

COMMENTARY

Testing Experimental Results in the Field: Reply to Hettyey and Pearman

Gentile F. Ficetola & Fiorenza De Bernardi

Department of Biology, Università degli Studi di Milano, V. Celoria 26, 20133 Milan, Italy

Received: November 21, 2005; **Initial acceptance:** January 20, 2006; **Final acceptance:** February 22, 2006 (L. Sundström)

Correspondence: E-mail: francesco.ficetola@unimi.it

doi: 10.1111/j.1439-0310.2006.01252.x

In their comment to our recent paper (Ficetola & De Bernardi 2005), Hettyey and Pearman outline two main weakness of our observational study: our sample size was too small and our data did not allow us to test the possibility of non linearity of the relationship between species ratio and egg fertility.

The issue of our sample size has already been addressed in our paper, but we stress that, despite our small sample size, our effect size was very small. Our power analysis shows that, given the observed effect size, a disproportionate number of populations would need to be sampled in order to obtain a significant result. For example, the estimated number of populations required to detect an effect significant at $\alpha = 0.05$ with power 0.8 was 1015 populations, a number greater than the number of known *Rana latastei* populations (Grossenbacher 1997).

Hettyey and Pearman suggest a second weakness of our paper. The relationship between the abundance of heterospecifics and the fertility of *R. latastei* is expected to be nonlinear and our test is biased as the reduction of fertility could be observable only at very high abundance of heterospecifics. In this regard, we stress that there is a difference between a nonlinear relationship and a relationship that has an effect only after a given threshold (Huggett 2005). Under outdoor laboratory conditions, the effect of heterospecific abundance on fertility of *R. latastei* is depicted by Fig. 2 in Hettyey & Pearman (2003). It is difficult to draw conclusions about the shape of this relationship, given the small number of different heterospecific densities tested ($n = 4$), but this relationship seems to be monotonic and there is no evident threshold effect, since fertility always decreases as heterospecific abundance increases. Indeed, in their paper Hettyey & Pearman (2003, p. 297) state that 'Mean embryo viability declined with decreasing abundance of conspecific males', and a model with a linear decline provides an adequate fit to their data

(Pearson's correlation based on the values of Fig. 2: $r = 0.959$, $n = 4$, $p = 0.041$). The above pattern is completely different from those in Fig. 3 of our paper.

When heterospecifics outnumber *R. latastei*, the difference in fertility between egg masses laid in plastic wading pools and in nature is pronounced and cannot be overlooked as Hettyey and Pearman do in their comment. Under skewed species ratio (1:5), the average egg fertility was 90% in the 32 egg masses we collected in nature ($SE = 2.7$) and approx. 14% in the four egg masses laid during the Hettyey and Pearman's experiment ($SE \approx 12$). Despite similar species ratio, the overlap of fertility ranges between the two studies is close to zero and the fertility observed under natural conditions is much higher than those observed in the laboratory study (Z test: $Z = 5.1$, $p < 0.0001$). Hettyey and Pearman suggest that raising embryos could create biases in the observed hatch rate, but we would be very surprised to observe a hatch rate of 90% from egg masses having <15% of fertility when they were laid.

In their comment, Hettyey and Pearman do not discuss the main point addressed by our paper. The main question that we addressed was whether the social interaction observed under laboratory conditions is important for the reproductive outcome of natural populations. Species are not randomly distributed in nature and therefore we wonder why Hettyey and Pearman suggest a random selection of populations. Our populations were selected from a large database (Bernini et al. 2004), to be representative of the situation in an area encompassing approx. 12% of the range of *R. latastei*. In these populations, there are no obvious trends of fertility in relationship to the presence/abundance of heterospecifics and there is no evidence of drop of fertility under very skewed species ratio (Ficetola & De Bernardi 2005). Moreover, the difference in egg fertility

between syntopic and allotopic populations, if any, is very small and it is hard to believe that it has a biological effect (Steidl et al. 1997). Therefore, our conclusion is not that social interaction between *R. latastei* and *Rana dalmatina* never occurs in nature. Our conclusion is that social interaction does not strongly affect the reproductive outcome of populations that are commonly found in nature, and thus other mechanisms should be hypothesized to explain their complex distribution pattern.

