

Author: Clive Hambler

Original Title: The false widow spider *Steatoda nobilis* is a notable invasive species.

Preprint on OSF, Version 1 published 28 June 2019

Reviews arranged by PCI Entomology.

Author's responses to reviewers' comments are in yellow highlighting

Some formatting (e.g. italics for species name) has been removed from reviewers' comments whilst copying text.

Review by anonymous reviewer, 2019-08-18 00:56

This is a fascinating and thought-provoking paper that discusses aspects of ecology, distribution and health concerns of a medically significant spider across multiple disciplines. Much of what the author discusses are important topics and would encourage further, and much needed discussion among the wider community.

While the author is setting out their case to identify contrast or comparisons between media headlines and bite stories with scientific journal papers, the author also seems to at times reference scientific literature and media interchangeably as though they were all fact-based research. This needs to be addressed throughout the manuscript.

I have added this statement in the Introduction: "Many media reports are quoted here as illustrative of errors, rather than as factual records."

It is difficult to separate literature and 'media' reports, for example in the case of popular 'scientific' blogs. Some of the media reports quote unpublished work by the world-leading scientists in the field, performing public outreach, who I hope will in future correct the record if they have been misrepresented. It was through such valuable outreach that I was able to make and propose some of the links between disciplines.

Under the section on 'Education' I have proposed a global repository of information on *S. nobilis* which could include an expert validation method, similar to peer review, for statements, identifications *etc.* I hope I have given enough of a warning of the need to view all reports, including scientific ones, with caution. It is evident that some media reports are accurate, whilst some scientific reports contain errors.

I have added the introductory statement: "Media outreach by scientists has presented discoveries before formal publication enabling links between disciplines to be proposed here. There may be a role for 'citizen science' in monitoring this distinctive spider and its effects, and this requires expert survey design and validation of reports (Henderson & Southwood 2016)." and included that reference.

I have renamed the bibliography "Literature and informal sources" as a further alert to it not being solely a scientific reference list.

This paper is about *Steatoda nobilis*, but throughout the paper the spiders are sometimes referred to simply as "a false widow", but since there are several other *Steatoda* species in the UK, it should be clarified and specifically referred to as *Steatoda nobilis* each time.

Page 1, Line 1: Title should include The "Noble" false widow ...

I have revised the use of names such as false widow and noble false widow and made terminology consistent throughout, using *S. nobilis* where that particular species is intended. Cases where other *Steatoda* species might be involved are indicated, and included since they help capture information of possible relevance to *S. nobilis*. It is not possible to separate which *Steatoda* species is being referred to in much of the reporting and even experienced arachnologists in Britain have referred to *S. nobilis* as simply 'the false widow' in media reports.

I have added the statement: "Some bites by other identified *Steatoda* species or unspecified *Steatoda* or "false widow" species are discussed here since they help capture possible information on *S. nobilis* and indicate lines for future research."

I have added a statement arguing that: "all bites by *Steatoda* species be treated in a similar way until any species-specific variation is identified."

Page 1, Line 21: While necrosis and bacterial infection is possible, there is no current evidence in the peer reviewed literature suggesting that anaphylaxis is associated with false widow spider envenomation. If it is the case that one such incident has been documented, especially when the specimen was identified by an expert (the author) then it should be presented in much fuller detail as a case report, especially since the author is trying to make the case for anaphylaxis being a potential and serious risk.

I believe anaphylaxis is the most urgent possible medical risk to investigate further, so do not wish to risk overlooking a case. However, a formal case report would require collaboration with medics to include hospital records and I invite such collaboration - which might take some time.

I have modified the abstract to state: "A plausible incident of anaphylactic shock is identified, requiring professional confirmation and case study."

I have modified the Table to state: "Media photograph reportedly of spider that bit her: identified from this photo. as *S. nobilis* by C. Hambler"

I have modified and updated the sub-section on anaphylaxis to read: "At least two patients have been reported with anaphylactic shock allegedly from *Steatoda* species: an observed bite with an associated photograph which I identify as *S. nobilis* (in Bournemouth, 2009; see

Magee 2009) and a possible case with a subsequent specimen of *S. grossa* (in Cumbria in 2009: Table 2). Another possible case in 2019 developed a swollen face and conjunctivitis. These cases merit urgent formal professional case review, if still possible. Such incidents should be routinely compiled and reviewed professionally. Some occupations may increase the risk of repeat bites, repeat bites are becoming more likely as spider density grows, and a possible example has been reported (Kitching 2019)."

In the Table noting the incident have added the data deficiencies: "Direct medical diagnosis of anaphylaxis" and "Ambiguity if the photograph is the same individual animal that bit".

Regarding repeat bites, I have added the following source to the references: "KITCHING, C. 2019: Mum ends up in A&E after false widow spider bites her on the bum. *The Mirror*, 24 September 2019. <https://www.mirror.co.uk/news/uk-news/mum-ends-up-ae-after-20140647> Accessed 24/9/2019.

Page 2, Line 35: Typo - Steatoda

Corrected.

Page 2, Line 69: This is more urgent than many realise, too often are bite victims asking spider groups on social media for medical advice, and too often are they given it from spider enthusiasts who have no medical experience and qualify themselves because they like spiders, rather than being advised to contact a GP.

