Journal of Insect Conservation
https://doi.org/10.1007/s10841-018-0045-0

ORIGINAL PAPER

The hand of man first then Santa Rosalia's blessing: a critical examination of the supposed criticism by Samraoui (2017)

Rassim Khelifa[1,2] · Rabah Zebsa[3] · Hichem Amari[4] · Mohammed Khalil Mellal[5] · Abdelheq Zouaimia[3] · Soufyane Bensouilah[4] · Abdeldjalil Laouar[6] · Moussa Houhamdi[7]

Received: 3 April 2017 / Accepted: 9 January 2018
© Springer International Publishing AG, part of Springer Nature 2018

Abstract
Samraoui (J Insect Conserv. https://doi.org/10.1007/s10841-017-9966-2, 2017) claims that he shows evidence that our conservation plan of *Urothemis edwardsii* has failed and that natural dispersal was the only cause of the recent rapid range expansion of the species in Northeast Algeria. Here, we show that his analysis is biased, many of his arguments are erroneous and strongly contradictory, many key studies are dismissed, and the few data used as evidence to refute our conclusions rather confirm them. We also provide data to prove that our conservation plan did not cause any harm to the source population by comparing exuviae-based estimation of population size in 2012 and 2016. We discuss the need for future monitoring and management and highlight that the recommendations of Samraoui (J Insect Conserv, 2017) are misleading, and thus are unlikely to bring us closer to an effective long-term conservation of the species in the region. Beyond our criticism, we explain why we should not dismiss the direct and indirect implications of final instar larvae translocation in successful colonization of odonates in particular, which could also be applied to aquatic insects in general.

Keywords Conservation · Reintroduction · Translocation · Exuviae · Population size · Colonization · Odonata · Dragonfly · North Africa

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s10841-018-0045-0) contains supplementary material, which is available to authorized users.

✉ Rassim Khelifa
rassimkhelifa@gmail.com

Rabah Zebsa
rabahzebsa@yahoo.fr

Hichem Amari
amari.hichem@yahoo.fr

Mohammed Khalil Mellal
mohamedkhalil.mellal@gmail.com

Abdelheq Zouaimia
zouaimia.abdelheq@gmail.com

Soufyane Bensouilah
soufyaneben@hotmail.com

Abdeldjalil Laouar
abdeldjalillaouar@gmail.com

Moussa Houhamdi
houhamdimoussa@yahoo.fr

[1] Department of Evolutionary Biology and Environmental Studies, University of Zurich, Winterthurerstrasse 190, 8057 Zurich, Switzerland

[2] Department of Biology, Faculty of Biological and Agricultural Sciences, University of Tizi Ouzou, 15000 Tizi Ouzou, Algeria

[3] Department of Nature and Life Sciences, Faculty of Nature and Life Sciences and Earth and Universe Sciences, University of 08 May 1945, 24000 Guelma, Algeria

[4] Laboratory of Functional and Evolutionary Ecology, Department of Biology, University of Chadli Bendjedid, 36000 El Tarf, Algeria

[5] Laboratory of Marine and Coastal Environments Ecobiology, Department of Biology, Badji Mokhtar University, BP 12, 23000 Annaba, Algeria

[6] Département de Zoology, Université de Mons, 20, place du Parc, B7000 Mons, Belgium

[7] Laboratoire Biologie, Eau et Environnement (LBEE), University of 08 May 1945, 24000 Guelma, Algeria

Published online: 09 March 2018

Introduction

In his book of *The growth of biological thought*, Ernst Mayr wrote “All interpretations made by a scientist are hypotheses, and all hypotheses are tentative. They must forever be tested and they must be revised if found to be unsatisfactory” (Mayr 1982). While it is the duty of scientists to raise a debate and provide alternative hypotheses, it is critical that these hypotheses are based on well-established theories, scientific evidence and coherent reasoning. Since we found the hypothesis of Samraoui (2017) very unsatisfactory, it is our responsibility to shed light on several biological and ecological aspects that were overlooked in the analysis.

Imagine a species that has been restricted to one site (site A) for two decades, showing no sign of dispersal although nearby sites were available. Now, imagine a distant site (site B) that has never harbored this species, showing all of a sudden, a group of individuals in a given year. Your first naïve impression would be: *there was a successful natural colonization*. Later you discover that larvae were translocated in this site during the same year. Normally, your answer would be: *ahaa! that explains a lot*. Instead, you insist on the fact that it was a natural dispersal, discounting the translocated larvae without having any tangible scientific evidence. This is the case of Samraoui (2017) who tries to refute the conclusions of Khelifa et al. (2016a).

Before showing that the evidence of Samraoui (2017) does not go against our conclusions, we would like to start with three questions: (1) what are the odds that *U. edwardsii*, which had not been observed in any site but Lake Bleu since 1990, would naturally colonize in the same year (2011) a site (Lake Tonga) where a translocation experiment was just launched? (2) if that natural dispersal happened, what are the chances that this phenomenon occurred independently from the already existing translocated conspecifics? (3) why would the only evidence of natural colonization occur in 2011 and not any time prior to this year during which the translocation scheme started? These are relevant questions that have to be considered before claiming that natural dispersal is the only source of the recent range expansion of the species in Northeast Algeria. The reasonable answer for these questions is that the likelihood of an *independent natural colonization* as suggested by Samraoui (2017) is very small, and the only way to prove it is to disentangle between the success of natural and assisted dispersal, and unravel the potential interplay between the two. None of these key questions were addressed in Samraoui (2017).

Here, we present a critical analysis of Samraoui (2017) addressing the contradictions, misquotations and misunderstandings, biased conclusions, major comments (those that supposedly refutes the main conclusions) and minor comments (those that were made on specific points and details but do not go against the main conclusions). To avoid any speculation, we provide additional data that confirm that our harvest technique at Lake Bleu did not affect the source population.

Critical examination

Contradictions

Contradiction 1: natural dispersal is possible, but assisted dispersal is not

Without any proof, Samraoui (2017) seems to be sure that all larvae translocated in Lake Tonga failed to emerge, but, at the same time, shows confidence that the new established population is the result of natural dispersal. Here we show that this is a contradictory statement. If natural colonization happens, assisted colonization should also happen (Fig. 1). In fact, the likelihood of the success of our translocation scheme (assisted dispersal) is higher than that of natural colonization for a simple reason. During a natural colonization, the dragonfly has to fly from site A to B, avoid being eaten along the way and at site B, meet a mate, copulate, lay eggs in the water, eggs have to hatch, the small larvae have to grow for several months among a large variety of predators, and finally the larvae have to emerge successfully (Fig. 1a). Translocation procedure of final instar larvae reduces this long process to just emergence (Fig. 1b). Assuming that natural dispersal from site A to site B is possible (Fig. 1a), but assisted dispersal presented in Khelifa et al. (2016a; Fig. 1b) is not, is just erroneous. As an objective analogy, it is similar to assume that a human can run (non-stop) 50 km from site A to B and go through different kinds of obstacles where he risks his life, but not believing that the same human can run 10 m. Therefore, it is very likely that our assisted dispersal has contributed to the establishment of Lake Tonga population.

