Comment on the paper entitled "Drugs: A review of promising novel corrosion inhibitors" by G. Gece – a (corrosion-free) bridge too far?

G. Shama

Department of Chemical Engineering, Loughborough University, Loughborough, Leics., UK.

E-mail address: G. Shama@Lboro.ac.uk

Keywords: Corrosion Inhibitors, Chemotherapeutic Agents, Antibiotics, Environmental Effects

The review by Gece [1] on the potential which chemotherapeutic agents may have as corrosion inhibitors is comprehensive in its coverage of the protective effects afforded by such agents. However, the author attempts within the first paragraph to dismiss the possibility that chemotherapeutic agents may have what he refers to as 'negative impacts' on the environment. The source of this reassurance is a single MSc thesis. It is of course perfectly acceptable to cite an MSc thesis in such a context, but one wonders why the author is content to limit himself to just one source when there is in fact a vast amount of literature that has been published in the form of far more readily accessible journal articles on this very topic. To mention just one example, evidence has recently been provided of the persistence of antibiotic residues in river sediments for periods of up to 40 years which must at the very least raise concerns about the likelihood of effects on aquatic organisms [2].

Antibiotics constitute the largest single class of drugs mentioned in the review, but Gece only considers their effects on pathogenic bacteria in total isolation to any anti-corrosive properties that antibiotics may possess. This is a serious oversight, as any use of antibiotics in environments where bacteria may be present increases the chances of selection for resistant organisms. Such organisms will not only transmit this resistance to their descendants but may also possibly transmit it *via* lateral or horizontal gene transfer to other species [3]. This is precisely the mechanism by which any particular antibiotic gradually become ineffective. For example, until

recently vancomycin was the antibiotic of last resort against methicillin resistant *Staphylococcus aureus* (MRSA) but accounts have appeared pointing to the emergence of vancomycin-resistant MRSA [4]. The use of this particular antibiotic outside of clinical applications would therefore serve to decrease the time-scale by which it would become completely ineffective against MRSA. This should be of universal concern as it is widely acknowledged that the 'discovery pipeline' for new antibiotics is showing alarming signs of running dry [5].

It is worth considering in slightly more detail how resistant bacteria could be selected for in the context of corrosion inhibition applications. Firstly, exposure of micro-organisms to antibiotics intended as corrosion inhibitors would be virtually impossible to prevent as micro-organisms are present in *all* human environments. Bacteria are to be found in association with dust particles that may readily become suspended in air and then go on to become widely distributed within buildings of all types. Some bacteria are even able to survive long exposures on the surfaces of metals [6]. Although there is no evidence of work having been conducted on the biostatic or biocidal properties of antibiotics that have been adsorbed onto metal surfaces, it is known, for example, that the antibiotic vancomycin is able to exert anti-bacterial activity even when adsorbed onto the surface of solid oxides [7]. All of which suggests that selection for antibiotic resistance could well be operating in parallel to the prevention of corrosion.

Antibiotic solutions remaining after anti-corrosion treatments had been applied would of course need to be disposed of and would thereby contribute to the complement of antibiotics that find their way into the sewers as a result of purely clinical applications. Antibiotics have been detected in the outflows from sewage treatment works as well as in environments such as river sediments which were mentioned above. Whilst their concentration in such environments may be very low, they may still be capable of exerting effects on other micro-organisms present in those environments as is explained below.

In the last few years a new function has come to be associated with antibiotics: at concentrations considerably below their minimum inhibitory concentration (MIC) they are able to modulate gene expression in a wide range of micro-organisms without exerting any lethal effects whatsoever, and under these conditions are viewed rather as 'signalling' molecules than as antibiotics [8]. The consequences of this signalling range from activating virulence genes to initiating biofilm formation. The concentration of individual antibiotics found in the environment will be considerably below those at which such effects are induced. However, environments such as estuarine sediments might contain residues of scores of pharmaceutically active compounds, and it is not impossible, but by no means proven, that they could exert a cumulative signalling effect on environmental organisms. All of these phenomenon merit further investigation – research which moreover should not be restricted solely to antibiotics, but which should encompass all the classes of chemotherapeutic agents mentioned by Gece.

The prevention of corrosion is, it goes without saying, of enormous economic importance. However, whether this should be achieved at the cost of speeding up the development of antibiotic resistance is, I would suggest, too high a price to pay.

References

[1] G. Gece, Drugs: A review of promising novel corrosion inhibitors. Corros. Sci. 53 (2011) 3873-3898.

[2] F. Tamtam, B. Le Bot, T. Dinh, S. Mompelat, J. Eurin, M. Chevreuil, P. Bonte, J.M. Mouchel, S. Ayrault, A 50-year record of quinolone and sulphonamide antimicrobial agents in Seine River sediments. J. Soils Sed. 11 (2011) 852-859.

[3] P.J. Hastings, S.M. Rosenberg, A. Slack, Antibiotic-induced lateral transfer of antibiotic resistance. Trends Microbiol. 12 (2004) 401-404.

[4] A. Iversen, I. Kuhn, A. Franklin, R. Mollby, High prevalence of vancomycin-resistant enterococci in Swedish sewage. Appl. Env. Microbiol. 68 (2002) 2838-2842.

[5] J. Clardy, M.A. Fischbach, C.T. Walsh, New antibiotics from bacterial natural products. Nature Biotechnol. 24 (2006) 1541-1550.

[6] S.A. Wilks, H. Michels, C.W. Keevil, The survival of *Escherichia coli* O157 on a range of metal surfaces. Int. J. Food Micriobiol. 105 (2005) 445-454.

[7] R.N. Palchesko, K.A. McGowan, E.S. Gawalt, The survival of *Escherichia coli* O157 on a range of metal surfaces. Mat. Sci. Eng. C – Mat. Biol. Applic. 31(2011) 637-642.

[8] D. Romero, M.F. Traxler, D. Lopez, R. Kolter, Antibiotics as signal molecules. Chem. Revs 111 (2011) 5492-5505.