who studied the snail's feeding apparatus in detail and also the mode of life of this group, report: "Pyramidellids are ectoparasites. Each species feeds on a particular species of host, usually a tubicolous polychaete or a lamellibranch mollusc, obtaining attachment to the body by means of the oral sucker, piercing the body wall with the buccal stylet and sucking blood, and perhaps tissue debris, by means of the buccal pump." These authors also gave a list of the hosts that have been found to be attacked by the members of the Pyramidellidae family. More recently, Cole and Hancock (*4*) added to this list *Odostomia eulimoides* (Hanley) and *Chrysallida obtusa* (Brown), which they found caused serious damage to the European oyster, *Ostrea edulis* L. Another pyramidellid was found by Medcof (*5*) to be attached to the siphons of *Mya arenaria* L. Medcof, however, thought that because it had no radula, it was commensal and not a predator.

Recently, I have been observing under laboratory conditions the behavior of *M. bisuturalis* in relation to young American oysters and found that it resembles the behavior described by Fretter and Graham for other Pyramidellidae. The typical feeding position of this snail is along the edges of the oyster shell, to which it attaches itself by the oral sucker. We have often seen groups of these snails occupying such a position on a single oyster. When the shells are open the snails protrude their proboscis to reach the soft parts of the oyster, usually the edge of the mantle. At first the oyster reacts to this stimulus by closing its shells but, apparently, it soon becomes accustomed to it and remains open, even if several *M. bisuturalis* are touching its mantle with their proboscis. In this respect the behavior of the oyster resembles, to a large extent, the reaction of other invertebrates attacked by related species of pyramidellids (*3*).

I found *M. bisuturalis* in large numbers on young oysters, especially those that came from shallow water areas. Although these snails may not be very successful in killing the oysters after the latter reach the size of about 1.0 cm, they, no doubt, interfere with the oysters' normal development and growth. This is often shown by the characteristically deformed shells of the young oysters that came from areas heavily infested with *M. bisuturalis*. The shells, instead of being flat, which is normal for shells of young oysters that are not too crowded, are deeply cupped and may have thickened edges. This abnormality is apparently due to injuries caused, by the activities of *M. bisuturalis,* to the edges of the oyster mantle, the organ that secretes the shell.

As in the case of *S. ellipticus,* it is apparent that we need more information on the feeding habits and general ecological requirements of *M. bisuturalis* before estimating its destructiveness and devising methods for its control.

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10 February 1956

Collection of Atomic Bomb Debris from the Atmosphere by Impaction on Screens

Some of the theoretical factors (*1*) which determine the efficiency of collection of aerosol particles on fibers in a moving air stream are inertia and interception, electrostatic attraction, gravity settling, Brownian diffusion, and thermal forces.

Radioactive particles having a wide range of sizes are produced in an atomic explosion and carried to high altitudes in the fireball. Gravity operates to modify the original particle-size distribution, so that, after a few days, particles in the micron range predominate at ground level. For particles of this size, electric attraction and inertial effects are the most important factors in the deposition process.

Preliminary work with charged wires showed that for fission-product activity, the inertial effect was predominant. The efficiency of collection depends on the extent to which particles aproaching a wire or fiber will strike it and become attached instead of following the streamlines of air flow. Theoretical efficiencies of at least a few percent are predicted for the wire diameters, particle sizes, and air velocities of concern in our experiments (*1*).

During the atomic tests held in Nevada during the fall of 1951 and the spring of 1955, metal screens of various mesh sizes were exposed at Washington, D.C., on a vane arrangement as shown in Fig. 1. The collected radioactivity was removed from the screen by repeated washing with acetone and nitric acid. The wash liquid was evaporated to dryness, and the residue was counted by standard beta-counting techniques. Chemical separation of individual isotopes followed by decay measurements identified the material as recently produced fission products.

