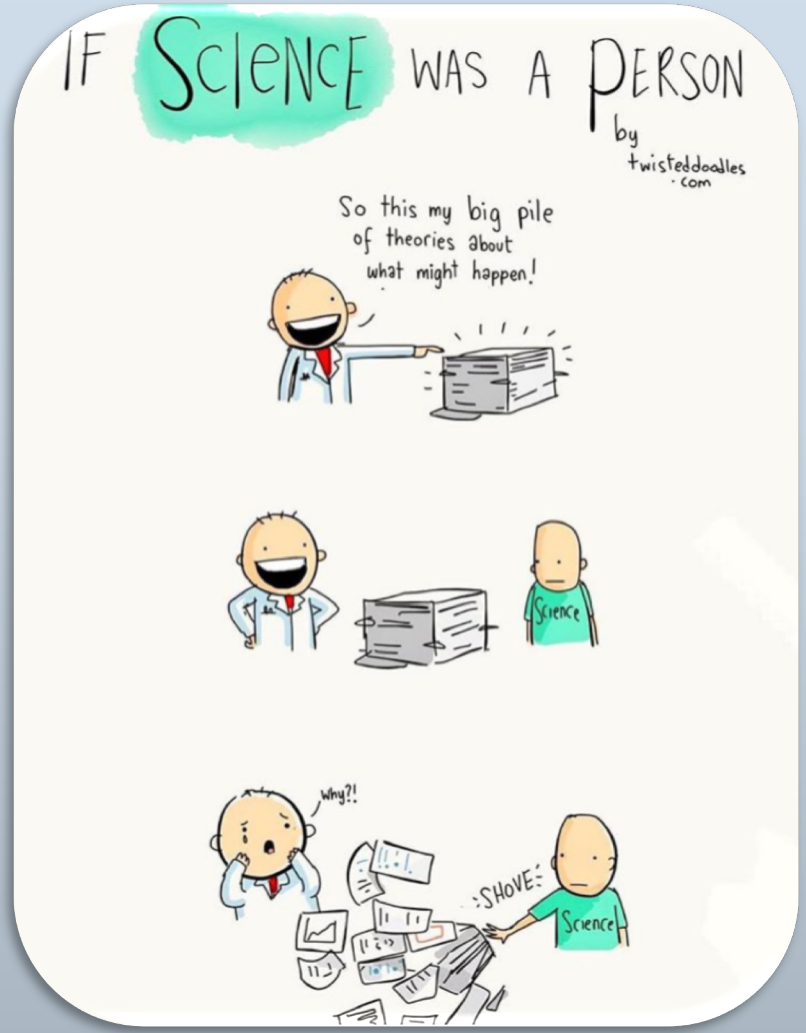
Scientific Publishing

- What is a research article/ science paper?
- What is peer-review?
- What is a science journal?




PROCEEDINGS B

royalsocietypublishing.org/journal/rspb

Research

Cite this article: Ono K, Knutsen H, Olsen EM, Ruus A, Hjermann DØ, Chr. Stenseth N. 2019 Possible adverse impact of contaminants on Atlantic cod population dynamics in coastal ecosystems. Proc. R. Soc. B 286: 20191167. http://dx.doi.org/10.1098/rspb.2019.1167

Received: 20 May 2019
Accepted: 8 July 2019

Subject Category:
Ecology

Subject Areas:
ecology

Keywords:
Atlantic cod, population dynamics, mercury, pollution, spatio-temporal, local adaptation

Author for correspondence:
Kotaro Ono
e-mail: kotaro.ono@ibv.uio.no

Possible adverse impact of contaminants on Atlantic cod population dynamics in coastal ecosystems

Kotaro Ono[1,2], Halvor Knutsen[1,2,4], Esben M. Olsen[1,4], Anders Ruus[3,5], Dag Ø. Hjermann[5] and Nils Chr. Stenseth[1,2]

[1]Centre for Coastal Research (CCR), University of Agder, 4604 Kristiansand, Norway
[2]Centre for Ecological and Evolutionary Synthesis (CEES), Department of Biosciences, and [3]Department of Biosciences, University of Oslo, PO Box 1066 Blindern, 0316 Oslo, Norway
[4]Institute of Marine Research, Flødevigen, 4817 His, Norway
[5]Norwegian Institute for Water Research, Gaustadalléen 21, 0349 Oslo, Norway

KO, 0000-0003-4236-5916; NCS, 0000-0002-1591-5399

While many in-laboratory ecotoxicological studies have shown the adverse impact of pollutants to the fitness of an individual, direct evidence from the field on the population dynamics of wildlife animals has been lacking. Here, we provide empirical support for a negative effect of pollution on Atlantic cod (*Gadus morhua*) population dynamics in coastal waters of Norway by combining unique time series of juvenile cod abundance, body size, environmental concentration of toxic contaminants and a spatially structured population dynamics model. The study shows that mercury concentration might have decreased the reproductive potential of cod in the region despite the general decline in the environmental concentration of mercury, cadmium and hexachlorobenzene since the implementation of national environmental laws. However, some cod populations appeared be more resistant to mercury pollution than others, and the strength shape of mercury effect on cod reproductive potential was fjord-sp Additionally, cod growth rate changed at scales smaller than fjords gradient related to the exposure to the open ocean and offshore co spatial differences in life-history traits emphasize the importan adaptation in shaping the dynamics of local wildlife popula this study highlights the possibility to mitigate pollution effe populations by reducing the overall pollution level, but a pollution reduction alone is not enough to rebuild local Cod population recovery probably requires complement regulation and habitat restoration.

1. Introduction

An increase in urbanization and anthro degradation/loss of natural habitat phenomenon and has changed th awareness of these environme environmental movement s mental challenges (oil health problems (e and spread al expansion

What is a paper?

