A COMPARATIVE STUDY OF THE NATURAL RESISTANCE OF COMMERCIAL WOOD SPECIES AGAINST MARINE BORERS IN EGYPTIAN WATERS

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"For many purposes wood is an ideal construction material and is often used without any protective treatment. The natural resistance of five common commercial woods against marine borers in Egyptian waters was investigated from June 1978 to May 1979. The results show the superiority of labbeck and mahogany over pine and pitch pine in resisting marine borer attack. The Suez area can be recommended as a good locality for testing wood as well as antiborer treatments."

Introduction

Wood is an important renewable natural resource. It is a versatile material that has many desirable physical properties and is generally cheaper to use than other construction materials. In Egypt, large quantities of wood are used for various purposes, the most important of which is the construction of fishing boats; all Egyptian fishing boats and vessels used in marine and inland fisheries are made of wood. However, tropical and subtropical countries are plagued by wood borers in their nearshore marine environments. Despite this, there is a total lack of information on the effect of wood borers on the various species of wood used in Egyptian waters.

The goals of this work, the first in a series on timber preservation for Egyptian waters, are to compare at various marine sites the natural borer resistance of commercial wood species in actual use by boat builders and to investigate the relative durability of some species of wood in common use in the marine environment. Such information will provide guidance to Egyptian companies in selecting the most resistant type of wood in a specific marine environment.

Materials and Methods

Sets of untreated specimens of known indigenous and imported types of wood were exposed in marine locations in the Suez Canal area (Port Said, Ismailia, and Suez harbors) and in Alexandria's eastern harbor from June 1978 to May 1979. Test frames consisting of two test groups of panels each were submerged in the sea at a depth of about 2 m from floating platforms at the test sites. Each group consisted of five wood specimens (2.5 x 7.5 x 15 cm) attached to the frame by nylon line near their corners. The five woods studied were labbeck, mahogany, white oak, pine, and pitch pine. Inspections were made at 3-month intervals, at which time the specimens were removed from the frames, photographed, and cleaned of fouling organisms prior to laboratory examination.

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Hydrographic Conditions of the Exposure Sites

Suez Canal Exposure Sites

The length of the Suez Canal from the Port Said lighthouse to its junction with Suez Bay is 162 km; the depth of the canal is 15.5 m; and its width at sea level is between 160 and 200 m. The canal water moves northward during the year except from July to September when it reverses direction. The first attempt to determine the difference of water level between the Mediterranean Sea and the Red Sea was carried out in 1799 and found to be 9.909 m. For several years this value was considered correct; then, measurements in 1847 found that the Red Sea is only 0.665 m higher than the Mediterranean. The tides at Port Said (Mediterranean Sea) and Port Tawfic (Red Sea) are 0.45 m and 1.20 m, respectively.

At Port Said the salinity ranges from 36 parts per thousand in summer to 41 in winter; at Ismailia the salinity ranges from 35 to 37 parts per thousand in summer and from 41 to 43 parts per thousand in winter. The highest salinity values, recorded at Suez, ranged between 42 and 43.5 parts per thousand (M. El-Awady, personal communication).

The water temperature in the Suez Canal varies from a minimum of 13°C in December to a maximum of 31.5°C in July (M. El-Awady, personal communication).

Alexandria Harbor Exposure Sites

The area of Alexandria's eastern harbor is 3.0 km^2; it is connected to the sea by two passages, the wider of which is 300 m. Water temperature at the harbor varies from 15.5°C in February to 28.0°C in July and August. There are no significant fluctuations in the chlorosity of the water throughout the year; it is always about 21.5 g/l. The phosphates fluctuate from 0.12 to 0.33 mg/l, whereas the dissolved oxygen and pH do not show significant fluctuations, being about 5.0 ml/l and about 8.40, respectively (Alsayes, 1971).

Results and Discussion

The borer tunnels in the wood specimens were just beneath and parallel to the surface at regular intervals, as small breathing holes not large enough for the animals to pass through. These holes serve as passages for oxygenated water, which is circulated through the burrows by the beating action of the pleopodes. The number of holes in the surface of an exposed specimen is thus a direct proportional index for expressing the degree of infestation by wood borers.

