EFFECTIVENESS OF INSECT WIRE SCREENING

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World War II, among many other things, was indirectly responsible for the first change in the shape of mesh in insect wire screening that has occurred in almost 90 years. From 1857, the earliest known date on which insect wire screening was introduced into commercial distribution, right down to 1945, wire screening for windows, doors and porches has always been made in square mesh.

In the early days, the mesh sizes were coarse, 12 x 12 being the most popular size. But, as time went on, it came to be recognized that mosquitoes among all of the flying insects constituted the greatest menace to the health of human beings, with the common house fly a close second in importance. It likewise became progressively apparent that most varieties of mosquitoes could enter a lighted interior at will through 12 x 12 mesh screening and that 14 x 14 mesh was only slightly more satisfactory. Hence, in late years, the trend has been steadily toward 16 x 16 mesh as offering maximum protection against mosquitoes, as well as flies, with only a minimum sacrifice of light and air.

In 1945, when the industry was straining to produce every last possible square foot of wire screening for South Pacific field hospitals, base hospitals, barracks and all rigid frame structures, the armed services, in response to front line appeals for more and more wire screening, initiated a restricted series of tests to determine whether the mesh had to be square. Obviously, if the filler count could be cut down by proportionately increasing the number of warp wires, loom time would be saved because a shuttle passing back and forth only 14 times to the inch would produce finished screening faster than one which had to travel across the loom 16 and 18 times to produce a lineal inch of screening. As a result of those hurried tests, the armed services decided that 18 x 14 mesh wire screening would be acceptable to them as a substitute for 16 x 16 and 18 x 18 mesh. Immediately following that decision, the War Production Board ordered the industry to produce nothing but 18 x 14 mesh wire screening for civilian use.

Without in any way opposing or obstructing the government on those decisions, the industry set about having further and exhaustive tests conducted by independent agencies to learn exactly how "good" 18 x 14 mesh was in comparison with 16 x 16 and 18 x 18 and particularly with 18 x 18.

Contracts were entered into by the Insect Wire Screening Bureau with the

FIG. 1. Section of Department of Entomology mosquito breeding room at the University of Delaware. Laboratory assistant removing *Aedes aegypti* pupae for insect wire cage screening tests.

University of Delaware and the University of Florida to get to the bottom of the matter. At Delaware, the work was carried on under the personal supervision of Dr. L. A. Stearns, Head of the Department of Entomology. At the University of Florida, Dr. S. S. Block, Associate Research Engineer, Engineering and Industrial Experiment Station, did the work in collaboration with Dr. R. A. Morgen, Assistant Director of the Station, and Dr. J. T. Creighton, Head Professor of Entomology.

Historical

There are but few references in literature giving what might be termed a quantitative comparison of the effectiveness of different sizes of mesh in insect wire screening. Rosenau (1), referring to previous experimental work at Vera Cruz, noted that the *Aedes* mosquito could pass through 15 x 15, but not 18 x 18 mesh screening. Boyd (2), found that coarse mesh screening, such as 12 x 12 and 14 x 14, afforded a certain amount of protection against *Anopheline* mosquitoes, as estimated from malaria incidence. Earle (3), in Puerto Rico, observed that standard 16 x 16 mesh screening would afford protection against all insects except the small culicoides. Herms and Gray (4) reported that standard 16 x 16 mesh screening does not exclude many *Aedes* and some *Anopheles* species of mosquitoes. For army requirements, the War Department (5), considered the openings of regular 16 x 16 mesh too large. The standard 18 x 18 mesh screen however, was said to exclude both malaria-carrying mosquitoes and the smaller insect pests.

