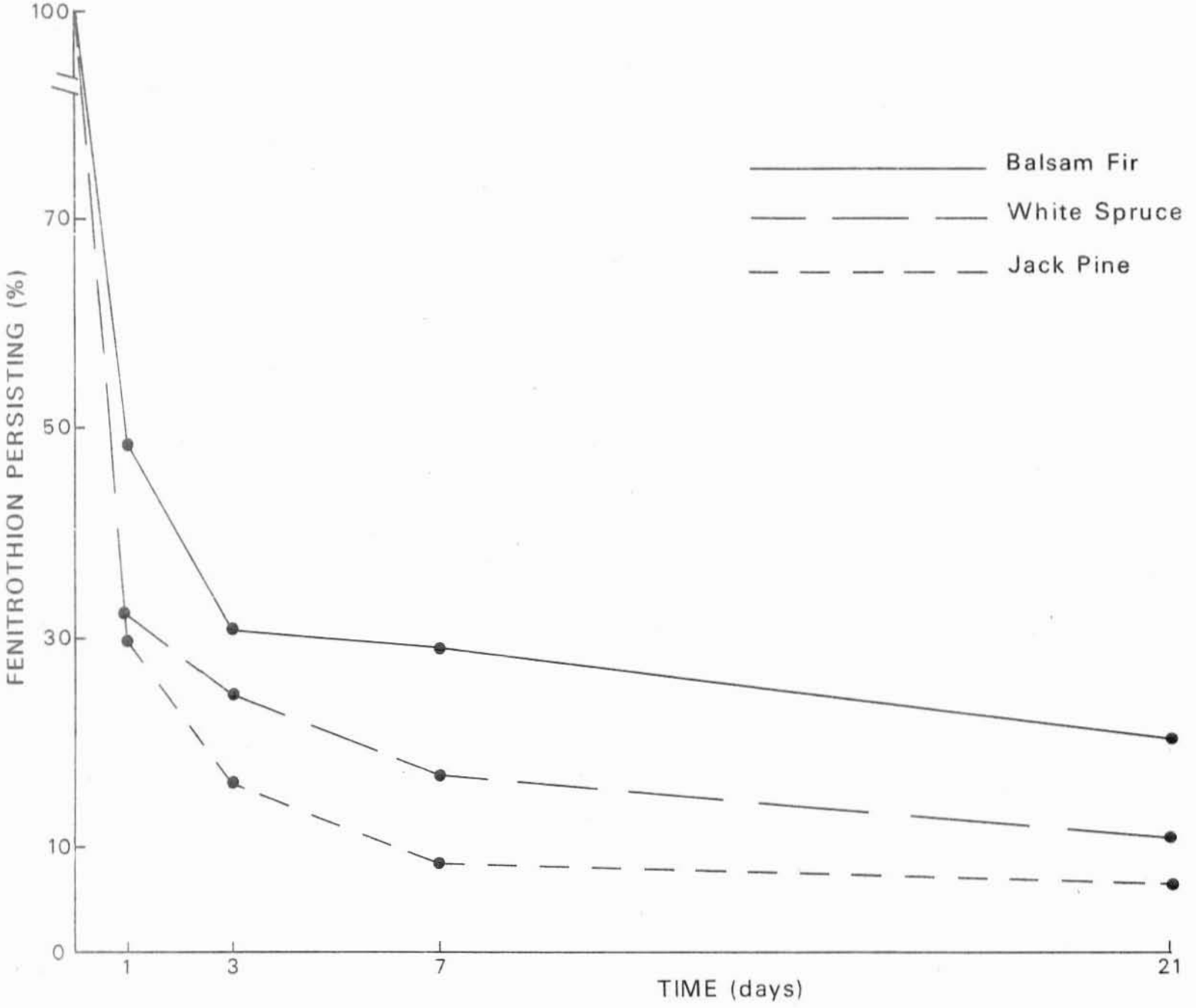


Fig. 1 (ii) Persistence of C^{14}-Fenitrothion on Fir, Spruce and Pine.

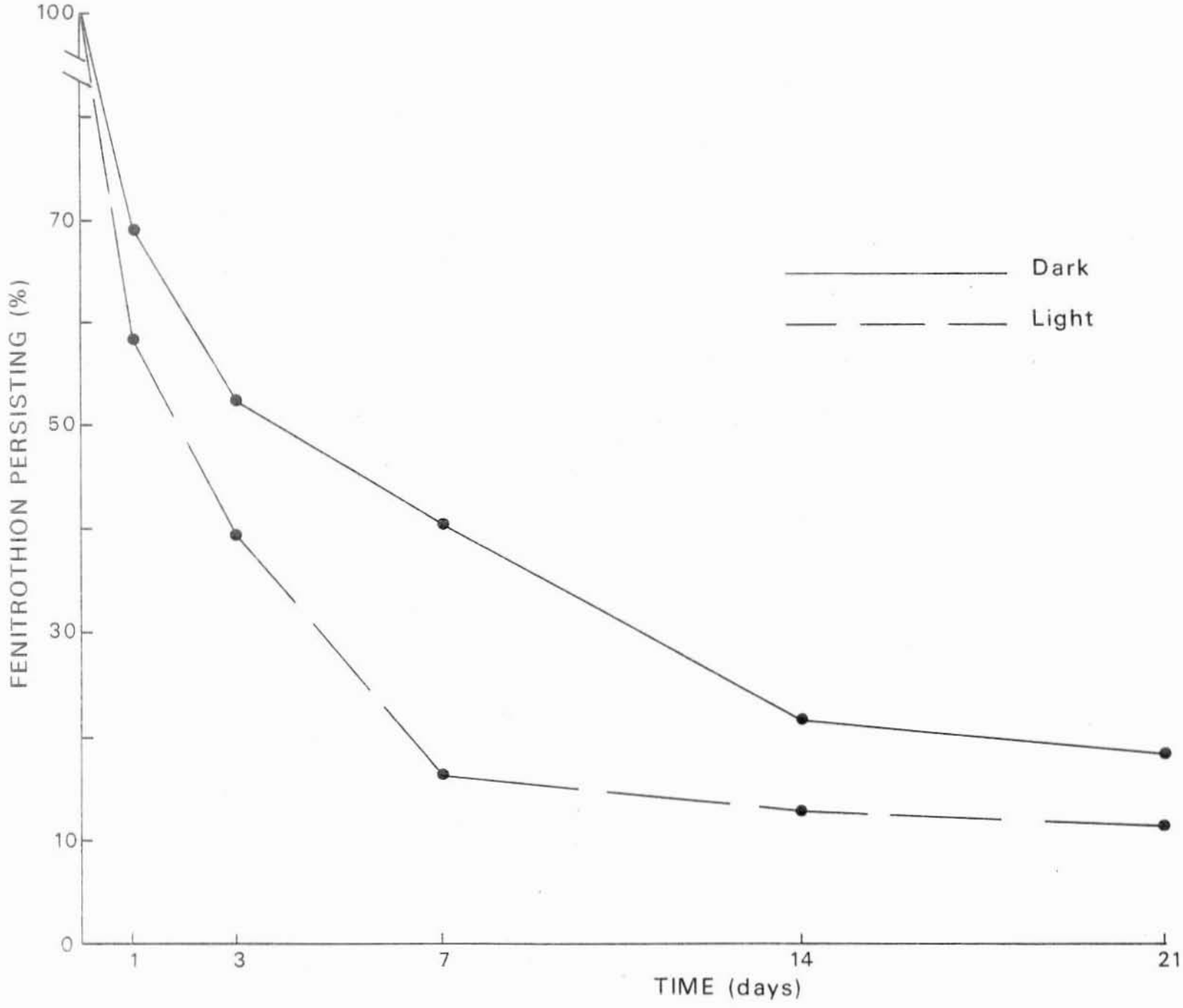


Fig. 2. Persistence of C^{14}-Fenitrothion on Glass Surfaces.

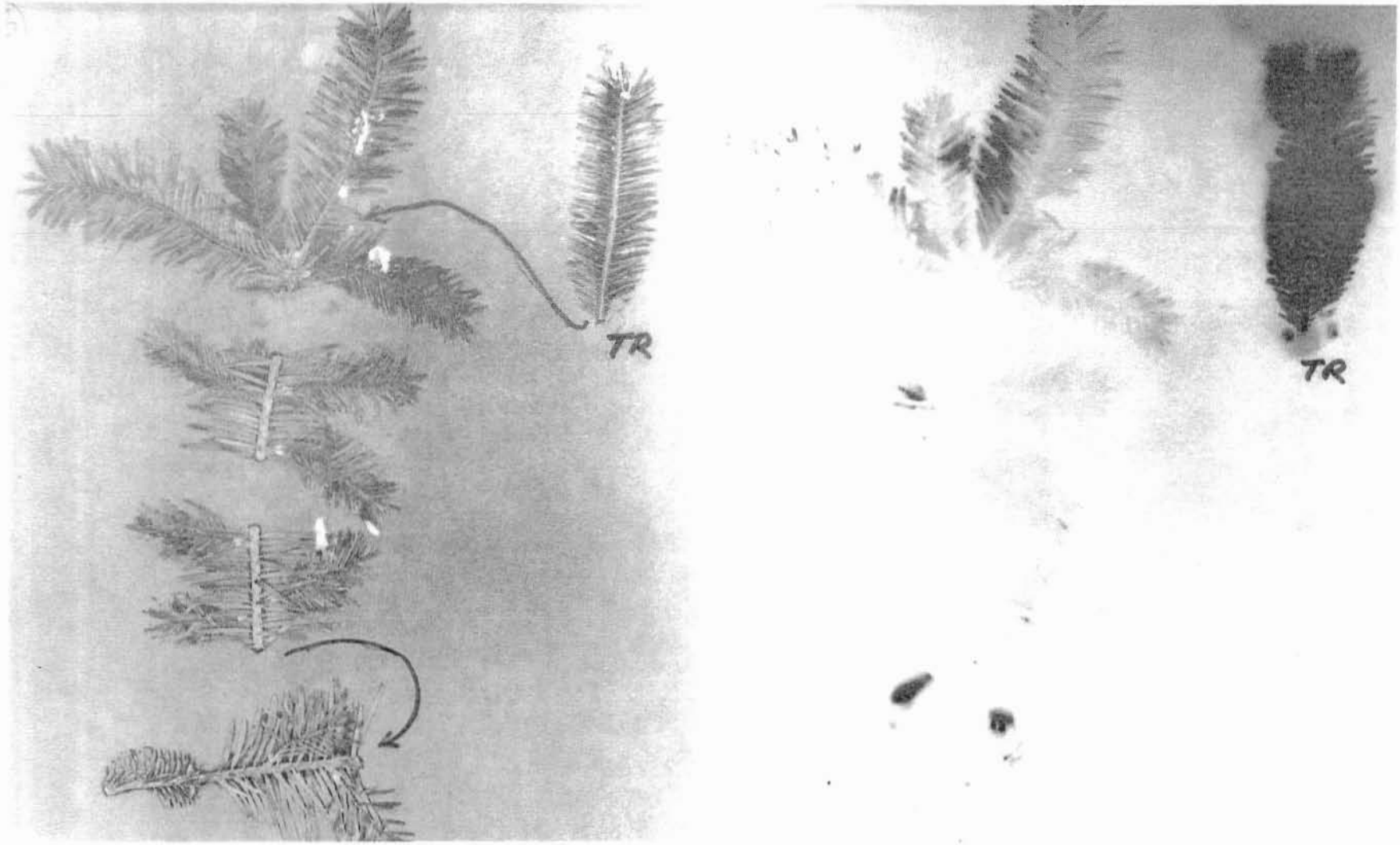


Fig. 3 (i) Above left, pressed tissue, and above right, autoradiograph of balsam fir sampled 7 days after treatment of young foliage with C^{14}-fenitrothion. Note evidence of acropetal translocation to the young foliage as well as some basipetal movement. Arrow denotes attachment site of treated tissue (TR).

Fig. 3 (ii) Above left, pressed tissue, and above right autoradiograph of balsam fir sampled 7 days after treatment of old foliage with C^{14}-fenitrothion. Note evidence of acropetal translocation to the young foliage. Arrow denotes attachment site of treated tissue (TR).

