Occurrence, reproductive rate and identification of the non-native Noble false widow spider *Steatoda nobilis* (Thorell, 1875) in Ireland

Michel M. Dugon, John P. Dunbar, Sam Afoullouss, Janic Schulte, Amanda McEvoy, Ruth Hogan, Collie Ennis, Ronan Sulpice

Biology and Environment: Proceedings of the Royal Irish Academy, Volume 117B, Number 2, 2017, pp. 77-89 (Article)

Published by Royal Irish Academy
DOI: *https://doi.org/10.1353/bae.2017.0005*

OCCURRENCE, REPRODUCTIVE RATE AND IDENTIFICATION OF THE NON-NATIVE NOBLE FALSE WIDOW SPIDER *STEATODA NOBILIS* (THORELL, 1875) IN IRELAND

Michel M. Dugon and John P. Dunbar, with Sam Afoullouss, Janic Schulte, Amanda McEvoy, Michael J. English, Ruth Hogan, Collie Ennis and Ronan Sulpice

Michel M. Dugon (corresponding author; email: Michel.dugon@nuigalway.ie), Room 214 - Zoology, The Ryan Institute, National University of Ireland, Galway, Co Galway, Republic of Ireland; John P. Dunbar, Sam Afoullouss, Janic Schulte, Amanda McEvoy, Michael J. English, Ruth Hogan, Collie Ennis and Ronan Sulpice, Venom Systems and Proteomics Lab, School of Natural Sciences, National University of Ireland Galway.

Cite as follows: Dugon, M., Dunbar, J.P., Afoullouss, S., Schulte, J., McEvoy, A., English, M.J., Hogan, R., Ennis, C. and Sulpice, R. 2017 Occurrence, reproductive rate and identification of the non-native Noble false widow spider *Steatoda nobilis* (Thorell, 1875) in Ireland. *Biology and Environment: Proceedings of the Royal Irish Academy* 2017. DOI: 10.3318/BIOE.2017.11

Received 02 February 2017. Accepted 26 July 2017. Published 04 September 2017.

ABSTRACT

The noble false widow *Steatoda nobilis* (Thorell, 1875) has established thriving populations in urban centres throughout England and Wales since it was accidentally imported from the Canary Islands and Madeira to Britain over a century ago. In recent years, *Steatoda nobilis* has colonised parts of Western Europe, California, Chile and the Middle East. In Ireland, *Steatoda nobilis* was first recorded in 1999 from a single location in Co Wicklow. The present study examines the current range and main habitats of *Steatoda nobilis* in Ireland and assesses its potential as an invasive species by documenting its reproductive rate. Additionally, we present photographic material illustrating the intraspecific phenotypic variations exhibited by *Steatoda nobilis* to assist in correct identification of this species by the public. Our data shows that *Steatoda nobilis* is an extremely prolific, resilient species with distinct synanthropic affinities. This species currently occurs in at least sixteen Irish counties with the largest populations observed in the greater Dublin area, where it has become widespread in buildings and on street furniture. *Steatoda nobilis* seems to be currently absent from natural, undisturbed habitats such as woodlands, bogs and grassland. We suggest that due to its comparatively fast reproductive rate, long life span and year-round activity, *Steatoda nobilis* might have a detrimental impact on native urban-dwelling spiders.

INTRODUCTION

The first Irish record for the noble false widow spider *Steatoda nobilis* (Thorell, 1875) occurred in Bray, Co Wicklow, in 1998 (Nolan 1999). This alien species is of particular interest in Great Britain and in Ireland as it has been involved in the only case of systemic envenomation (steatodism) reported in these islands (Warrell *et al.* 1991). Additionally, studies suggest that *Steatoda nobilis* might have a negative impact on populations of native arthropods in areas it has colonised (Kulczycki 2012).

The geographical expansion of *Steatoda nobilis* has been fairly well documented for over a century, thanks to its relatively large size, conspicuous markings and superficial resemblance to the black widows of the genus *Latrodectus* (Walckenaer 1805). *Steatoda nobilis* is thought to originate from the Atlantic archipelagos of Madeira (Thorell 1875) and the Canaries (Bristowe 1929). In 1879, *Steatoda nobilis* was recorded for the first time outside its native range; Rev. Pickard-Cambridge identified a sub-adult female collected a few years earlier by Rev. Hamlet Clark near Torquay, Devon (Pickard-Cambridge 1879). This confirms that *Steatoda nobilis* reached the British Isles—at least as an occasional visitor—well before the turn of the twentieth century. In 1906, A.R. Jackson came into the possession of at least one adult female collected by a third party on a cliff in southern England, away from man-made structures (Jackson 1907). Jackson concluded that the specimen was unlikely to be a mere alien 'visitor', and implied that a population may have already been established in southern England by the early 1900's. Referring to Pickard-Cambridge's work, Bristowe (1929) suggested that *Steatoda nobilis* may have been imported occasionally from the Canary Islands in shipments of bananas but rejected the idea that *Steatoda nobilis* had established sustainable colonies at the time of publication. *Steatoda nobilis* was later recorded at closer intervals in the southern half of Britain: Hampshire (Jones 1979; Jones 1987), Dorset (Snazell and Jones 1989),

Essex (Smith 1992; Merrett 2001), Sussex (Warrell *et al*. 1991), Warwickshire (Bate 2005), Glamorganshire (Jones, 2006), Leicestershire (Daws 2008) and Lincolnshire (Binding 2014). Further afield, the distribution range of *Steatoda nobilis* has been continuously expanding since the turn of the twenty-first century. *Steatoda nobilis* has become widespread in coastal urban centres in France (Kovoor and Munoz-Cuevas 2000), Belgium (Van Keer 2010), Italy (Kulczycki 2012), Spain (Déjean 2013), Portugal (Cardoso 2000), California (Vetter and Rust 2012; Vetter *et al*. 2015) and Chile (Taucare-Rios *et al*. 2016; Faúndez and Téllez 2016). Eastward, *Steatoda nobilis* has been observed in Germany (Reiser 2013), Turkey (Turkey and Mergen 2007) and as far as Iran (Zamani *et al*. 2015).

Although *Steatoda nobilis* is thought to have spread in many parts of Ireland since Nolan's original report (1999), the occurrence and the ecological impact of this species at the national level have not been assessed yet. The aims of the present study are threefold: 1) assess if *Steatoda nobilis* has expanded its Irish range since it was first recorded; 2) document the reproductive rate of *Steatoda nobilis*; 3) document the intraspecific phenotypic variations exhibited by *Steatoda nobilis* in Ireland to assist in correct identification by the public.