Contradiction 2: questioning the choice of Lake Tonga as adequate for the translocation of the species

Another contradiction in Samraoui (2017) is the complaint about the choice of Lake Tonga as a potential host site, but at the same time, he asserts natural establishment of a population. So in other words, his question was: why did we choose a site where the species is currently flourishing? Our answer is: because we had prior knowledge on the biology and ecological requirements of the species which we documented in Khelifa et al. (2013a, b) through adult and exuviae-based

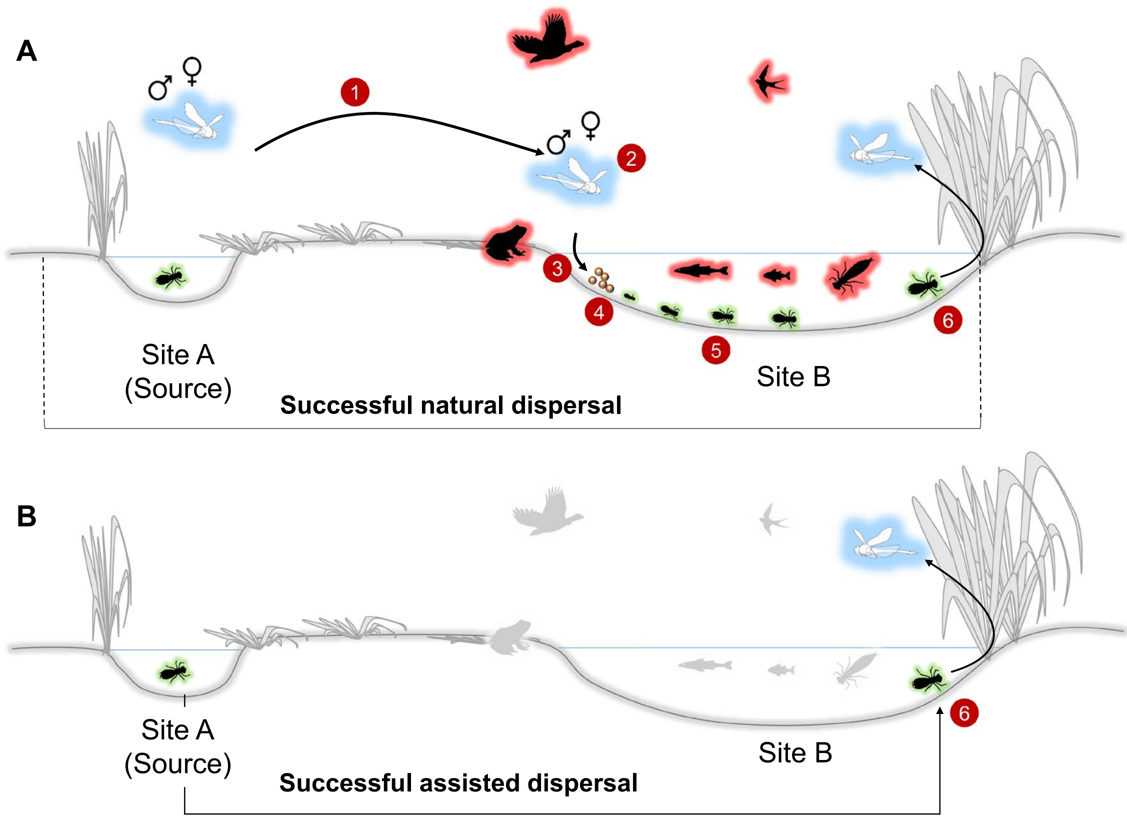

Fig. 1 Natural versus assisted dispersal. **a** and **b** refer to natural and assisted dispersal (used in Khelifa et al. 2016a) in a dragonfly, respectively. Numbers refer to the sequential process that the dragonfly goes through for successful colonization. 1: movement from site A to site B. 2: mate encounter and copulation; 3: oviposition; 4: egg hatching; 5: larval development until reaching the last instar; 6: emergence. Natural dispersal (**a**) is a long process that involves many ecological barriers such as aerial, terrestrial and aquatic predators (in red). Assisted dispersal (**b**) used in Khelifa et al. (2016a) reduces this long process to emergence. Samraoui's rebuttal claims that a natural dispersal is the only reason for Lake Tonga colonization, discounting totally the assisted dispersal that we carried out. (Color figure online)

studies. These works were not cited in Samraoui (2017). We described the final instar exuvia of the species, which allowed us to identify and select the species at the larval stage. We also collected information on habitat preferences (plant preferences and water depth) of the species during emergence, which allowed us to pinpoint where final instar larvae should be translocated for a successful emergence. Such information on habitat characteristics is important for a successful translocation (Thompson et al. 2015). Samraoui (2017) states that size, substrate, plant and animal communities of Lake Bleu and Lake Tonga are different. It is obvious that when you compare 2 ha pond with 2700 ha marsh, biological communities are likely to be different. However, a large wetland like Lake Tonga should not be considered as a homogenous habitat because it presents a wide range of microhabitats that are potentially favorable for various communities (discussed after). So, instead of focusing on bird and fish communities as Samraoui (2017) pointed out, the right approach is to use accurate ecological knowledge on the species (Khelifa et al. 2013b) and the concept of bioindication (da Rocha et al. 2010; Relyea et al. 2000) to select the appropriate host sites within 2700 ha wetland. We explain explicitly the reasons for our choice of Lake Tonga in our paper, but Samraoui (2017) did not discuss any. To summarize, in sections of Lake Tonga where translocation was conducted, odonate and plant community were very similar to the source population, which bioindicate that the ecological requirements for the species are likely to be met. The success of the colonization was the proof that our selective approach pinpointed the preferred ecological niche of the species. As mentioned in Khelifa et al. (2016a), the other important reason why Lake Tonga was selected is the prospect for the population in the long term. By 2010, the species was restricted to a 2 ha pond in Algeria, which makes it very vulnerable to extinction. With its 2700 ha, Lake Tonga most likely has a large carrying capacity for a dragonfly like *U. edwardsii* and a greater resilience against drought. The population can increase in numbers and play the role of a source population for other habitats in the vicinity. So our plan was also successful in this way since the southern part of the lake was subsequently colonized, most likely by the new established population in the northern part of the lake.