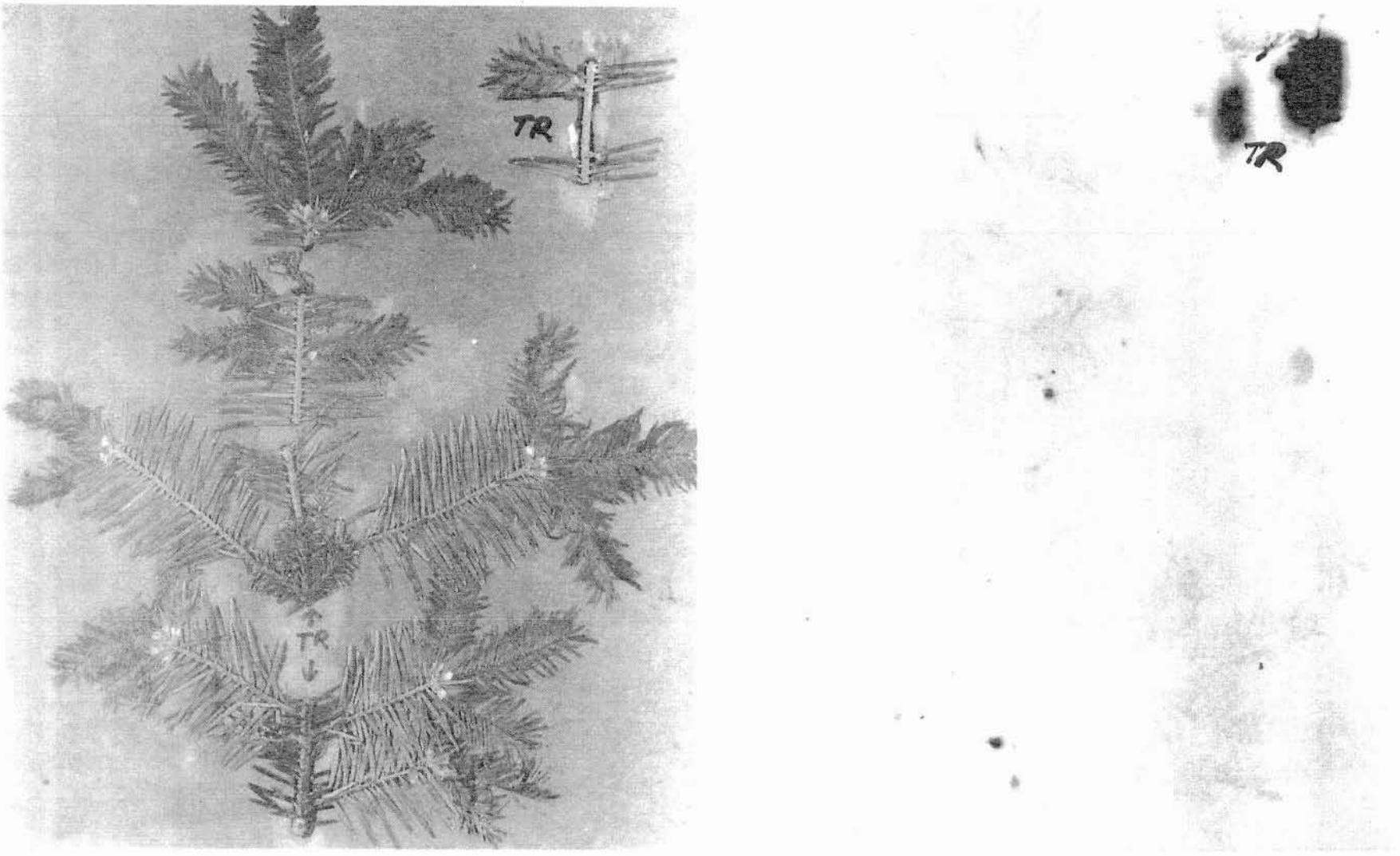


Fig. 3 (iii) Above left, pressed tissue, and above right autoradiograph of balsam fir sampled 7 days after treatment of stems with C^{14}-fenitrothion. Note evidence of acropetal translocation to the young foliage. Arrow denotes attachment site of treated tissue (TR).

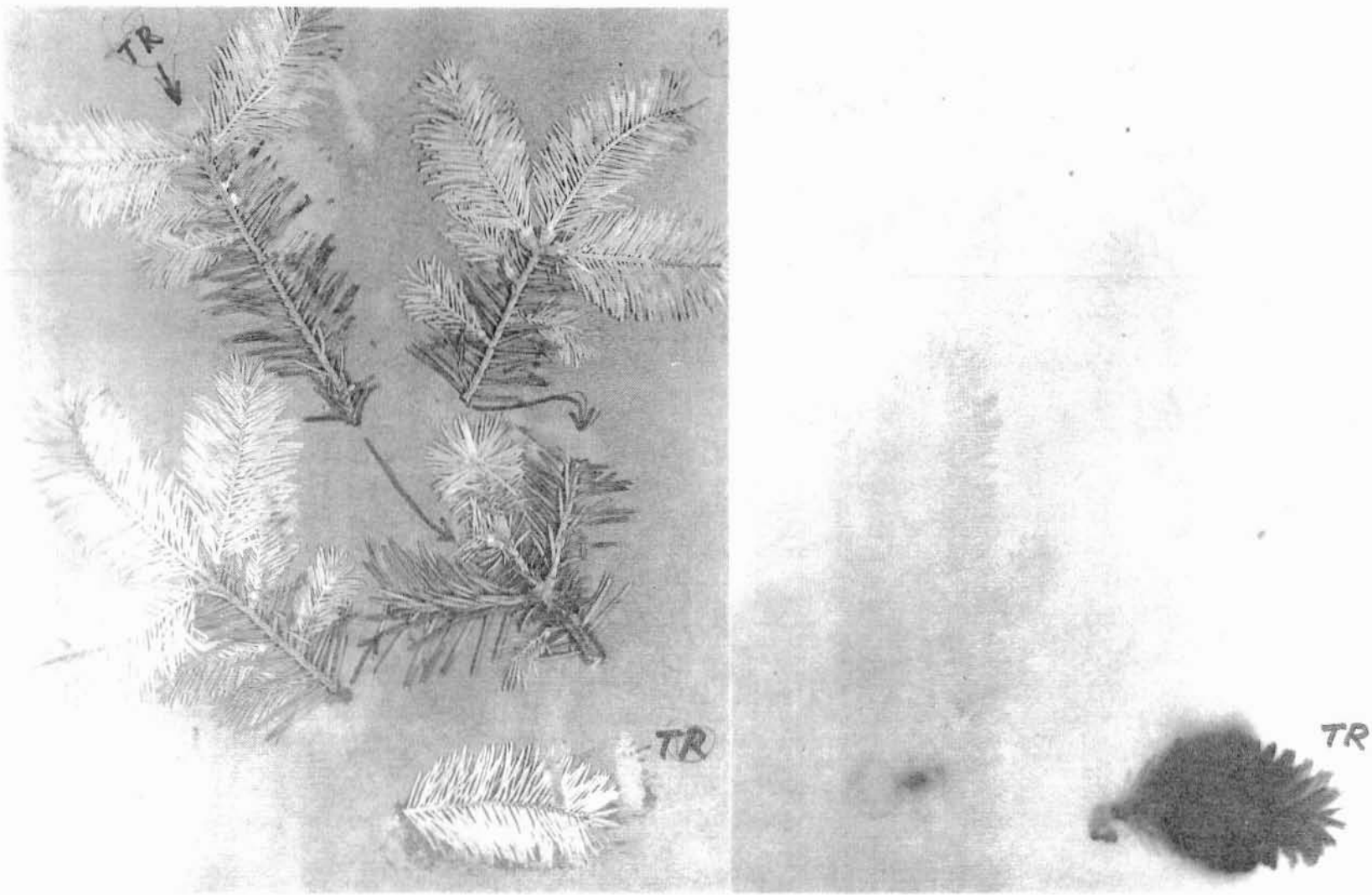


Fig. 3 (iv) Above left, pressed tissue, and above right autoradiograph of balsam fir sampled 21 days after treatment of young foliage with C^{14}-fenitrothion. Note evidence of basipetal translocation, with subsequent acopetal translocation and persistence in the young foliage. Arrow denotes attachment site of treated tissue (TR).

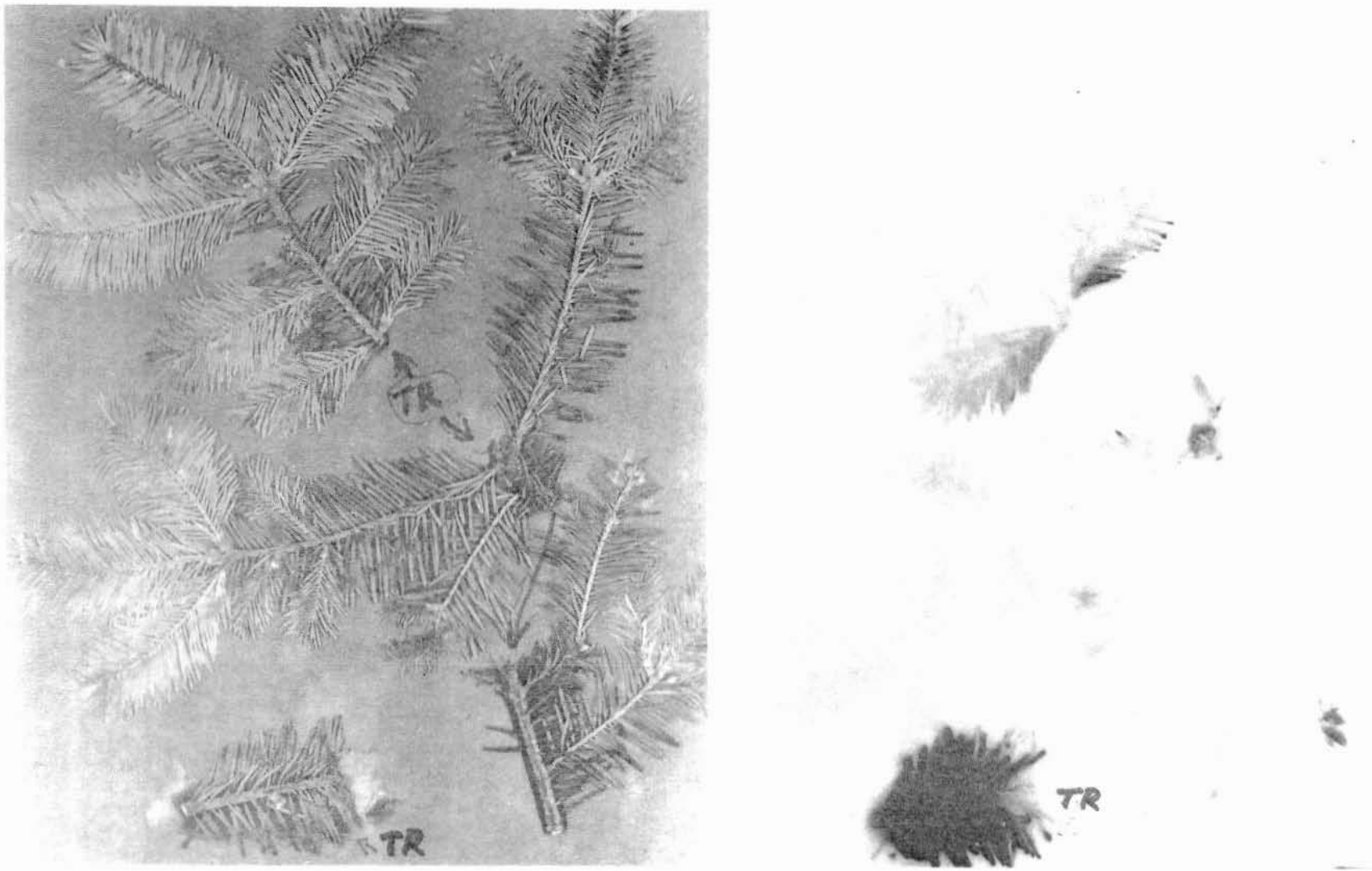


Fig. 3 (v) Above left, pressed tissue, and above right autoradiograph of balsam fir sampled 21 days after treatment of old foliage with C^{14}-fenitrothion. Note evidence of acropetal translocation to the young foliage. Arrow denotes attachment site of treated tissue (TR).