I have added the statement in the Introduction: " The intent is to facilitate inter-disciplinary debate, hasten correction of errors, and discourage potentially dangerous comments by spider enthusiasts."

Page 3, Line 101: An additional reference should be included for the spread of *Steatoda nobilis* in Ireland is: Dunbar, J.P., Schulte, J., Lyons, K., Fort, A. and Dugon, M.M. (2018) New Irish record for *Steatoda triangulosa* (Walckenaer, 1802), and new county records for *Steatoda nobilis* (Thorell, 1875), *Steatoda bipunctata* (Linnaeus, 1758) and *Steatoda grossa* (C.L. Koch, 1838). *Irish Naturalists' Journal* 36: 39-43.

Important reference, now included.

Page 4, Line 115: I agree as I also found in August of 2017 during a short visit to Oxford that they were very abundant and collected dozens of specimens on a walk from St Hilda's College to my hotel on Abingdon Road 1, even in the pubs on high street, sitting in the beer gardens I was able to collect multiple specimens.

Page 7, Figure 1: These photos are very useful for highlighting habitat.

I have added a few more, including two showing vehicle mirrors.

Page 9, Line 274: In the two paragraphs previous, it says “2000 alleged bite reports revealed by the National Health Service Trusts between 2014 and 2018”. Now there is a giant leap to predicting that millions will be bitten in the near future. While I strongly agree that this species is proliferating at an alarming rate, and bite cases are certainly under reported and undoubtedly only going to increase, it’s too extreme to suddenly jump to suggesting that millions will be bitten.

I have changed this to: "I find it plausible that many people in southern Britain will be bitten by *S. nobilis* - and that most will not recognise this as a spider or false widow bite."

(I will not include the estimate of millions in the paper, and the prediction is available in the preprint. It is however notable that once one starts talking to the public and colleagues about spider bites, many volunteer they have had one or know of somebody who has. I would not be at all surprised if most people in Britain get bitten.)

Page 11, Table 1: While the victims claimed to have seen a spider, this is only acceptable that a spider was involved, this is not enough evidence to confirm that at least five of these were False widow spiders at all. For example, in table 1 there are statements such as “Evidence it may be false widow - Patient thinks may have been false widow” followed by “Victim or media imply medical confirmation of a spider bite? - Yes: reported diagnosis of necrotising fasciitis secondary to a spider bite”. This does not constitute a species confirmation. Self-identification of the species by a victim with no experience in arachnology, or even a description that is similar to the species is not acceptable, especially when on many occasions some colour and pattern morphs are so diverse one can resemble *Zygiella x notata* and equally other specimens can resemble *Amaurobius similis*. There must be a specimen captured or a clear photo taken of the specific spider that bit the victim otherwise we can’t develop a true and accurate table of symptoms by this species. I would accept that the identification made by the author should be considered as a reliable confirmation of the species and that further investigation into the potential for *Steatoda nobilis* venom to induce anaphylaxis is warranted. It should be noted that puncture wounds are most likely undetectable from *Steatoda nobilis*, at least in most cases.

I have substantially reworded this section, Table and the caption for the Table to illustrate and stress that these examples / cases are fraught with problems, but are presented in order to stimulate urgent, simultaneous and accurate recording of a range of information. Some of these data deficiencies are very well known to arachnologists or medics, but scientists and the media can be unaware of the challenges in others' research fields.

I have added the statement: "(although absence of visible punctures does not disprove a bite)".

The author's assessment of these cases as the correct identification because *Steatoda nobilis* is often relatively distinctive and now very abundant - and because there are very few other likely candidates for the injury in these cases cannot hold ground especially in light of what is said earlier in the previous paragraph. However, in my experience a victim's description cannot be relied upon and while some genuine cases will be missed due to the nature of the events, an expert opinion must be made from a collected specimen or photo. It's possible, very likely and also evident that in a panic a victim might start a Google search and unintentionally associate and muddle the Google search with the true events.

Page 12, line 331: I disagree that Table 1 is evidence of confirmed *Steatoda nobilis* spider bites.

I have renumbered the Table, and added the clarification: "I would not accept any of the cases in Table 2 as 'confirmed' or 'definite' or 'proven' *S. nobilis* bites, and it may be too late to confirm some of these should the effort be made".

I have rewritten much of the section on identification of the spider that bit people, in the light of this and other reviewers' comments. It should therefore be noted that since there is evidence many people misidentify "false widow" spiders, much wider public health advice will be needed about the handling of spiders in general, given the serious consequences of many confirmed bites with unconfirmed identification.

Page 13, Line 359: I agree, while some sources say that females are sedentary and males may wander at certain times, I have found dozens of times, large females wandering on walls, walking across footpaths etc..

Another good example of how very confident statements are made by entomologists or conservationists without them knowing much about the species. I have added this statement: "Females have been observed "dozens of times" walking on walls and the ground (anonymous reviewer, 2019)".

Pages 13, Line 374: I think given all previous bites reported in the medical literature it is safe to assume that both males and females do wander and find themselves in beds.

Pages 13, Lines 379 to 382: I agree this is very likely why most bites are recorded from victims who were in bed.

Page 14, line 399: It would be preferable to have a hypolink so the videos can be accessed directly by clicking the link. I was not able to find these videos.

Website link inserted at various points in the text where videos are mentioned.