MATERIALS AND METHODS

DISTRIBUTION STUDY

New distribution records were compiled either directly by the authors during habitat surveys or by screening wildlife-recording and social media resources for photographic records posted online by amateur arachnologists.

Field inspection and spider collection

Surveys took place between September 2014 and February 2017 as part of a series of student-led arthropod surveys held by the National University of Ireland Galway Discipline of Zoology. Urbanised areas, woodlands, coastal habitats, bogs, meadows and a cave system were inspected across nine Irish counties for the presence of alien arthropods, including *Steatoda nobilis*. Depending on habitats, survey methods included visual inspection, net sweeping, beating trays, pitfall traps and cryptozoic traps. The latter consisted of 40cm-wide pieces of cardboard wrapped around tree trunks and checked weekly for a period of three weeks. Coordinates, habitats, dates and sampling methods for each surveyed location are detailed in Table 1.

When sightings were made, the subsequent area was extensively searched by the authors and *Steatoda nobilis* were collected using either a pair of flexible tweezers or a Katcha™ Bug Buster Spider Vacuum and then placed in 50ml falcon tubes. Locations were systematically recorded. In those instances when they occurred, predation events involving *Steatoda nobilis* were recorded and photographed.

The collection of live specimens for lab-based experiments took place after sunset (when *Steatoda nobilis* is most active) in the larger Dublin area between September 2015 and October 2016.

Online-based records

Records of *Steatoda nobilis* sightings were compiled following a web search on four wildlife recording websites (brc.ac.uk/irecord/; biodiversityireland.ie; ispotnature.org; nbnatlas.org/) and two online social media groups (facebook.com/groups/BritishSpiderIdentification/; facebook.com/groups/insectsinvertebratesire/).

Webpages were searched using the following key words: *Steatoda, nobilis,* false widow, spider, Theridiidae, cobweb, comb-footed. A list of messages containing positive photographic identification of *Steatoda nobilis* was compiled. Photographers were contacted by the authors to confirm recorded sightings and to obtain photographic voucher material. Additionally, the authors posted public messages on the two social media webpages aforementioned, inviting group members to submit photographic material of new sightings. Records were subsequently compiled and locations were mapped to their nearest 10km grid using ArcGIS v10 (ESRI, California, USA).

REPRODUCTIVE STUDY

Previous studies (Hann, 1990) suggest that the high reproductive rate of the invasive *Steatoda capensis* (Hann 1990) in New Zealand is a contributing factor in the displacement of the native *Latrodectus katipo* (Powell, 1871). Following Hann's lead, we investigated the reproductive rate of *Steatoda nobilis* in captivity and compared it with existing data on the reproductive rate of the missing-sector orb weaver *Zygiella x-notata* (Clerck, 1757), a common urban dweller in Ireland (Wherry and Elwood 2009).

Steatoda nobilis caught in Co Dublin were kept individually in 80mm x 50mm cylindrical plastic containers with shredded paper as substratum. Spiders were stored in chest incubators at a constant 20°C, watered and fed weekly on a diet of commercially available crickets (*Gryllus assimilis,* Fabricius, 1775) and fruit flies (*Drosophila melanogaster*, Meigen, 1830). Each spider was individually coded to facilitate records of egg-laying. Egg sacs were consistently removed from the mother in the 24 hours following egg-laying. Each egg sac was individually coded, measured and incubated at 20°C in a 25ml falcon tube containing wet cotton to avoid dehydration. Egg sacs were either left to hatch or processed for further developmental investigations. Hatchlings were kept

Table 1—Habitats surveyed for the presence of the noble false widow spider *Steatoda nobilis*. Surveys took place between September 2014 and February 2017 across six Irish counties. Coordinates were obtained from the National Biodiversity Data Centre, Waterford (http://maps.biodiversityireland.ie/#/Map). *Cryptozoic traps* refer to 40cm wide pieces of cardboard wrapped around ten tree trunks and checked weekly for a period of three weeks. *Pitfall traps* consisted of five plastic cups of 7.7cm diameter and 10.6cm height filled with a saline solution. Traps openings were covered with plastic lids secured into the ground with two nails, leaving a 1cm gap between the rim of the cup and the lid. Pitfall traps were relieved weekly for a period of three weeks. The *Transect belt* consisted in a 20m long ribbon laid on the floor. The survey area extended one meter on each side of the ribbon, vegetation up to approximately 1.8m in height was searched. Surveys were typically two to two and a half hours long and involved one to six surveyors. (*) Surveys / collection performed after sunset; all other surveys were performed during daytime.

Location	*Coordinates*	*Habitats*	*Sampling methods*	*Number of visits / Sampling dates*	*Specimens caught*
Co Galway - Galway City Docks	130127, 224953	Apartment complex outdoors	Visual inspection	First sighting in Galway November 2011	1
Co Galway – Galway City City centre	129986, 225191	Parking lots	Visual inspection	Three visits September 2014	4
Co Galway - Galway City Southpark	130005, 224475	Sandy shore / coastal meadow	Visual inspection Sweeping net	Three visits (weekly) October 2014	0
Co Galway - Galway City NUI Galway campus	129340, 225689	Mix trees / buildings	Visual inspection Cryptozoic traps	Three visits (weekly) September–October 2014	0
Co Galway – Galway City Terryland Forest Park	129863, 226223	Peri-urban mixed deciduous woodland	Cryptozoic traps Pitfall traps Visual inspection Sweeping net	Seven visits (weekly) September–November 2014	0
Co Galway – Knocknacarra Rusheen Bay	125847, 223820	Sandy shore / coastal meadow	Visual inspection Sweeping net	Three visits (weekly) September–October 2014	0
Co Galway – Barna Barna Woods	124380, 223775	Deciduous woodlands	Cryptozoic traps Pitfall traps Visual inspection	Three visits (weekly) September–October 2014	0
Co Galway - Barna Barna bog	122467, 227026	Blanket bog	Pitfall traps Visual inspection Visual inspection	Three visits (weekly) September–October 2014	0
Co Galway - Monivea Monivea Woods	153980, 236403	Mixed woodlands	Cryptozoic traps Pitfall traps	Three visits (weekly) September–October 2014	0
	154284, 236034	Thickets of *Prunus laurocerasus* exclusively	Visual inspection Sweeping net		0

Table 1 (*Continued*)