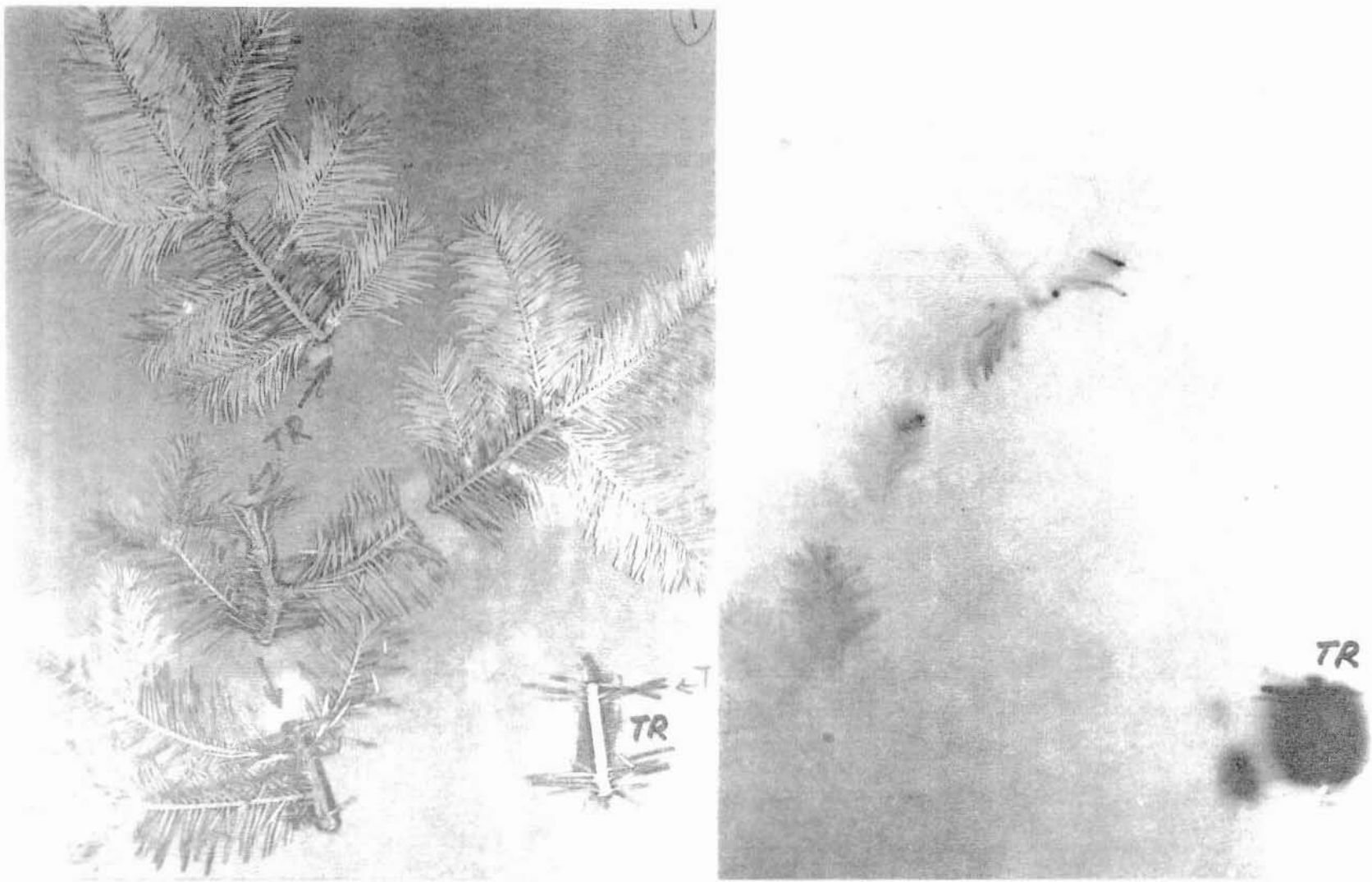


Fig. 3 (vi) Above left, pressed tissue, and above right autoradiograph of balsam fir sampled 21 days after treatment of stem with C^{14}-fenitrothion. Note evidence of acropetal translocation to the young foliage. Arrow denotes attachment site of treated tissue (TR).

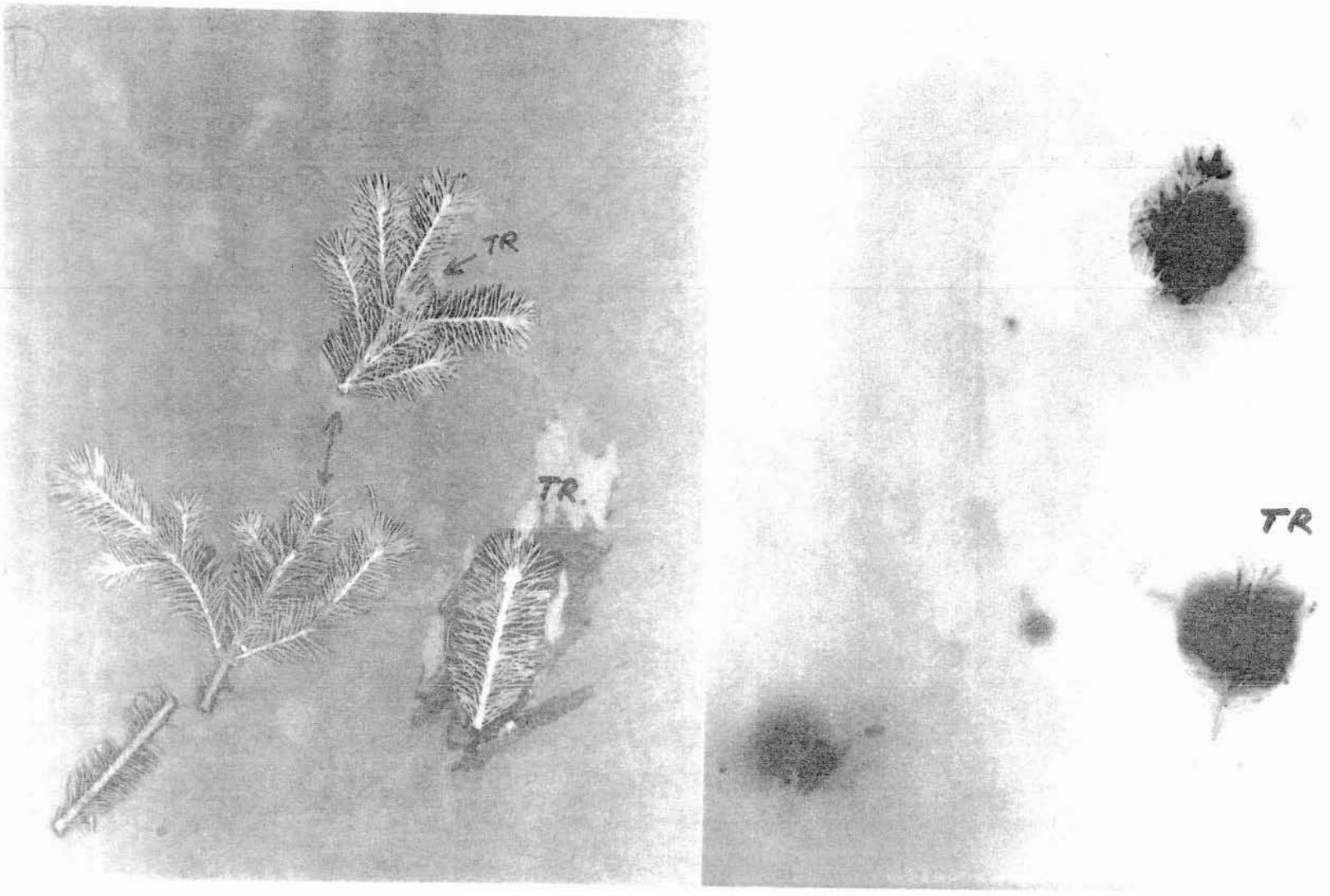


Fig. 3 (vii) Above left, pressed tissue, and above right autoradiograph of white spruce sampled 7 days after treatment of young foliage with C^{14}-fenitrothion. Note absence of any major translocation. Arrow denotes attachment site of treated tissue (TR).

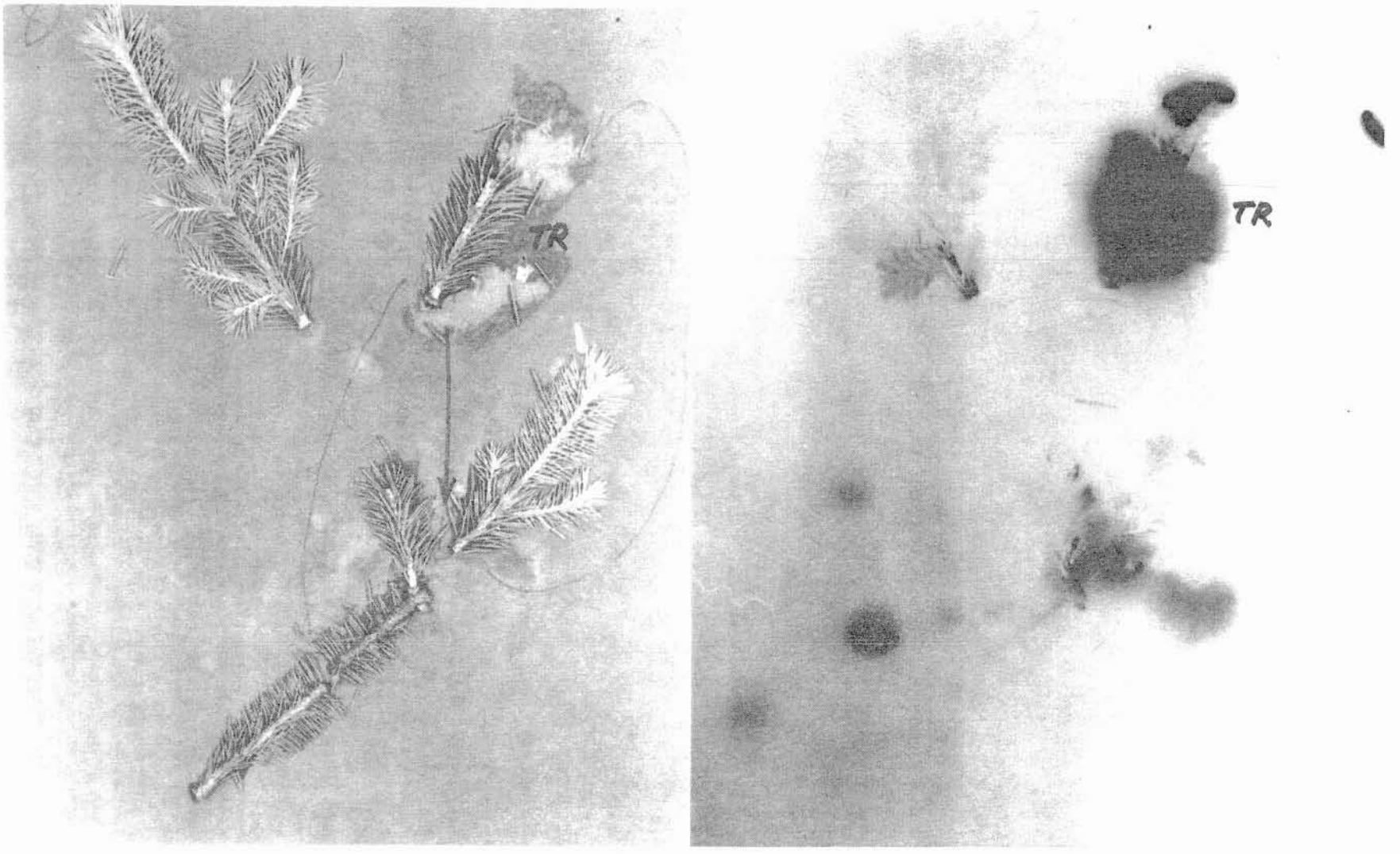


Fig. 3 (viii) Above left, pressed tissue, and above right autoradiograph of white spruce sampled 7 days after treatment of old foliage with C^{14}-fenitrothion. Note evidence of only minor acropetal translocation to the young foliage. Arrow denotes attachment site of treated tissue (TR).