The degree of fouling settlement and burrowing activity on the wood specimens at Alexandria's eastern harbor demonstrated that the fouling rate there was comparatively high. Figure 1 shows the surfaces of wood specimens submerged from April 1978 to August 1978. After removing the fouling organisms, we carefully examined the surfaces of the wood specimens, and found them absolutely free of breathing holes, as indicated in Figure 2. Thus, the borrowing activity in the water of Alexandria's harbor is low.

According to Ghobashy et al. (1979), the most severe fouling in the canal takes place at Ismailia, and settlement of bivalves in large quantities emphasizes this severity. All marine organisms grow abundantly at Ismailia, and in

FIGURE 1. Settlement of macrofouling organisms on a test frame submerged at Alexandria's eastern harbor from April 1978 to August 1978.

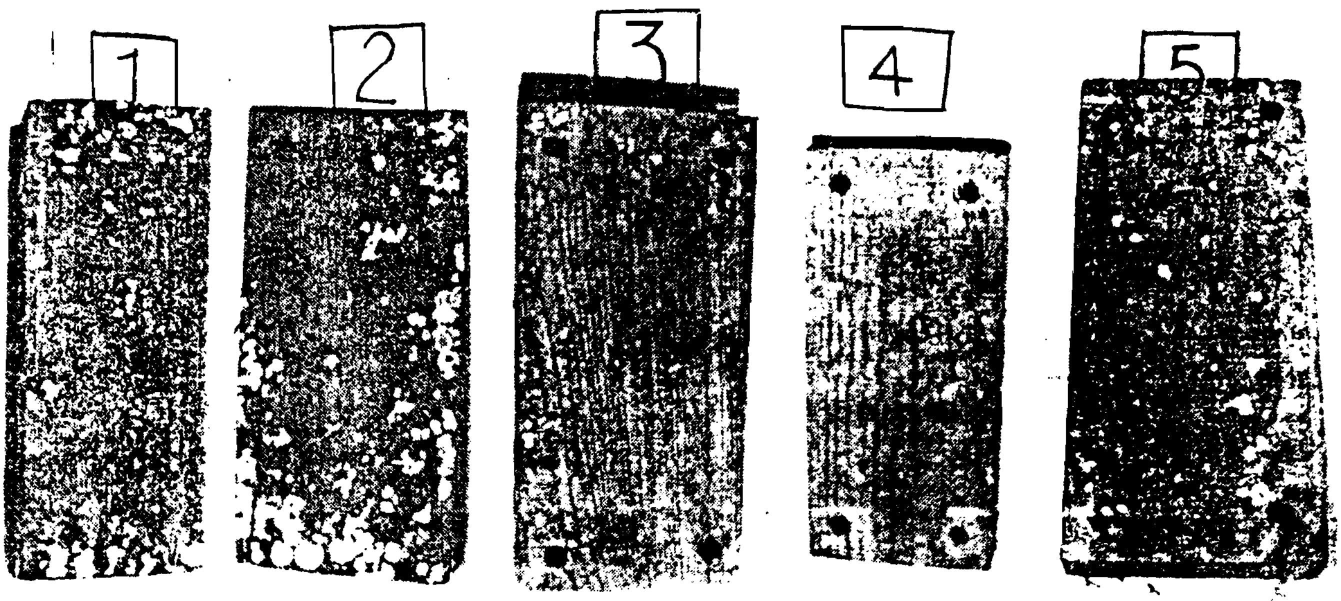

FIGURE 2. Surfaces of wood specimens submerged at Alexandria's eastern harbor from April 1978 to August 1978. The wood species are (1) labbeck, (2) mahogany, (3) white oak, (4) pine, and (5) pitch pine.

some months the exposure sites become inhabited exclusively by a large population of one or two species. Our investigation demonstrates that the rate of fouling in the Suez Canal is maximal at Ismailia and minimal at Suez.