Laboratory and field studies are intrinsically different, and both approaches are needed to understand the behavioural and ecological processes. Laboratory studies are necessary to 'develop, parameterize and/or test hypothesis' (Huston 1999). Field studies can not obtain the same degree of replication and manipulation of laboratory, however the laboratory conditions are a simplification of the complexity that is found in nature, and the researcher's choice of experimental settings can influence the results (Miner et al. 2006). Therefore, field experiments are needed to test the realism of predictions, under the limited range of conditions that are found in nature (Huston 1999; Skelly & Kiesecker 2001); this can be particularly important for the analysis of complex processes, such as interspecific interactions. Sometimes, debate arises about the validity of one of these approaches (e.g. Carpenter 1996, 1999; Drenner & Mazumder 1999; Huston 1999; Skelly & Kiesecker 2001; Leps 2004; Schmid & Hector 2004; Hettyey & Pearman in press). However, we believe that this dialogue can be constructive only if the results obtained under different conditions are gathered and used altogether, to achieve a better understanding of the processes. Field researchers have to use the results obtained in laboratory studies, to translate the predictions under conditions that are as much adequate as possible. Furthermore, the results of field studies can be very helpful in shaping new controlled experiments (Miner et al. 2006). We believe that a strong, constructive feedback between controlled and field studies can lead to an improvement to the standards of behavioural sciences.

Literature Cited

- Bernini, F., Bonini, L., Ferri, V., Gentilli, A., Razzetti, E. & Scali, S. 2004: Atlante degli Anfibi e dei Rettili della Lombardia. Provincia di Cremona, Cremona.
- Carpenter, S. R. 1996: Microcosm experiments have limited relevance for community and ecosystem ecology. *Ecology* **77**, 677–680.
- Carpenter, S. R. 1999: Microcosm experiments have limited relevance for community and ecosystem ecology: reply. *Ecology* **80**, 1085–1088.
- Drenner, R. W. & Mazumder, A. 1999: Microcosm experiments have limited relevance for community and ecosystem ecology: comment. *Ecology* **80**, 1081–1085.
- Ficetola, G. F. & De Bernardi, F. 2005: Interspecific social interactions and breeding success of the frog *Rana latastei*: a field study. *Ethology* **111**, 764–774.
- Grossenbacher, K. 1997: *Rana latastei*. In: *Atlas of the Amphibians and Reptiles in Europe* (Gasc, J. P., Cabela, A., Crnobrnja-Isailovic, J., Dolmen, D., Grossenbacher, K., Haffner, P., Lescure, J., Martens, H., Martínez Rica, J. P., Maurin, H., Oliveira, M. E., Sofianidou, T. S., Veith, M. & Zuiderwijk, A., eds). Societas Europaea Herpetologica & Museum National d'Histoire Naturelle, Paris, pp. 146–147.
- Hettyey, A. & Pearman, P. B. 2003: Social environment and reproductive interference affect reproductive success in the frog *Rana latastei*. *Behav. Ecol.* **14**, 294–300.
- Hettyey, A. & Pearman, P. B. in press: Testing experimental results in the field: comment on Ficetola and De Bernardi (2005).
- Huggett, A. J. 2005: The concept and utility of 'ecological thresholds' in biodiversity conservation. *Biol. Conserv.* **124**, 301–310.
- Huston, M. A. 1999: Microcosm experiments have limited relevance for community and ecosystem ecology: synthesis of comments. *Ecology* **80**, 1088–1089.
- Leps, J. 2004: What do the biodiversity experiments tell us about consequences of plant species loss in the real world? *Basic Appl. Ecol.* **5**, 529–534.
- Miner, B. G., Sultan, S. E., Morgan, S. G., Padilla, D. K. & Relyea, R. A. 2006: Ecological consequences of phenotypic plasticity. *Trends Ecol. Evol.* **20**, 685–692.
- Schmid, B. & Hector, A. 2004: The value of biodiversity experiments. *Basic Appl. Ecol.* **5**, 435–542.
- Skelly, D. K. & Kiesecker, J. M. 2001: Venue and outcome in ecological experiments: manipulations of larval anurans. *Oikos* **94**, 198–208.
- Steidl, R. J., Hayes, J. P. & Schaub, E. 1997: Statistical power analysis in wildlife research. *J. Wildl. Manage.* **61**, 270–279.