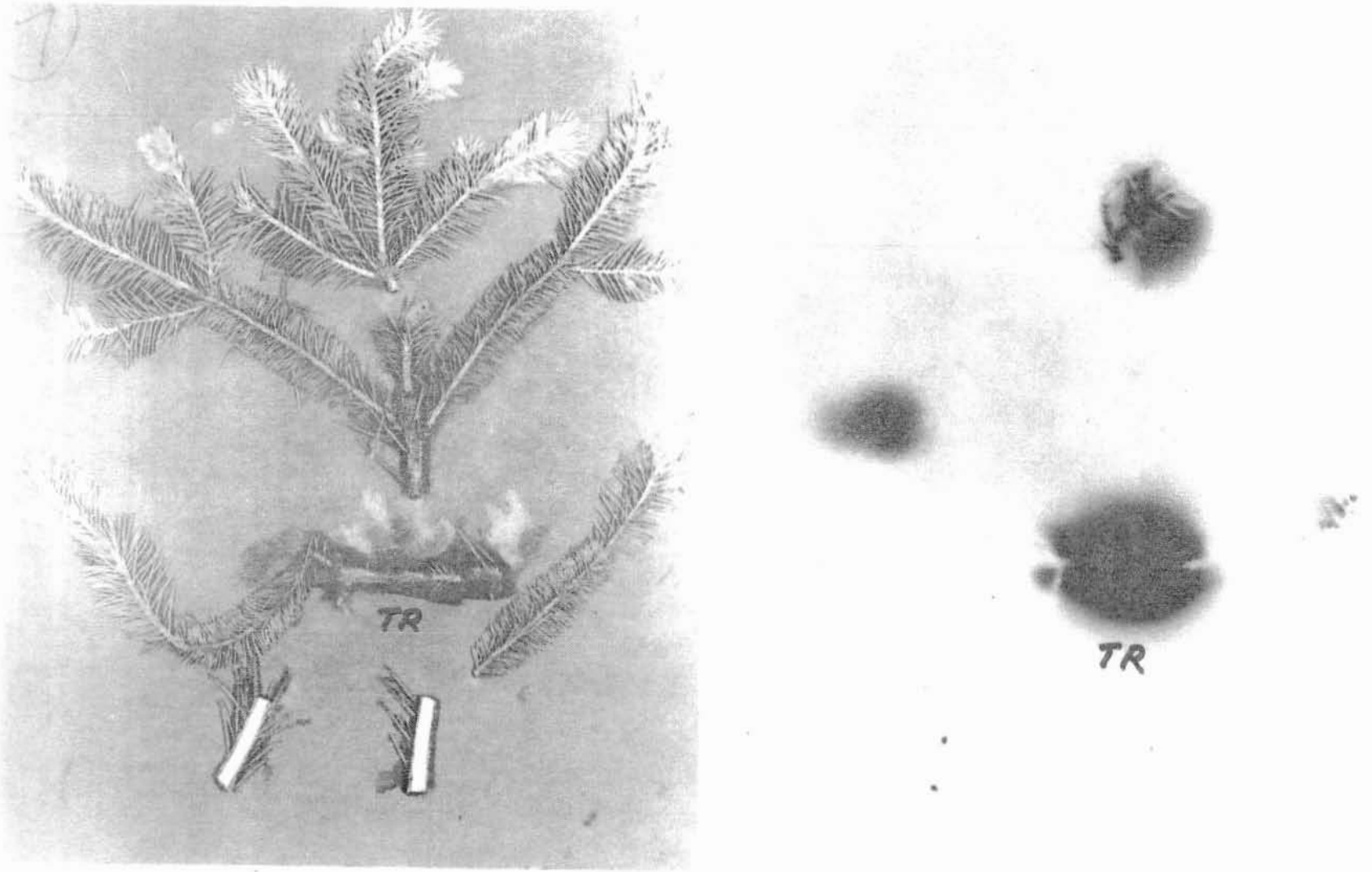


Fig. 3 (ix) Above left, pressed tissue and above right, autoradiograph of white spruce sampled 7 days after treatment of stem with C^{14}-fenitrothion. Note absence of any major translocation. Arrow denotes attachment site of treated tissue (TR).

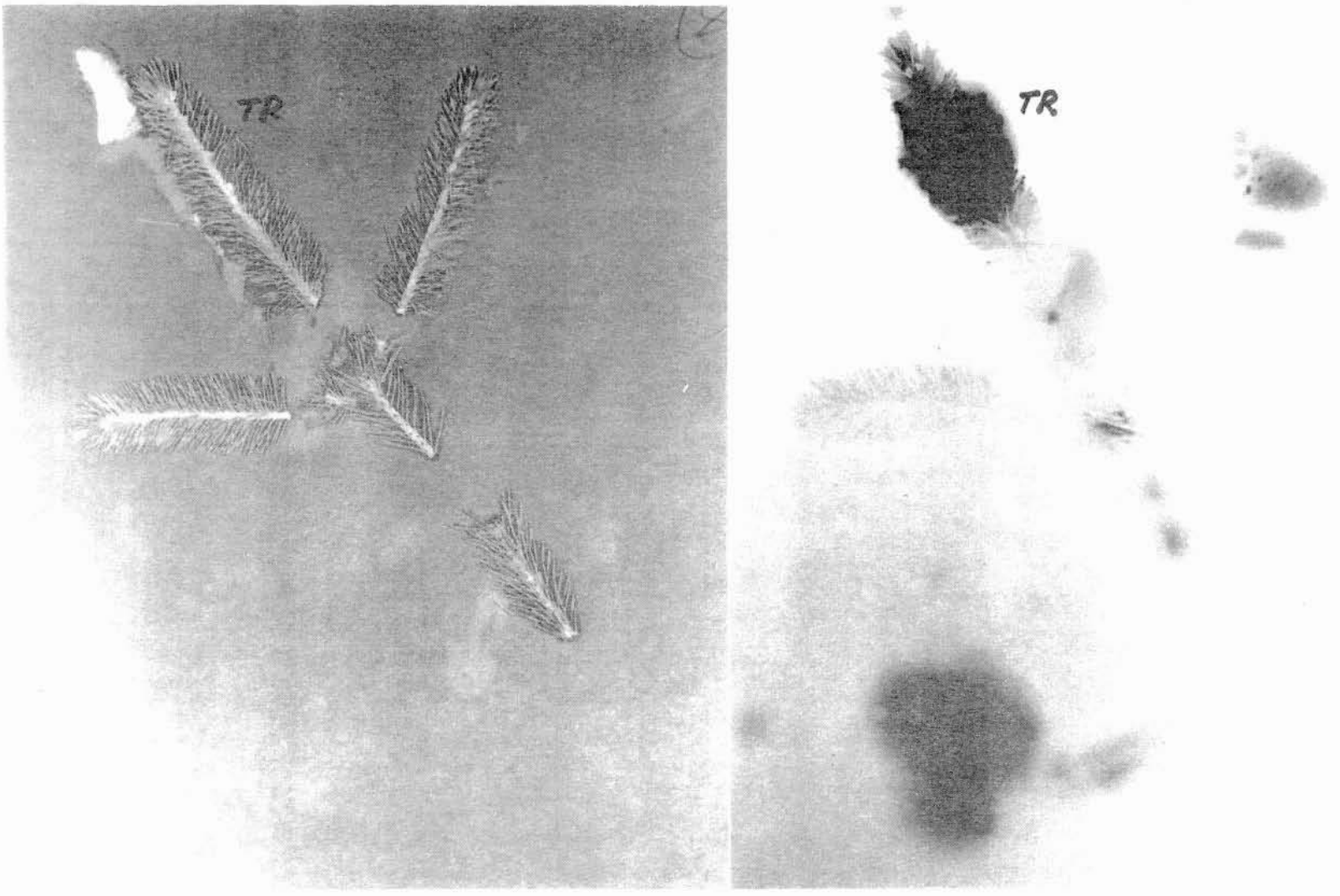


Fig. 3 (x) Above left, pressed tissue, and above right autoradiograph of white spruce sampled 21 days after treatment with C^{14}-fenitrothion. Note evidence of basipetal translocation. Arrow denotes attachment site of treated tissue (TR).

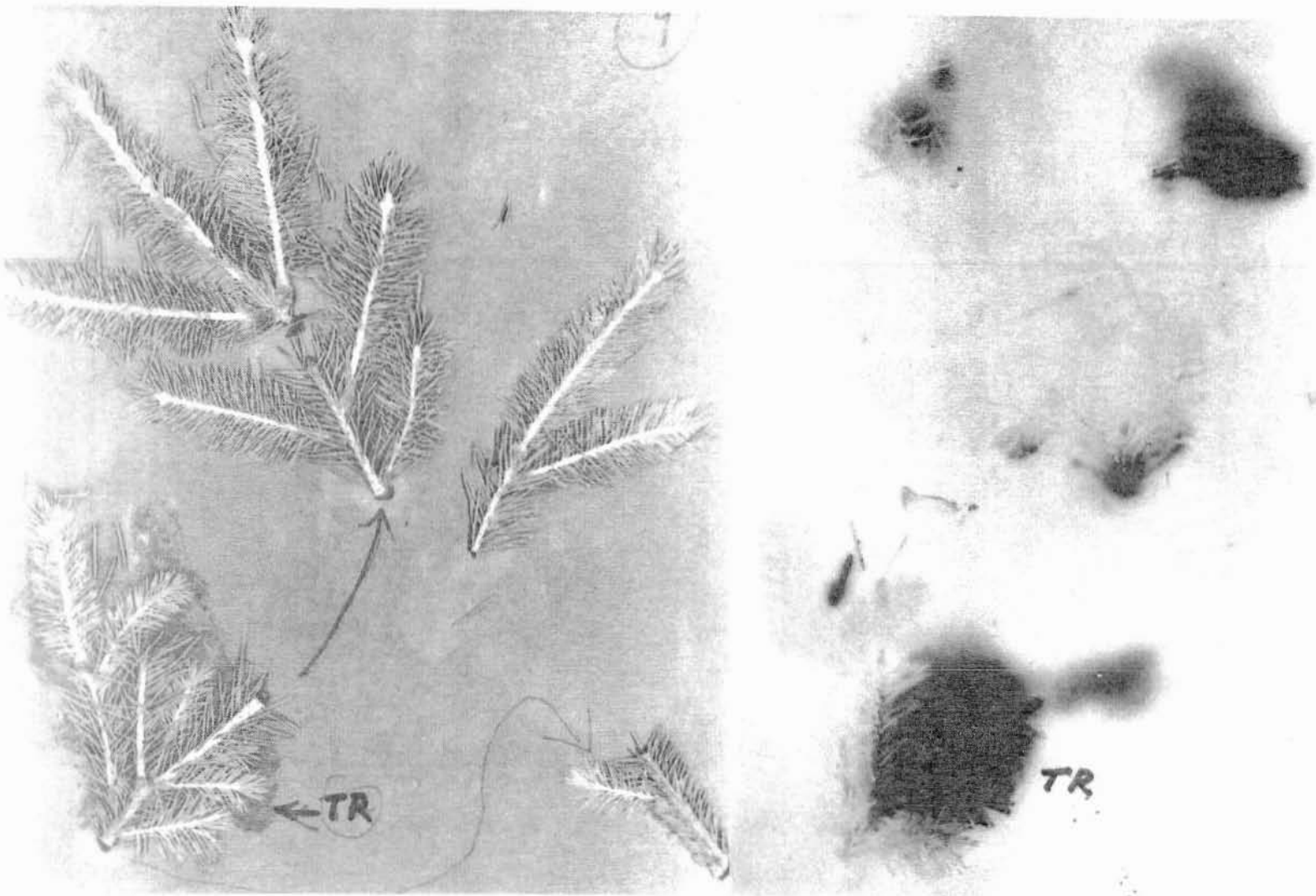


Fig. 3 (xi) Above left, pressed tissue and above right autoradiograph of white spruce sampled 21 days after treatment of old foliage with C^{14}-fenitrothion. Note evidence of some acropetal translocation. Arrow denotes attachment site of treated tissue (TR).