Two factors may have played essential roles in affecting the fouling rate in the various parts of the canal. First, the salinity is comparatively low at Ismailia (35 parts per thousand), which is caused by freshwater runoff, bringing nutritive salts from the Nile River (Gerges, 1976). These salts increase the fertility of the lake and consequently enhance the phytoplankton and zooplankton populations (Steeman-Nielson, 1961). Such plankton-rich water produces a flourishing fouling community. In contrast, the salinity is higher at Suez, ranging from 42 to 43 parts per thousand, caused by the high salinity of the Red Sea water and the absence of freshwater runoff.

The second factor that might affect the rate of fouling in the Suez Canal is the tidal range. Agitation of the water caused by the strong wind in the Gulf of Suez and accelerated by the swift currents of tides, which range between 80 and 140 in neap and spring tides (Morcos, 1960), respectively, obviously produces silt as the major settler in the Suez area. Silting will prevent metamorphosing larvae from reaching attachment sites, and, if some do succeed, the settling silt will prevent further growth. Therefore, growth of colonies of foulers to a normal size is lacking (Ghobashy et al., 1979). Figures 3a and 3b show the surfaces of wood specimens submerged in the Suez Canal at Ismailia and at Suez harbors from June 1978 to February 1979. Clearly, the rate of fouling settlement was considerably higher at the Ismailia site.

In contrast, burrowing activity was clearly higher at Suez, as indicated in Figures 3a and 3b. Thus, there is an inverse relationship between the fouling and the burrowing activities in these marine environments. This general conclusion agrees with the findings of Deschamps (1976), who stated that "appearance of fouling can also reduce or even suppress the borer infestation. In La Rochelle, we found large plates due to Ascidias, which have prevented the borer larvae from settling down."

Figure 4 shows the surfaces of two pitch pine specimens submerged at the Suez and Ismailia sites from June 1978 to June 1979. The higher rate of fouling accumulation at Ismailia (Figure 4, right) reduced the degree of infestation by borers; the latter were dominant in the pitch pine specimen submerged at Suez (Figure 4, left). The higher burrowing activity is indicated by so many breathing holes per unit area of the wood surface.

Burrowing was considerably more severe at Suez harbor as compared to the other sites investigated; there were several holes in the surfaces of most of the wood specimens after relatively short immersion periods. Much longer exposure periods were needed to observe any indication of burrowing activity at the other sites.

We may consider the burrowing activity on the various species of woods submerged at Suez as the index of durability of other woods in a marine environment rich in borers. Since the durability of most woods varies a great deal, even among pieces cut from the same tree, we cannot draw firm conclusions on durability from experiments using only a limited number of wood specimens with such initial potential difference among the replicates from the same source.