Location	*Coordinates*	*Habitats*	*Sampling methods*	*Number of visits / Sampling dates*	*Specimens caught*
Co Galway – Coole Coole Park	143731, 205117	Mixed deciduous and coniferous woodlands	Cryptozoic traps Pitfall traps	Three visits (weekly) September – October 2014	0
	143387, 204757	Turlough shores / meadows	Visual inspection Sweeping net 20m transect belt		0
Co Galway - Salthill Quincentenary Rd	128344, 223833	Apartment complex Indoors	Report from the public – collected by MD	One visit (collection) November 2014	1
Co Galway - Galway City Newcastle Street	128915, 226361	Semi-detached houses Indoors and outdoors	Report from the public – collected by MD	One visit (collection) March 2015	1
Co Galway - Galway City Terryland Retail Park	129980, 226058	Industrial estate Indoors and outdoors	Visual inspection	Three visits (weekly) September 2015	0
Co Galway - Oranmore Gurraun North	137019, 226188	Peri-urban bungalow	Visual inspection Sweeping net	Three visits (weekly) September– November 2015	0★
Co Galway – Oranmore Claregalway Rd	138500, 227034	Peri-urban bungalow	Visual inspection Sweeping net	Three visits (weekly) September– December 2015	0★
Co Galway – Oranmore Tudor Vale	137936, 225423	Hotel complex Outdoors		One visit September 2016	4
Co Mayo – Ballina Belleek Castle Park	125127, 320744	Mixed deciduous and coniferous woodlands	Visual inspection Sweeping net 20m transect belt	One visit May 2015	0
Co Sligo – Ballimote Kesh cave system	170587, 312149	Limestone cave system	Visual inspection	Two visits June 2016 & January 2017	0
Co Roscommon - Ballymurray Mote Park	190563, 261296	Mixed deciduous and coniferous woodlands	Visual inspection Sweeping net 20m transect belt	One visit September 2015	0
Co Tipperary – Clogheen	195749, 113229	Farmland, inside dry shed	Visual inspection	One visit October 2016	1
Co Longford – Edgeworthstown	224682, 273918	Across the dashboard on the registration plate, wing mirrors and oil cap of a car	Visual inspection	Two visits October 2015	5
		Outside between wall of house and drain pipe		July 2016	1

Table 1 (*Continued*)

Location	*Coordinates*	*Habitats*	*Sampling methods*	*Number of visits / Sampling dates*	*Specimens caught*
Co Westmeath – Mullingar	245211, 253612	Indoors, inside a garden shed	Report from the public – collected by JD	One visit (collection) October 2016	3
Co Kildare – Maynooth NUI Maynooth Campus	292997, 238528	Indoors on walls, outdoors on windows, concrete and steel structures	Visual inspection	Four visits August 2015 to September 2016	34★
Co Dublin – Tallaght	310309, 227410	Indoors under kitchen units, inside garden shed, greenhouse and outdoors around windows	Visual inspection	One visit February 2016	20
Co Dublin – Tallaght Tallaght Business Park	308322, 227041	Indoors	Report from the public Collected by MD and JD	One visit February 2016	20
Co Dublin – Dublin City Merrion St	316434, 233550	Metallic railing	Visual inspection	One visit June 2016	2
Co Dublin - Clondalkin, Green Isle hotel	306471, 229989	Outdoors on boundary railings	Visual inspection	One visit Junes 2016	4
Co Dublin – Lucan public park	304694, 234684	Public park boundary wall and railings	Visual inspection	One visit July 2016	54★
Co Dublin - Stephens Green	315880, 233507	Public park boundary railings	Visual inspection	One visit July 2016	3
Co Dublin - Raheny	321695, 238343	Indoors on a blanket and outdoors on garden wall	Visual inspection	Two visits August 2016	1
				September 2016	4
Co Dublin - Lucan	305265, 234054	Inside and outside of garden shed, along garden walls and furniture	Visual inspection	Eight visits	
				August 2015	15
				October 2015	71★
				February 2016	50★
				March 2016	1★
				September 2016	150★
				October 2016	172★
				December 2016	1★
				February 2017	160★
Co Dublin – Bawnogue, Clondalkin	305363, 231769	Outdoors - Inside and outside a wheelie bin	Visual inspection	One visit October 2016	7

communally for the first week after emerging from the sac. They were then separated, kept individually in 1ml Eppendorf tubes and fed *Drosophila melanogaster* (a stock of the *wingless* mutant for ease of handling) twice weekly. The number of eggs or hatchlings for each egg sac was recorded.

IDENTIFICATION CHART: PHOTOGRAPHY AND CARAPACE MEASUREMENTS

Photographs of *Steatoda nobilis* were taken using a Nikon AF-P DX NIKKOR 18–55mm f/3.5–5.6G and a Nikon AF-S DX Micro Nikkor 40mm f2.8G lenses mounted on a Nikon D5200 DSLR camera. Macro-photographs were taken using a Sigma 105mm Macro lens mounted on a Canon 5DS camera. Pictures were manually adjusted for light, contrast and colour using IrfanView 3.92 (1996–2004 Irfan Skijan; Vienna University of Technology).

To investigate the mean size of individuals within the Irish population of *Steatoda nobilis*, we measured 102 mature specimens collected between September 2015 and October 2016 in Co Dublin. Specimens were placed in a gas chamber and exposed to CO_2 for two minutes until anaesthetised. Spiders were then placed lying flat on their ventral aspect. Carapace length was measured using a precision analogue calliper and measurements rounded to the closest 0.1mm. Carapace length was determined by measuring each specimen from the proximal article of the chelicerae (in 'normal' resting position) to the base of the spinnerets. Eggs and hatchlings were measured with a ruler reticle mounted on an Olympus SZ61 stereomicroscope.

RESULTS

COUNTY DISTRIBUTION OF *STEATODA NOBILIS*

During the study that took place between September 2014 and February 2017, *Steatoda nobilis* was identified in 54 geographically distinct locations across 16 Irish counties, of which a total of 15 are new county records (Fig. 1). The social media-based inquiries produced 36 of the new geographic locations (67%) across 13 counties, some dating back as far as 2009 (Table 2). The remaining eighteen locations (33%) were registered by the authors between 2014 and 2016 across six counties (Table 1). As of 1 April 2017, our search on online wildlife recording websites did not return any record for Ireland.

A total of 23 sighting locations (43%) were in Co Dublin, where *Steatoda nobilis* was found in the highest number and appears to be the most common species in and around street furniture. Thirty of the 37 social media-based records were of a single specimen. Four of the 32 locations surveyed by the authors yielded single specimens and 14 yielded multiple specimens. The remaining 16 locations surveyed did not yield any specimen. At the national level, a majority of specimens were sighted in coastal areas as opposed to the midland counties (Fig. 1). The authors observed mature *Steatoda nobilis* throughout the year regardless of ambient temperatures, both outdoors and indoors (Table 1).