Page 15, Line 449: I agree that much genuine bites must have gone unreported. Very strict guidelines to confirmation, especially the photo or specimen should continue. This has to be

the case because from my experience alleged victims will erroneously claim what are obvious insect bites, scrapes, bacterial infection where no spider was ever even seen, or any bite ever felt etc... so while media reports appear to associate deaths and amputations with the spider they need to be corroborated with a specimen or photo. Often it is our experience that media will publish stock photos beside victims that implies this was the spider.

I agree how frustrating it is that the provenance of photographs are often so vague, making the identification definite but the link to a bite in doubt. I have added the statements: "and the appropriate reluctance of arachnologists to confirm identification", and " For the purposes of verification it is particularly important that media reports clarify if a photograph of a spider is definitely the actual individual animal seen or alleged to bite.

Page 16, Line 474: Add closing bracket to reference.

Done.

Page 16, line 481: This reference is to a media report on treating cancer cells with *Steatoda nobilis* venom but this article is completely absent of data.

This is an extremely important quoted discovery in relation to the potential for necrosis, and I consider it important to alert readers to keep an eye out for publications from the quoted author and research lab, confirming or refuting this result. I do not know the timescale for publication of such details, and perhaps there are intellectual property issues which preclude publishing these data at this time. Some authors and commentators have been dismissive of necrosis in part because the species was not thought to have cytotoxic venom, unlike species with confirmed necrotising bites.

I have added the statement: "Publication and discussion of these very important data will be of great value".

Page 17, Line 521 to 530: I agree that this should be studied more, the absence of evidence supporting bacterial carriage seems to stem from the lack of research on this area. *Steatoda nobilis* appears to have never been studied for this and should therefore be researched before dismissing it just because bacteria may be unlikely for some other species.

I have substantially reworded and restructured the sections on ulceration, bacteria and antibiotic resistance to clarify what is known and what is needed.

Overall, this is a fascinating paper but needs some reworking before being published. There are too much personal predictions supported by little or no data for a fact-based research article. "I explicitly speculate and present testable hypotheses and predictions - which researchers with appropriate resources and skills might follow up", Might it be more suitable

to present these predictions in a table rather than throughout the main text? I think careful consideration and distinction should be made between what's fact-based research and what's media or anecdotal reporting when discussing in main text and for referencing.

I have moved most predictions and many suggestions into a new Table 4, in the final section on 'Proposed research priorities'.

I make even greater effort to distinguish personal opinion, predictions and hypotheses from evidence, but I retain many predictions and suggestions: it is by making such prediction that I have discovered features of the species' biology that were previously unknown or erroneously described.

Several instances of "I suggest" are replaced by "I argue" or "I hypothesize" or "I believe".

I have considered separating scientific and media sources but believe it would be untidy and unworkable (as per my response above).

I think for this paper it might be important to reference "Faúndez EI, Téllez F. Primer registro de una mordedura de *Steatoda nobilis* (Thorell, 1875) (Arachnida: Araneae: Theridiidae) en Chile. *Archivos Entomológicos*. 2016;15:237-240." As it represents the only bite case outside of Ireland and the UK, and demonstrates that even where they were not yet known (numbers are certainly very low) bites can occur, so it's not only when population size has reached its carrying capacity that we will see a rise in bites, as evident in Chile.

Thanks: an important reference, now cited in various sections of the text. I have added this statement to the Introduction: "*S. nobilis* bites to humans have now been confirmed from Britain (Warrell *et al.* 1991), Chile (Faúndez & Téllez 2016) and Ireland (Dunbar *et al.* 2017)".

I have added this statement: "beds are the most common location for the verified bites in Britain and Ireland and Chile (Faúndez & Téllez 2016; Dunbar *et al.* 2017)".

I have added this statement under 'Medical significance': "Similarly, *S. grossa* is reportedly becoming a health concern in Australia (Gray 2018) and both species merit further study and global collation of reports (*e.g.* from Chile, Faúndez & Téllez 2016).

There are interesting points made regarding distribution and abundance. The author should construct their observations into a dataset and present clearly in a table and/or map.

I have collated the data on search effort and location into a new table (Table 1). Under the 'Changes in local abundance...' section, I have added the statement: "an abundance gradient is also very evident from my personal search effort in outdoors areas. Approximate times taken to find the species in a search are given in Table 1 for the few sites I have visited with this purpose - which may not be representative."

I have added a map. I have not included dates since this might cause confusion between my records, first published records for a site and first records.

The comments on *Steatoda paykulliana* are reasonable, while Maretics work would not meet the standards of an ethics committee today, the work was carried out 40 to 50 years ago and highlight some interesting results. This is certainly a neglected area and urgently requires research.

I have noted that such experiments would not be acceptable nowadays.

I recommend that the author considers a revised version of the manuscript taking on board the recommendations above.

Reviewed by Michel Dugon, 2019-08-16 17:28

This manuscript present personal observations, predictions and thoughts on the spread, potential invasiveness and potential medical importance of the alien Noble false widow spider *Steatoda nobilis*. The manuscript can be divided in three main sections: 1) Current distribution and recording in Britain, 2) Incidence of bites, associated risks and societal response, 3) Ecology and invasiveness.