- A report of a particular research project- a finding
- Written by a team of researchers, affiliated to a research institution

  e.g. a University
- ~2.5 million papers published every year

1. Introduction

An increase in urbanization and anthropogenic pressure on coastal areas (e.g. degradation/loss of natural habitat and pollution) has now become a global phenomenon and has changed the face of many coastal ecosystems [1,2]. Yet awareness of these environmental problems did not grow in synchrony. The environmental movement slowly grew after World War II, when vast environmental challenges (oil spills, nuclear testing, smog) as well as cases of human health problems (e.g. the 'itai itai' and the Minamata disease) started to burgeon and spread all around the globe, in parallel with the economic and industrial expansion. Environmental regulations and treaties were not implemented ur… the 1960s and 1970s (e.g. Clean Air Act (1963) and National Environm… Policy Act (1969) in the USA, Water Pollution Control Act (1970) in Norw…

…Despite the wealth of information on the above pollutants at the individual level (from molecular to organism level), few studies have attempted to link pollution to direct population effects in the natural environment [3,4]. Some studies have tried to extrapolate the individual-level contaminant effects observed in laboratory condition to the population level by creating individual-based models or theoretical (no fit to empirical data) population-level models (e.g. Leslie matrix models), but such approaches were not always successful and hard to validate. Others have performed a before–after–control–impact type analysis to evaluate the effect of pollution on natural population (often associated with cases of severe pollution e.g. oil spill [5,6]) or a correlative analysis comparing time series of population growth …in mitigating the pollution impacts to this iconic species.

2. Material and methods

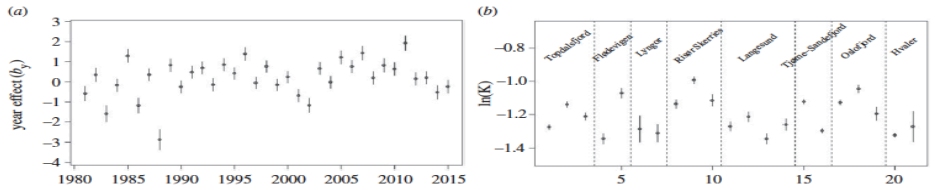
(a) Study system: species and location

The Atlantic cod—hereafter named cod—plays an important role in many of the world's ecosystems [10], including Norway, where it has been a central species both culturally (back to the Viking era [11]) and economically (greater than 6 billion NOK in value in 2017, which is more than one-third of the total value of the fishery; https://www.ssb.no/en/fiskeri). The focus of this study is on the southern stock where two genetically distinct ecotypes coexist (figure 1): an oceanic type and a coastal type. While the oceanic ecotype is more mobile [12], the coastal ecotype—the …all ranged from 0 to 1. Such transformation was necessary as the scale of pollution concentration differed between pollutants. Additionally, we did not know the functional form of the effect of pollution to the recruitment success. We therefore tested for a linear, exponential and sigmoidal decrease in recruitment success with pollutant concentration (electronic supplementary material, table S1, equation (S8)). We also tested for any potential time lag in pollution effect to the population, i.e. no lag (pollution affect recruitment survival), 1-year lag (pollution affect spawning potential) and 2-year lags (pollution affect spawning

3. Results

(a) Reconstructed pollution time series

The average reconstructed pollution time series for Cd, Hg and HCB showed a generally declining trend since 1980 (figure 1; electronic supplementary material, figures S2–S4). While Cd and Hg in all eight regions experienced a steady decline over time (there was a mean correlation level of 0.65 …between these two time series). HCB concentration fluctuated



4. Discussion

By combining unique time series of juvenile cod abundance, body size, environmental concentration of toxic contaminants and a spatially structured population dynamics model, we were able to shed light on several aspects of Skagerrak coastal cod population dynamics, their life history and their sensitivity to Hg, Cd and HCB concentration in the environment.

(a) Cod population dynamics over the last 4 decades

Many local cod populations appeared to have been declining since 1980 as was suggested in many other studies [20,34], but these patterns were not shared among all locations. In fact, some local cod populations in Lyngor or Risør Skerries, for example, were slightly increasing since 1980. Nevertheless, some patterns were common to all fjords. One example is the recruitment failure in 1988 that was caused by large toxic algae bloom that hit the coast of Skagerrak [35]. Alternatively, local cod populations shared several peak recruitment events (e.g. 1985, 1989, 1996, 1998 and 2011), with a few (1985 and 1996) overlapping those of the oceanic cod from the North Sea, Skagerrak and Kattegat region [34] (electronic supplementary material, figure S13); this observation strengthens the possibility that oceanic cod population influences coastal cod populations and that its magnitude depends partly on the connectivity with the North Sea [21].

(b) Local-scale variation in life-history parameters

We also confirmed the importance of local-scale dynamics in …shaping natural populations as in many other studies …large differences in SSB (figure 4) and recruitment (electronic supplementary material, figure S13) trends over time even between units within fjords such as in Topdalsfjord. Some of these dynamics could be related to the ocean exposure as sheltered sites showed a slower juvenile growth than exposed sites (e.g. unit 2 versus 1 and 3; figure 3; electronic supplementary material, figure S1) [36]. These exposed sites might be experiencing more favourable growth condition owing to an increased influence of the outer ocean and/or due to their genetic difference (small but significant) [16]. We also found some surprising results that juvenile cod growth was above average in the Oslo fjord area despite its history of pollution and anoxia [37]. This is probably due to the above average exchange of North Sea waters transporting faster-growing cod compared with other areas in the Skagerrak [36].

(c) Pollution history in Skagerrak and its possible … on coastal cod

We found that the concentration of Hg, Cd … mussel tissue have all been declining (whil… variability around the estimated polluti… the early 1980s, suggesting a possibl… the pollution control act of 13 M… mental laws (e.g. Stockhol… int/). However, the … inside the fjords … impact on … not …

What is a paper?

- It consists of:
  - Abstract
  - Introduction
  - Methods
  - Results
  - Discussion

numbers and juvenile survival rates) [38]. Additionally, there was some local difference in cod sensitivity to Hg concentration: a pollution effect was more visible in the northern region than in the southern region despite having a similar range of Hg concentration. These fjord-level differences in pollution effect could, for example, be attributed to local adaptations [14,39]. However, we have to keep in mind that the estimated functional form of pollution effect was sensitive to the reconstructed pollution history, thus care must be taken in interpreting this result. Nevertheless, this source of uncertainty did not affect much the resulting value and trend in the SSB which was generally quite robust (figure 4; electronic supplementary material, figure S11).

(d) Challenge of scales in ecological analysis

Like in any ecological study, scientists must adequately choose the scale of analysis. Past studies have shown that a poor choice of scale can mask important variations and trends in local populations [20]. In this work, we reduced the scale of analysis from fjords (as in past studies such as [20,28]) to 'geographical units' in the attempt to maximize the value of information. By doing so, we found out that all units within fjords did not follow the same population trend over time. However, the choice was not easy, and a careful examination of residual pattern, parameter estimates and a simulation-estimation exercise was required to confirm modelling choices.