Contradiction 3: claiming high dispersal, but high recapture rate

Samraoui (2017) expressed some concerns about the low recapture rate that we reported, suggesting that marked individuals have mainly died due to handling. However, he argues that the species colonized naturally all sites which suggests a high dispersal rate. If the species disperses, the recapture rate of individuals in its original population must be low (Davies and Saccheri 2015). One could not claim natural colonization and be surprised about the low recapture rates.

Besides the fact that no individual was damaged due to our CMR, we have been carrying out CMR studies for the last 8 years with both dragonflies and damselflies (Khelifa et al. 2014, 2015, 2016b; Khelifa and Mellal 2016; Mahdjoub et al. 2014; Zebsa et al. 2015). Thus, we had acquired experience in handling adults safely prior to the study. Furthermore, CMR was conducted in 2015 when the population showed range expansion and was not carried out in our previous study on adults (Khelifa et al. 2013a). In addition, although damselflies are quite fragile and sometimes show increased mortality due to handling (Cordero-Rivera et al. 2002; Cordero-Rivera and Stoks 2008), large dragonflies are more robust and thus less susceptible to damage. In fact, low recapture rates in odonates are not uncommon (Andrés and Rivera 2001; Anholt et al. 2001; Zebsa et al. 2015), particularly in large dragonflies. We are confident that there was no major effect of handling on adults since during the same day of their marking, they showed a normal reproductive behavior including chasing females, competing with conspecifics, copulation, and/or oviposition.

Is the low recapture rate of the species only indicative of mortality and migration? Not necessarily. There are few non-exclusive hypothesis to explain the low recapture rates in *U. edwardsii*. First, our sampling procedure was not on a daily basis (twice a week), which reduced the probability of encountering a marked individual from one sampling occasion to another. We explain our methodology in our paper and we clearly state that only 2 h of sampling (capture and marking) was carried out in each occasion and in each site. Due to the fact that capturing a large dragonfly like *U. edwardsii* was challenging, the number of marked individuals was lower than the number of unmarked individuals in each occasion, which indicates that the marked sample size was quite small with respect to the entire population. Second, the occurrence of large population size also reduces the probability of encountering marked individuals because of the so-called 'needle-in-a-haystack' effect (Rubenstein and Hobson 2004). As shown hereafter, the population size of Lake Bleu is larger than assumed before and this plays an important role in the non-detection of marked individuals. Last but not least, the spatial distribution of adults in the reproductive site makes the detection of marked individuals challenging. In our study (Khelifa et al. 2016a), we demonstrated that adults were widely scattered around the sites and could reach distances that are > 1 km far from the waterbody. This is probably due to the territorial mating system of the species which makes males scattered across a large area; a reproductive aspect that has not been investigated yet.

Misquotations and misunderstandings

Samraoui (2017) has repeatedly mistaken our methodology of egg translocation and capture-mark-recapture (CMR). The rebuttal refers to 16 and 74 eggs, whereas Khelifa et al. (2016a) clearly refers to clutches. So, what difference in number would this make? It is worthwhile to give a basic definition of a clutch as indicated in Corbet (1999) "complement of oocytes that mature together to produce a batch of eggs which are typically laid during an episode". We estimated in our previous study the clutch size of the species which was about 650 eggs (Khelifa et al. 2013a). Therefore, in terms of difference in number, Samraoui (2017) just underestimated the initial egg population size by 650 times, which might explain the skepticism about the success of the translocation.

Samraoui (2017) states "Khelifa et al. (2016a) also claim that Lake Tonga and Lac Bleu exhibit a close resemblance in habitat characteristics." This is not true. In Khelifa et al. (2016a) it was stated "The Northeastern part of the lake (Lac Tonga NE)", indicating the geographic coordinates, is similar to Lake Bleu. Lake Tonga is 2700 ha marsh and is therefore very distinct from Lac Bleu (2 ha) as mentioned before, but some part of this gigantic wetland has physical and biological features that are similar to Lake Bleu (as discussed above).

Samraoui (2017) states "Of the 102 marked individuals at Lake Tonga, only 7.8% were recaptured". No capture-mark-recapture (CMR) was carried out in Lake Tonga. The data referred to Lake Bleu. He further states "These very low recapture rates were not addressed by the authors", which is also not true. We clearly stated "the very low recapture rate of the species was probably not only the result of mortality". This severe negligence shown through the repeated mistakes affects the scientific credibility of the entire rebuttal.

Major comments

As a main evidence, Samraoui (2017) states that he counted 49 individuals along 450 m stretch at the very same year and location where 46 final instar larvae were translocated. Our selection of final instar larvae as candidates of translocation ensured very high probability of emergence (Khelifa 2012). The methodology that Samraoui (2017) used was based on unmarked individuals and thus it is misleading and often yields inaccurate estimates of the total number of individuals (Seber 1982), especially in dragonflies. One unmarked dragonfly can be counted several times along 450 m transect because it flies back and forth as a result of disturbance from conspecific males (Khelifa et al. 2013a), and other sources of disturbance. Therefore, this only single data point collected by Samraoui (2017) proves only that several specimens were flying after the translocation event.

He also cited the work of Douakha and Kaddeche (2012) who coincidently recorded the new population of Lake Tonga in 2011, when the translocation plan was launched. Douakha and Kaddeche (2012) recorded a maximum of 31 individuals, counted visually without any marking technique. Thus, these recorded individuals of Douakha and Kaddeche (2012) likely originated from successful emergence of the translocated larvae in 2011.

Moreover, Samraoui (2017) refers to an observation of the species at Kebir-East (7 km south of Lake Tonga) reported in Satha and Samraoui (2017) as another proof of "range expansion" of *U. edwardsii*. In addition to the fact that Satha and Samraoui (2017) was not cited in the reference list, the observation was made on the adult stage with no indication of the number of individuals. Adults are far from being the best indicators of successful colonization. By claiming range expansion based on such observation, Samraoui (2017) dismissed a series of studies warning about the use of adult stage as indicator of successful colonization (Hardersen 2008; Ott 2007; Raebel et al. 2010; Samways et al. 2010). Vagrant dragonflies are occasionally observed far from their emergence site (Corbet 1999), but this does not reflect or confirm a colonization. Indicators of emergence (exuviae and tenerals) do. Furthermore, we already stated in our paper that the "dispersal ability of the species might have been underestimated in the past", but there is a big difference between reaching a site and establishing a population there. Thus, this argument does not oppose the conclusions of Khelifa et al. (2016a).