Section 1

In the first section, the author aims to demonstrate that *Steatoda nobilis* is on the rise in Britain and has been largely under-recorded. I definitely agree with this, and this claim is largely backed by the few peer-reviewed articles on the topic. In this MS, new data is given in the form of unstructured personal observations made over the past two decades in different parts of Britain. While these are interesting and worthy of consideration (and I personally find them very interesting), one could argue that personal observations hardly qualify as structured data produced using a rigorous approach and methodology. I think however that there is space and scope for unstructured observations as they presented in this section.

I agree the observations are unstructured and opportunistic, since they were not part of a designed research project. Despite this they have increased the expanse of Britain in which *S. nobilis* is known to be well established outdoors - including several heavily populated areas and the relatively well-recorded northern city of York. It should no longer be surprising to find high densities in any urban areas south of York. I have added a Table giving approximate search effort involved to find the species in some locations, as a baseline for future monitoring in a few sites.

Section 2

In the second section, the author proceeds to review bite incidence and associated medical risks in view of the (rare) existing scientific literature and media reports (often quoting tabloids, where such unconfirmed bite reports are most likely to be published). The author warns against the quasi-automatic dismissal of such reports by arachnologists and speculates that at least 6 media-borne cases (out of 50) over the past 15 years are extremely likely to be true spider bites. I would argue that it is extremely difficult to diagnose a spider bite based uniquely on symptoms, without having the specimen available for identification.

I have now further emphasised that the Table gives *examples* of the challenges faced in diagnosing spider bite and indentifying the spider species. Unfortunately I think arachnologists may have generally discouraged publication in more reliable sources or have been reluctant to comment, leading to loss of valid records as well as sensibly excluding much nonsense.

In some of the cases in the Table a spider was observed to bite, so it is the *identification* that is the main source of error. There may also be coincidence that symptoms developed at the bite site.

I have now included a column in the Table highlighting the data deficiencies, as a call for all relevant details to be documented in suspected cases.

For example, in case #1 (St Albans), the victim describes a spider “3 inches” in leg span found amongst fruits (according the BBC report). This vastly exceed the maximum size for a *Steatoda nobilis*, which is presented in the report as the most likely candidate.

I have noted this in the Table. It is possible the media suggested the spiders' size, not the patient.

In case #2, the victim recalls seeing a small spider but did not feel any sharp prick / burning sensation immediately after the bite, which is a symptom consistent in all demonstrated cases of envenomation by *S. nobilis* (See Dunbar et al., 2017).

In the second example in the Table the patient was woken from a deep sleep by a tingling sensation, so presumably would not have not have the same recollection as a conscious patient.

I have added this statement in the 'Incidence of bites' section: However, it should be noted that an immediate prick or burning sensation was observed in all demonstrated cases of *S. nobilis* envenomation (Dunbar *et al.* 2017).

I agree with the author that bites are most likely under-reported, probably because most of them develop into benign envenomation which are not brought to the attention of the medical community. I also agree that in some rare instances, envenomation by *Steatoda nobilis* may results in debilitating systemic effects. The array of possible symptoms resulting from an envenomation by a false widow (steatodism) has only been partially characterised, and I am not sure that including unconfirmed cases would actually help the scientific and medical communities to characterise accurately this envenomation syndrome.

One aim of the paper is to suggest we don't know as much about the effects of this spider's bite as many arachnologists have argued. Reporting unconfirmed cases, filtered by an arachnologist as at least plausible, may stimulate crucial research that few have attempted - and provide a pool of data and ideas for professionals to attempt to dismiss or confirm.

I have added this to the concluding section on research priorities: "Other potential *Steatoda* bite symptoms that have been informally reported to me, including vomiting, loss of bowel control and a 'tight' chest c. 2 hours after the observed bite."

Below are some thoughts and comments addressing specifically this second section on envenomation and medical importance: L.339: I would also mention Faúndez, E.I. & Téllez,

F. (2016). First record of a *Steatoda nobilis* (Thorell, 1875) (Arachnida: Araneae: Theridiidae) bite from Chile. *Arquivos Entomol6xicos*, 15: 237-240. The first and only bite reported from Chile involves a mature male specimen.

An important reference, now cited in various sections of the text.

L. 384: *Steatoda* is reported as “more aggressive than *Latrodectus*”. Yes and no. If the author refers to Maretic papers on *Steatoda paykulliana*, I would agree that the latter is indeed fairly aggressive (defensive, should I say). Stating this about *Steatoda nobilis* could be misleading. L.424-430 and L.432-440: Semantic is indeed important when scientists are communicating with the public.

I have clarified the species in the quote. Using "aggressive" for *S. nobilis* would be consistent with other species which have been described as such by arachnologists, particularly those that may lunge to bite.

I hope to have shown that arachnologists have used "aggressive" in a range of ways, with both defensive and offensive contexts arguably being appropriate for *S. nobilis*.

I have condensed a reference to aggression from a later section into this section.

L.476-477: Maretic crude experiments using *S. paykulliana* have never been repeated by another research group in a more controlled setup (e.g. using measured amounts of venom and considering symptoms in a time and dose-dependent manner). There is no literature (as far as I know) reporting specifically on envenomation by *S. paykulliana*, which tends to demonstrate that the medical importance of this species is probably limited in severity and number of occurrence. I could consider the idea that bites attributed to *Latrodectus tredecimguttatus* in the literature might in fact be due to *S. paykulliana*. L.521-L.530:

I agree with the author that the idea that spiders do not carry pathogenic bacteria needs to be challenged using rigorous studies.