The condition of the wood specimens and their ultimate weight loss were

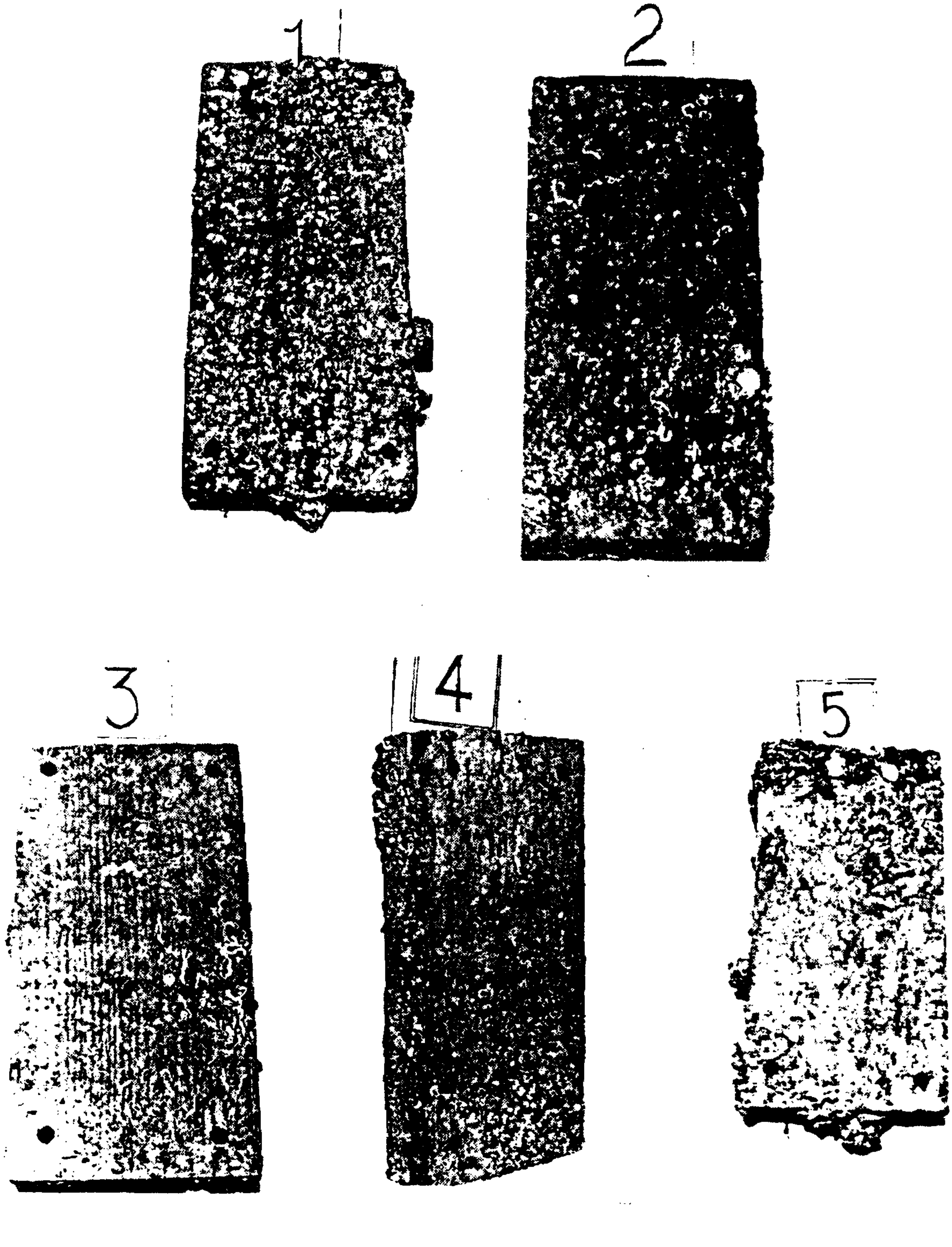

FIGURE 3a. Test group of wood specimens submerged at Ismailia from June 1978 to February 1979.