We also had to choose the geographical scale for reconstructing the pollution history. We were only able to model pollution at the fjord scale (i.e. assuming all units within a fjord had the same pollution history) as data availability was prohibitive. However, there are probably local differences in pollution concentration within a fjord based on proximity to the pollution source or localized water circulation pattern. Additionally, we ignored possible seasonal pollution dynamics (some information were collected at different time of the year), but other studies indicated that concentration changes through

5. Conclusion

In this study, we provided one of the first direct empirical indications of an adverse effect of contaminants on coastal cod population dynamics. Despite the overall decrease in Hg, Cd and HCB concentration in the southern Norwegian coastal waters since the 1980s, Hg appeared to have had a negative impact on cod reproductive success, with the reservation of confounding factors. In general, cod in the northern region showed a stronger sensitivity to Hg than the southern population and the populations showed a large variability in growth at scales smaller than fjords. Both observations suggest the importance of local adaptation in shaping the population dynamics of the natural resources in coastal waters. Nonetheless, many local cod populations are still in bad shape and only a few are doing well. This highlights that pollution reduction alone is not sufficient to rebuild cod populations, and that complementary actions on fishing regulation, habitat improvement and understanding on fish biology are needed to ensure a sustainable use and conservation of coastal natural resources.

Data accessibility. The applied code and data are available from the Drya
Digital Repository: https://doi.org/10.5061/dryad.3r8h547 [40].

Authors' contributions. All authors have substantially contributed t
conception, design, acquisition of data, analysis, interpretat
the data, drafting, revising and approving the final versio
manuscript.

Competing interests. We declare we have no competing inte

Funding. K.O. was funded by the Research Council of N
the SkagCore project no. 255675.

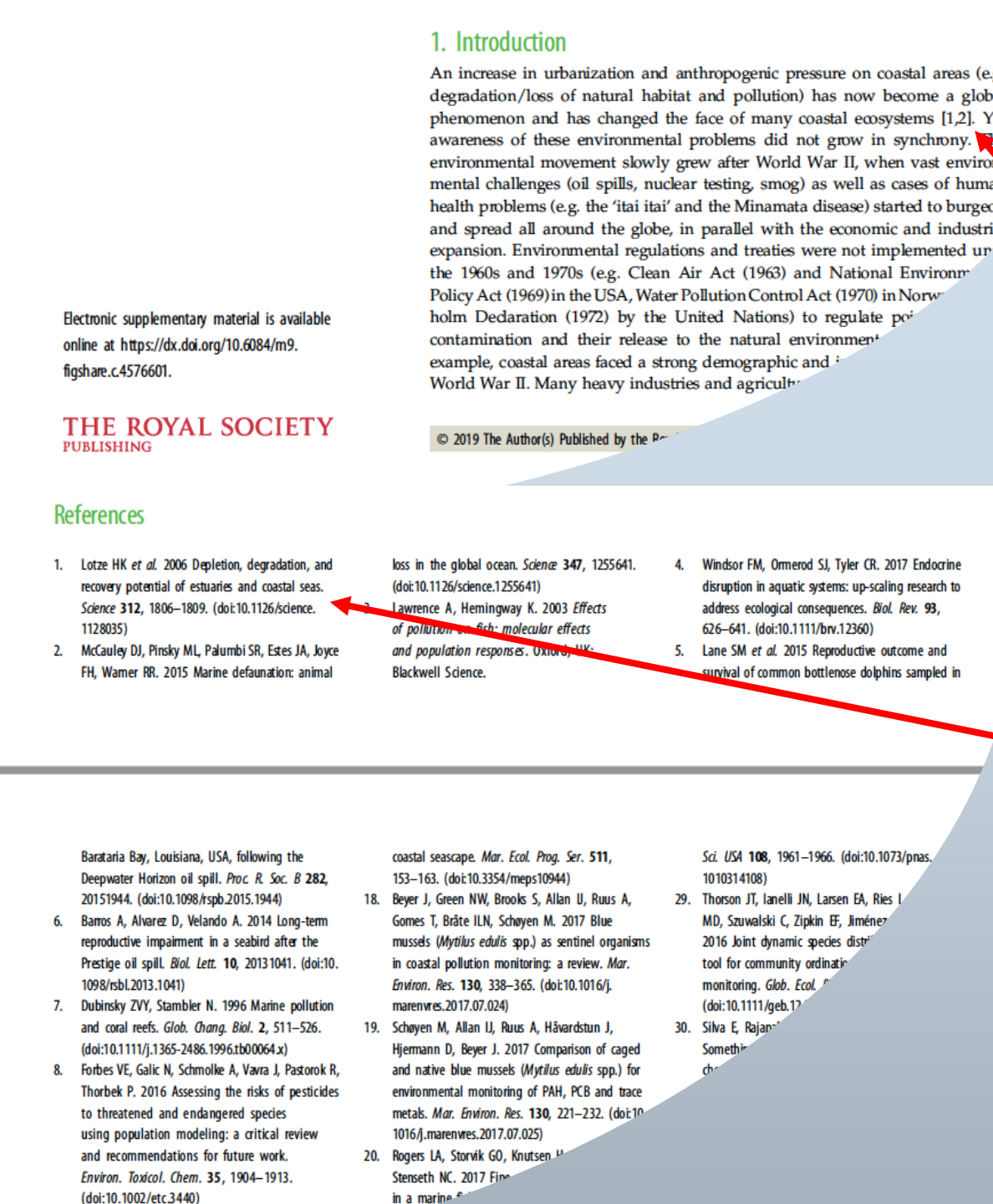
Acknowledgements. We are very grateful to scientist
Marine Research (Flødevigen Marine Researc
conducted the beach seine survey through
NIVA scientists who collected the pollutio
ful to two anonymous reviewers and th
improve the quality of our manuscri

References

1. Lotze HK *et al.* 2006 Depletion, degradation, and recovery potential of estuaries and coastal seas. *Science* **312**, 1806–1809. (doi:10.1126/science.1128035)
2. McCauley DJ, Pinsky ML, Palumbi SR, Estes JA, Joyce FH, Warner RR. 2015 Marine defaunation: animal loss in the global ocean. *Science* **347**, 125564
(doi:10.1126/science.1255641)
3. Lawrence A, Hemingway K. 200
of pollution on fish: molec
and population res
Blackwell Sc

What is a paper?