So, why were Khelifa et al. (2016a) careful about claiming that natural colonization was likely? The species was restricted to one site for more than two decades, although a large number of nearby wetlands were available. Also, our study showed no exchange of marked individuals between Lake Bleu and Lake Noir. If we use the available data and a scientific reasoning, it would be bold to claim that the species has colonized the sites naturally, especially when we translocated larvae. So, yes, we are not against the hypothesis that a natural dispersal could have occurred, however, all available data strengthened the hypothesis that the colonization was mainly the result of our translocation scheme. Even after reading the few additional records of Samraoui (2017), we are still unconvinced that natural dispersal could explain 100% of the colonization, and thus refute the conclusions of Samraoui (2017).

Biased conclusions

As scientists, we have to test all alternative hypotheses and use the available data to support them. So, let's assume there were actually 49 individuals (or more) in Lake Tonga in 2011, does it mean that the translocation failed? There is a crucial fact in behavioral ecology that has been totally ignored by Samraoui (2017). This fact is the social cue and the conspecific effects on colonization rates, which suggests that individuals are more likely to colonize areas where conspecifics are already present because they use this cue for habitat quality assessment (Fahrig 2007; Smith and Peacock 1990; Stamps 1988). There is an overwhelming literature on the implication of conspecific occurrence on habitat choice in mammals (Boyd and Pletscher 1999; Gregory Welsh and Muller-Schwarze 1989), birds (Muller et al. 1997; Serrano and Tella 2003), amphibians (Rudolf and Rödel 2005), reptiles (Graves and Duvall 1995), fish (Lecchini et al. 2007), crustaceans (Zimmer-Faust et al. 1985) and also insects (Jeanson and Deneubourg 2007; Raitanen et al. 2013). In fact, the influence of social cue in behavioral decisions of odonate adults has been confirmed in several species from different families such as Coenagrionidae (Byers and Eason 2009; Martens 1994), Calopterygidae (Grether and Switzer 2000), Platycnemididae (Martens 2002) and even Libellulidae (McMillan 2000). Thus, even if the count reported by Samraoui (2017) was correct, which is unlikely, the extra individuals which would represent the new dispersers would likely have arrived because of the already existent individuals that we translocated. The latter may have played the role of attractors, paving the way for natural colonization. This hypothesis is more acceptable and objective given the available relevant literature and the history of the absence of colonization of the species during the last two decades. This is therefore a relevant hypothesis that should be considered.

Was the population of Lake Bleu imperiled?

Samraoui (2017) also claims that our sampling of Lake Bleu might have imperiled the population. Data that shows that Lake Bleu population was not harmed was already published in Khelifa et al. (2016a), but Samraoui (2017) failed to discuss it. CMR carried out in 2015 in Lake Bleu for only 2 h during 10 occasions at the end of the flight season yielded 102 marked adults, although many unmarked adults were left in the site in each occasion. Besides that, the low recapture rate indicates that the population size was recently large and flourishing. However, we would like to further demonstrate based on exuviae collections that his claims are wrong.

Regular exuviae sampling gives good indication of the actual population size (Foster and Soluk 2004) because exuviae reflect successful emergence of adults (Raebel et al. 2010). We conducted collections of final instar exuviae in Lake Bleu in 2012 (Khelifa et al. 2013b) and 2016a within randomly chosen 2×2 m^2 quadrates (total of 400 m^2) (Fig. 2a, b; see supplementary methods). A total of 86 (0.215 exuvia m^{-2}) and 119 (0.297 exuvia m^{-2}) exuviae were collected in 2012 and 2016, respectively. We used a generalized negative binomial model to determine the factors that determine the density of exuviae in Lake Bleu. Then based on these factors, we predicted the total number of individuals in the entire site (excluding the unvegetated areas).

Our best model included water depth (with the quadratic effect) and the slope of the substrate as main effects (Fig. 3a; Table 1). Models including year-effect did not significantly explain more variation, which suggests that the density of exuviae, although higher in 2016 than in 2012, was not significantly different. Then, based on bathymetry (Fig. 3b) and vegetation cover information (to the nearest 4 m^2), our best model predicted a total population size of 3185 exuviae. This is the first estimate of the population size of Lake Bleu based on a described scientific methodology. Although survival to maturation is still unknown to estimate the effective population size, our exuviae sampling shows that the population size of Lake Bleu is most likely far beyond the estimated 250 breeding pairs (with undescribed methodology). Moreover, the total number of exuviae collected was likely underestimated because we sampled each quadrate only twice during the second half of the emergence season (to avoid disturbance), and thus many exuviae may have fallen down on the water surface and sink over the season due to various abiotic (wind and rain) and biotic (waterbirds, reptiles and other animals) factors. Therefore, our sampling of about 50 larvae every year should not have harmed the population.

To summarize, our critical analysis of the major comments of Samraoui (2017) led us to conclude that the very few data presented does not disagree with the success of our conservation plan. Using the available evidence and an objective scientific thinking, we are confident that our translocation scheme was successful, and even if natural dispersal happened, it is uncertain that it occurred independently from the translocated individuals.

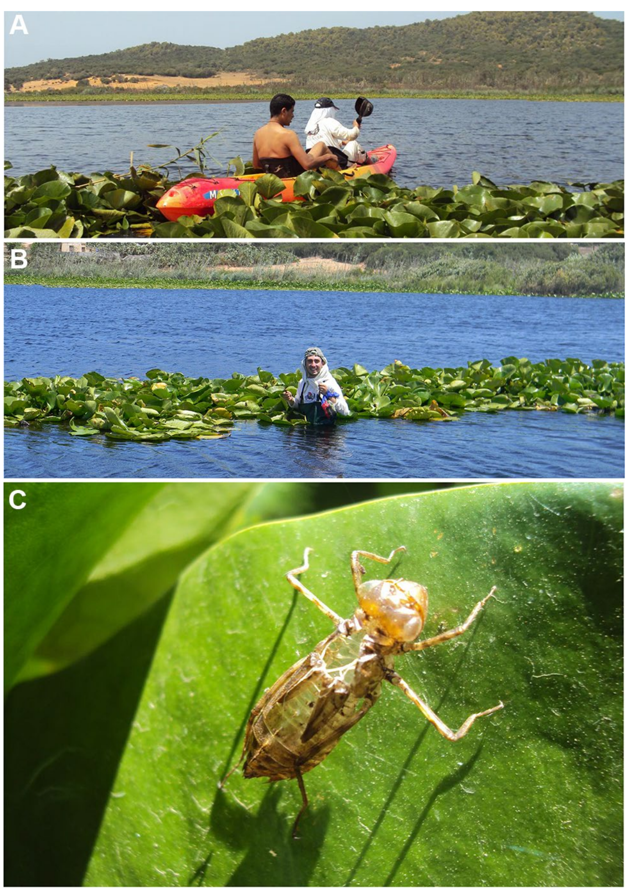

Fig. 2 **a** and **b** Exuviae sampling of *Urothemis edwardsii* in Lake Bleu. **c** Final instar exuviae of *Urothemis edwardsii* in Lake Bleu

Minor comments

Samraoui (2017) doubted the "credibility of the whole monitoring scheme" because we failed to detect *U. edwardsii* at Lake Tonga in 2011. It is possible not to detect a dragonfly in successive sampling occasions. For example, *U. edwardsii* was not detected during the flight season of 2007 at Lake Bleu (Riservato et al. 2009), although subsequent visits confirmed the presence of the population (Khelifa et al. 2013a). In addition, we find it incautious that Samraoui confirms the presence of an already established and large population based on one [or a few considering Douakha and Kaddeche (2012)] data point that was collected with a methodology that does not allow reliable estimates of abundance of adults, and no indicator of successful reproduction was reported.