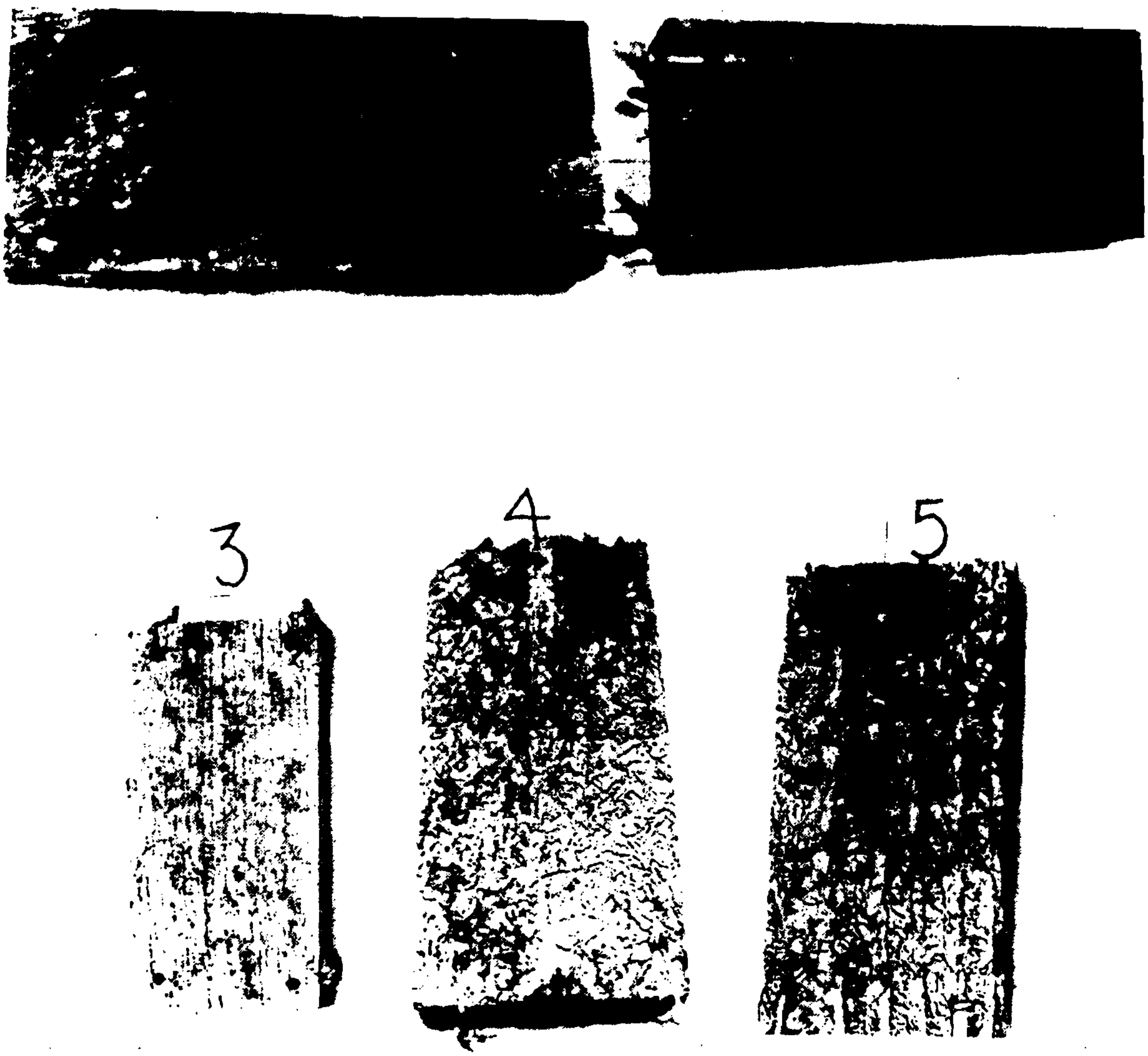

FIGURE 3b. Test group of wood specimens submerged at Suez from June 1978 to February 1979.