STEATODA NOBILIS HABITAT

Urbanised areas, woodlands, coastal habitats, bogs, meadows, turlough shores and a cave system were investigated for the presence of *Steatoda nobilis.* Adult specimens were exclusively found on steel, concrete or timber structures in heavily urbanised areas. Such habitats included sheds, steel fencing, concrete walls, cellars, room ceilings, skirting boards and window ledges. All locations surveyed in and around Dublin yielded at least one specimen on each visit. Over a period of 18 months, 620 specimens were obtained from a single row of semi-detached houses in Lucan, Co Dublin. Meanwhile, not a single *Steatoda nobilis* was found in the ten non-urbanised locations we surveyed.

A total of six juveniles were sighted on vegetation in two locations. In Lucan, Co Dublin, two specimens were collected in a public park, on webs built amongst the branches at *c.* two meters high and less than ten meters away from the parks' outer boundary railings which contained large numbers of adult specimens. An additional four juveniles were observed in Oranmore, Co Galway on the leaves of a large Hydrangea contiguous to the glass wall of a heated swimming pool located in the courtyard of a hotel complex.

PREDATION RECORDS

While sampling, several predation events were observed, consisting of nine diet items and two predators of *Steatoda nobilis*. Diet items included a variety of Irish native invertebrates belonging to three arthropod subphyla. The subphylum Insecta was most represented with six, comparatively medium to large prey items, including a Coleopteran (*Ocypus olens* Müller, 1764), a Dermapteran (*Forficula auricularia* Linnaeus, 1758), a Hemipteran (*Palomena prasina* Linnaeus, 1761), a Hymenopteran (*Vespula vulgaris* Linnaeus, 1758) and two Dipterans, (*Calliphora vomitoria* Linnaeus, 1758 and a smaller non-identified specimen). Two additional prey items belonged to the class Arachnida (subphylum Chelicerata) (*Eratigena atrica* Koch, 1843 and *Araneus diadematus* Clerck, 1758). Woodlice (subphylum Crustacea) seem to be the commonest prey of all. In two instances we recorded adult *Steatoda nobilis* falling prey to common suburban spiders: the cellar spider *Pholcus phalangioides* (Fuesslin, 1775) and the lace-webbed spider *Amaurobius fenestralis* (Ström, 1768).

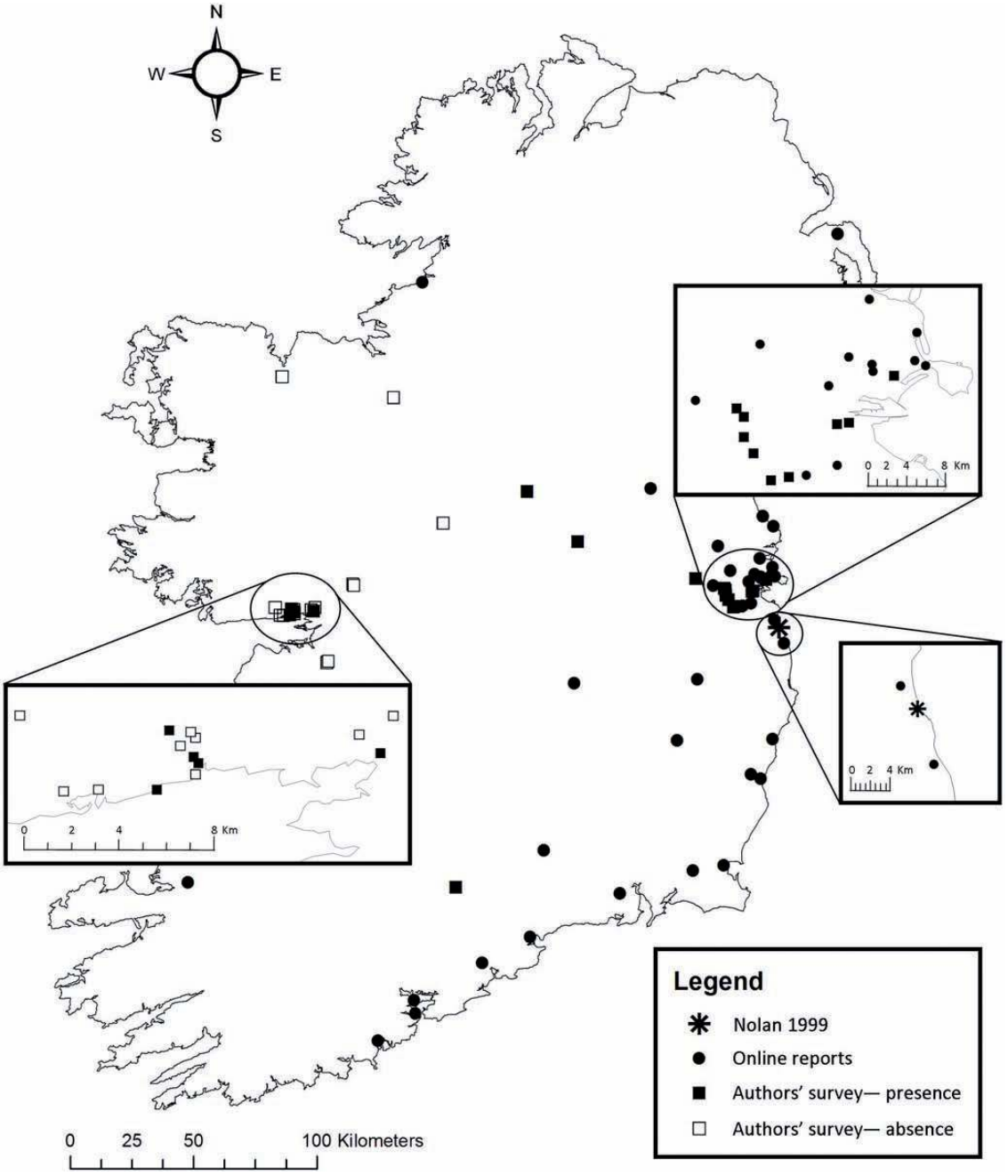

Fig. 1—Occurrence of the Noble false widow *Steatoda nobilis* in Ireland. 36 positive reports across 13 counties were obtained from online social media. 32 additional locations across nine counties were surveyed by the authors between September 2014 and February 2017. A total of 14 locations in six counties yielded at least one specimen of *Steatoda nobilis*. The first Irish sighting in Bray, Co Wicklow (Nolan 1999) is marked by a star.

IDENTIFICATION CHART

Male and female *Steatoda nobilis* were photographed at various stages of their development to help with identification. *Steatoda nobilis* displays a wide range of variation in overall size, opisthosomal shape, colouration and dorsal markings, making identification very difficult to the untrained eye (Fig. 2). Those variations do not seem to correlate with geographical origins or relatedness: specimens collected centimetres apart and siblings born from the same egg sac can display widely different dorsal patterns (Figs. 3A–3D).