I have substantially reworked the controversial sections on ulceration and bacteria.

L.549-L.560: rather extreme but not impossible. The author should stress that such complications, while possible would remain very rare.

I have now added the statement: "With appropriate recognition of symptoms and treatment, serious bacterial complications from spider bites should continue to be very rare overall".

Other unconfirmed / speculative hypotheses are worth mentioning / exploring: venom variations leading to direct cell lysis, venom triggering an immune response leading to control cell death (Dunbar et al., 2019) and a synergic activity between the venom and pathogenic bacteria.

I have substantially modified reorganised and the text relating to bite effects, and included these interesting suggestions.

I have added the statement "Other areas deserving of investigation include variation amongst venoms of individual spiders, cell lysis, immune response leading to controlled cell death (Dunbar *et al.* 2019) and synergies between venoms and symbionts."

I have now referenced Dunbar *et al.* (2019) elsewhere in the text.

L.573-L.574: "15 cases in the media in which medics are reported to concur a spider bite is a possible cause": two things here: 1) the statement is explicitly highly speculative; 2) a majority (most?) medics actually lack training in recognising spider bite or any other envenomation site / syndrome / symptomatic.

I have added the statement: Medics, however, may be misquoted and often lack specific training in recognising envenomation.

L.581: This is really highly speculative and does not have any basis so far! I would advise correcting or removing this statement.

I have amended the statement to read: I suggest *S. nobilis* has the potential to become a globally widespread but infrequent cause of necrotising arachnidism.

L.583 - L.589: yes - and this statement should stand tall before all the speculations

I have moved this paragraph to the start of the 'Cytotoxicity' section.

L.532 - L.581. L.603 - L.660: this section is very discussable. I would argue the following: Are the risks associated with the presence of *S. nobilis* greater than the risks associated with the presence of a common hymenoptera, e.g. a honeybee? Honeybees can (and do!) kill people every year all around the world. Honeybee venom is highly toxic, can potentially trigger anaphylaxis in a sizable part of the population and in rare cases, envenomation have been linked to secondary infections and necrotic wounds (especially in the case of multiple stings). Does it mean that honeybees should be considered a major health risk to the global human population? What is the medical importance of honeybees in the UK or in Ireland? Low, moderate or high?

Under 'Medical significance' I have added the statement: It is often argued that bees, wasps or nuts are more dangerous than false widows, and I do not attempt to rank risks here. Instead, the aim is to alert to unrecognised and potentially growing risks. The public in some regions have been warned or learned about risks from bees or nuts, and the possible need for *immediate* treatment, but have had much misinformation about spider bite frequency and effect.

I agree however with the recommendations presented L.645 - 652.

L.717 onwards: would it be of interest to actually turn this section into a table with two columns 1) misinformation and 2) corrections? Just an idea!

I have created Table 3 to do this. I do not give the sources of some quotes to spare them potential embarrassment.

Section 3

The section on species interaction is relevant and interesting. There is much work to be done in this area. Some statements however remain unsupported (E.g. L.861-863).

I have clarified this to read: "Based on casual personal observation of co-occurrence I hypothesise that *Zygiella x-notata* and *S. grossa* are two of the most resistant species to displacement in Britain; in Oxford it is only in shallow holes in crumbling limestone walls, and at ground level, that I can find *S. grossa* locally more abundant than *S. nobilis*."

I also support the interesting statements from L.946 onwards on the supposed origin of *Steatoda nobilis*. These topics (biogeography, ecology, behaviour, and risk to endemic arthropods) need to be revisited or investigated).

Overall tone and vocabulary used in this manuscript:

After careful reading, I must admit that I agree with many of the points raised by the author in all three sections (I understand that some of my fellow arachnologists won't agree with me!). However, I must emphasize on the fact that this manuscript is highly speculative. It represents the opinion of the author and is partly based on informal, unstructured personal observations and unconfirmed information collected from unverified sources. A rapid scan through the corpus of expressions used throughout the manuscript demonstrate this point: "I predict" is used 11 times through the text, "I hypothesise" appears 6 times, "I argue" appears 8 times, "possible" 31 times, "personal" 27 times, "suggest" + "suggesting" 40 times. ("I suggest" alone appears 18 times) and "alleged" appears 19 times. It will be the responsibility of the editorial team to decide if such a manuscript falls within the scope of the journal. I believe that there should be a place for such articles (e.g. an opinion column, preprints) but I'd be wary that some members of the public and a part of the media will use the most

sensationalist parts of this manuscript and forget the carefully crafted, more pondered paragraphs dotting this article.

I have condensed many predictions into a new Table 4 in the 'Research priorities' section.

Several instances of "I suggest" are replaced by "I argue" or "I hypothesise" or "I believe".

I hope the repetition helps to distinguish established information from required information.

I have chosen the novel route of publishing a preprint open access, with transparent peer review if recommended by Peer Community In (PCI), because journals are often too narrow and have too low a word-count limit for interdisciplinary discussion. Moreover, it is indeed unusual to combine and intermix review, observation, prediction and formal and less reliable sources so extensively, but this has served to draw much information and discussion together which conventional approaches have hitherto not achieved, in what I hope was a readable structure for the non-specialist.