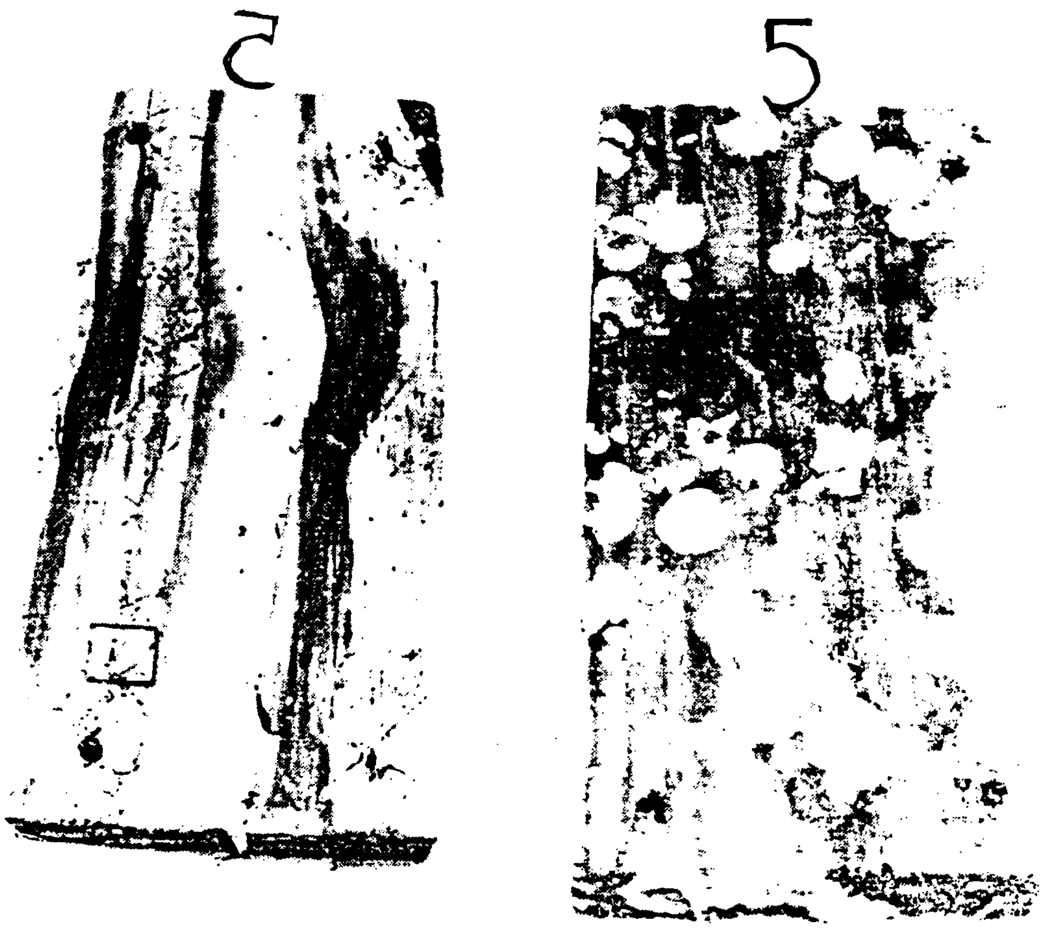

FIGURE 4. Pitch pine specimens submerged at Suez (left) and at Ismailia (right) from June 1978 to November 1978.