In Ireland, *Steatoda nobilis* can be consistently distinguished from other local spiders (including

Table 2—Noble false widow spider *Steatoda nobilis* sightings in Ireland based on online reports retrieved from two social media interest groups (facebook.com/groups/BritishSpiderIdentification/; facebook.com/groups/insectsinvertebratesire/). All reporters were contacted to obtain precise location, details on habitat, dates of observation and photographic voucher material. Only reports accompanied with unambiguous photographic material were retained. Coordinates were retrieved from the National Biodiversity Data Centre, Waterford (http://maps.biodiversityireland.ie/#/Map).

Location	*Coordinates*	*Habitats*	*Observation dates*
Co Dublin – Tyrellstown	307202, 241771	On a garden fence	July 2009
Co Dublin – Balbriggan	320305, 263918	Outdoors - Garden wall	October 2014
Co Dublin – Balbriggan	320371, 263938	Outdoors - On a flower pot	September 2015
Co Dublin – Portmarnock	324224, 243176	Indoors	September 2015
Co Dublin – Santry	316959, 240469	Outdoors - On stone pavement	2016
Co Dublin – Baldoyle	323986, 239991	Indoors - Window frame	May 2016
Co Dublin - Glasnevin	314638, 237366	Outdoors - on garden wall	May 2016
Co Dublin - Churchtown	315625, 228650	Indoors	June 2016
Co Dublin - Skerries	324632, 259875	Indoors	July 2016
Co Dublin - Coolock	319396, 239360	Outdoors	August 2016
Co Dublin - Knocklyon	312220, 227546	Indoors - On wooden structure	September 2016
Co Dublin - Shankill	324975, 221856	Outdoors - On a garden rock	September 2016
Co Dublin - Sutton	325135, 239555	Outdoors - In garden	September 2016
Co Dublin - Swords	319036, 246777	Outdoors - Garden wall	October 2016
Co Donegal - Bundoran	182121, 358977	In arm pit of wet suit	March 2016
Down – Bangor	350722, 378692	Indoors	December 2016
Meath Kells	274762, 275309	Indoors - On a wall	July 2014
Meath – Ratoath	302166, 251766	Indoors - Window frame	October 2016
Kildare – Leixlip	300209, 235770	Outdoors	November 2015
Laois – Clonkeen	243768, 196040	Indoors	2016
Wicklow – Hollywood /Donard	293708, 197630	Indoors on skirting board	2016
Wicklow – Greystones	328949, 212314	Indoors	June 2016
Wicklow – Arklow	324208, 173379	Indoors	October 2016
Wexford – Gorey	315525, 159179	Inside garden shed	October 2010
Wexford – Wexford town	304477, 122145	Indoors	November 2015
Wexford – Taghmon	291884, 119945	Indoors on a blanket	September 2016
Wexford – Courttown	319446, 157427	Indoors - On window frame	October 2016
Tipperary – Kilcash, Clonmel	231489, 128155	Indoors - On a wall	July 2016
Waterford – Waterford City	262304, 110758	Indoors - On wooden floor	September 2015
Waterford – Cherrymount	206328, 82579	Indoors	March 2016
Waterford – Dungarvan	225932, 93016	Outdoors	2016
Carlow – Tullow	285544, 172950	Outdoors - on stone	2016
Kerry – Tralee	86865, 115194	Outdoors, on concrete	February 2015
Cork – Cobh	178777, 67245	Indoors	May 2015
Cork – Curraghbinny Woods	179281, 62036	Indoors - Window frame	October 2016
Cork – Glanbeg	164119, 50847	Indoors	2016

other members from the genus *Steatoda*) by the presence of a cream crescent on the antero-lateral part of the opisthosoma (Figs. 2B and 2E), an intricate pentagonal or hexagonal cream-coloured pattern on the dorsal aspect of the opisthosoma (Figs. 2A–2H) and sturdy reddish to orange legs banded with black markings (Figs. 2D and 3E). The prosoma is consistently solid black in mature specimens but it may be light yellow to cream colour in immature and freshly moulted specimens (Fig. 2B). The cuticle of the opisthosoma bears four small depressions on the dorsal aspect (Figs. 2D and 2F). Mature males are easily distinguished from mature females due to the presence of a pair of palpal bulbs on the distal end of the pedipalps (Figs. 2C, 2E and 2G). The size and shape of the opisthosoma varies from short and slender (Figs. 2E and 2G) to large and bulbous (Fig. 2C). Old specimens—particularly females—may present a small and shrivelled opisthosoma with faded or absent dorsal and antero-dorsal markings (Figs. 2G, 2H).