- It has to consist of:
  - Funding
  - Competing interest
  - Ethics
  - Acknowledgements



1. Introduction

An increase in urbanization and anthropogenic pressure on coastal areas (e.g. degradation/loss of natural habitat and pollution) has now become a global phenomenon and has changed the face of many coastal ecosystems [1,2]. Yet awareness of these environmental problems did not grow in synchrony. The environmental movement slowly grew after World War II, when vast environmental challenges (oil spills, nuclear testing, smog) as well as cases of human health problems (e.g. the 'itai itai' and the Minamata disease) started to burgeon and spread all around the globe, in parallel with the economic and industrial expansion. Environmental regulations and treaties were not implemented until the 1960s and 1970s (e.g. Clean Air Act (1963) and National Environmental Policy Act (1969) in the USA, Water Pollution Control Act (1970) in Norway, Stockholm Declaration (1972) by the United Nations) to regulate pollutant contamination and their release to the natural environment. For example, coastal areas faced a strong demographic and industrial growth after World War II. Many heavy industries and agricultural

Electronic supplementary material is available online at https://dx.doi.org/10.6084/m9.figshare.c.4576601.

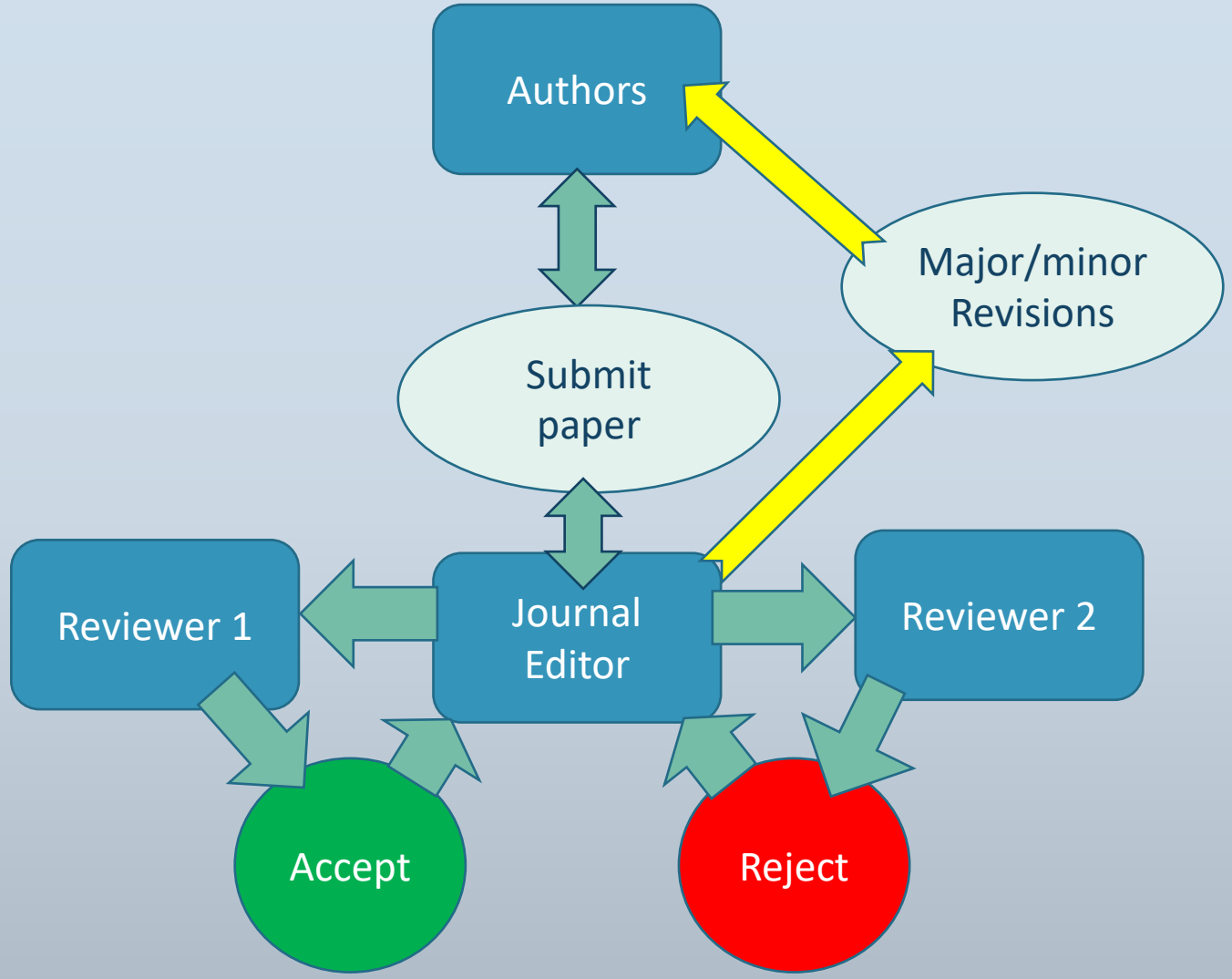
THE ROYAL SOCIETY PUBLISHING

References

1. Lotze HK *et al.* 2006 Depletion, degradation, and recovery potential of estuaries and coastal seas. *Science* **312**, 1806–1809. (doi:10.1126/science.1128035)
2. McCauley DJ, Pinsky ML, Palumbi SR, Estes JA, Joyce FH, Warner RR. 2015 Marine defaunation: animal loss in the global ocean. *Science* **347**, 1255641. (doi:10.1126/science.1255641)
3. Lawrence A, Hemingway K. 2003 *Effects of pollution on fish: molecular effects and population responses*. Oxford, UK: Blackwell Science.
4. Windsor FM, Ormerod SJ, Tyler CR. 2017 Endocrine disruption in aquatic systems: up-scaling research to address ecological consequences. *Biol. Rev.* **93**, 626–641. (doi:10.1111/brv.12360)
5. Lane SM *et al.* 2015 Reproductive outcome and survival of common bottlenose dolphins sampled in Barataria Bay, Louisiana, USA, following the Deepwater Horizon oil spill. *Proc. R. Soc. B* **282**, 20151944. (doi:10.1098/rspb.2015.1944)
6. Barros A, Alvarez D, Velando A. 2014 Long-term reproductive impairment in a seabird after the Prestige oil spill. *Biol. Lett.* **10**, 20131041. (doi:10.1098/rsbl.2013.1041)
7. Dubinsky ZVY, Stambler N. 1996 Marine pollution and coral reefs. *Glob. Chang. Biol.* **2**, 511–526. (doi:10.1111/j.1365-2486.1996.tb00064.x)
8. Forbes VE, Galic N, Schmolke A, Vavra J, Pastorok R, Thorbek P. 2016 Assessing the risks of pesticides to threatened and endangered species using population modeling: a critical review and recommendations for future work. *Environ. Toxicol. Chem.* **35**, 1904–1913. (doi:10.1002/etc.3440)
18. Beyer J, Green NW, Brooks S, Allan U, Ruus A, Gomes T, Bråte ILN, Schøyen M. 2017 Blue mussels (*Mytilus edulis* spp.) as sentinel organisms in coastal pollution monitoring: a review. *Mar. Environ. Res.* **130**, 338–365. (doi:10.1016/j.marenvres.2017.07.024)
19. Schøyen M, Allan IJ, Ruus A, Håvardstun J, Hjermann D, Beyer J. 2017 Comparison of caged and native blue mussels (*Mytilus edulis* spp.) for environmental monitoring of PAH, PCB and trace metals. *Mar. Environ. Res.* **130**, 221–232. (doi:10.1016/j.marenvres.2017.07.025)
20. Rogers LA, Storvik GO, Knutsen H, Stenseth NC. 2017 Fine
29. Thorson JT, Ianelli JN, Larsen EA, Ries L, MD, Szuwalski C, Zipkin EF, Jiménez 2016 Joint dynamic species distribution tool for community ordination monitoring. *Glob. Ecol.* (doi:10.1111/geb.12
30. Silva E, Rajan Somethi