Samraoui (2017) suggests that Lake Tonga population was established between 2007 and 2010, but there is no data to prove that. Although detection probability by a few researchers might be low in this large wetland, we and other ecologists had visited the site several times during these years and no *U. edwardsii* individual was observed. In fact, Lake Tonga is a very popular wetland in Northeast Algeria where many students and researchers carry out their research projects. Moreover, authorities of the PNEK (National Park of El Kala) conduct regular biodiversity checklists, and given that *U. edwardsii* is the emblematic species for the region, technicians and researchers would have noticed its presence. Therefore, the establishment of a population prior to 2011 seems very unlikely.

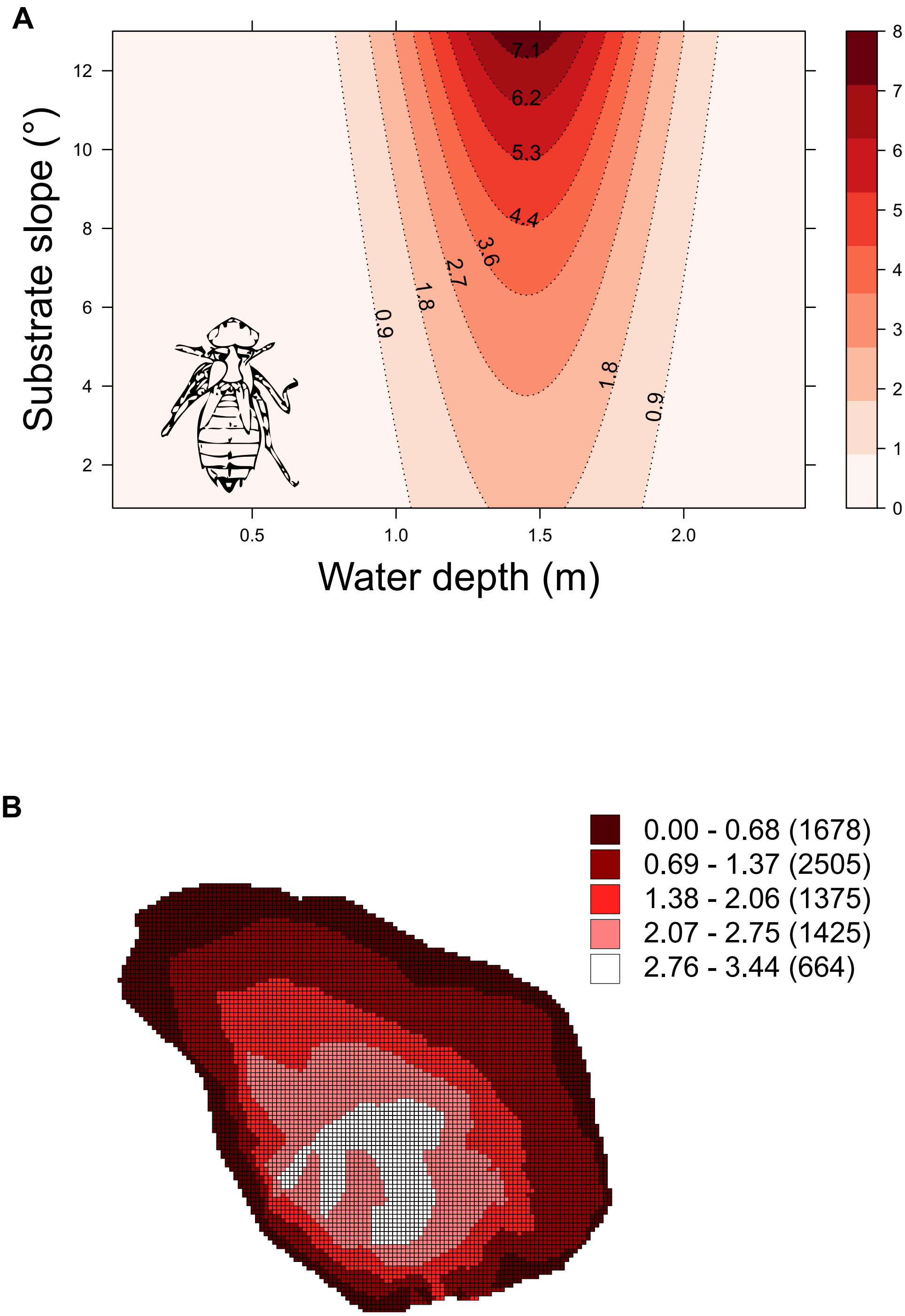

Fig. 3 **a** Predicted number of exuviae across water depth and substrate slope. **b** Bathymetric map of Lake Bleu. Grids are 2 × 2 m^2. The unit of water depth is in meters. Values between brackets refer to the number of grids for each depth stratum. This map was used to determine the population size of *U. edwardsii* based on exuviae sampling. (Color figure online)

Table 1 Summary results of the negative binomial regression of the number of exuviae against water depth and substrate slope

	Estimate	SE	z value	P-value
Intercept	− 9.608	1.802	− 5.331	< 0.0001
Depth	14.000	2.651	5.280	< 0.0001
Depth^2	− 4.814	0.937	− 5.136	< 0.0001
Subs. slope	0.112	0.074	1.514	0.13

The comment of Samraoui (2017) on the potential outbreeding depression that our translocation may have exposed Lake Tonga population is out of context. Outbreeding depression may happen when two populations adapted to different environments are brought together (Dobzhansky 1948). For *U. edwardsii*, this could happen if one translocates individuals from its main home range (Sub-Saharan Africa) to our relict population. In our region, all available data show that there is one population (Lake Bleu). So the problem should be inbreeding and not outbreeding.