Materials and Methods

Adult laboratory-bred mosquitoes were introduced, a single species at a time, and in predetermined numbers and sex, into specially constructed screen cages which in turn, were placed inside of gauze covered "escape" containers. At the University of Florida, after 48 hours in the laboratory at 85° F. and ordinary room

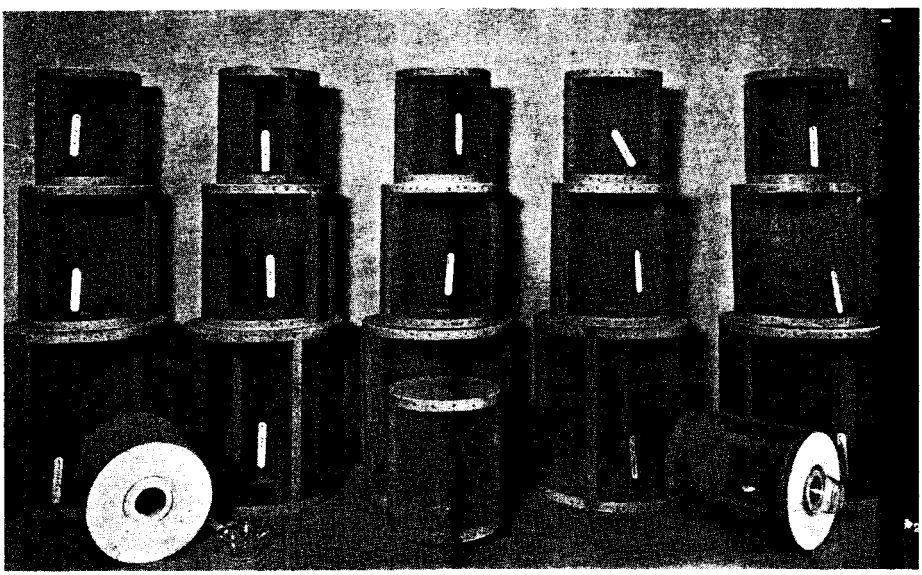
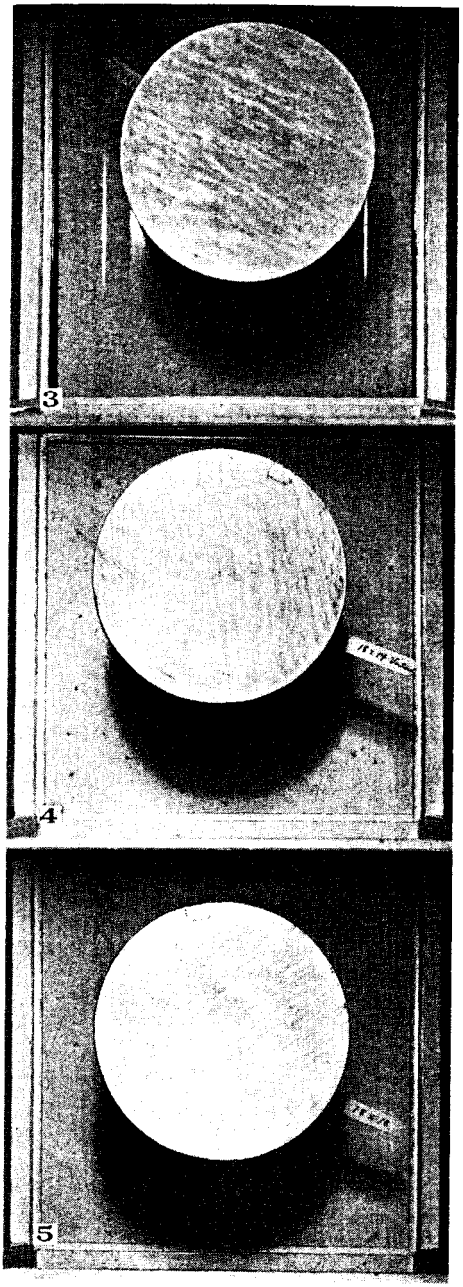


FIG. 2. Cylindrical cages of ¼, ½, and 1 cubic foot capacity, for testing efficiency of 16 x 16, 18 x 14, and 18 x 18 mesh bronze and steel insect screening wire. Note base construction to permit attachment of glass dish containing mosquito pupae.



FIGS. 3, 4 AND 5. Looking down on bottom of box "escape traps," showing insect wire screen "confinement cages," and the numbers of mosquitoes which escaped through each of three mesh types. Fig. 3, 16 x 16 mesh. Fig. 4, 18 x 14 mesh, vertical. Fig. 5, 18 x 18 mesh.

lighting conditions, the mosquitoes were gassed with ethylene dichloride and the numbers in the outside escape cages were counted. At the University of Delaware, the procedure was to leave each test undisturbed until all of the mosquitoes died of starvation, a process which required approximately one week for each test.