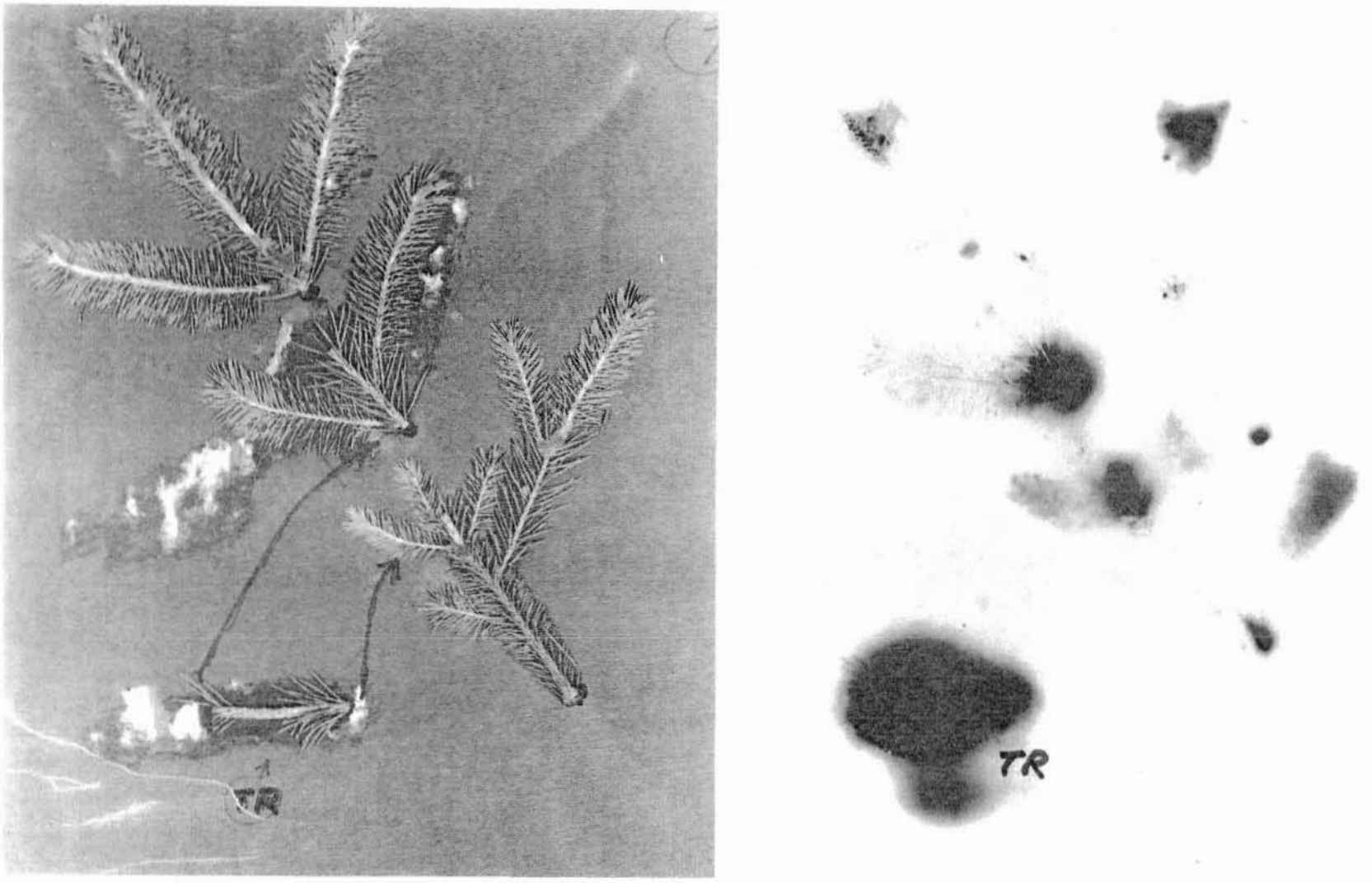


Fig. 3 (xii) Above left, pressed tissue, and above right autoradiograph of white spruce sampled 21 days after treatment of stem with C^{14}-fenitrothion. Note evidence of some acropetal translocation. Arrow denotes attachment site of treated tissue (TR).

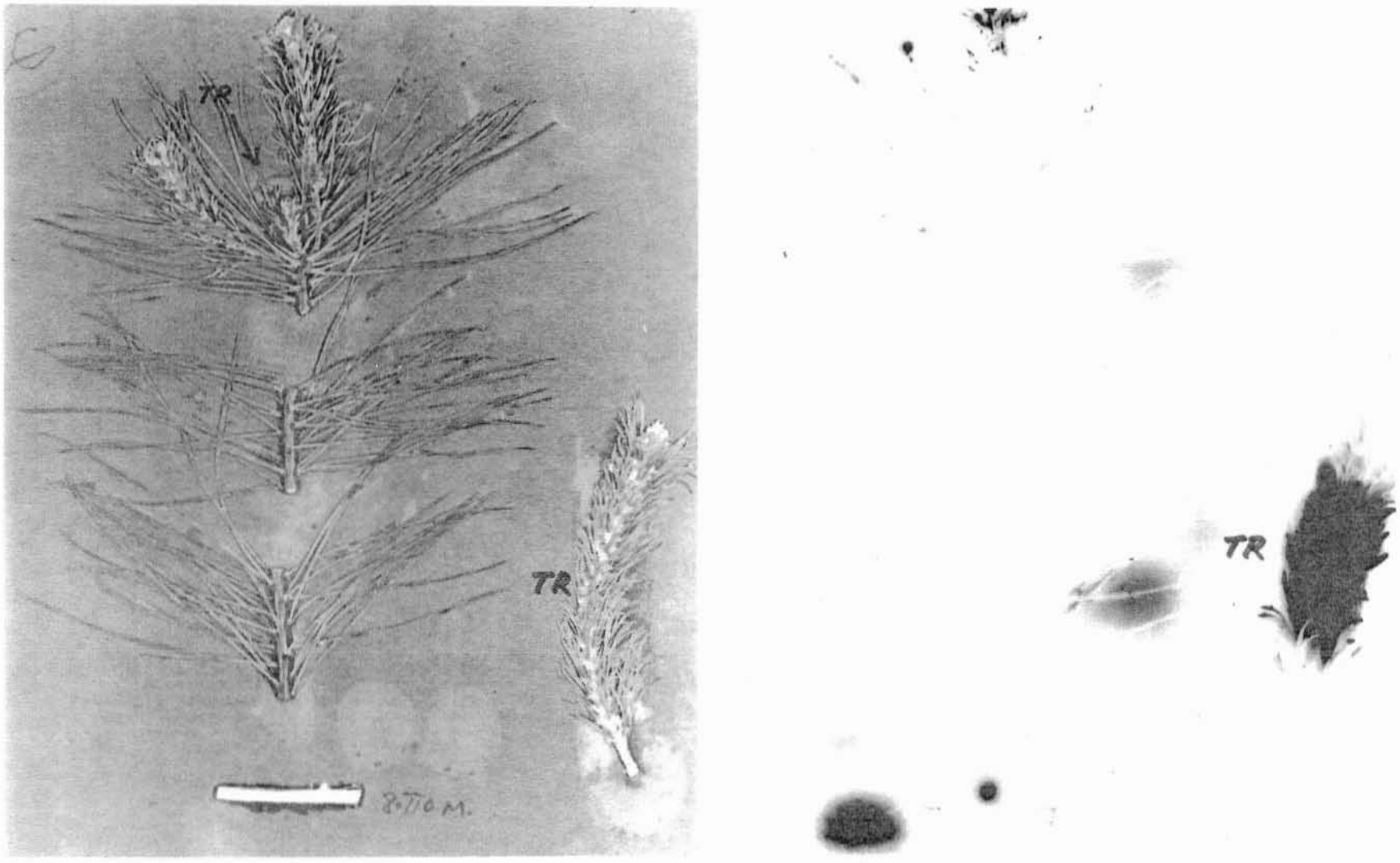


Fig. 3 (xiii) Above left, pressed tissue, and above right autoradiograph of Jack pine sampled 7 days after treatement of young foliage with C^{14}-fenitrothion. Note absence of any major translocation. Arrow denotes attachment site of treated tissue (TR).

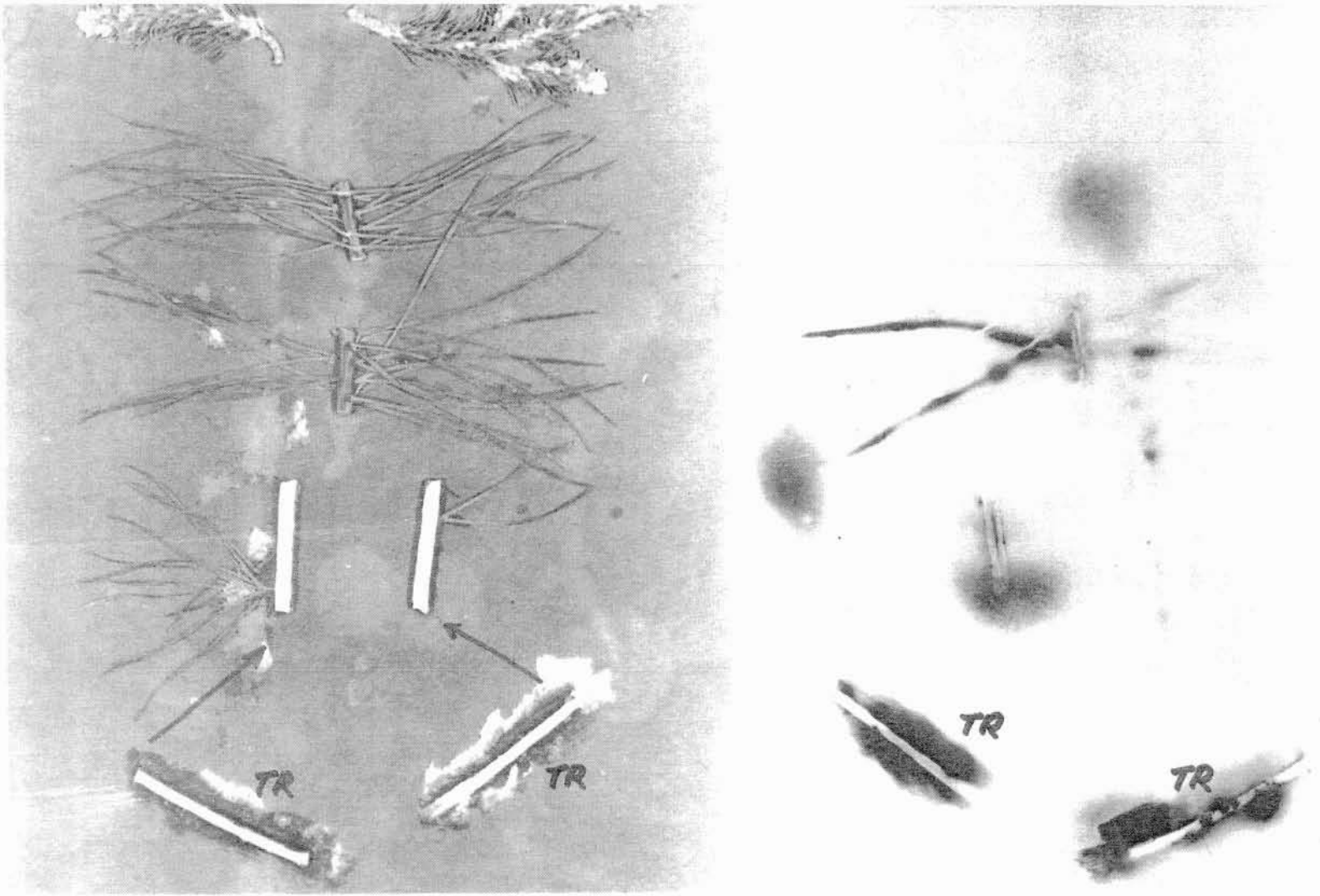


Fig. 3 (xiv) Above left, pressed tissue, and above right autoradiograph of Jack pine sampled 7 days after treatment of old foliage with C^{14}-fenitrothion. Note absence of any major translocation. Arrow denotes attachment site of treated tissue (TR).