Table 1 compares the activity (beta counts per minute corrected for geometry) of weekly collections made at Washington, D.C., during early 1955 with (i) an 80-mesh stainless steel screen, (ii) an efficient filter apparatus (capacity 30 ft^3/min) and (iii) the standard gummed-paper fallout technique (*2*). The total activity collected by the screen in 1 week was roughly comparable to that of a filter collection of approximately 3×10^5 ft^3 of air and, in some cases, was as much as 100 times that deposited on an equal horizontal area by fallout. As determined from the estimated air flow and the amount of activity collected, the screen is about 1-percent efficient in the absence of rain. Since a strong dependence of fallout on rain has been observed, and since there are indications that precipitation will wash activity from the screen, figures for the total precipitation have been included in Table 1.

Comparative measurements of 1-week collections were made, using electrically grounded screens of 40, 60, 80, and 200 mesh. During the period of observation, the amount of activity collected did not vary in a regular way with mesh size. It is possible that the increase in collecting area obtained with the smaller mesh sizes was compensated by the reduced air flow. In a single comparison between grounded and well-insulated screens, the amount of radioactivity collected was not affected appreciably, although the weight of solid matter in the residue was nearly doubled in the case of the insulated screen.

Ordinary cheesecloth (*3*) (about 40 mesh) can be used in place of metal screens and seems to lose less activity during rain. It has the advantage that it may be ignited and the ash counted directly in the same manner as the gummed papers. Flags made of cheesecloth also collect fission-product activity, but with only about one-tenth of the efficiency of the vane-mounted cloth.

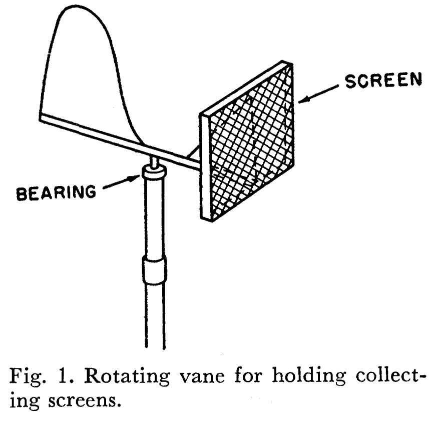

Fig. 1. Rotating vane for holding collecting screens.

Table 1. Comparison of simultaneous filter, gummed-paper, and screen collections.

Date of collection (1955)	Filter collector (disintegration/min)	Gummed paper (disintegration/min)	Stainless steel screen (disintegration/min)	Rainfall (in.)
21–28 Feb.	8,400	340	3,100	1.22 (snow)
28 Feb.–7 Mar.	2,500	200	2,100	1.78
7–14 Mar.	4,900	92	3,400	0.13
14–21 Mar.	5,200	5,100	1,700	1.13
21–28 Mar.	7,500	2,000	11,000	0.43
28 Mar.–4 Apr.	6,700	64	7,700	0
4–11 Apr.	8,000	320	3,800	0.07
11–18 Apr.	14,000	130,000	75,000	1.50
18–25 Apr.	8,900	2,300	1,500	0.47
25 Apr.–2 May	2,000	700	1,900	0.40
2–9 May	9,800	31,000	14,000	0.01
9–16 May	9,300	5,500	2,600	1.62
16–23 May	10,000	9,700	4,700	0.50
23–31 May	110,000	13,000	24,000*	1.11
Total	207,000	200,000	157,000	

* Cloth screen.

During the 2-month period of maximum fallout in the spring of 1955, daily samples of 1-ft^2 cloth screen gave a total fission-product collection of 2.8×10^5 beta disintegrations per minute as compared with 1.8×10^5 disintegrations per minute using the filter device and 1.9×10^5 disintegrations per minute on standard 1-ft^2 gummed papers.

In order to get some idea of the efficiency of the screen collector, a composite filter was made up of 7-in. squares of 40-mesh nickel screen on top of 100-mesh copper screen and backed by an efficient filter paper. Air was drawn through this filter at a face velocity of 3000 ft/min by a blower. A rough measure of the efficiencies of the screen filters was obtained from the relative amounts of the cerium-144 (praseodymium-144) isotope deposited on the different filter components. Particle retentions on the screens were compared by assuming that the filter paper was 100-percent efficient. The 40-mesh nickel screen at the top retained 11 percent of the total radioactivity, and the 100-mesh copper screen retained 18 percent, giving a total retention on both screens of 29 percent.