I am pleased to provide this second version which is in a more conventional scientific structure.

I suspect it is not possible to write on this topic without some media misrepresentation - but hope to be proven wrong. I believe the understandable fear of causing alarm has impeded important medical research.

It is rewarding to note this preprint has been published open access for three months without causing a panic or backlash against spiders, but it has already led to some interesting scientific discussion.

I understand that this article aims to be thought provoking and open to debate (and in that sense, it is successful) but some statements should be toned down or just eliminated (e.g. "I find it very vable that millions and perhaps most people in southern Britain will be bitten by *S. nobilis*", L. 274).

I have added even more caveats, since word-count has not been raised as a major concern in these reviews.

Whilst I still believe millions of people will be bitten, I have revised this to read: "I find it conceivable that many people in southern Britain will be bitten by *S. nobilis* - and that most will not know they have been."

I would urge the author to review parts of the manuscripts in view of the referees and editors comments, and I look forward to reading an amended version of it.

Reviewed by anonymous reviewer, 2019-08-01 23:38

Article Under Review: The false widow spider *Steatoda nobilis* is a notable invasive species.

Recommendation:

I recommend this article.

Summary:

This article synthesizes considerable personal observations of the false widow spider (*Steatoda nobilis*) across Britain in rural and urban habitats and available media and public reports spanning multiple years. These observations characterize the range, putative symptoms from bites and the lifestyle of this spider. These observations are not in line with the popular understanding of the risks these spiders pose, nor the current distribution described by the British Arachnological Society. The most important suggestion in this article is that the chance of being bitten by this spider is much higher than previously described, due to recent increases in abundance, observed aggression, and the synanthropy of this species. As such, the author urgently suggests action should be taken to mobilize interdisciplinary professionals to assess the risks of bites and educate the public and media about the presence of this spider and appropriate measures to take in response. From the outset of the paper, the author made clear the intention was to draw attention to these issues to stimulate further (more rigorous) studies. Still, the observations presented, including video evidence, make a convincing case for the arguments and conclusions in this article.

Comments:

Ln 1: The title is underwhelming considering the implications in this article. Consider adding the phrase “emerging public health threat” or something similar.

I have revised the title to: The 'Noble false widow spider' *Steatoda nobilis* is an emerging public health and ecological threat.

Ln 34: The manuscript would benefit tremendously from a description of the lifecycle and ecology of the spider in the introduction. I have added such an introductory section on life-cycle and incorporated some such material from elsewhere in the text. Various aspects of ecology have to be in different sections to avoid repetition.

Line 114: This description should be accompanied by a map of the sites where this spider was observed each year.

I have added a map with the British cities and towns I mention. I have included dates only for my recent observations and some northern observations, because time series maps or diagrams showing the spread of records in Britain are freely available from B.A.S. (2019a) and Bauer *et al.* (2019) and new ones would take me a long time to produce.

Ln 135-142: Here, a figure showing similar spiders side-by-side with differences highlighted would be informative.

I have provided some images under Creative Commons licences, with notes on the key differences. I might be able to improve on these later in a future version of the paper. I also give references to identification guides with photographs showing the great variation of *S. nobilis* body colour.

Ln 163: What factors may contribute to displacement of native species? The discussion about this later could be expanded upon here.

I have added discussion, but under the section on 'Species interactions'.

"*Z. x-notata* often does not need a crevice for a retreat, and can build a retreat and egg sac in a right angle between surfaces, whilst this is uncommon for *S. nobilis* which typically have a concealed retreat in a crevice."

"Native species may have greater frost hardiness. Natives might be better able to evade predation by *S. nobilis* in colder climates if they are more alert and / or faster. *S. nobilis* achieves larger size than many native spiders in Britain, disperses quickly and its web is very versatile. It is also possible that with more recent colonisation of more northerly British sites by *S. nobilis* and its currently lower density in the north, native species have not yet been excluded in many areas, but will be. Manipulation experiments are required to understand mechanisms for likely displacement in warmer regions."

Ln 217: Why do you predict this is much higher?

I have added the statement: "(and I predict much higher, since the web can survive strong winds, although I have not yet searched tall buildings due to access restrictions)".

Ln 219: This seems critical for understanding the spread and for establishing control methods. I suggest expanding upon this and mentioning it earlier.

I have moved this a little earlier and referred to it in the section on 'Biosecurity', where I have added the statement: "Invasion has presumably been so successful in part due to ability to survive months with few resources, and the strength of its web enabling it to persist on the outside of active vehicles." I have added photographs of webs on wing mirrors.

Ln 236: Did colonization of this structure occur at a similar rate with other spiders in these two years or was this limited to *S. nobilis*?

I have expanded the comment to read: "within two years (personal observation to 2018) as did *Z. x-notata*."

Ln 260: What was the rate for years before? Do data for each year show an increase from 2014 through to 2018 (if available)?

This is unknown to me, and might require a Freedom of Information request. I have not seen these data (obtained by a commercial organisation) or know if they were broken down by year.

I have added the statement: "It would be valuable to have comparable data for earlier four-year periods."

