30 September, 2007

Dear Editor:

The article, "Investigating the process of diffusion using an analytical puzzle," that was published in the September 2007 issue of the *American Biology Teacher* describes a clever approach to teaching some principles of diffusion (Villani *et. al*., 2007). Sadly, this article has serious errors. Specifically, the authors state that the "effect of diameter is inversely proportionate to the rate of diffusion (p 412)." Exactly the opposite is true – the diffusion rate is ***directly proportional*** to cross-sectional area of the diffusing path. This error is a little surprising considering the authors correctly write the equation for Fick's Law showing "A" (cross-sectional area) in the numerator.

This error is probably the result of the authors' confusion about the term, L, in denominator. The authors erroneously assumed that "*l* is the distance the dye travels, which we are observing in our demonstration today (Fig. 3)." This term actually refers to the distance that separates two points of different concentration (*i.e.,* the concentration gradient) such as the thickness of a membrane. In reality, the demonstration is measuring the rate of transport or flux density (F), which also can be symbolized by the letter "J" and is commonly expressed in units of mol m^{-2} s^{-1}.

One relatively simple way that the authors could have demonstrated that the diffusion rate or flux density is directly proportional to cross-sectional area is to calculate, using the equation for the volume of a cylinder ($=\pi r^2 l$), the volume of agar permeated by the dye. If we measure the size of the images in Fig. 4A, the smaller tube is approximately 4.5 mm wide and the dye migrated 38 mm, which means that the total volume of agar into which the dye diffused is 604.4 mm^3. Performing the same calculations for the larger tube (7 x 32 mm) the volume of agar permeated by dye is 1231.5 mm^3. These results clearly support the predictions of Fick's Law. The authors' excellent analogy of herding a cat down a hallway explains why the dye diffuses further in the smaller tube (Fig. 4A). Unfortunately, this analogy isn't applicable to Fick's Law because it doesn't consider ***how much*** dye diffuses.

If a teacher corrects the mistakes in this article, this exercise will provide a nice visual demonstration of diffusion. However, this article provides further evidence that students and teachers may have difficulties understanding diffusion as past articles in this journal have shown (Vogel, 1994).

Literature Cited

Villani, P., R. Dunlop, B. Damitz (2007) Investigating the process of diffusion using an analytical puzzle. *American Biology Teacher* 69: 411 – 415.

Vogel, S. (1994) Dealing honestly with diffusion. *American Biology Teacher* 56: 405 – 407.

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