Preliminary tests demonstrated that lighting conditions (except direct sunlight, which in a very short time proved to be lethal to caged mosquitoes), age, sex and the density (number of mosquitoes confined) had little or no influence on their ability to escape from any of the wire screening test cages.

The sizes of wire screening used in these tests consisted of 18 x 18, 18 x 14, 16 x 16 and 14 x 14 mesh in bronze and electro galvanized steel; all made with standard .011 wire, or its averaged commercial equivalent.

At the University of Delaware, a total of 7,535 mosquitoes were utilized in the 244 separate tests which were conducted at that location. At the University of Florida, 3,406 mosquitoes were used in a series of 100 tests.

Escapes of Mosquitoes from Wire Screen Cages

Curiously enough, while the number of "escapes" at Delaware varied widely from the results obtained at Florida, the proportion was almost exactly the same at both universities: 35.5 per cent for 18 x 14 mesh and 35.8 per cent for 16 x 16 mesh at Delaware and at Florida, 14.3 per cent for both sizes of mesh. Just why the percentages of escapes should have differed so materially is not clear, but results at both stations established the seemingly incontrovertible fact that 18 x 14 mesh is no poorer, nor is it any better than 16 x 16 mesh—the two types of mesh are definitely on a par, one with the other.

18 x 14 mesh as well as 16 x 16 mesh, did not show up at all well at either university in comparison with 18 x 18; 2.7 per cent (average of 15 tests) at Florida and 3.3 per cent (averaged) at Delaware. Both of these percentages, it is readily seen, indicate the far superior protective effectiveness of 18 x 18 mesh over 18 x 14 and 16 x 16 mesh.

14 x 14 mesh and all other off-count meshes tested at Florida failed to approach 16 x 16 and 18 x 14 in protective efficiency; 55 per cent of the mosquitoes confined in 14 x 14 mesh cages escaped, as compared to 14.3 per cent through 16 x 16 and 18 x 14 mesh.

Summary

18 x 14 mesh is on a par with 16 x 16 mesh.

18 x 14 mesh is not anywhere near as efficient as 18 x 18 mesh.

It makes little or no difference in protective efficiency whether the "long" mesh in 18 x 14 is installed vertically or horizontally.

14 x 14 mesh is nowhere near as efficient as 16 x 16 or 18 x 14 mesh for household protection against mosquitoes. And 18 x 18 mesh is from 5 to 10 and more times as effective as any of the coarser sizes.

No differences were discernible between steel and bronze or copper as either an attractant or a repellent of mosquitoes.

The diagonal measurement of a mesh, square or oblong, is believed to be the determining factor in barring out mosquitoes of any given size. The diagonal measurements of ordinary commercial 18 x 14 and 16 x 16 meshes selected at random by the University of Florida proved to be almost exactly the same (.0723" for 16 x 16 and .0739" for 18 x 14; in theoretically perfect cloth the mesh diagonals would measure .0728" for 16 x 16 and .0751" for 18 x 14).

Will 18 x 14 Mesh be a Permanent Size?

Public acceptance and continued consumer demand for that specific size in preference to 16 x 16 will have an important bearing upon the question of whether 18 x 14 mesh will be retained as a permanent item in the insect wire screening "line." That factor cannot be fully evaluated until after the end of the current buying season.

References

(1) Rosenau, M. J. 1935. "Preventative medicine and hygiene." D. Appleton-Century Co., New York.

(2) Boyd, M. F. 1926. "The influence of obstacles unconsciously erected against anophelines (housing and screening) upon the incidence of malaria." Am. J. Trop. Med. 6.

(3) Earle, W. C. 1932. "Some observations of anti-mosquito screening and screening materials." Puerto J. Public Health 8.

(4) Herms, W. B. and Gray, H. F. 1944. "Mosquito control." The Commonwealth Fund, New York.

(5) War Department Technical Manual TM 5-632, "Insect and rodent control." 1945.