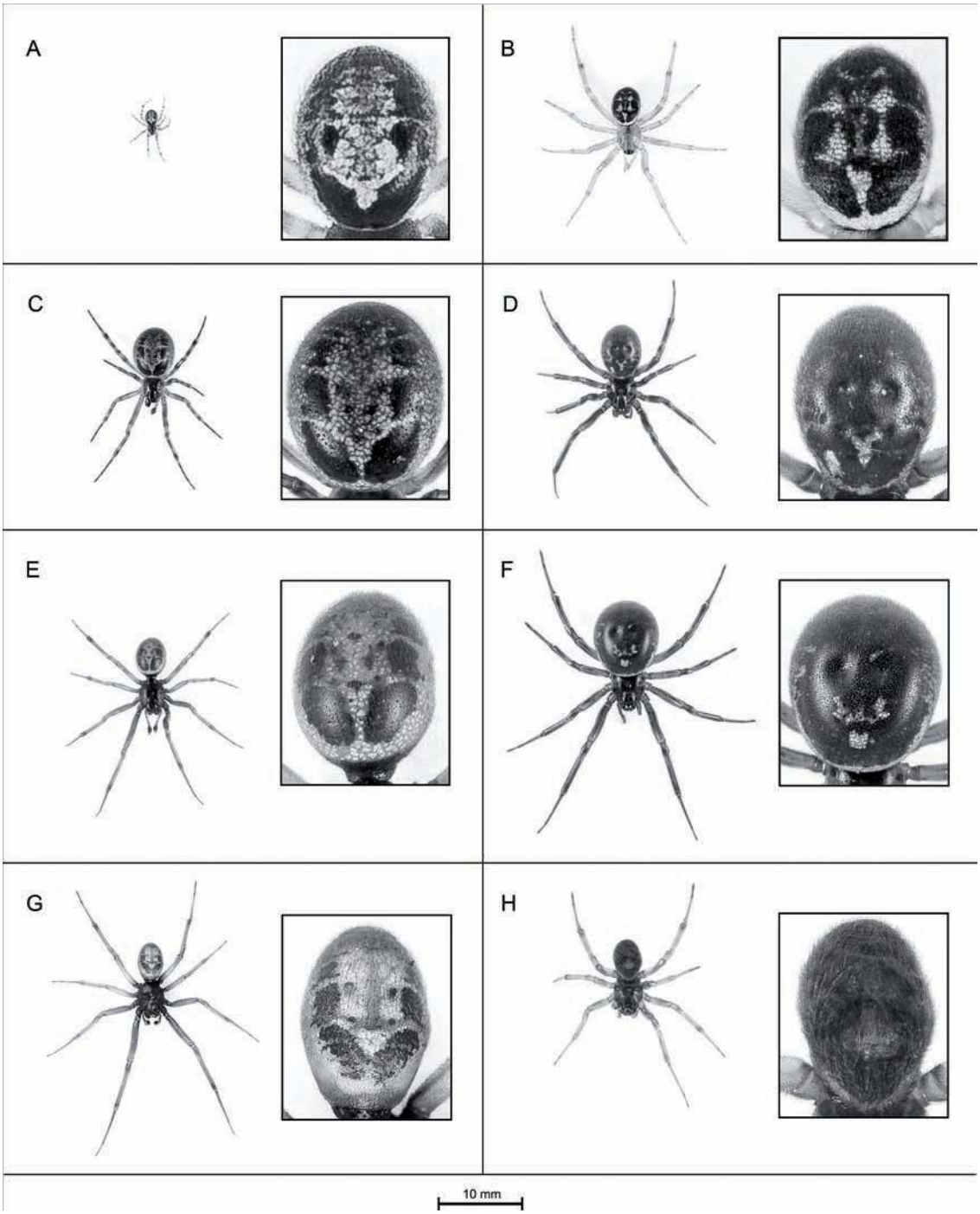

Fig. 2—Identification chart for various life stages of *Steatoda nobilis* collected in Ireland. Variations in opisthosoma markings are presented in each frame. (A) Unsexed second instar juvenile specimen; (B) Unsexed sub-adult specimen hours after ecdysis. Notice the pale colour of the prosoma and legs in contrast to other specimens. (C) Male specimen at the penultimate developmental stage; (D) Mature female with reduced opisthosomal markings; (E) Mature male displaying mature palpal bulbs on the distal end of the pedipalps; (F) Large mature female with round, bulbous abdomen and reduced opisthosomal markings; (G) Mature male with slender, discoloured opisthosoma and mature palpal bulbs on the distal end of the pedipalps; (H) Old mature female, with a missing frontal leg, slender, shrivelled abdomen. The opisthosomal markings are barely visible.

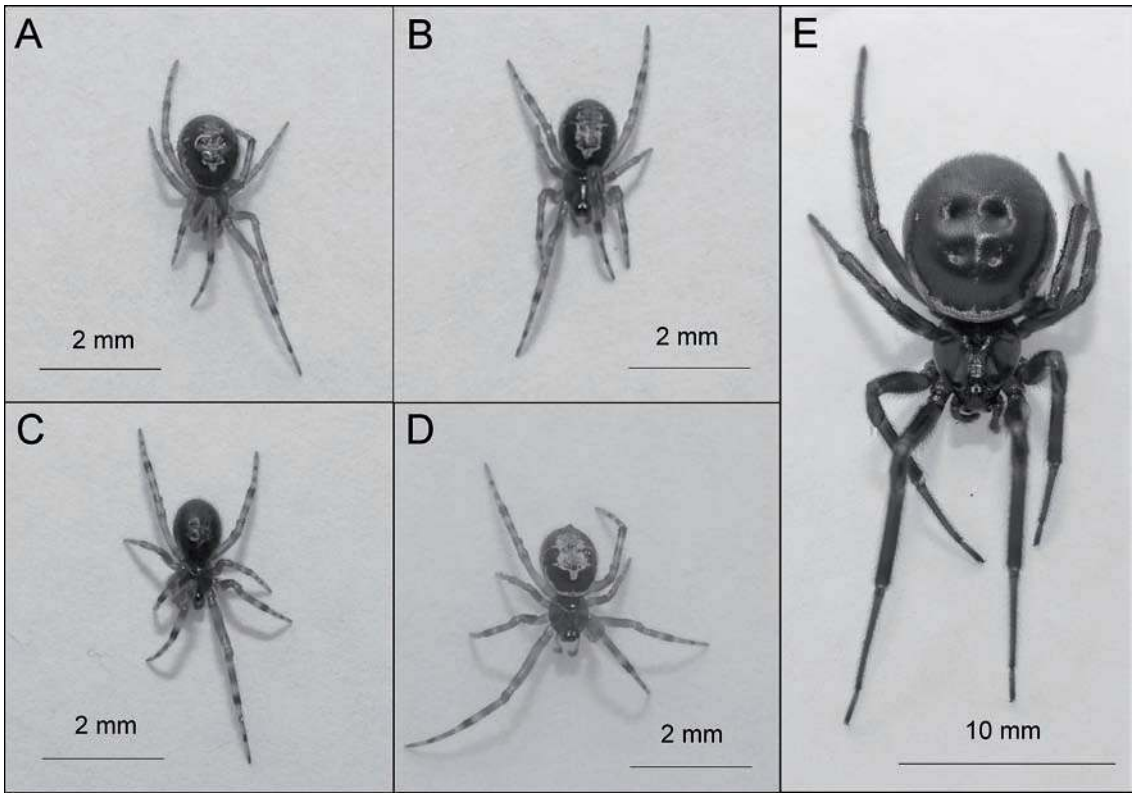

Fig. 3—(A–D) Sibling second instar *Steatoda nobilis* hatched from the same egg sack. Note the wide variations in the intensity and shape of the opisthosomal markings. (E) Mature female *S. nobilis* with four prominent dimples on the dorsal aspect of the opisthosoma, characteristic of the genus *Steatoda*. Note the reduced dorsal markings but the presence of a cream band on the antero-lateral aspect of the opisthosoma.

The average body length (prosoma + opisthosoma) was 10.5mm for mature females (N=90) and 9.4 mm for mature males (N=12). The largest mature female measured 13.7mm and the largest mature male measured 11.6mm. When hatching, juveniles measure 1.7mm (N=15) and the sexes are indistinguishable from each other.

REPRODUCTIVE RATE

For the present study, females and males were housed separately in the lab; over a period of 11 months, 40 wild-caught females produced a total of 50 egg sacs in captivity. Each egg sac contained on average 94 eggs (range 34 to 208 eggs). The most prolific spider produced four egg sacs within four months.