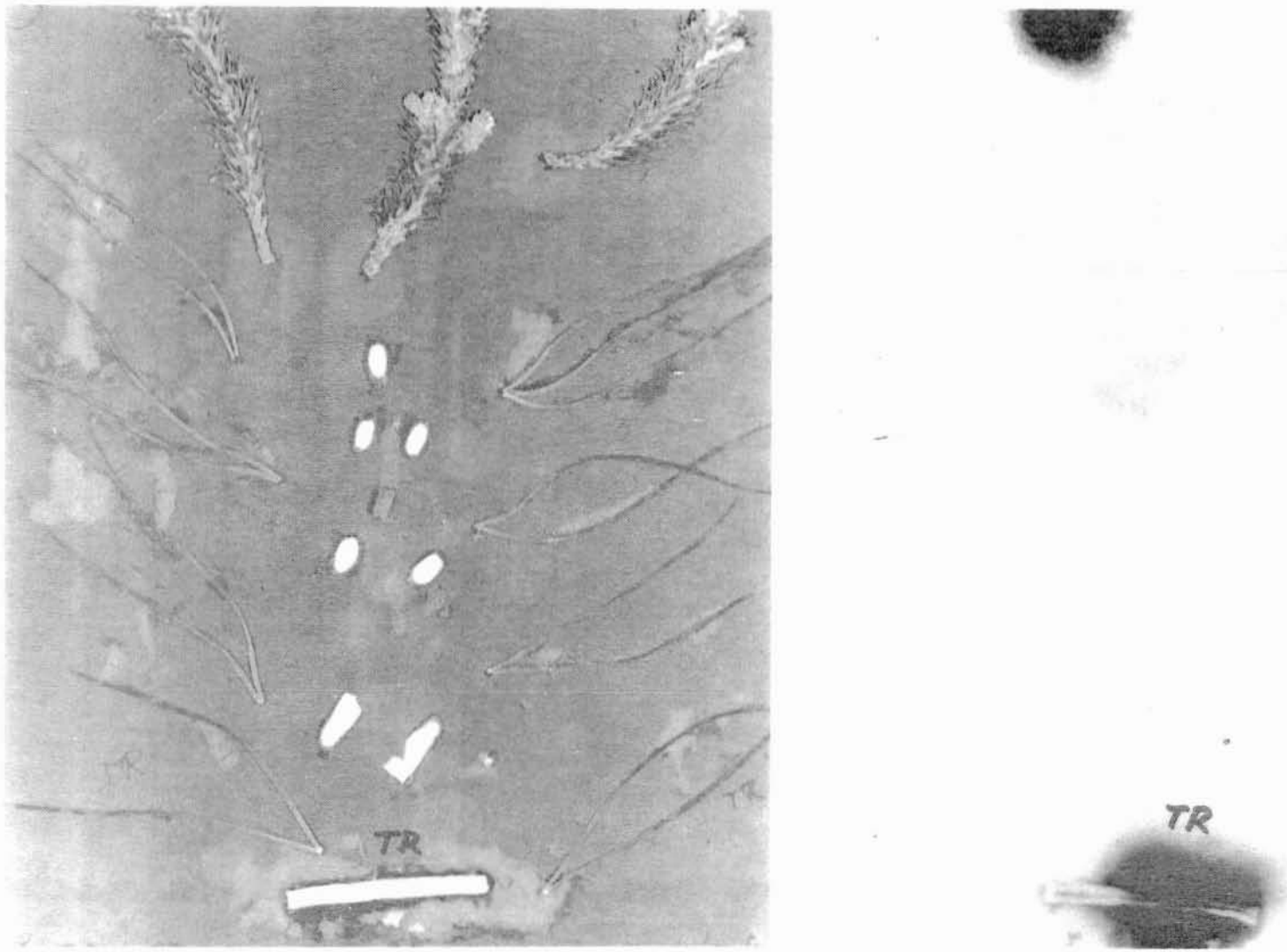


Fig. 3 (xv) Above left, pressed tissue, and above right autoradiograph of Jack pine sampled 7 days after treatment of stem with C^{14}-fenitrothion. Note absence of any major translocation. Arrow denotes attachment site of treated tissue (TR).

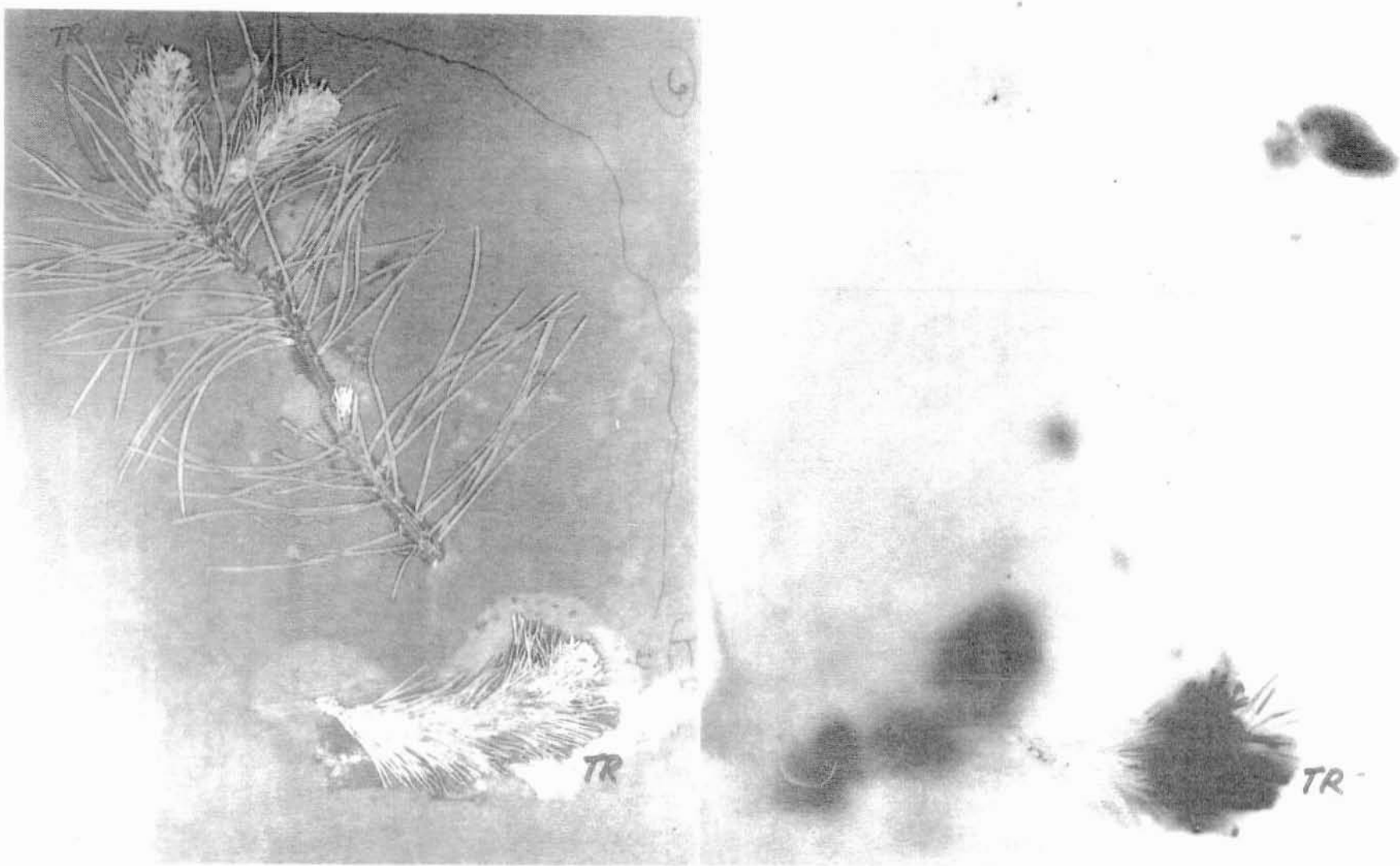


Fig. 3 (xvi) Above left, pressed tissue, and above right autoradiograph of Jack pine sampled 21 days after treatment of young foliage with C^{14}-fenitrothion. Note absence of any major translocation. Arrow denotes attachment site of treated tissue (TR).

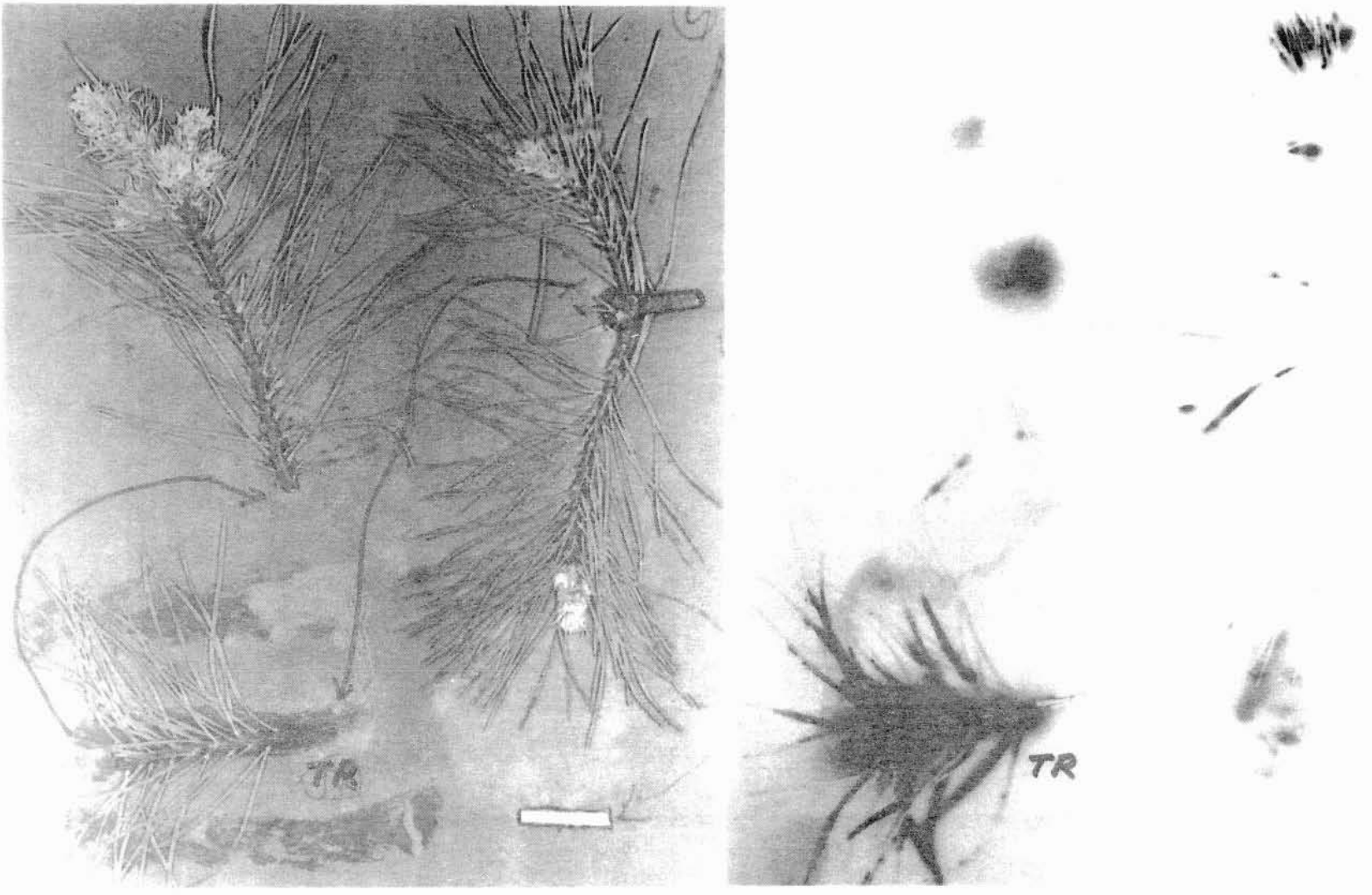


Fig. 3 (xvii) Above left, pressed tissue and above right autoradiograph of Jack pine sampled 21 days after treatment of old foliage with C^{14}-fenitrothion. Note absence of any major translocation. Arrow denotes attachment site of treated tissue (TR).

