NEW FOREST WATER.

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In the autumn of 1889, my attention was directed by the Rt. Hon. Sir W. V. Harcourt, M.P., to the very great corrosive action of the water in the New Forest upon metals, and at his request I undertook some experiments with the water obtained from the supply to his residence at Malwood.

The metals submitted to the action of the water were iron, lead, copper, tin, zinc, galvanized iron, and an alloy of tin and lead, which properly should have been tin-foil.

All these metals were attacked, after different periods of time, when placed in the water in a stoppered bottle; iron in the shortest time and to the greatest extent. One very peculiar result of the action of the water upon iron was the clean bright surface it maintained throughout, even when the water had become so thick with red oxide that the iron was invisible; on removing and washing it with water the surface was as bright as when the iron was first put in the water.

The iron dissolves from the surface completely as ferrous-oxide or protoxide, and the compound absorbs oxygen from the water, and is converted into the ferric-oxide or red oxide This red oxide being less soluble than the protoxide is precipitated, and fresh portions of the iron are again dissolved, oxidised, and deposited, the process going on for months, the iron remaining undissolved, being as bright at the end of that time as when first immersed.

This peculiar condition was noticed in some pipes, removed for repairs from the kitchen boiler at Malwood, in the early part of 1890, the parts where most corrosion had taken place being quite bright.

The tubes were corroded in such a manner as to form deep pits, especially near their junction with the boiler, which was made of the same kind of iron as that of the pipes.

A similar action, after a longer time and to a much less extent, took place with tin, lead, zinc, and galvanized iron. Small quantities of these metals were found in solution after about twenty-four hours, and subsequently white deposits were formed which consisted of the oxides of tin, lead, and zinc. In the case of the alloy (so called tin-foil), it became coated with crystals, which after a time were detached as fresh ones were formed, until the alloy was completely disintegrated, and the bottom of the vessel was covered with crystals, some of which could be seen floating about in the liquid. On examining these crystals with the microscope two forms were seen, one hexagonal plates, the other long hexagonal prisms, these latter rotating polarised light. The hexagonal plates consisted of lead nitrate, the prisms being probably lead chloride.

With copper no deposit was formed, but the metal passed into solution. A sample of water which had passed from the kitchen boiler above mentioned through copper pipes to the bath room at Malwood, was sent me, and I found it to contain about one-tenth of a grain of copper per gallon of the water, and this appears to be the maximum amount dissolved. The action is limited in the case of copper, but not so in the case of the other metals.

This peculiar action of the water is due to the presence of a free acid, which all three samples submitted were found to contain. The samples were carefully examined for a free mineral acid as being most likely to cause the effects observed, but none being found an organic acid was tested for, and all three samples were found to contain a small quantity of crenic acid, to which the acidity was due, and this undoubtedly is the primary cause of the mischief.

The crenic acid is produced by the water dissolving organic matter from the surface soil, which becomes partially oxidised during the passage of the water through the underlying strata.

It seems strange that a small quantity of a weak acid like crenic should produce such results, and it is certain that it could not do so of itself, but it has been found, in the presence of salts containing nitric and hydrochloric acids or organic acids, which otherwise are unable to attack metals by themselves to effect their solution, and it is therefore to the presence of nitrates and chlorides in conjunction with this free crenic acid, and probably other so-called humic acids, as apo-crenic, geic, etc., that forest waters owe their mischievous property and cause so much trouble.

Lead, tin, copper, and zinc all form poisonous compounds, and iron though less poisonous is objectionable both to taste and sight, and its frequent renewal becomes expensive.

The use of lead pipes, with proper care, is undoubtedly best, as the action of the water on lead soon ceases in the presence of a sufficient quantity of carbonates in the water, as shown by a piece of lead pipe sent me by Sir W. Harcourt, and which had been in use at Malwood for about a year and a half, and which was then as good as new, with the exception of a thin white coating on the inside. This coating on analysis proved to be lead carbonate. For the purpose of forming this protective coating, and probably also of preventing or modifying the action of the water on other metals, I suggested to Sir William Harcourt that the precaution be taken of passing the water over a layer of chalk before it entered the pipes, or of putting chalk in the well, or other source from which the water might be obtained.

I have no doubt that conditions exist in the water from wells in many other parts of the county similar to those at Malwood, and here I would point out that when lead pipes are new the water attacks them, especially when allowed to stand in them, until the protective coating of lead carbonate has had time to form, so that great care should be exercised, and water that has stood in them overnight should be drawn off before any is used.

ANALYSIS OF THREE SAMPLES OF WATER FROM MALWOOD.

The quantities are all in grains per gallon, and a gallon of water weighs 70,000 grains.

	Forest Spring.	*Orchard Well.*	*N.E. Well.*
Free Ammonia	0.0005	0.021	0.0007
Albumenoid do.	0.0089	0.0037	0.0018
Nitrogen as nitrates & nitrites	0.0000	0.098	0.8071
Total nitrogen in above 3 forms	0.0078	0.1172	0.8091
Oxygen absorbed in 15 minutes at 80° F.	0.0417	0.0082	0.0000
Oxygen absorbed in 4 hours at 80° F.	0.0000	0.0759	0 0000
Chlorine in chlorides	2.520	2.38	2.8000
Volatile solids	1.68	3.36	6.44
Fixed do.	7.14	8.96	8.96
Total do. by evaporation	8.82	12.32	15.40
Phosphoric acid	none	none	none
Iron	a small trace	a large trace	none
Lead	none	none	none
Crenic acid	a small quantity	small quantity	small quantity
Total hardness, Clark's scale	1.9°	3.4°	4.81°
Fixed do.	1.9°	1.52°	4.81°
Removeable do. by boiling	0°	1.88°	0°.

These samples are all from the same strata and within a comparatively short distance of each other. The forest spring and N.E. well being situated on opposite sides of the hill on which the house stands, and the orchard well being intermediate. The N.E. well was abandoned and the orchard well was sunk as a substitute when the house was built. The forest spring comes out at the outcrop of a bed of clay, and the two wells are sunk down to the same bed of clay, all three being in the Bracklesham beds.