I have added this statement to the 'Proposed research priorities' section: "The number of cases of spider bites or suspected spider bites reported by the National Health Service Trusts, particularly in the south of Britain, in the years before 2014."

Does the location of bites correspond with the range you suggest for this spider?

I have added the statement: The distribution of these cases is predominantly in the South East and South West of England, as with *S. nobilis* records, but includes a concentration in the Southport, Ormskirk and mid Cheshire area where there are also outlying records of *S. nobilis* (perhaps associated with the port city of Liverpool).

Ln 275: Would “recognize” work better than “realize”? “Realize” implies the bite would have no symptoms.

I have changed this to: I find it conceivable that many people in southern Britain will be bitten by *S. nobilis* - and that most will not know they have been.

Ln 283: Perhaps “skepticism” may work better than “caution” here?

Agreed.

Ln 305: If all victims in this table are adults, say this in the legend.

All but one are definitely adult, and the other very likely to be. I have added this statement in the legend: All patients known or very likely to be adults.

Table 1: Add a column with the source of these reports. Fill in the blank cells with something explanatory.

Sources given and cells filled.

Ln 389: Could aggression vary by population or spider density? If so, how might this impact expected bite risk?

It is highly plausible, since many species' behaviour varies with density. In theory species might become more or less 'aggressive' with density / competition. Since I already speculate many times in this paper, I'd prefer not to do so on something I know very little about. I have added the possibility of regional variation to the concluding research proposal section.

Ln 422: Can you add a citation to this sentence?

I have clarified this (untestable suggestion) with the statement: "It is parsimonious to assume that the common ancestor of *Steatoda* and *Latrodectus* within the subfamily Latrodectinae often killed vertebrate prey using webs."

Ln 521: I suggest you remove this section and all assertions that this spider is acting as a “bacterial carrier” or vector. This theory is particularly dubious with the sentence on line 525. While this may be possible, it requires significant evidence. This is especially true with the points made about drug-resistant bacteria, which would need evidence of enrichment in these bacteria. Ln 555-560: I suggest removing this section, which is too speculative.

I have modified this controversial section substantially.

Ln 635: This is another mention of “bacterial carriage” that I suggest removing.

I have edited this to read: "The long-standing medical focus on the neurotoxins in bites of *Steatoda* and *Latrodectus*, and failure to recognise cytotoxicity, bacterial complications or risk of anaphylaxis, could lead to inadequate responses in human medicine (or veterinary medicine, e.g. Ahrens & Crocker 2011)."

Under 'Medical significance' I have edited to read: "Bacteria somehow introduced in the bite area may become the highest risk from spider bites in Britain. However, such complications would likely continue to be very rare overall."

Ln 647: Can you cite or recommend a method for identification using DNA?

I have added the statement: " Spider identification should become possible using DNA; mitochondrial DNA sequence data are available for *S. nobilis* from the Barcode of Life Data System (Bauer et al. 2019). I have added a reference Blagoev et al. 2016.

Ln 677: This was covered internationally: USA Today has an article on this.
I have amended to "international media coverage" and added the reference (Hafner 2018)."

Ln 739-748: This is a fine idea. How can it be implemented? Why aren't arachnologists talking with media already? Can B.A.S. train arachnologists in media outreach and/or connect media with relevant experts? These practical suggestions would strengthen the article.

I have added the statement: "The British Arachnological Society group on spider envenomation has interdisciplinary expertise and might benefit from hosting some joint meetings with responsible, influential journalists. A global repository of information on the species with some form of scientific accreditation of individual statements and observations by a large inter-disciplinary expert audience would be valuable to help lead journalists and the public to relatively reliable sources from a wider range of disciplines and perspectives.

Ln 790-799: A major barrier for this solution, which you mention earlier, is the amount of misinformation out there. How will this new information be set apart? Would it be beneficial to focus on teaching people to distinguish between high- and low-quality sources for spider information?

I have added the statement: "Such materials would ideally be made freely available for download from a global repository on *Steatoda*, as mooted above."

Under the section on 'Education...' I have added a proposal for a global repository of information on the species; information in this could be assessed and commented on by experts from a wide catchment, as with peer review.

Ln 815: Since this paper argues that this is not taken seriously enough in places, a discussion about the differences between media alarmism versus "justified alarm" may be useful.

I have added the statement: "Media alarmism should not prevent justifiable alarm being raised, particularly now it is evident the species is of more medical significance than the spiders the public and medics are used to in some regions (Dunbar 2019)."

Ln 933: Why is climate change never mentioned or discussed here? This seems highly relevant. Was this an intentional decision? Yes: the regional forecasts for Britain (IPCC 2013) have too much uncertainty for prediction of changes.

Yes, it was deliberate: there are predictions of Britain warming and/or cooling on various timescales. I have added the statement: "Observed warming in Europe over recent decades is projected to continue in some climate change modelling (Kovats *et al.* 2014) which might benefit the species in some areas although there is much uncertainty in climate change predictions at the regional scale (IPCC 2013)". I have added both these references.

Ln 1058: Given that webs are inter-generational, would this mean web removal would be expected to inter-generational effects on spider success?

Probably, but they rebuild very quickly as noted in the section on pest control.

I have added a the statement: "...matrphagy would be worth investigating, as would the fitness effects of web removal."