Prior to oviposition, the female produces an irregular silky brooding chamber approximately 3–4cm in diameter which does not possess any entrance. After two to ten days spent in the brooding chamber, a spherical or pear-shaped egg sac is produced. Eggs are laid in quick succession and clumped together into a spherical mass. A first layer of loose silk is produced around the egg mass, followed by a second layer of denser silk. Ultimately, the egg sac resembles a spherical or pear-shaped mass 5–12mm in diameter, suspended by threads inside the brooding chamber (Fig. 4). After an average of 18 days at 20°C, spiderlings emerge from their chorion, and remain within the egg sac, where

Fig. 4—Captive mature female *Steatoda nobilis* guarding her egg sac suspended in a brooding chamber made for that purpose. The egg mass is visible through the silk as the faint yellow circular shape at the centre of the egg sac.

they undergo a first ecdysis. Two to four days after the first moult, spiderlings emerge from the egg sac and collectively produce a long clump of silk threads along which they settle as a group. At this stage, the spiderlings are capable of capturing and consuming small live prey (e.g. *Drosophila melanogaster*). Dispersal occurs several days later, at which point the spiderlings display increasing cannibalistic behaviour against their siblings.

DISCUSSION

IRISH DISTRIBUTION

Considering its conspicuous dorsal markings, overall body size and synanthropic affinities, it is unlikely (but not impossible) that Irish populations of *Steatoda nobilis* passed unnoticed for several years prior to Nolan's report (1999). Van Helsdingen (1996), did not include the species in his extensive literature review on Irish spiders. Rapid colonisation event by *Steatoda nobilis* has been reported before from California, where the species has become widespread within three years of the first sighting (Vetter and Rust 2012;Vetter *et al*. 2015).

Although we did not survey each of the 32 Irish counties, the present study shows that since Nolan's report (1999), *Steatoda nobilis* has expanded its range that now includes at least sixteen counties. Within the last two decades, *Steatoda nobilis* has established thriving colonies in major port towns on the eastern, southern and western coasts of Ireland and, to a lesser extent, in the midland counties. Most sightings recorded during the course of this study occurred in cities or along major transport routes across Ireland, with the exception of a single specimen captured in a bungalow located in Curraghbinny Woods, near the coastal village of Crosshaven, Co Cork. Surveys of coastal habitats, meadows and woodlands in Cos Galway, Mayo and Roscommon did not yield any additional specimen. There is no doubt however that a comprehensive, nationwide survey would yield many more additional positive records.

The evident distribution pattern that emerges from our survey is the distinct preference of *Steatoda nobilis* for man-made structures: all sightings were made in and around houses or on street furniture. This is in contrast to its native range where *Steatoda nobilis* occupy mixed habitats consisting of natural features (e.g. plants and rock crevices) and man-made structures. In Italy, *Steatoda nobilis* occurred first in urban areas and then spread to the surrounding countryside (Kulczycki *et al*., 2012) while in the northern part of its new range, *Steatoda nobilis* appears to be restricted to man-made habitats. This pattern suggests a climate-dependent colonisation: *Steatoda nobilis* is an exclusively synanthropic species in Ireland, and its current long-range expansion is highly dependent on human activity rather than natural dispersal methods such as ballooning. Unintentional human-led introductions are believed to have been the main factor in the introduction of over 87 species of non-native spiders in Europe between 1850 and 2000, of which 71% live synanthropically (Kobelt and Nentwig 2008).

INTRAGUILD COMPETITION, REPRODUCTIVE RATE AND POTENTIAL IMPACT

The impact of alien spiders on native Irish ecosystems has not been investigated yet but some observations can be drawn from our dataset. *Steatoda nobilis* appears to be a generalist feeder, preying on a wide range of arthropods, as long as the prey can be immobilised and consumed. The few interactions between *Steatoda nobilis* and native (or naturalised) spiders recorded here show that large numbers of *Steatoda nobilis* might have a negative impact on local populations of common urban dwellers such as the missing sector orb weaver *Zygiella x-notata*. This species occurs in habitats which are also favoured by *Steatoda nobilis* (e.g. street furniture, railings and stone walls) and competition between both species is therefore likely. Although *Zygiella x-notata* and *Steatoda nobilis* have been observed side by side during our site inspections, it seems that *Zygiella x-notata* is not as widespread in those areas colonised by *Steatoda nobilis* than in locations where we did not observe the presence of *Steatoda nobilis.* Interspecific competition for prey items is a possible factor for this observation, as it has been shown that prey availability is a major factor for the successful establishment or the displacement of *Zygiella x-notata* colonies (Wherry and Elwood 2009).

Differences in reproductive rates may bring additional stress on local species that are unable to compete with the larger, more productive *Steatoda nobilis. Zygiella x-notata* has been shown to produce one–three egg sacs per year, each containing *c*.10–70 eggs (Wherry and Elwood 2009). In comparison, our data shows that *Steatoda nobilis* can produce much larger egg sacs containing between 34 and 208 eggs (98 eggs in average per clutch), every month, over a period of several months. Previous reports show that *Steatoda nobilis* can still produce viable clutches 18 months following fertilisation (Locket 1979). Additionally, *Zygiella x-notata* does not lay eggs during the coldest month of the year (Wherry and Elwood 2009) while female *Steatoda nobilis* are cold tolerant (Jones 1979) and active throughout the year. In our study, *Steatoda nobilis* captured outdoors in the middle of winter were capable of producing viable egg sacs days only after being established in the lab. In addition, *Steatoda nobilis* has a remarkable life span: a specimen kept in a sheltered environment free of predators can live over five and a half years (Snazell 1993) against

twelve months on average for *Zygiella x-notata* (Yoward 1999). Considering the preference of *Steatoda nobilis* for sheltered habitats where it has few to no predators, it is likely that 'wild' specimens are almost as productive and long-lived as the specimens kept in captivity. If this is the case, *Steatoda nobilis* may well have the potential to outcompete native urban dwelling spiders. Further field-based studies and long-term surveys will be needed to monitor the range expansion of *Steatoda nobilis* and to assess if this occurs at the expense of native species.

ACKNOWLEDGEMENTS

The authors would like to thank P and J Dunbar, Emma Lawlor, Dylan O Moore, Nicholas Irani, James Dunbar, Eoin MacLoughlin and Craig Curry for assistance during field work; Milca Gabb and Andy Wilson (MIAN Photography and Training) for their help with photography; Dr Margaret Flaherty for her assistance with GIS data and Prof Wallace Arthur for kindly reviewing this manuscript before submission. This work has been financed through an Irish Research Council postdoctoral fellowship held by Michel Dugon and a NUI Galway College of Science PhD scholarship held by John Dunbar.

