Exposure of strain B DNA to 5×10^{-4} mg/ml of RNase for 1 minute before testing allowed the DNase to exhibit 10 units (instead of 1.3 units obtained in tests without preliminary RNase treatment), or 77 percent of the activity which it showed against thymus DNA. (If, in addition, the DNase preparation itself was subjected to RNase action, a higher DNase activity was demonstrated.) Lower concentrations of RNase also evidenced some inhibitor-destroying capacity, justifying the conclusion that this DNase inhibitor is a ribonucleic acid.

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Second Pain: Fact or Artifact?

The phenomenon of "double pain," two temporally discrete and sometimes qualitatively different responses to a single noxious stimulus, has been reported intermittently for the past 75 years. Although there is a good deal of evidence that the phenomenon may be an artifact, it is accepted as genuine by many physiologists. Sinclair, who has been associated with much recent work on second pain, has concluded that it needs reinvestigation (*1*).

The problem is not simple. There are two quite separate and distinct aspects —sensation, a psychological term implying awareness, and afferent impulses, a physiological phenomenon revealed by electric recording techniques. These are often treated as though they were one and the same thing—indeed, it has recently become the fashion to speak of "C-fiber pain." The first question to be asked is whether there is a genuine sensory phenomenon that can be called "second pain." The present experimental data bear on this question only.

The experimental work consisted of three successive attempts to elicit double pain by stimulation of cutaneous receptors of the arm. In the first series, contact heat thresholds (time for a known temperature) were determined for eight subjects for hand, forearm, and elbow. In about one-fourth of the trials, two pains could be inferred—either one brief flash (which disappeared before the subject could respond) followed by a second pain, or fluctuation in the intensity of the pain. It seems obvious that any stimulus of this nature is essentially uncontrolled at the receptor level, and that heat continues to penetrate deeper into the tissues and to stimulate more remote receptors as well as deeper ones, even after the stimulator is removed. For this reason, no further work was done with this type of stimulus. The literature shows this to be one of the most effective stimuli in eliciting double pain.

In the second series, mechanical pain thresholds for three spots on the dorsal forearm were first determined for eight subjects. A rigidly-mounted needle algesimeter, calibrated in ¼-g steps, was used. The needle was sharpened under a microscope to minimize the stimulation of pressure, a probable reason for some of the reports of double pain, as von Frey contended (*2*). No double pains were reported. Adaptation trials at threshold and at 1 g above threshold (thresholds range from 2.5 to 5.0 g) were made. The course of adaptation showed fluctuations. In about one-fifth of the trials, there were only two peaks, which naive observers might possibly have interpreted as double pains, although ours did not. This work was repeated with four subjects who were highly practiced in psychophysical observation, using three spots on the dorsal forearm and three spots on the dorsal aspect of the middle finger. Additional adaptation trials were made at 2 g above threshold. Again no double pains were observed.

It is common knowledge in psychophysical research on pain that the stimulus must be unvarying. This would rule out handheld needles and similar apparatus, the sort of equipment which appears frequently in positive reports of double pain. If one permits the needle to remain in place, one finds fluctuations in sensation, as illustrated in the preceding paragraph. If one pulls it out, one has restimulated the receptor, as shown electrophysiologically by Zotterman (*3*). These phenomena will be intensified with suprathreshold stimuli. At or near threshold, double pains are not reported for mechanical stimulation. Where thresholds have not been experimentally determined (in the majority of studies), reports of double pain are suspect.

A further difficulty besets mechanical stimulation with suprathreshold stimuli —namely, the possibility of stimulating two discrete receptors sequentially. The fact that it takes appreciable time for a needle to penetrate to its maximum depth (*4*), makes this possibility very real. When our four experienced subjects were requested to observe carefully for a possible double pain and then were stimulated with suprathreshold stimuli, there were four reports of double sensations out of 20 trials. But two of these involved other cutaneous senses; one was cold and pain, and one was pressure and pain. Only two were double pains. This lends support to the hypothesis that two discrete receptors may be stimulated at different times under these conditions.

The third series consisted of 120 electric pain thresholds on the dorsal forearm for the group of four experienced subjects. A square-wave pulse from a Grass stimulator was used, the duration being physiologically infinite. There were no double pains, and no single, delayed pains.

In many ways, electric stimulation is less subject to artifacts than other kinds —at least, the time of action of the stimulus is constant, so that if two receptors are stimulated, they are stimulated simultaneously. In addition, it is possible to stimulate pain without the concomitant arousal of other cutaneous senses. It is significant that no experimenter has reported double pain with a single electric stimulus. Since all other senses are stimulable electrically, it seems difficult to believe that if there is a second, slower pain system leading to sensation, it would not appear in 480 separate determinations. The argument that a second pain system is suppressed by the faster system lacks evidence.

Double pain was not found with normal subjects under controlled conditions. Landau and Bishop also obtained somewhat similar results with their normal subjects (*5*).

Other lines of evidence have been thoroughly reviewed recently (*6*). One of the prime lines of evidence for double pain has been the order of loss of sensations during nerve blocks. Careful experimentation on several different areas, coupled with statistical analysis of the significance of the order of loss, shows this evidence to be unreliable (*6, 7, 8*).

