Electrochemistry: quo vadis or where should we head to?

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Whether Mark Twain really said that it is difficult to make predictions, particularly because they are about the future, will presumably remain an open question. The quote nevertheless nicely illustrates a challenge frequently ignored by authors who seemingly have a crystal ball at home. It also applies to science. But apparently it has sometimes an unintended effect: People, scientists included, tend to forget to think about aims and directions beyond continuing the daily routine. And as another quote says: When you do not know your aim no wind is blowing in the right direction. Thus, the invitation by the editor of this journal is a good reason to stop for a moment, look back, and consider and define aim(s) and direction(s) (initially and basically the authors one, but certainly, as asked for, more general aim(s) and direction(s) are preferred).

Electrochemistry is extremely interdisciplinary—which has almost caused its collapse as a science in some countries [1, 2]—with the associated excitements and risks. In addition, there is the question of the frogs and the birds: F. Dyson once said, that “some mathematicians are birds, others are frogs.” [3] The birds are flying high in the air; they have a wide perspective and a great overview. The frogs are in the mud,¹ hardly seeing beyond the task (and mud). But they provide the details; they complete and fill out the overview of the bird. Certainly this picture can be applied to electrochemistry and the subject of this note also. Chen et al. [4] have recently done this. They deplore the lack of frogs, and they conclude with a call for more frogs in

electrochemistry. To make their point, they provide names of past and present electrochemists. Arguing about the assignment of a particular scientist to one of the two “classes” may be tempting, but it is useless. The present author indeed believes that there are plenty of frogs in electrochemistry. A look into a recent publication in a typical journal (like this one) frequented by electrochemists or into any of some other “high impact journal(s)” more (or very) general, and in most cases a little bit farther away from our field illustrates the point: After a generic statement regarding the need for energy storage or cheaper analytical methods, the authors happily and straightforwardly dig on (to quote Dyson: into the mud). Already in the introduction, a serious attempt to put the own research into perspective is frequently missing. And beyond the concluding remark, that the described electrode material may point the way to successful batteries elsewhere, any attempt towards a wider view is absent. At this point, more of a birds-eye perspective would be welcome. Presumably Dyson’s picture is related to the competition between generalists and specialists. For electrochemistry, and in particular for progress and technically relevant achievements regarding, e.g., said electrode material, specialists are required at first. But for more general developments, new directions, transfer of concepts, materials and methods from fields more or less far away from electrochemistry into our field, the generalists are welcome, perhaps even needed. Current trends towards ever more specialized bachelor and master courses at universities and more narrowly described denomination of academic positions are hardly auspicious. Discussions with scientists sometimes seem to support this slightly dystopian view: Interest for things beyond the specific own research interest is rather limited, perhaps even absent. Pronounced curiosity, once considered to be the bedrock of a scientific attitude, is almost gone.

To answer the initial question: Extrapolating the current trajectory electrochemistry seems to be on the way to even more specialization (digging even deeper into the mud) with a growing risk of missing the benefits from the generalists’ knowledge and perspective. Current trends in teaching seem to enforce this. Remedies and suggestions are easy only at first glance: More care and chances for the generalists (and the birds). Electrochemistry should not be relegated to the backbenches

¹ Presumably this statement and the sometimes unattractive pictures of toads have tainted the image of a frog. Just think of the optimistic green fellow (*Hyla arborea*). But in our image this fellow is not necessarily digging in the mud. Perhaps Dyson was thinking of toads?

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in teaching, and it should not be considered either as a simple tool which every chemist can easily use without understanding it (see publications on cyclic voltammetry in chemical journals) or a collection of rather mysterious methods and procedures (see the poor reputation and impact of electrosynthetic procedures beyond making aluminum, magnesium, and chlorine). Instead we should spend time and effort (possibly more than now in some places) on providing the birds-eye view of electrochemistry to students thus attracting more of them. When reviewing manuscripts, we should encourage authors to put their work into a broader context; we should request more than just proof of the desire to add one number to the author's publication list. In research, we should look more frequently beyond the borders of our pet project and current object of investigation. We should think more out-of-the-box.

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