Direct impaction on small fibers is an effective mechanism for deposition of the radioactive particulate matter produced by atomic bombs. While even at highflow rates the collection efficiency of screens is comparatively low, their low airflow resistance and tendency to discriminate against the extremely small particles comprising the natural activities may be advantageous where simple detection of air-borne, fission-product radioactivity is the sole consideration.

Natural filters such as grass or trees may behave like many layers of filter fibers in removing activity carried by surface winds. In this case, the removal of particulates is fairly efficient and may account for a large fraction of the fission-product activity deposited on vegetation, particularly in the absence of precipitation.

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19 January 1956

Bonding in the Molecular Addition Complexes of the Alkyl Phosphates and Thiophosphates

In connection with a recent study involving the determination of the solubilities of certain inorganic metal nitrates in the trialkyl phosphates and thiophosphates (*1*), a great difference was observed in the solubilities of the salts in these two solvents. Since the dielectric constants for the two solvents are similar (*2*), the difference in solubility must be due to the difference in bonding between the metal salts and the organic molecules.

To elucidate the nature of this bonding, the solubility of uranium (VI) nitrate hexahydrate, thorium nitrate tetrahydrate, and copper (II) nitrate hexahydrate were determined in tri-*n*-butyl phosphate (TBP) and tri-*n*-butyl thiophosphate (TBPS) (*3*). These two compounds are alike in structure, except that the TBP has a semipolar $P \rightarrow O$ bond, while the TBPS has a semipolar $P \rightarrow S$ bond.

The procedure for the solubility determinations consisted of adding about 25 g of the solid salt to 20 ml of the pure solvent contained in a 50-ml bottle, sealing the bottle, and equilibrating the contents on a mechanical shaker for 48 hours at room temperature (25 to 27°C). It was found that this was sufficient time for equilibrium conditions to be established. At the end of this time, three phases were present in the bottle—a solid hydrated-salt phase, an aqueous phase containing a saturated solution of the metal salt, and an organic phase. The organic phase was separated, centrifuged, and analyzed for metal content.

The analysis consisted of weighing out 1- to 4-g duplicate samples of the centrifuged organic phase into separatory funnels containing 25 ml of benzene and 50 ml of water. After equilibration for 2 minutes, the aqueous phase was separated, 50 ml of water was added, and the equilibration was repeated. Two such extractions were sufficient to remove the metal salt from the organic phase. The metal content in the extracted aqueous phases was determined as follows: uranium by the 8-quinolinol method (*4*), thorium by the oxalate method (*5*), and copper by the cupferron method (*6*).

The solubilities of the metal nitrates are given in Table 1. In the TBP, it can be seen that uranium (VI) nitrate is the most soluble. Thorium nitrate is only slightly less soluble than the uranium salt, while copper (II) nitrate is about half as soluble as the other two. The striking observation is that the metal nitrates are only about one-twentieth as soluble in the TBPS as they are in the TBP.

The solubility of uranium (VI) nitrate in TBP has been attributed to the formation of the molecular addition complex, $[UO_2(TBP)_2(NO_3)_2]$ (*7*). The solubilities of the other metal nitrates can also be attributed to this effect but as yet have not been investigated.

The decreased solubilities of the metal

Table 1. Solubilities of the metal nitrates in tributyl phosphate and tributyl thiophosphate at room temperature (25–27°C). The solubilities are expressed in grams of anhydrous metal nitrate per 100 g of solution.

Metal nitrate	TBP	TBPS
$Th(NO_3)_4 \cdot 4H_2O$	42.6 ± 0.2	2.1 ± 0.2
	42.4	1.8
$UO_2(NO_3)_2 \cdot 6H_2O$	43.6 ± 0.2	1.8 ± 0.2
	43.4	2.3
$Cu(NO_3)_2 \cdot 6H_2O$	21.5 ± 0.1	0.62 ± 0.05
	21.3	0.51