Regarding the critique made by Samraoui (2017) on the taxonomy of the species, we would like to answer with a quote: “If the reader is to grasp what the writer means, the writer must understand what the reader needs” (Gopen and Swan 1990). Samraoui (2017) suggested that we had to highlight in the title or in the abstract that the species once was moved from the genus *Libellula* to *Urothemis*. Are we supposed to highlight a historical taxonomic misclassification of the species in the title or the abstract of a conservation paper? Samraoui’s (2017) suggestion is out of context and misleading, and we, as any other scientific writer, have the duty to highly recommend to writers to avoid writing irrelevant details (to the purpose of the paper) in their manuscripts, especially in the title and abstract (Peat et al. 2002). We named the species as indicated by the IUCN where the author of Samraoui (2017) himself is a co-author of the species overview page (Boudot et al. 2016), and any other recent source (Boudot et al. 2009; Dijkstra and Lewington 2006).

Concerning our statement that *U. edwardsii* is the most critically endangered species of dragonfly in the Mediterranean, Samraoui (2017) suggests that *Onychogomphus boudoti* should be considered as the most endangered one instead. Indeed, by early 2011 both species were restricted to one locality. *O. boudoti* was discovered in 2011 in Morocco (Ferreira et al. 2014), and although IUCN Red list currently classified it as critically endangered, further investigations need to be carried out to determine its entire range of distribution. It is too early to assert that the distribution range of this freshly discovered species is definitely restricted to one locality. *U. edwardsii*, on the hand, has been confined to a single site for more than two decades which makes it a good candidate for the most endangered species before our conservation efforts. Thus, unlike Samraoui (2017), one has to be careful when comparing a species that we have so little data on with another species that has been sampled for a longer period in order to avoid biases.

Regarding Lake Okrera that we named as El Graeate in our manuscript, Samraoui claims that the site was already repeatedly visited several times in the 90s. Once again, Samraoui showed a lack of careful reading of our paper. In our manuscript, we have four sites named as El Graeate (1–4) and Lake Okrera coordinates as indicated in Samraoui and Corbet (2000) falls in Graeate 1. The map (Fig. 1: locality 2) presented in Khelifa et al. (2016a) clearly shows that the new population is restricted to Graeate 2 which is a few 100 m far from Graeate 1.

Samraoui states ‘Of concern is that after their first attempt at translocation at Lake Tonga in 2011 with 46 larvae failed, Khelifa et al. (2016a) repeated the same experiment the following year with a smaller number: 23!’ This statement is inaccurate or incomplete. We collected the same number of larvae (46) in 2011 and 2012, but we translocated 23 in each Lake Tonga and Lake Noir. In addition, we do not follow the blurred reasoning of Samraoui here because the reason why we translocated 46 larvae was not because we found only 46, but rather because we selected them.

Regarding the obviously non-significant negative pattern of the number of individuals recorded within 100 m in Lake Bleu, we reanalyzed the data of population trend with a generalized model (negative binomial distribution) and it showed the exact same pattern with an even higher P-value for Lake Bleu ($P = 0.77$) which confirms that the slightly negative pattern is far from significance and could be the result of weather conditions during sampling. Our exuviae-based population estimation confirms it.

Samraoui (2017) made also a comment on why do we divide Lake Tonga population into two, arguing that adults could fly from one population to another. It depends on how we should define a population of a flying insect. It is important to keep in mind that odonates have complex life cycles and that populations should not be determined based on adults, but rather on successful emergence of larvae (Raebel et al. 2010; Samways et al. 2010). It is similar to birds; although individuals can fly substantial distances, the breeding areas are restricted to specific sites. A large wetland like Lake Tonga (2700 ha) should not be perceived as a single homogenous habitat where the aquatic stage (larvae) of the species can be randomly distributed (Schindler and Scheuerell 2002). For instance, a river, despite is a single waterbody, it could harbor different populations (Khelifa and Mellal 2016), even though these latter could be linked by dispersal and form a meta-population (Hanski and Gilpin 1997). In our particular case, we started with a situation where we knew that the lake did not harbor *U. edwardsii*. Then, after translocating the species we detected a new population a year later at the other extreme of the lake which is 7 km away. If we consider two ponds like Lake Noir and Graeate (2 km away) as two populations, Northern and southern Lake Tonga (7 km away) should also be considered as separate populations (linked by dispersal).

Title

While the sixth mass extinction is under way, the comment of Samraoui (2017) expresses in the title his belief in “Santa Rosalia’s blessing” which might have been the cause of the rapid range expansion of *U. edwardsii*. Blessing has not occurred for the thousands of species that have been recorded extinct or endangered (Strayer and Dudgeon 2010). As conservation biologists, our role is to investigate and understand the different ecological requirements of species and the mechanisms underlying population dynamics, colonization and extinction processes in order to establish good management plans that, for some critical instances like in *U. edwardsii* in Northeast Algeria, might involve restoration and translocation. Blessing may come after action. Researchers responsible for the protection of *U. edwardsii* has been witnessing *U. edwardsii* demise and agony during the last two decades, but, to our knowledge, no attempt to restore and expand the range of the species has been made, regardless of the IUCN call for an urgent action. Such action was conducted in a timely manner by Khelifa et al. (2016a), resulting in an unprecedented increase of population size in the region. Monitoring the area in the next years is crucial to understand the true value of the translocation action.

Should translocation efforts be stopped?

Samraoui (2017) 'urge for translocation initiative to be discontinued' because it may imperil the population of Lake Bleu. First of all, we have never recommended that Lake Bleu should be harvested continually. Second, stopping translocation efforts without having any data on genetic diversity and population differentiation is just an inadequate conservation measure. Since all populations probably come from Lake Bleu, the main issue is inbreeding, and thus the new established populations have low genetic diversity and are subject to founder effect which makes them vulnerable to extinction.

The conservation of the species should be addressed from a metapopulation perspective (Suhonen et al. 2010) and should involve genetic analyses at the continental scale (Ferreira et al. 2016) to determine whether there is a level of genetic differentiation that indicates differently locally-adapted populations within Northeast Algeria (very unlikely), recent migration from the main home range (less likely), or the occurrence of one population that colonized all other populations (most likely). It is most probable that Lake Bleu population is the origin of all newly established populations, and thus stopping assisted dispersal without any knowledge on the dispersal rates at such an early stage is very risky and could imperil the entire conservation scheme. Hannon and Hafernik (2007) have reintroduced the damselfly *Ischnura gemina* in a Californian extinct population, but it survived for only 1 year. Hence, it is very crucial to take into account that freshly established populations are known to be very vulnerable to extinction and thus regular monitoring of all populations in Northeast Algeria remains a priority.