A second line of defense has been the delay in pain perception under ischemic conditions, often interpreted as a dropping out of one pain system while a second is spared. But it has been shown that all the cutaneous senses show this increasing delay in perception under these circumstances (*8, 9*).

A third argument has been based on reaction time: presumably, the reaction time to "delayed" pain in the extremities corresponds to the conduction time for the C fibers. In a recent study involving a larger number of trials, coupled with statistical analysis of results, reaction time could not be related to distance from the central nervous system, probably because of the large number of uncontrolled variables (*10*).

Several other lines of recent evidence (conduction rates of fibers subserving slowly adapting touch versus hair touch fibers, strength-duration curves for pain) are also negative. The best evidence of all varieties points to double pain as an artifact. Positive reports appear to be due to inadequate experimental control, particularly with regard to control of the stimulus and psychophysical methods, and to lack of statistical analysis.

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4 June 1956

Marine Borer Attack on Lead Cable Sheath

The activity of molluscan borers on such materials as wood, cellulose fibers, rocks, and shells is extensively documented. However, reports in the literature regarding their attack on metals are uncommon. Only two references (*1, 2*) on this subject have come to our attention. Both of these refer to the penetration of lead—one (*1*) by *Martesia* (*Diploplax*) *funisicola,* a member of the family Pholadidae and the other (*2*) by one of the Teredinidae, *Teredo navalis.* In view of this limited information, it seems desirable to document a recent case in which a mollusk penetrated a lead-sheathed submarine telephone cable.

The cable which was attacked belongs to the Southern Bell Telephone and Telegraph Company and lies in the Ortega River at Jacksonville, Florida. The sheath of the cable is composed of a solid lead covering approximately 4 mm thick. Over the lead sheath are two layers of asphalt-impregnated jute which serve as bedding for a single layer of galvanized steel armor wires.

The cable was placed in service in 1927, and the present trouble occurred in 1955. Attack occurred at a point approximately 350 ft from the shore, at a depth of about 3.5 ft. The river bottom at that location was muddy.

At the point where penetration occurred, the armor wire had rusted away, leaving the lead sheath exposed. Two holes had been bored in the sample of damaged sheath received at Bell Laboratories. One hole completely penetrated the lead, while the other had barely punctured the inside face of the sheath. The general appearance and detail of the damaged area are illustrated in Fig. 1 (*3*).

The dimensions of the holes suggest that they were caused by a member of the family Pholadidae. At the point of entry, both holes are slightly elliptical. In one case, the diameter is 3.5 mm at the widest point and 3.0 mm at the narrowest. In the second case, the dimensions are 3.0 and 2.5 mm, respectively. As the tunnels progress inward, the diameters increase until, at a depth of about 2 mm, they are each approximately 5 or 6 mm. In the case of the hole which completely penetrates the sheath, it is doubtful that the organism progressed through the inside surface, since the greatest diameter at that point is only 2.5 mm.

In Fig. 2, a photomicrograph of the interior of the shallower hole, striations in the lead resulting from boring action are readily apparent. In some cases, minute lead shavings were observed, where the rocking action of the shells had peeled off the substrate. The closely cross-hatched pattern of the striations is illustrative of the rocking and heaving motion described by Turner (*4*) as characteristic of the valves of *Barnea truncata* and *Martesia striata.* Although it is not readily apparent in the photomicrograph, small bits of mineral that resemble quartz crystals in appearance are imbedded in the lead, particularly in the wall of the hole. As suggested by Turner (*4*), the presence of such hard particles around the anterior portion of the valves may be of material aid in boring. No information is available concerning whether the jute that underlies the armor wires was present in the damaged area when the attack occurred. It is conceivable that the organisms obtained their start in the jute and progressed into the lead.

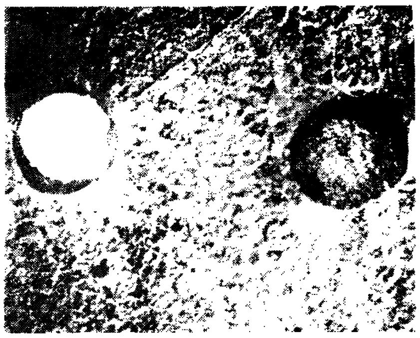

Fig. 1. Holes made in sheath of submarine telephone cable by marine borers. The hole on the right has barely broken the inside surface of the sheath (× 5).

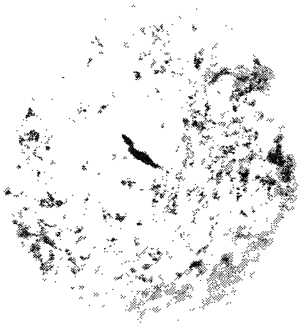

Fig. 2. Striations on the face of the hole in lead sheath caused by rocking action of the shells of the borer (× 12).

Although the attack of metals by mollusks is indicated by existing data to be unusual, it is evident that penetration may occur in lead.

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In defense of accuracy we must be zealous, as it were, even to slaying.—P. G. TAIT.