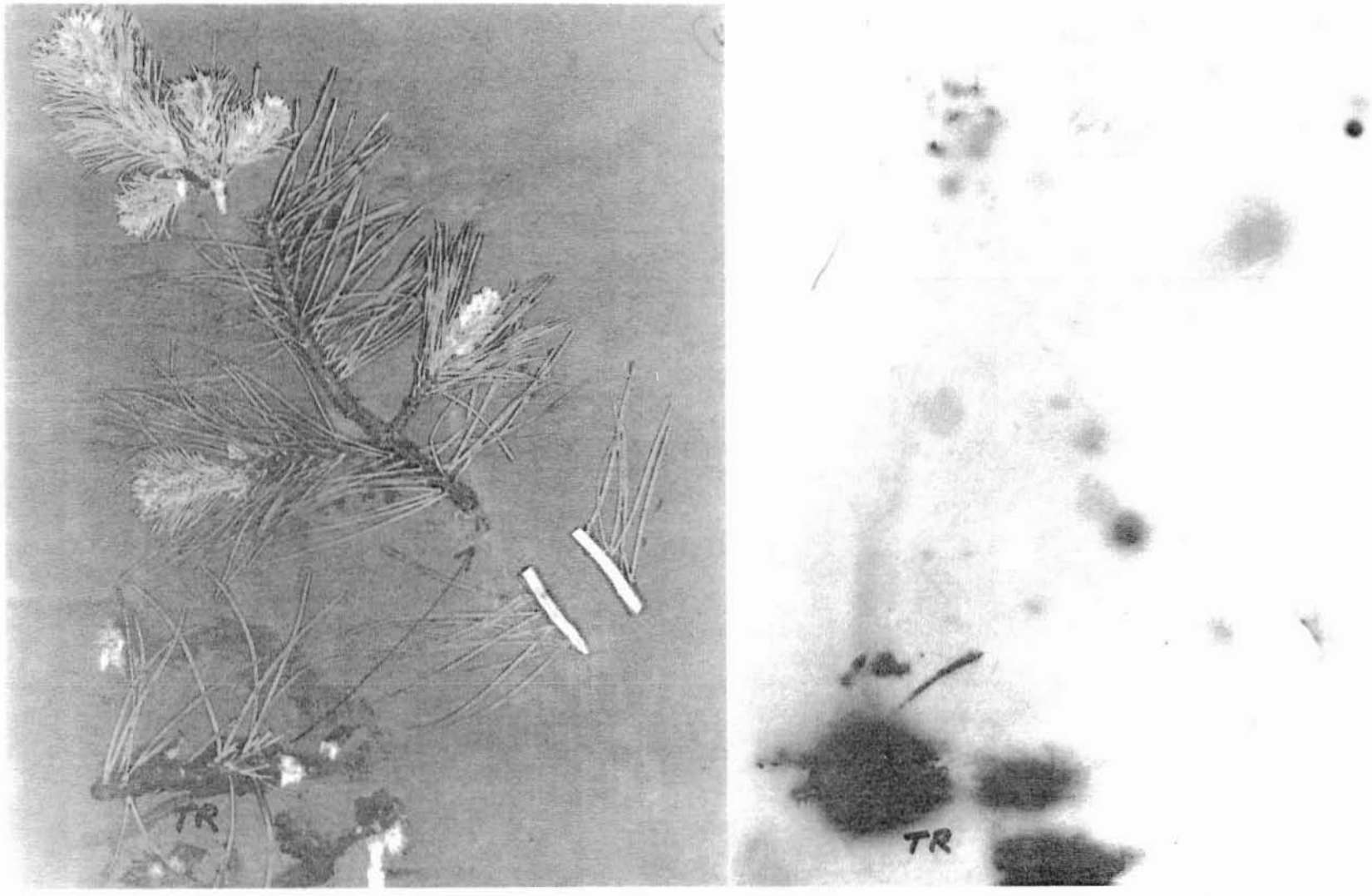


Fig 3 (xviii) Above left, pressed tissue, and above right autoradiograph of Jack pine sampled 21 days after treatment of stem with C^{14}-fenitrothion. Note absence of any major translocation. Arrow denotes attachment site of treated tissue (TR).

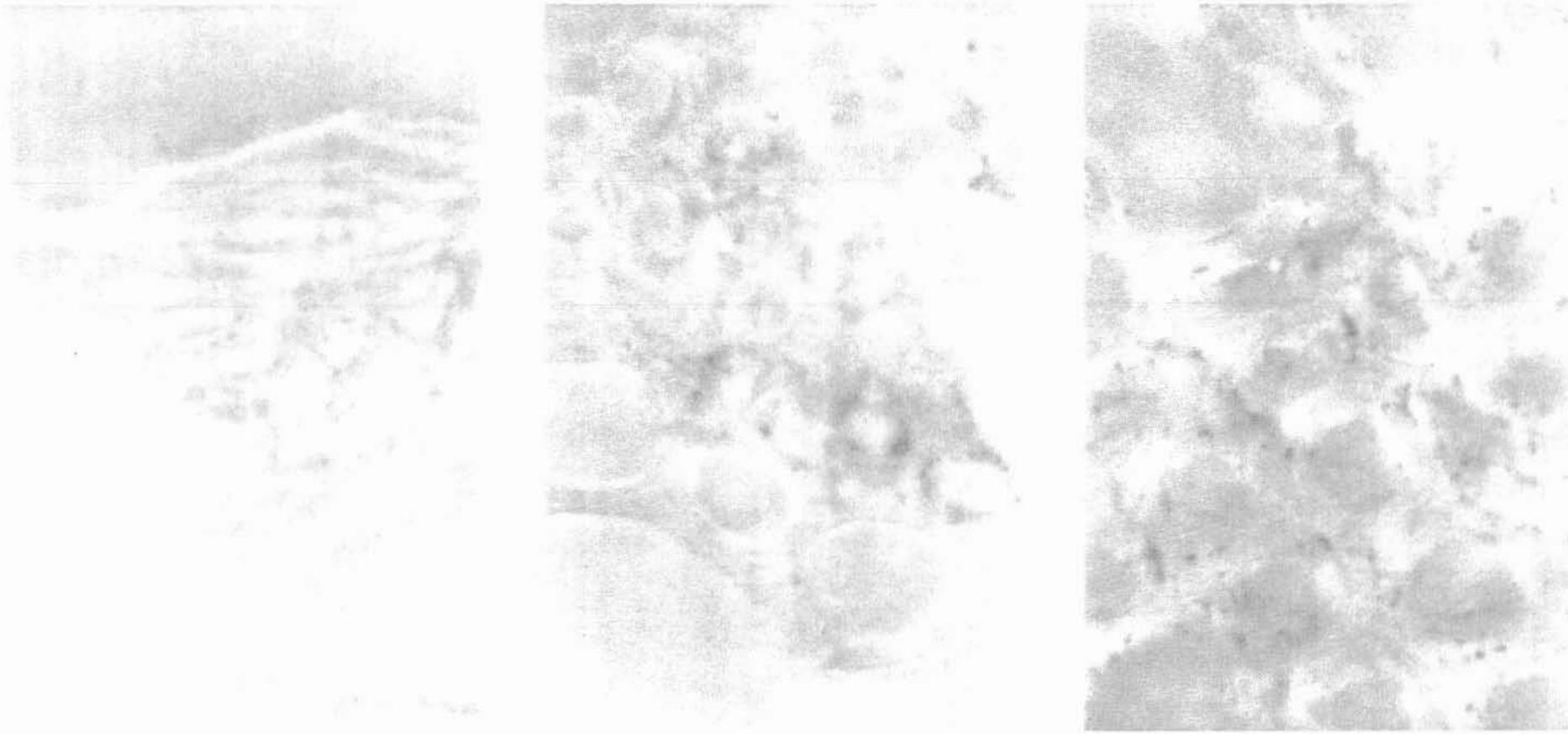


Fig. 4. Translocation of C^{14} - Fenitrothion in balsam fir (histoautoradiography)

(i) Cross section of balsam fir young foliage showing C^{14} activity in a vascular system. (x 1,000)

(ii) Cross section of balsam fir old foliage showing C^{14} activity in vascular system. (x 1,000)

(iii) Cross section of balsam fir stem showing C^{14} activity in xylem vessels. (x 1,000)

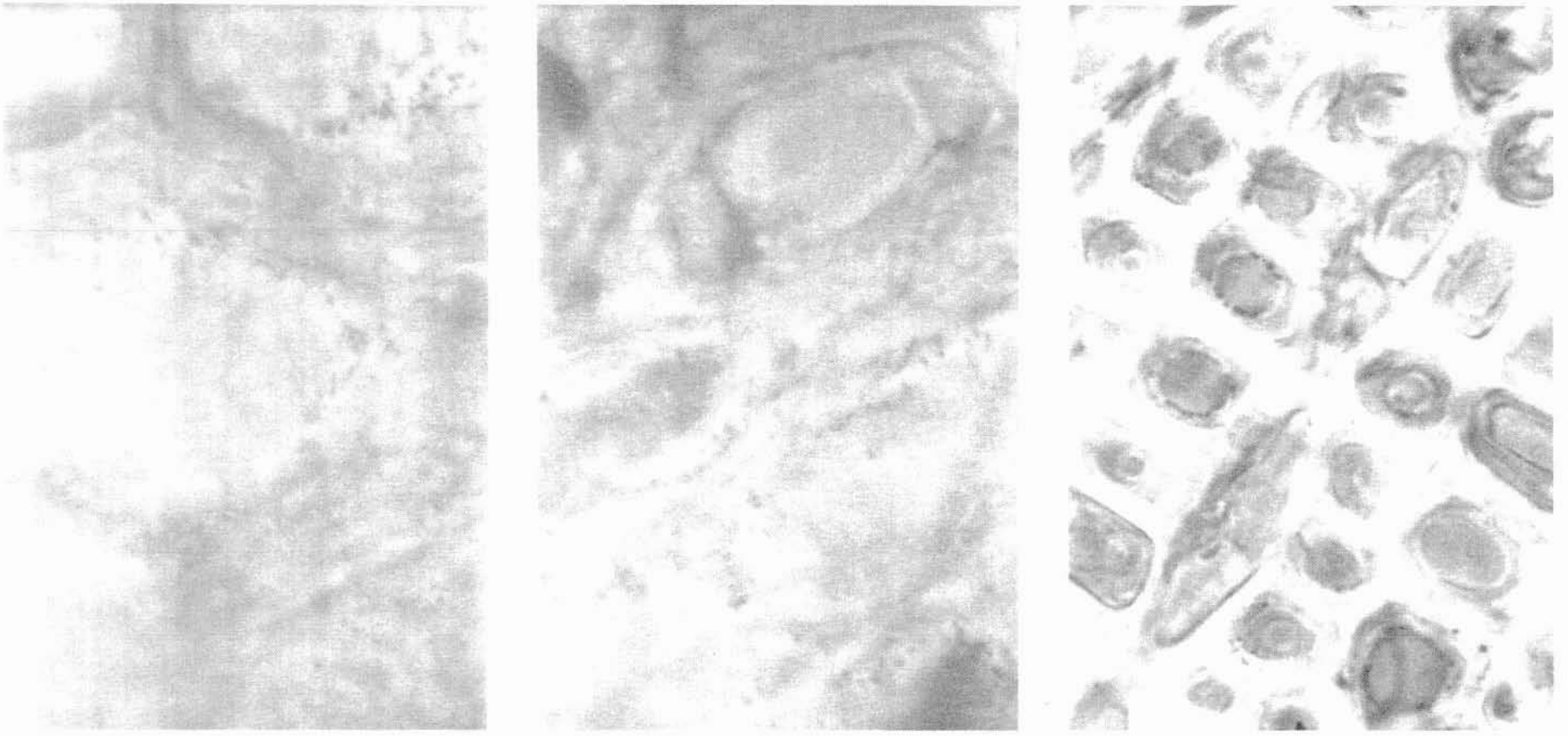


Fig. 4. Translocation of C^{14} - fenitrothion in white spruce (histoautoradiography)

(iv) Cross section of white spruce young foliage showing C^{14} activity in mesophyll. (x 1,000)

(v) Cross section of white spruce old foliage showing C^{14} activity in vascular system. (x 1,000)

(vi) Cross section of white spruce stem showing C^{14} activity in xylem vessels. (x 1,000)

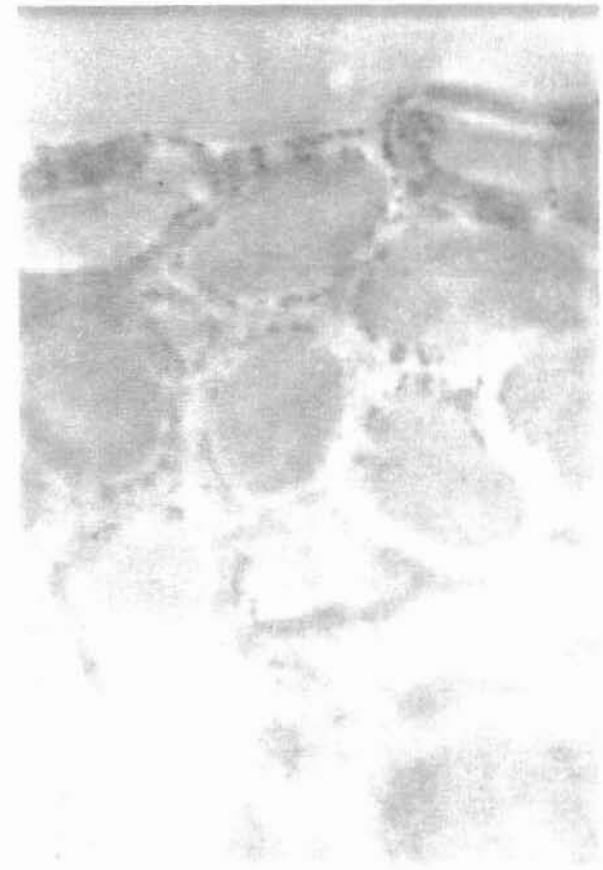


Fig. 4. Translocation of C^{14} - fenitrothion in Jack pine (histoautoradiography)

(vii) Cross section of Jack pine young foliage showing C^{14} activity in vascular system. (x 1,000)

(viii) Cross section of Jack pine old foliage showing C^{14} activity in vascular system. (x 1,000)

(ix) Cross section of Jack pine stem showing C^{14} activity in outer xylem vessels. (x 1,000)

Fig. 5. Scanning electron micrographs

(i) Upper surface of a balsam fir needle (x 5,000) showing surface deposit of epicuticular wax.