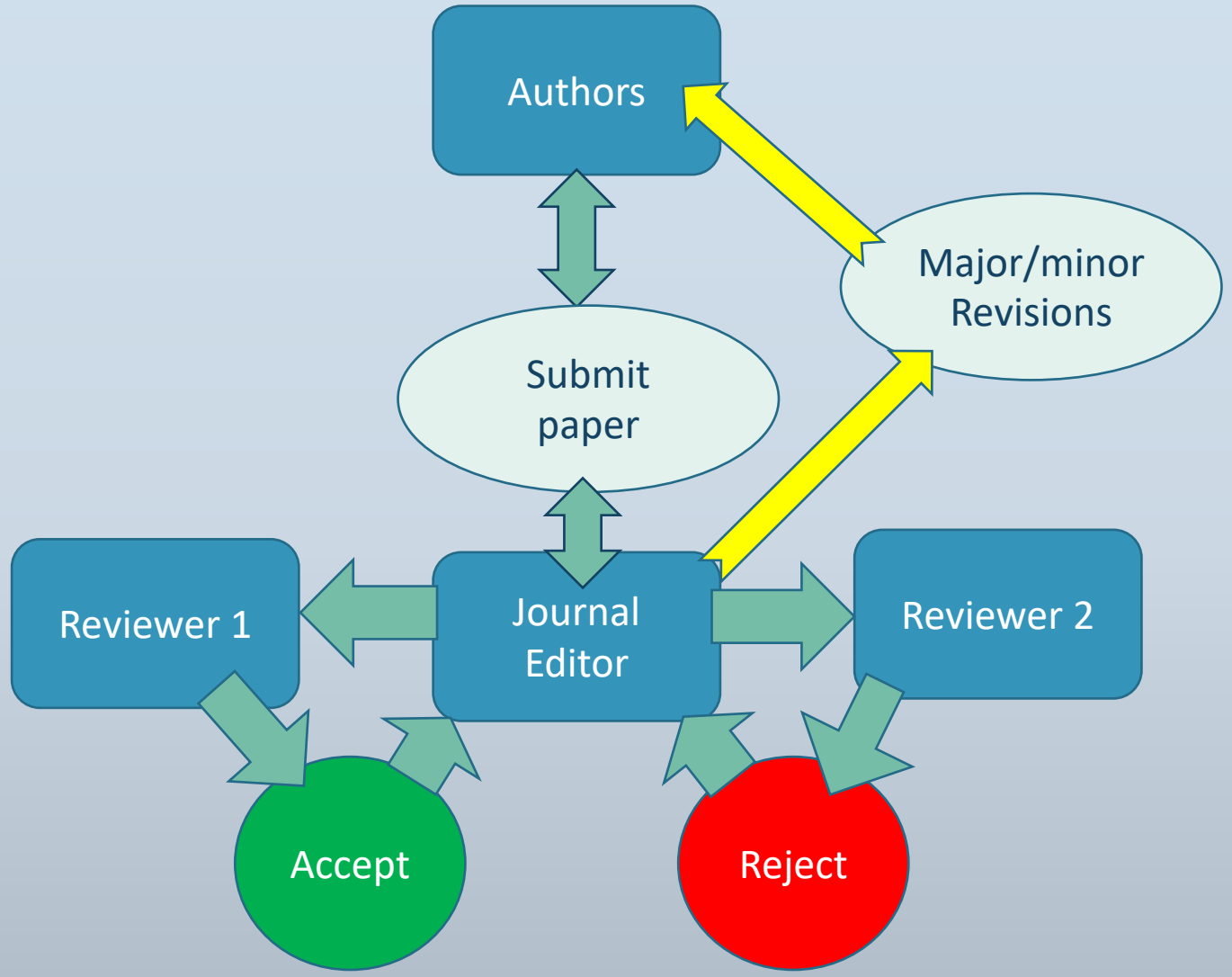
What is a reference?

- Every statement in the paper has to be backed up with a **citation**
- This is a **reference** to a previous paper that backs up your statement
- These all have to be listed at the end of the paper
- There are ~50 references for each paper



What is peer-review?

The difference between a science paper and any other publication (e.g. media article, book) is that it goes through external *peer-review*



What is peer-review?

- Each paper is sent to at least two other researchers in the same scientific field = the reviewers
- The reviewers must not have been involved with any aspect of the research themselves, must not be a collaborator of any of the authors, nor from the same institution

Each step can take weeks to months….

