and Note), have a known material dependence, and each may be employed in determining the other: for instance, the Note may be employed in determining the velocity of sound and the elasticity of the vibrating substance.

Chladni,[1] and the Webers,[2] had made valuable experimental inquiries on such subjects. But more complete investigations of this kind have been conducted with care and skill by M. Wertheim.[3] For instance, he has determined the velocity with which sound travels in water, by making an organ-pipe to sound by the passage of water through it. This is a matter of some difficulty; for the mouthpiece of an organ-pipe, if it be not properly and carefully constructed, produces sounds of its own, which are not the genuine musical note of the pipe. And though the note depends mainly upon the length of the pipe, it depends also, in a small degree, on the breadth of the pipe and the size of the mouthpiece.

If the pipe were a mere line, the time of a vibration would be the time in which a vibration travels from one end of the pipe to the other; and thus the note for a given length (which is determined by the time of vibration), is connected with the velocity of vibration. He thus found that the velocity of a vibration along the pipe in sea-water is 1157 *mètres* per second.

But M. Wertheim conceived that he had previously shown, by general mathematical reasoning, that the velocity with which sound travels in an unlimited expanse of any substance, is to the velocity with which it travels along a pipe or linear strip of the same substance as the square root of 3 to the square root of 2. Hence the velocity of sound in sea-water would be 1454 *mètres* a second. The velocity of sound in air is 332 *mètres*.

M. Wertheim also employed the vibrations of rods of steel and other metals in order to determine their *modulus of elasticity*—that is, the quantity which determines for each substance, the extent to which, in virtue of its elasticity, it is compressed and expanded by given pressures or tensions. For this purpose he caused the rod to vibrate near to a tuning-fork of given pitch, so that both the rod and the tuning-fork by their vibrations traced undulating curves on a revolving disk. The curves traced by the two could be compared so as to give their relative rate, and thus to determine the elasticity of the substance.

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[1] *Traité d'Acoustique*, 1809.

[2] *Wellenlehre*, 1852.

[3] *Mémoires de Physique Mécanique*. Paris, 1848.