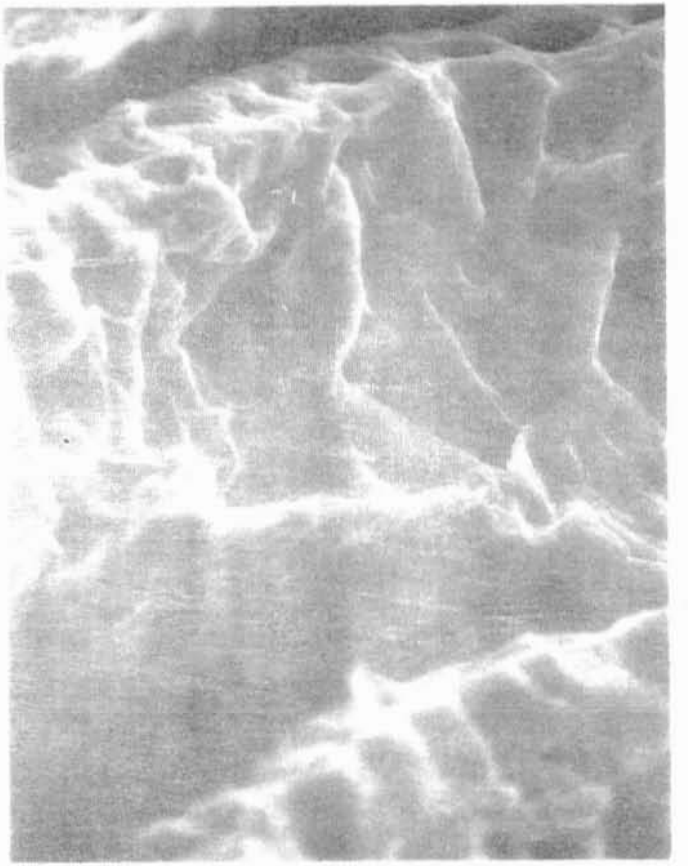
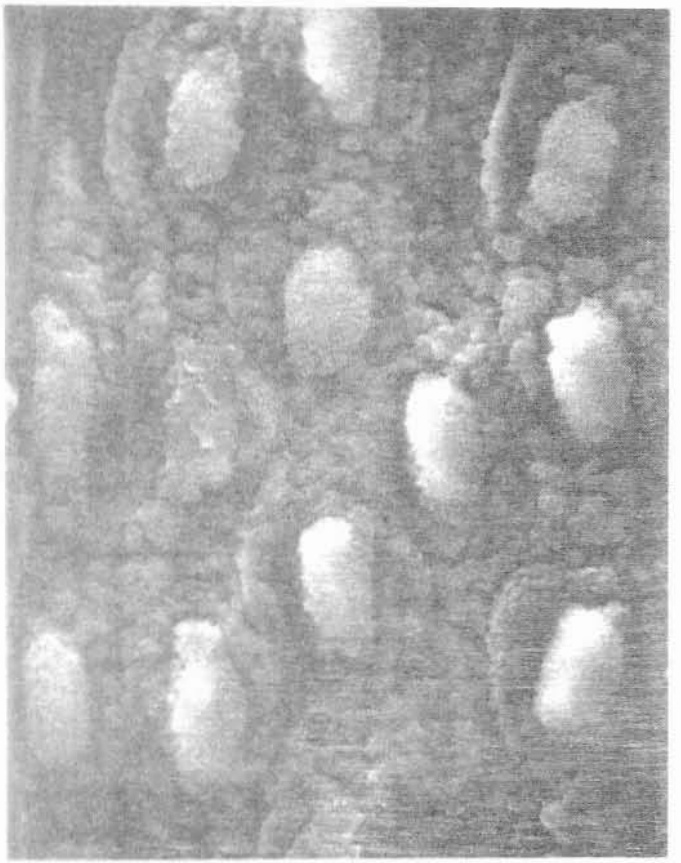


Fig. 5 (ii) Cross section of a balsam fir needle (x 1,000).



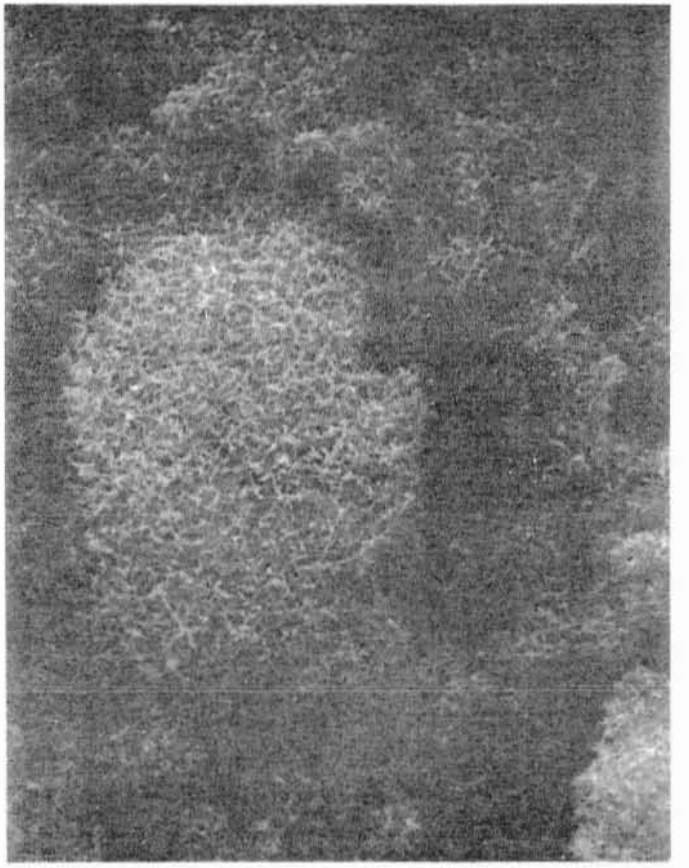


Fig. 5. Scanning electron micrographs

(iii) Lower surface of balsam fir needle (x 500) showing stomata covered by wax deposits.

Fig. 5 (iv) Lower surface of balsam fir needle (x 2,000) showing the wax deposit covering one stoma.

Fig. 6 Thin layer chromatography (TLC) autoradiograph of TLC plate spotted with extract of balsam fir young foliage sampled after 21 days. F - fenitrothion; A - unknown metabolite; 0 - origin.

DISCUSSION

Our previous investigation (Moody et al, 1975) demonstrated rapid loss of fenitrothion from conifers held in the greenhouse. The present study was consistent with the earlier results as shown by the percent recovery data plotted in Fig. 1 (ii) which demonstrates that 60-70% of the applied fenitrothion had been lost one day after the treatment. Fig. 2 demonstrates the equally rapid dissipation of the pesticide from glass surfaces under both conditions of light and dark. The observed lag in rate of dissipation in the dark was also apparent in our previous in vitro study with "cold" (unlabelled) fenitrothion. This observation may be due to the thermal effect of the impinging light which would increase the rate of volatilization of the pesticide. Since the present data were obtained by monitoring of total C^{14} activity, the observed loss of activity with time would preclude the possibility of large scale degradation via metabolite formation, since any metabolite possessing the C^{14}-ring moiety would still be detected. This point is significant since the GC methodology used previously for detection of "cold" fenitrothion was not sensitive to some of the more polar matabolites. The TLC data (Table 1) showed only trace amounts of C^{14} metabolites present in most of the conifer extracts. This is further evidence for postulating a volatilization-dissipation mechanism to explain the rapid disappearance of the pesticide. The preferential localization of the C^{14}-metabolite (A) in the young foliage extracts of fir and spruce might be explained by the high metabolic activity of this tissue (Linskens et al, 1965) although it might also have been formed elsewhere and then transported acropetally. The latter

explanation seems to be the more probable as will be discussed later.

The data show a direct relationship between the amount of pesticide absorbed (Fig. 1 (i)) and the amount persisting (Fig. 1(ii)) in the conifer tissue, since successively greater absorption was matched by increasing persistence in pine, spruce and fir. This could be explained by the more persistent nature of absorbed residues since solubilization in plant waxes and oils would tend to retard volatilization of these residues (Spencer et al, 1973).

The SEM photomicrographs (Fig. 5 (i-iv)) illustrate the presence of thick deposit of epicuticular wax present on the surface of balsam fir foliage. Yule and Duffy (1972) speculated that the unusual persistence of fenitrothion on conifer foliage could be attributed to solubilization in these waxes, where the residue would be protected from physical loss resulting from leaching and volatilization. However, Table 1 shows that the persistent residues were mainly present in the tissue extracts and not in the surface washes which contained much of the epicuticular waxes. It seems more likely then, that the persistent residues are located at some subcuticular level, raising the possibility of their being translocated systematically.

It is evident from Table 1 that the greater persistence of fenitrothion in fir after 21 days was mainly due to the high levels present in the young foliage extracts. This phenomenon was also noted in our previous report (Moody at al, 1975) which raised the hypothesis that fenitrothion could penetrate the tissue and be translocated acropetally to the young fir foliage. This is in fact the case as shown by the gross autoradiographs given in Fig. 3 (i-xviii). Although some basipetal transport is apparent

(Fig. 3 (i)) the major route of translocation is acropetal, from the old to the newly developing foliage (Fig. 3 (v)). Movement was less apparent in spruce than in fir and was practically negligible in pine. The presence of the C^{14}-metabolite (A) in the young foliage extracts of fir and spruce but not in pine, may be further evidence of acropetal translocation. The reason for these species related differences, whether resulting from differences in needle morphology, degree of cutinization etc. remains to be determined. However, their observation in two separate laboratory studies by the authors, as well as in various field studies (Yule and Duffy, 1972; Howse et al, 1971) necessitates further, detailed investigations. The ability of fenitrothion to translocate acropetally in balsam fir, and to a minor extent in the other species, raises the possiblity of a systemic potential for this pesticide. The spruce budworm always attacks the newly flushed foliage of conifers, and the ability of the pesticide to be transported to this tissue, and to persist there in a biologically toxic state would be most advantageous for budworm control.

Future research should incorporate further investigation of the mechanisms involved in the translocation of this pesticide. The results given for the histoautoradiography (Fig. 4 (i-ix) demonstrated that the major transport was apoplastic, i.e. via the xylem vessels. However, more research is needed to determine the rate limiting factors governing this process so that the observed species related differences for fir, spruce and pine could be better understood. Some endeavour should also be made to determine whether modification of the spray formulation or time and method of application could take advantage of the mechanism operating in fir, or activate this mechanism in spruce and pine.

SUMMARY AND CONCLUSIONS

An investigation was carried out to determine the fate and persistence of C^{14}-labelled fenitrothion applied to four year old seedlings of balsam fir, white spruce, and Jack pine held in the greenhouse. The insecticide disappeared rapidly from the surface of conifer tissue while the absorbed residues were more persistent. Greater absorption of the pesticide was coupled with increasing persistence in pine, spruce and fir. An in vitro study carried out on glass surfaces demonstrated that rapid disappearance of the pesticide was probably due to volatilization. TLC analysis of the conifer extracts was consistent with this dissipation mechanism since C^{14}- ring metabolites were present for the most part only in trace amounts.

Autoradiographic tracing studies demonstrated the ability of C^{14}-fenitrothion to be translocated acropetally into the young foliage of fir, and to a lesser extent in spruce. That this took place via the xylem vessels (apoplastically) was confirmed by histoautoradiography. These results were taken as evidence for the systemic potential of fenitrothion for budworm control.

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