PROCEEDINGS
OF THE ROYAL SOCIETY B
BIOLOGICAL SCIENCES

You have access

Check for updates

View PDF

Tools | Share

Cite this article

Section

Abstract

1. Introduction

Research articles

Male black widows parasitize mate-searching effort of rivals to find females faster

Catherine E. Scott, Sean McCann and Maydianne C. B. Andrade

Published: 31 July 2019 | https://doi.org/10.1098/rspb.2019.1470

Abstract

Mate-searching s
on traits and tact
Theory and avail

Details | References | Related | Figures

This Issue

PDF

THE ROYAL SOCIETY PUBLISHING | All Journals | Brought to you by University of Exeter | Sign in | Search

Home | Content | Information for | About us | Sign up | Submit

Abstract

Mate-searching success is a critical precursor to mating, but there is a dearth of research on traits and tactics that confer a competitive advantage in finding potential mates. Theory and available empirical evidence suggest that males locate mates using mate-attraction signals produced by receptive females (personal information) and avoid inadvertently produced cues from rival males (social information) that indicate a female has probably already mated. Here, we show that western black widow males use both kinds of information to find females efficiently, parasitizing the searching effort of rivals in a way that guarantees competition over mating after reaching a female's web. This tactic may be adaptive because female receptivity is transient, and we show that (i) mate searching is risky (88% mortality) and (ii) a strongly male-biased operational sex ratio (from 1.2 : 1 to more than 10 : 1) makes competition inevitable. Males with access to rivals' silk trails moved at higher speeds than those with only personal information, and located females even when personal information was unreliable or absent. We show that following rivals can increase the potential for sexual selection on females as well as males and argue it may be more widespread in nature than is currently realized.

1. Introduction

Sexual selection arises when the reproductive success of one sex is limited by access to potential mates [1]. In most sexually reproducing species, males compete to fertilize the relatively limited number of eggs produced by females, and the form of competition depends on ecological factors including the distribution of potential mates in space and time [2]. In many taxa, females become sexually receptive at unpredictable spatial or

Details | References | Related | Figures

This Issue

31 July 2019
Volume 286, Issue 1908

Article Information
DOI: https://doi.org/10.1098/rspb.2019.1470
PubMed: 31362641
Published by: Royal Society
Print ISSN: 0962-8452

PDF

Back to top

Review form: Reviewer 1 (Greg Holwell)

Recommendation
Accept with minor revision (please list in comments)

Scientific importance: Is the manuscript an original and important contribution to its field?
Excellent

General interest: Is the paper of sufficient general interest?
Excellent

Quality of the paper: Is the overall quality of the paper suitable?
Excellent

Is the length of the paper justified?
Yes

Should the paper be seen by a specialist statistical reviewer?
No

Do you have any concerns about statistical analyses in this paper? If so, ple
explicitly in your report.
No

It is a condition of publication that authors make their supporting data, code and materials available - either as supplementary material or hosted in an external repository. Please rate, if applicable, the supporting data on the following criteria.

Is it accessible?
Yes

Is it clear?
Yes

Is it adequate?
Yes

Do you have any ethical concerns with this paper?
No

Comments to the Author
I really enjoyed reading the manuscript. The authors beautifully combine natural history observations, field experiments and laboratory manipulations to put forward clear hypotheses, and explicitly test them in a number of ways. This is exactly how science should be done. The study and its findings are important, because they contribute to our understanding of a severely neglected component of sexual selection: scramble competition. Compared with the enormous number of studies of mate choice, contest competition and sperm competition, our understanding of the traits under selection via scramble competition is in its infancy. What is known about scramble competition is clearly introduced and the methods are mostly clear, with a particularly clear explanation of the statistical methods used. The figures are excellent and beautifully presented. I only have a few minor suggestions below which I hope will improve the manuscript.

Lines 4-6. The distinction in the abstract between 'personal information' and 'social information' seemed unclear to me at this point in the manuscript. I would have considered females as much a part of each male's social environment as rival males. But after reading the explanation in the introduction of the distinction, it made more sense. I wonder if it could be phrased differently to be clear in the abstract.

Review form: Reviewer 2

Recommendation
Reject – article is scientifically unsound

Scientific importance: Is the manuscript an original and important contribution to its field?
Acceptable

General interest: Is the paper of sufficient general ir
Marginal

Quality of the paper: Is the overall quality of the pa
Marginal

Is the length of the paper justified?
No

Comments to the Author
Locating the potential mates so as to get mating opportunities within a males' mature life span is critical but risky and laborious for the mate-searching males in most spiders. It is very interesting and valuable to know if the males use other information, especially information from the conspecific rivals, to find the females efficiently except for signals produced by receptive females. I can see that the authors put a lot of efforts in both field and laboratory experiments to explore the male strategies in mate-searching. Though the authors hypothesized that males in the black widow spider use the cues of male silk to facilitate their mate searching, the results of their experiments cannot strongly support the conclusion. I think they need to adjust the experimental design and get more data to prove their hypothesis.

Comment 1: The introduction part is too long and needs to be refined.

Comment 2: Though OSR is widely used to predict the male competition intensity, it is very tricky to find male spiders in the field survey during breeding season because they are wandering around, good at hiding and too small to be spotted (just as the authors mentioned). Besides, even if the OSR is not male-biased, male-competition is probably still intense because females in this species just mate once while males apply multiple-mating strategy. Therefore, OSR is not a necessary metric to explain the intensity of male competition because the male competition always exists according to mating system of this species.

Comment 3: References No. 5. It's not a journal article. I think the authors should lay out the editors and publisher of this book, as bellow or similar (according to the style of the journal they submit to). "In M. Naguib, J. Podos, L. W. Simmons, L. Barrett, S. D. Healy, & M. Zuk (Eds.), Advances in the study of behavior (Vol. 49, pp. 237-295). Cambridge, Massachusetts: Elsevier."

Decision letter (RSPB-2019-1010.R0)

10-Jun-2019

Dear Ms Scott:

I am writing to inform you that your manuscript RSPB-2019-1010 entitled "Male black widows parasitize mate-searching effort of rivals to find females faster" has, in its current form, been rejected for publication in Proceedings B.

This action has been taken on the advice of referees, who have recommended that substantial revisions are necessary. With this in mind we would be happy to consider a resubmission, provided the comments of the referees are fully addressed. However please note that this is not a provisional acceptance.

The resubmission will be treated as a new manuscript. Hov
reviewers if they are available and it is deemed appropriate
that resubmissions must be submitted within six months of
circumstances, extensions may be possible if agreed with th
submitted after this date will be automatically rejected.

Please find below the comments made by the referees, not i
Editor, which I hope you will find useful. If you do choose t
upload the following:

1) A 'response to referees' document including details of ho
comments, and the adjustments you have made.
2) A clean copy of the manuscript and one with 'tracked cha
referees' comments document.
3) Line numbers in your main document.

We would like to thank both reviewers as well as the subject editor for critically examining our work and making such helpful suggestions. The degree of detail both reviewers provide is very welcome, and we are happy to incorporate the majority of the suggested changes and clarifications. Where we have declined any suggested changes, we have provided commentary on the reasons behind this, and often clarification in the manuscript to allay any similar concerns other readers might have.