Currently, we know that the number of populations has increased, and that the population of Graeate has shown a very promising population (a total of 170 exuviae collected within 8 m^2 in 2016; Khelifa et al. unpublished data). Thus different populations can potentially be used as source for further restoration plans and the choice of the source populations and the number of individuals to be taken should be carried out in the light of data on dispersal capacity and source population size for the better understanding of colonization processes and the effective management of the species in the region.

Conclusion

We read with interest the comment of Samraoui (2017), but as we showed above, the conclusions are strongly biased and inconsistent due to the accumulation of contradictions, misquotations, misunderstandings, dismissal of key research, and lack of objectivity. Samraoui (2017) provided a very few data points that have poor predictive power, do not go against our conclusions, and tend to confirm the success of our experiment. Unfortunately, the misguided recommendations of Samraoui (2017) are unlikely to bring us closer to an effective long-term conservation of the species in the region and thus should be disregarded. Further studies should focus on the direct and indirect implications of final instar larvae translocation in successful colonization of odonates.

Acknowledgements The authors accept the apologies of the journal for publishing Samraoui's comment prematurely without our response. We are grateful for the helpful comments of the reviewers. This paper is dedicated to Dr. Ali Zeraoula for his support and incredible patience and dedication to science during his Magister. Although the study was mainly conducted voluntarily without funding, we would like to thank Ahmed Bechiri for his field assistance in 2012.

Compliance with ethical standards

Conflict of interest The authors declare no conflict of interest.

References

Andrés JA, Rivera AC (2001) Survival rates in a natural population of the damselfly *Ceriagrion tenellum*: effects of sex and female phenotype. Ecol Entomol 26:341–346

Anholt BR, Vorburger C, Knaus P (2001) Mark-recapture estimates of daily survival rates of two damselflies (*Coenagrion puella* and *Ischnura elegans*). Can J Zool 79:895–899

Boudot J-P et al (2009) Atlas of the Odonata of the Mediterranean and North Africa. Libellula 9:1–256

Boudot J-P, Clausnitzer V, Dijkstra K-DB, Suhling F, Samraoui B, Schneider W (2016) *Urothemis edwardsii*. The IUCN red list of threatened species 2016:e.T60073A83876779. https://doi.org/10.2305/IUCN.UK.2016-3.RLTS.T60073A83876779.en

Boyd DK, Pletscher DH (1999) Characteristics of dispersal in a colonizing wolf population in the central Rocky Mountains. J Wildl Manag 63:1094–1108

Byers CJ, Eason PK (2009) Conspecifics and their posture influence site choice and oviposition in the damselfly *Argia moesta*. Ethology 115:721–730

Corbet PS (1999) Dragonflies: behaviour and ecology of Odonata. Harley books, Colchester

Cordero-Rivera A, Stoks R (2008) Mark-recapture studies and demography. In: Córdoba-Aguilar A (ed) Dragonflies and damselflies: model organisms for ecological and evolutionary research. Oxford University Press, Oxford, pp 7–20

Cordero-Rivera A, Perez FE, Andres J (2002) The effect of handling damage, mobility, body size, and fluctuating asymmetry on lifetime mating success of *Ischnura graellsii* (Rambur) (Zygoptera: Coenagrionidae). Odonatologica 31:117–128

da Rocha JRM, De Almeida JR, Lins GA, Durval A (2010) Insects as indicators of environmental changing and pollution: a review of appropriate species and their monitoring. Holos Environ 10:250–262

Davies WJ, Saccheri IJ (2015) Male emergence schedule and dispersal behaviour are modified by mate availability in heterogeneous landscapes: evidence from the orange-tip butterfly. PeerJ 3:e707

Dijkstra K-DB, Lewington R (2006) Field guide to the dragonflies of Britain and Europe. British Wildlife Publishing, Dorset

Dobzhansky T (1948) Genetics of natural populations. XVIII. Experiments on chromosomes of *Drosophila pseudoobscura* from different geographic regions. Genetics 33:588

Douakha H, Kaddeche H (2012) Contribution à l'étude de la faune odonatologique de la Numidie orientale dans l'Est algérien. University of Guelma, Guelma

Fahrig L (2007) Non-optimal animal movement in human-altered landscapes. Funct Ecol 21:1003–1015

Ferreira S et al (2014) A critically endangered new dragonfly species from Morocco: *Onychogomphus boudoti* sp. nov.(Odonata: Gomphidae). Zootaxa 3856:349–365

Ferreira S, Boudot J-P, El Haissoufi M, Alves PC, Thompson DJ, Brito JC, Watts PC (2016) Genetic distinctiveness of the damselfly *Coenagrion puella*. Conserv Genet 17:985–991

Foster S, Soluk D (2004) Evaluating exuvia collection as a management tool for the federally endangered Hine's emerald dragonfly, *Somatochlora hineana* Williamson (Odonata: Cordulidae). Biol Conserv 118:15–20

Gopen GD, Swan JA (1990) The science of scientific writing. Am Sci 78:550–558

Graves BM, Duvall D (1995) Aggregation of squamate reptiles associated with gestation, oviposition, and parturition. Herpetol Monogr 9:102–119

Gregory Welsh R, Muller-Schwarze D (1989) Experimental habitat scenting inhibits colonization by beaver, *Castor canadensis*. J Chem Ecol 15:887–893

Grether GF, Switzer PV (2000) Mechanisms for the formation and maintenance of traditional night roost aggregations in a territorial damselfly. Anim Behav 60:569–579

Hanski I, Gilpin ME (1997) Metapopulation biology. Academic press, San Diego

Hannon ER, Hafernik JE (2007) Reintroduction of the rare damselfly *Ischnura gemina* (Odonata: Coenagrionidae) into an urban California park. J Insect Conserv 11:141–149

Hardersen S (2008) Dragonfly (Odonata) communities at three lotic sites with different hydrological characteristics. Ital J Zool 75:271–283

Jeanson R, Deneubourg J-L (2007) Conspecific attraction and shelter selection in gregarious insects. Am Nat 170:47–58

Khelifa R (2012) Description of the final instar larva of *Calopteryx exul* Sélys, 1853 (Zygoptera: Calopterygidae). Int J Odonatol 15:107–114

Khelifa R, Mellal MK (2016) Host-plant-based restoration as a potential tool to improve conservation status of odonate specialists. Insect Conserv Divers 10:151–160

Khelifa R, Mahdjoub H, Zebsa R, Kahalerras A, Guebailia A, Amari H, Houhamdi M (2013a) Aspects of reproductive biology and behaviour of the regional critically endangered *Urothemis edwardsii* (Odonata: Libellulidae) on Lake Bleu (Algeria). Zool Ecol 23:282–285