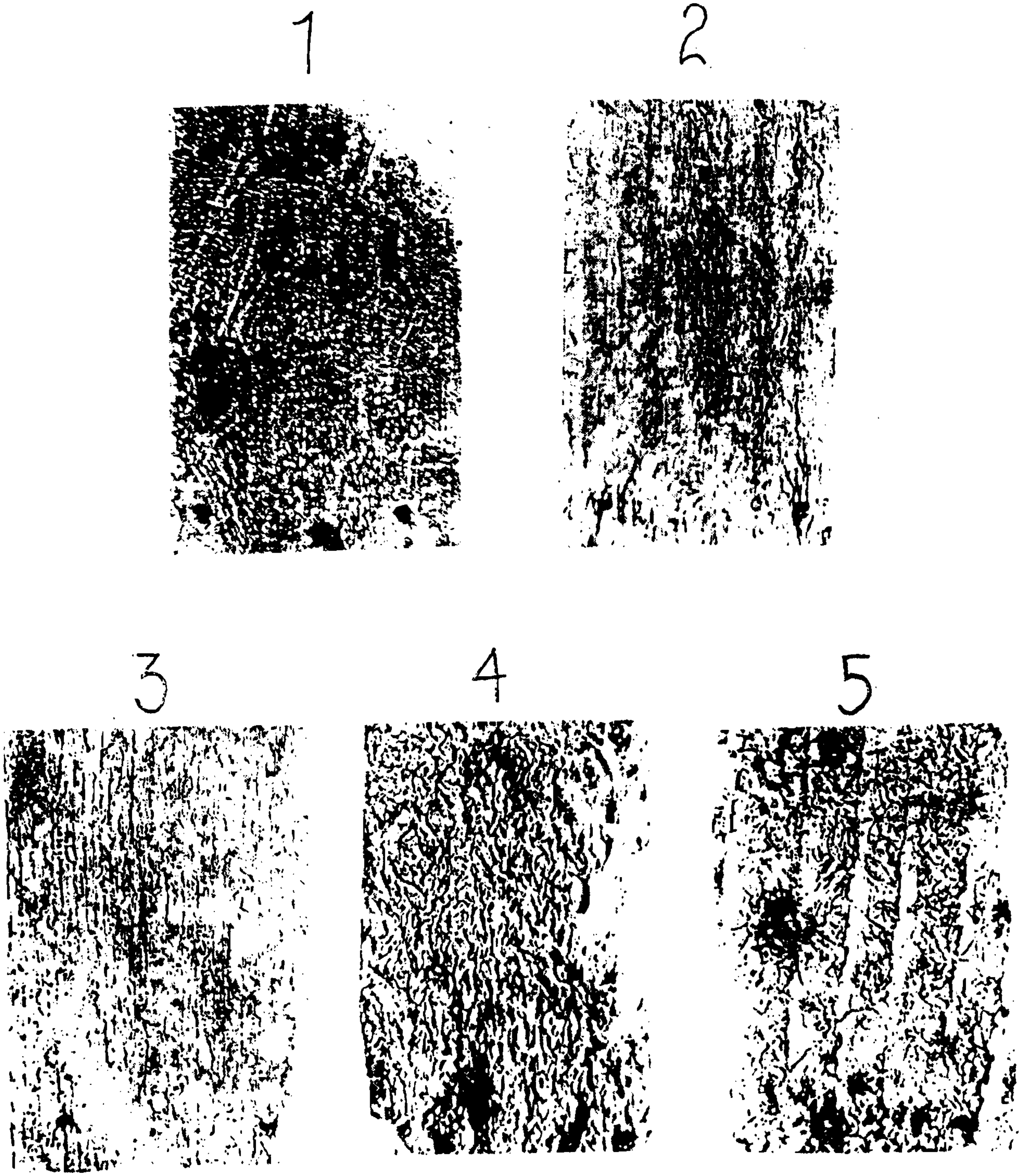

FIGURE 5. Wood specimens of (1) labbeck, (2) mahogany, (3) white oak, (4) pine, and (5) pitch pine exposed to marine borers at Suez harbor from June 1978 to May 1979.

indications of their natural resistance against the destructive effects of borers in the Suez harbor area. Figure 5 shows the condition of five wood specimens (one of each species) submerged at the Suez site from June 1978 to May 1979; the percentages of weight of remaining wood for these five specimens are given in Table 1. These final weights after exposure also include the weights of the calcareous remains left after the decomposition of the burrowing organisms. There is a remarkable difference in natural resistance to burrowing activity among the five woods. The less resistant woods were pine and pitch pine; the most resistant was labbeck. The pines lost about 75 percent of their initial weight over a little less than a year of exposure, whereas the labbeck weight loss due to borer activity during the same period did not exceed 20 percent of its initial weight. Moreover, the general physical condition of labbeck specimens was far better than that of the pine and the pitch pine specimens.

TABLE 1. Amount of specimen remaining after various exposure periods as percentage of the original panel weight for the five woods submerged in Suez harbor from June 1978 to May 1979.

Type of Wood	Percent Weight Remaining		
	5 months	8 months	11 months
Labbeck	100	91	78
Mahogany	100	61	50
White Oak	100	55	41
Pine	100	42	27
Pitch pine	100	36	25

Conclusions

Labbeck and mahogany are preferable, and pine and pitch pine should be avoided for marine construction, including boats, in borer-infested waters such as those of the Suez area. However, this conclusion must be viewed with reservation, since great resistance variations exist within the same species of wood. Rather than depend upon the natural resistance of a wood, it is more reasonable to use appropriate treatments and/or coatings on various seaworthy woods for borer-infested waters.

Suez harbor is typical of such waters. The ongoing program on wood preservation there is useful not only to that site, but also to other localities suffering from excessive marine borer activity. In view of the rapidly developing concern for the marine environment, wood preservation techniques should be essentially nontoxic and nonpolluting; this adds a new aspect to an already well-established technology.

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