We have numbered each response (R1-R15) below and highlighted all changes to the manuscript using these response numbers in comment boxes on a tracked-changes word document. The first line numbers referenced in the responses below correspond to lines in the tracked-changed document. Line numbers in square brackets correspond to lines in the "clean" document.

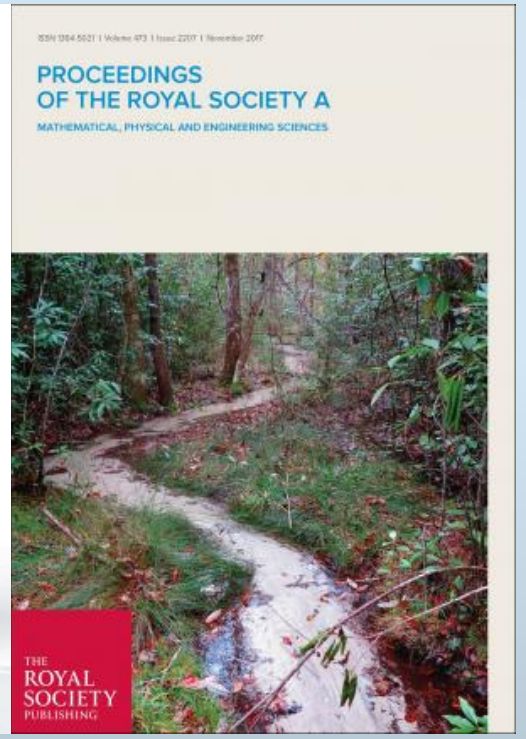
Please note that in the process of doing these revisions, we realized that we had made an error in compiling our OSR dataset, and we have updated the data, analyses, figures, and results reporting to correct this. These corrections do not change our conclusions but result in lower OSR estimates than reported in the version we originally submitted. These changes are reflected in line 12 [12], lines 264-275 [243-248], line 354 [322], and Figure 1 of the resubmitted manuscript (all changes tracked and flagged with comments in tracked-changes document).

R14. It is true that no males released at 50 or 60 m were successful, but in this experiment, all males released further than 10 m from the line of females would have had access to social information from the silk draglines produced by the males released closer to the line of females. In addition to 16 of the males released at 10 m, 9 males released at 20 m, 7 males released at 30 m, and 2 males released at 40 m successfully found a female (Table S1). These 17 males would have all had the opportunity to encounter social information after they had moved at least 10 m. In support of our conclusion, as we state in lines 305-306 [275-278], "more than half of all males (53%) that found females arrived after the first two hours, when personal information was unavailable or inconsistent." These males would not have had access to female pheromones because the wind was blowing either opposite to or perpendicular to their direction of travel toward females (see Fig. 2d). Therefore, we conclude that they most likely used social information to guide them to females. We then designed the laboratory experiments discussed below to test this idea directly, and these support our inference.

Details matter, even for spider mating…

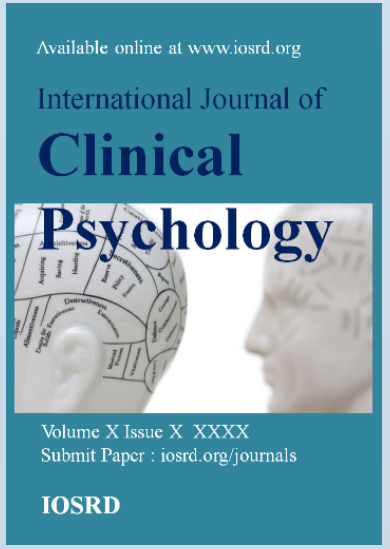
What is a science "Journal"?

- They contain research articles or "papers" written by scientists
- Each journal publishes 10-50 papers per issue
- Estimated 25,000 -40,000 journals in circulation
- Go from very broad to very specific
- Can be released weekly, bi-weekly, monthly, bi-monthly or less