REFERENCES

Bate, R. (2005). Steatoda nobilis in Warwickshire. Spider Recording Scheme **80**, 15. Newsletter of the British Arachnological Society, **131.**

Binding, A. (2014). Steatoda nobilis, the first record from Lincolnshire. Spider Recording Scheme **41**, 8. *Newsletter of the British Arachnological Society*.

Bristowe, W.S. (1929). The Distribution and Dispersal of Spiders. *Proceedings of the Zoological Society of London*, **99**, 633–657.

Cardoso, P. (2000). Portuguese spiders (Araneae): a preliminary checklist. *Ekológia (Bratislava)*, **19**, 19–29.

Daws, J. (2008). Steatoda nobilis in Leicestershire. Spider Recording Scheme **62**, 18. *Newsletter of the British Arachnological Society*, **113**, 18.

Déjean, S. (2013). Quelques observations d'araignées (Arachnida, Araneae) dans les provinces de Castillon et de Valence (Espagne). *Revista Ibérica de Aracnología*, **23,** 133–140.

Faúndez, E.I. and Téllez, F. (2016). Primer registro de una mordedura de Steatoda nobilis (Thorell, 1875) (Arachnida: Araneae: Theridiidae) en Chile. *Arquivos Entomolóxicos*, **15**, 237–240.

Hann, S.W. (1990). Evidence for the displacement of an endemic New Zealand spider, Latrodectus katipo Powell by the South African species Steatoda capensis Hann (Araneae: Theridiidae). *New Zealand Journal of Zoology*, **17**, 295–307.

Jackson, A.R. (1907). On some rare arachnids captured during 1906. *Report and Proceedings of the Chester Society of Natural Science*, **6**, 1–8.

Jones, D. (1979). Steatoda nobilis (Thorell) 1875, its occasional appearance in Britain. *Newsletter of the British Arachnological Society*, **24**, 3–5.

Jones, D. (1987). The return of Steatoda nobilis (Thorell). *Newsletter of the British Arachnological Society*, **49**, 7–8.

Jones, G. (2006). Steatoda nobilis (Thorell 1875) a spider new to Wales at Barry, Glamorgan (VC41). Spider Recording Scheme 55, 20. *Newsletter of the British Arachnological Society.*

Kobelt, M. and Nentwig, W. (2008). Alien spider introductions to Europe supported by global trade. *Journal of Diversity and Distribution*, **14**, 273–280.

Kovoor J. and Muñoz-Cuevas A. (2000). Diversité des Arachnides dans les îles d'Hyères (Porquerolles et Port-Cros, Var, France). Modifications au cours du XXe siècle. *Zoosystema*, **22**, 33–69.

Kulczycki, A., Simeon, E., Legittimo, C.M. and Di Pompeo, P. (2012). New Records of Steatoda nobilis (Thorell, 1875) (Araneae, Theridiidae), an introduced species on the Italian mainland and in Sardinia. *Arachnology*, **15**, 269–272.

Locket, G. H. (1979). Some notes on the life history of Steatoda nobilis (Thorell). *Newsletter of the British Arachnological Society*, **25**, 8.

Merrett, P. (1989). Twelve hundred new county records of British spiders. *Bulletin of the British Arachnological Society*, **8**, 1–4.

Nolan, M. (1999). Three spiders (Araneae) new to Ireland: Bolyphantes alticeps, Oonops domesticus and Steatoda nobilis. *The Irish Naturalists' Journal*, **26**, 200–202.

Pickard-Cambridge, O. (1879). On some new and rare British spiders, with characters of a new genus. *Annals and Magazine of Natural History*, **5**, 190–215.

Reiser, N. (2013). Einschleppung und Einwanderung von Spinnentieren (Araneae; Opiliones) in Deutschland. Bachelorarbeit zur Erlangung des akademischen GradeSteatoda Hochschule Neubrandenburg Fachbereich Landschaftswissenschaften und Geomatik Naturschutz und Landnutzungsplanung.

Smith, C. J. (1992). Steatoda nobilis Spider Recording Scheme **15**, 7. *Newsletter of the British Arachnological Society*.

Snazell, R. and Jones, D. (1993). The theridiid spider Steatoda nobilis (Thorell, 1875) in Britain. *Bulletin of the Bitish arachnological Society*, **9**, 164–167.

Taucare-Ríos, A., Mardones, D., Zúñiga-Reinoso, A. (2016). Steatoda nobilis (Araneae: Theridiidae) in South America: a new alien species for Chile. *The Canadian Entomologist*, **148**, 479–481.

Thorell, T. (1875). Diagnoses Aranearum Europaearum aliquot novarum. *Tijdschrift voor Entomologie*, **18**, 81–108.

Turkey, T. and Mergen, O. (2007). The comb-footed spider fauna of the central Anatolia region and new records for the Turkish fauna (Araneae: Theridiidae). *Serket*, **10**, 112–119.

Van Helsdingen, P. J. (1996). The county distribution of Irish spiders, incorporating a revised catalogue of the species. *The Irish Naturalists' Journal*, **25**: 1–87, 89-92.

Van Keer, K. (2010). An update on the verified reports of imported spiders (Araneae) from Belgium. *Nieuwsbrief van de Belgische Arachnologische Vereniging*, **25**, 210–214.

Vetter, R.S. and M.K. Rust. (2012). A large European comb-foot spider, Steatoda nobilis (Thorell, 1875) (Araneae: Theridiidae) newly established in Ventura County, California. *The Pan-Pacific Entomologist*, **88**, 92–97.

Vetter, R.S., Adams, R.J., Berrian, J.E. and Vincent, L.S. (2015). The European spider Steatoda nobilis (Thorell, 1875) (Araneae: Theridiidae) becoming widespread in California. *The Pan-Pacific Entomologist*, **91**, 98–100.

Warrell, D.A., Shaheen, J., Hillyard, P.D. and Jones, D. (1991). Neurotoxic envenoming by an immigrant spider (Steatoda nobilis) in southern England. *Toxicon*, **29**, 1263–1265.

Wherry, T. and Elwood, R.W. (2009). Relocation, reproduction and remaining alive in an orb-web spider. *Journal of Zoology*, **279**, 57–63.

Yoward, P. (1999). Sedentary monogamy and geriatric persistence of existence in the spider Zygiella x-notata (Clerck, 1757). Spider Recording Scheme **84**, 6. *Newsletter of the British Arachnological Society*.

Zamani, A., Mirshamsi, O., Jannesar, B., Marusik, Y.M. and Esyunin, S.L. (2015). New data on spider fauna of Iran (Arachnida: Araneae), Part II. *Zoology and Ecology*, **25**, 339–346.