Khelifa R, Zebsa R, Kahalerras A, Laouar A, Mahdjoub H, Houhamdi M (2013b) Description of the final instar Exuvia of *Urothemis edwardsii* with reference to its emergence site selection (Odonata: Libellulidae). Entomol Gen 34:303–312

Khelifa R, Zebsa R, Sakrane NE, Youcefi A, Bensouilah S, Amari H (2014) Long-range movements of an endangered endemic damselfly *Calopteryx exul* Selys, 1853 (Calopterygidae: Odonata). Afr J Ecol 52:375–377

Khelifa R, Guebailia A, Mahdjoub H, Aouaouche MS, Houhamdi M (2015) Aspects of life history of *Platycnemis subdilatata* (Zygoptera: Platycnemididae) in Northeast Algeria. Int J Odonatol 18:317–327

Khelifa R et al (2016a) On the restoration of the last relict population of a dragonfly *Urothemis edwardsii* Selys (Libellulidae: Odonata) in the Mediterranean. J Insect Conserv 20:797–805

Khelifa R, Zebsa R, Amari H, Mellal MK, Mahdjoub H, Kahalerras A (2016b) A hotspot for threatened Mediterranean odonates in the Seybouse River (Northeast Algeria): are IUCN population sizes drastically underestimated? Int J Odonatol 19:1–11

Lecchini D, Planes S, Galzin R (2007) The influence of habitat characteristics and conspecifics on attraction and survival of coral reef fish juveniles. J Exp Mar Biol Ecol 341:85–90

Mahdjoub H, Khelifa R, Zebsa R, Mellal MK, Bouslama Z, Houhamdi M (2014) Aspects of reproductive biology and ecology of *Coenagrion mercuriale* at its southern range margin. Int J Odonatol 17:173–180

Martens A (1994) Field experiments on aggregation behaviour and oviposition in *Coenagrion puella* (L.) (Zygoptera: Coenagrionidae). Adv Odonatol 6:49–58

Martens A (2002) Group oviposition in three platycnemidid species (Odonata: Platycnemididae). Int J Odonatol 5:75–80

Mayr E (1982) The growth of biological thought: diversity, evolution, and inheritance. Harvard University Press, Cambridge

McMillan VE (2000) Aggregating behavior during oviposition in the dragonfly *Sympetrum vicinum* (Hagen) (Odonata: Libellulidae). Am Midl Nat 144:11–18

Muller K, Stamps J, Krishnan V, Willits N (1997) The effects of conspecific attraction and habitat quality on habitat selection in territorial birds (*Troglodytes aedon*). Am Nat 150:650–661

Ott J (2007) Artenschutzprogramm für die Gekielte Smaragdlibelle (*Oxygastra curtisii*, Insecta, Odonata) in Deutschland: das Beispeiel der Population an der Our, vol 3. Pensoft Publishers, Sofia

Peat J, Elliott E, Baur L, Keena V (2002) Scientific writing-easy when you know how. The BMJ Publishing Group, London

Raebel EM, Merckx T, Riordan P, Macdonald DW, Thompson DJ (2010) The dragonfly delusion: why it is essential to sample exuviae to avoid biased surveys. J Insect Conserv 14:523–533

Raitanen J, Forsman JT, Kivelä SM, Mäenpää MI, Välimäki P (2013) Attraction to conspecific eggs may guide oviposition site selection in a solitary insect. Behav Ecol 25:110–116

Relyea CD, Minshall GW, Danehy RJ (2000) Stream insects as bioindicators of fine sediment. Proc Water Environ Fed 2000:663–686

Riservato E, Boudot JP, Ferreira S, Joviæ M, Kalkman VJ, Schneider W, Samraoui B, Cuttelod A (2009) The status and distribution of dragonflies of the Mediterranean Basin. IUCN, Gland, 33 p

Rubenstein DR, Hobson KA (2004) From birds to butterflies: animal movement patterns and stable isotopes. Trends Ecol Evol 19:256–263

Rudolf VH, Rödel M-O (2005) Oviposition site selection in a complex and variable environment: the role of habitat quality and conspecific cues. Oecologia 142:316–325

Samraoui B (2017) The hand of man or Santa Rosalia's blessing? A rebuttal of the paper "on the restoration of the relict population of a dragonfly *Urothemis edwardsii* Selys (Libellulidae: Odonata) in the Mediterranean". J Insect Conserv. https://doi.org/10.1007/s10841-017-9966-2

Samraoui B, Corbet PS (2000) The odonata of Numidia, Northeastern Algeria part I: status and distribution. Int J Odonatol 3:11–25

Samways MJ, McGeoch MA, New TR (2010) Insect conservation: a handbook of approaches and methods. Oxford University Press, Oxford

Satha A, Samraoui B (2017) Environmental factors influencing Odonata communities of three mediterranean rivers: Kebir-east, Seybouse, and Rhumel wadis, northeastern Algeria. Revue d'Ecologie (Terre et Vie) 72:314–329

Schindler DE, Scheuerell MD (2002) Habitat coupling in lake ecosystems. Oikos 98:177–189

Seber GAF (1982) The estimation of animal abundance and related parameters. Macmillan Publishing Company, New York

Serrano D, Tella JL (2003) Dispersal within a spatially structured population of lesser kestrels: the role of spatial isolation and conspecific attraction. J Anim Ecol 72:400–410

Smith AT, Peacock MM (1990) Conspecific attraction and the determination of metapopulation colonization rates. Conserv Biol 4:320–323

Stamps JA (1988) Conspecific attraction and aggregation in territorial species. Am Nat 131:329–347

Strayer DL, Dudgeon D (2010) Freshwater biodiversity conservation: recent progress and future challenges. J N Am Benthol Soc 29:344–358

Suhonen J, Hilli-Lukkarinen M, Korkeamaeki E, Kuitunen M, Kullas J, Penttinen J, Salmela J (2010) Local extinction of dragonfly and damselfly populations in low-and high-quality habitat patches. Conserv Biol 24:1148–1153

Thompson D, Thompson A, Kerry L, Gotham P (2015) Reintroduction and establishment of *Coenagrion mercuriale* (Charpentier) (the southern damselfly) on venn ottery common, devon. J Br Dragonfly Soc 31:14–23

Zebsa R, Khelifa R, Kahalerras A (2015) Adult movement pattern and habitat preferences of the Maghribian endemic *Gomphus lucasii* (Odonata: Gomphidae). J Insect Sci 15:151

Zimmer-Faust RK, Tyre JE, Case JF (1985) Chemical attraction causing aggregation in the spiny lobster, *Panulirus interruptus* (Randall), and its probable ecological significance. Biol Bull 169:106–118