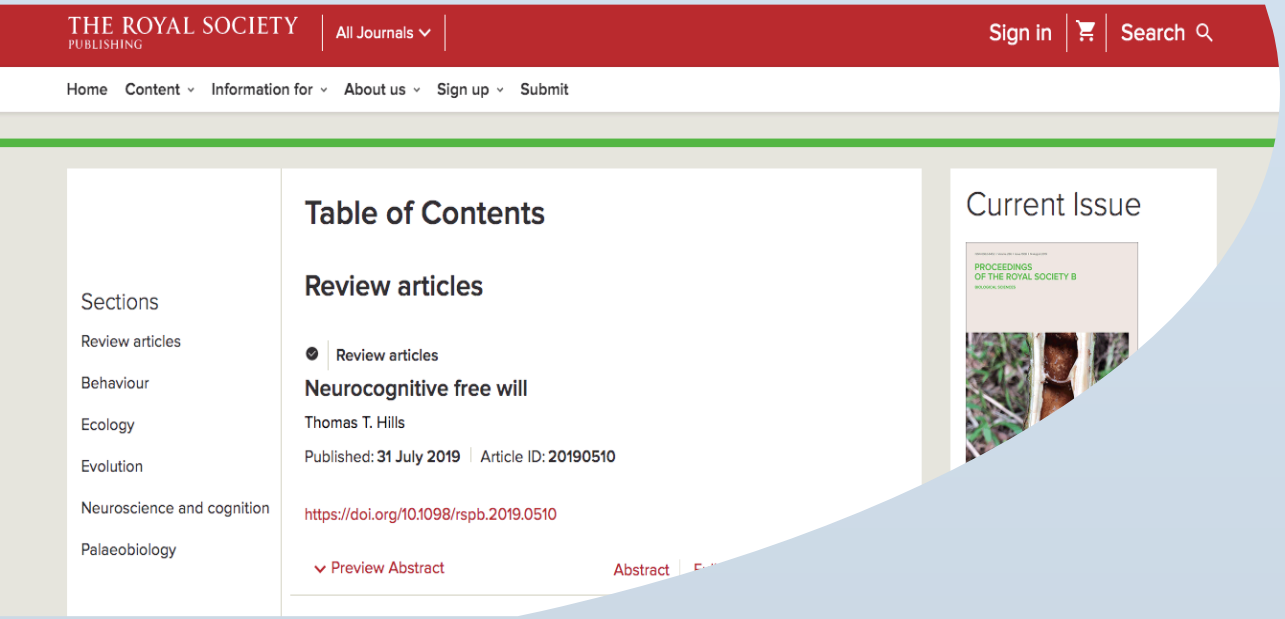


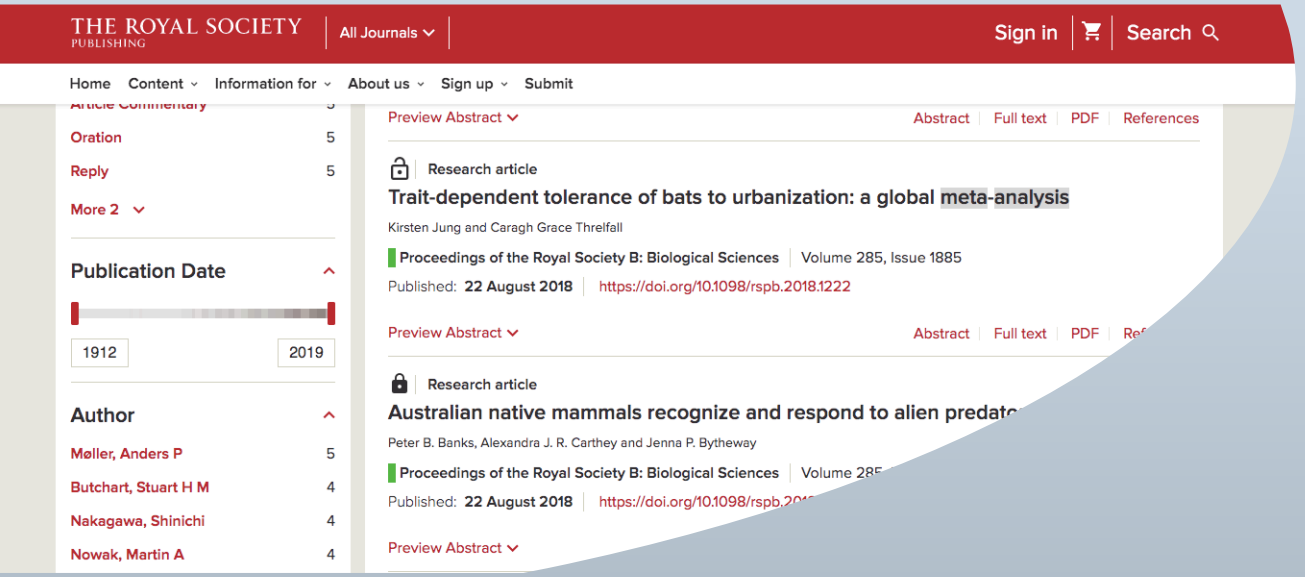
← Broad in topic

← Of interest to a wide scientific audience



- Can be very niche
- Of interest to psychology specialists





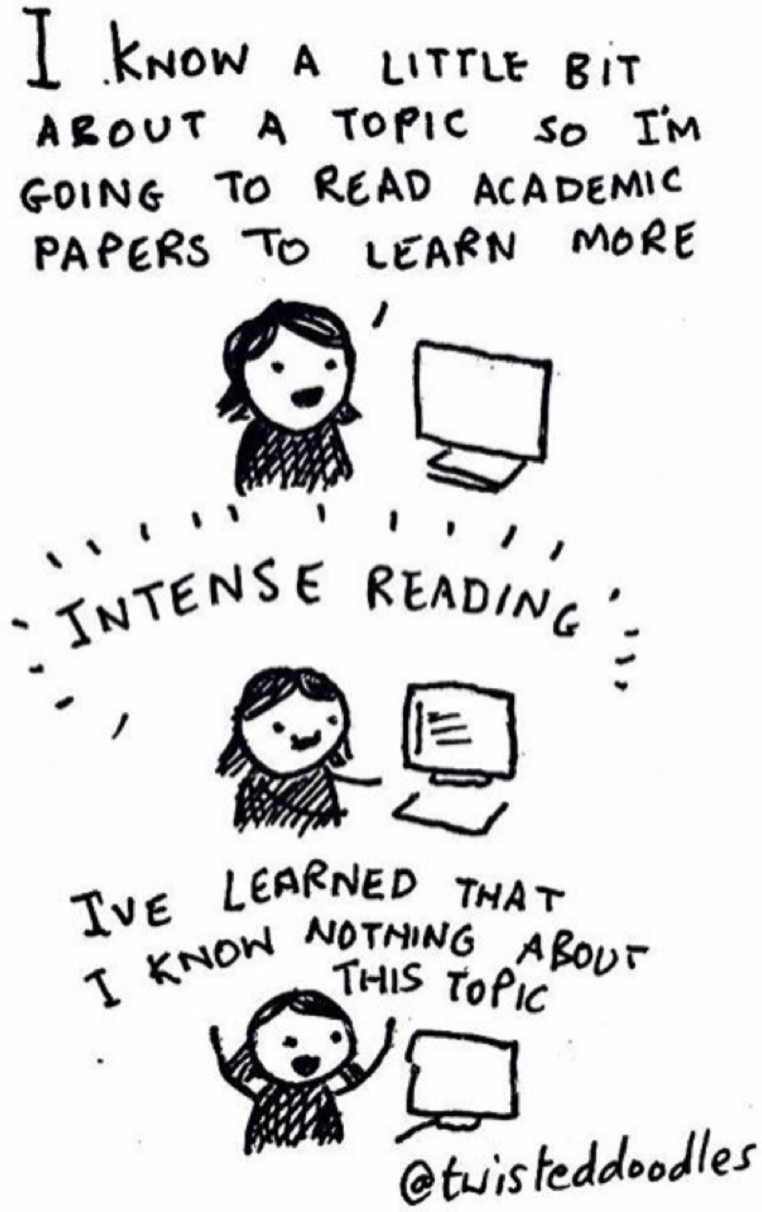
What is a review paper?

- Some papers are not presenting new findings but are reviewing current literature
- Authors go over previously published papers on a specific topic to give an overview or to present a new interpretation/theory
- Meta-analyses go through previously published papers on a specific topic and conduct a new analysis based on all of the data

Why does all this matter?

- There is a ginormous body of scientific information out there that is constantly being updated
- Due to the publishing process it is one of the most trustworthy sources of information available on most topics
- Peer-review means scientists cannot publish a completely unfounded idea
- It’s not perfect but it’s currently the best system we have and is being improved all the time
- BUT: journals are only accessible to those with subscription (i.e. Universities)

→ hence, Access Lab!


I KNOW A LITTLE BIT ABOUT A TOPIC SO I'M GOING TO READ ACADEMIC PAPERS TO LEARN MORE
INTENSE READING
IVE LEARNED THAT I KNOW NOTHING ABOUT THIS TOPIC
@twisteddoodles