Ln 1131: This is the first mention of gene drive in the article. I suggest removing it. While developing gene drive in this spider is not outside the realm of technical possibility, I expect

releasing sufficient spiders with a suitable gene drive would be hard to justify, particularly with the risks described in this paper.

I have amended this to read: Natural enemies in potential biological control of *S. nobilis*, considering risks to native species.

Suggested Revisions:

Ln 49: change “significant a” to “prevalent this”

Amended to: "review how prevalent and medically significant this spider species is"

Ln 79: remove the comma after “bites”

Amended to: "of bites (aiming to precipitate discussion)".

Ln 208: add “from” before “*S. nobilis*”

Done.

Ln 265: change “I have heard of via” to “relayed by”

Done.

Table 1: add space to cell C3; remove “c.” from cell C6.

Done. Changed "c." to "Around" since the report is not clear.

Ln 386: change “disturbing” to “reprehensible”

It would be reprehensible these days, but I do not wish to condemn scientists working legally within the very different ethical framework of the time, which has of course changed greatly for the better.

Ln 419: add “and amphibians” after “reptiles”

I have revised this to state: the lizards, snakes and geckos that *Steatoda* and *Latrodectus* kill must simply be rubbing on the web - as a finger might do by chance. Such reptiles (and frogs taken by *Latrodectus*, Anderson 2011) are often very fast".

Under Cytotoxicity I have added the statement: some kill frogs and might catch birds (Anderson 2011).

Ln 474: add “)” after “1991”

Done.

Ln 643: add a comma after “case”

Done.

Ln 1087: add “formally” before “developed”

Done

Ln 1121: remove “vectors of MRSA”

Done, and replaced by: The risk of ulceration and necrosis after *Steatoda* bites, including assessment of *S. nobilis* as facilitators or vectors of antibiotic resistant and other bacteria in their microbiome.

Other comments and revisions by the author:

These extremely thoughtful reviews have been very useful and interesting. They also indicate the value of discussing and pooling internationally fragmented information on *Steatoda* and other medically significant species.

I have edited the Abstract to reflect the revisions.

I have added anaphylaxis to the keywords

I have edited the Introduction to read: "I hope that [this paper] will facilitate fast interdisciplinary debate, hasten correction of errors, and discourage potentially dangerous comments by spider enthusiasts. I add: [the paper] "draws on arachnological experience to assess media reports which appear hitherto to have been dismissed or overlooked by many commentators and researchers".

New records (by the author) of *S. nobilis* in Hull, UK, August 2019 are included. I remove the word gradual when suggesting population increases are easily overlooked.

"Assessing the risk to public health and conservation requires use and expert screening of both the specialist literature and of numerous blogs, newspapers and other often unreliable sources."

Three recent examples of likely bites are included in Table 2.

I have added the statement: "If it is established that other European spider species are involved in some of the ulcerations and other serious consequences in Table 2, the implications are even more profound, and much more general and restrictive advice would have to be given to the European public about the safety of handling any spiders - contrary to much existing advice."

I have noted infection is also a common risk with many minor injuries.

I have noted coevolution, convergence or mimicry of similar species would occur over long timescales.

Under 'Global distribution' I have reworded the statements on lags.

I have made small changes to wording of section on proposed research priorities to reflect reviews, and adding: "Potential behavioural triggers for bites, including movement, warmth and chemicals."

I have added scaffolders and gardeners to those at occupational risk.

I have modified the section on Proposed research priorities, and including the need to review which other spiders might cause similar symptoms. 11) Review of which other species, such as *Amaurobius*, might be misidentified as *Steatoda* and be causing ulcerating bites in Europe.

I have given the section on 'Changes in local abundance' a more formal style.

I have moved information on identification and similar species to the introduction.

I have noted that for identification even fragments of the spider in *e.g.* vodka can be valuable.

I have noted in the 'Introduction' that eradication is particularly problematic once the species is established outdoors, and under 'Societal response' that: "I suggest eradication should be seriously considered as an option for colonies that are demonstrably isolated, indoors or outdoors, for example the first record in a region, after checking the scale of the invasion".

I have added the reference Vetter & Rust 2012.

I have added a note about risks under Education: "Panic or severe pain could also cause risks through a startled reaction to a bite - for example on ladders or when handling power tools or driving".

Under "The arachnological conflict of interest I have added: "In my experience of scientific outreach on spider conservation, I find people are often relieved to hear arachnophobia is likely adaptive, not necessarily irrational, can often be desensitized - and are reassured that some scientists will at least listen to their experiences".

I have added the observation that: "The species can survive for months, build a web and lay eggs in a domestic fridge (c. 9°C, dark most of the time)" and noted an observation of four juveniles using one web.

I have noted that survey often attracts security personnel.

I suggest that destruction of the webs is likely to slow recolonisation.

I have modified the section on Proposed research priorities, and including the need to review which other spiders might cause similar symptoms. 11) Review of which other species, such as *Amaurobius*, might be misidentified as *Steatoda* and be causing ulcerating bites in Europe.

I have added reference to another the recent school closure.

I have added the comment: "Given the many current difficulties of obtaining all the required evidence for confirmation of a *Steatoda* bite, immunological surveillance may prove the only realistic way to assess bite frequency and symptoms."

I have made other minor changes throughout the text for clarity, to reduce repetition and to increase consistency.