



THE IRISH NATURALISTS' JOURNAL

c/o National Museums Northern Ireland, Cultra, Holywood, Co. Down BT18 0EU

UK Company No. NI 027133 Charity Ref. XO 887/91

www.irishnaturalistsjournal.org

INJ Article Offprint

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This article should be cited as:

Nelson, B., O Connor, Á., Foster, G.N., Doddy, P. and Roden, C. (2019) A review of *Ochthebius nilssoni* Hebauer (Coleoptera: Hydraenidae) in western Ireland including a first report from Lough Carra. *Irish Naturalists' Journal* **36** (2): 117-122.

Published: 25 April 2019

A review of *Ochthebius nilssoni* Hebauer (Coleoptera: Hydraenidae) in western Ireland including a first report from Lough Carra

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The hydraenid water beetle Ochthebius nilssoni Hebauer, 1986 was a surprising addition to the Irish fauna in 2006 given that the species was known with certainty only from its type locality in northern Sweden (O'Callaghan et al. 2009). Between 2006 and 2010 the species was recorded from five Irish localities all within the eastern Burren. Here we report on the discovery of the species in Lough Carra in Co. Mayo, which is a significant extension of its Irish range. We discuss the broad ecology of Ochthebius nilssoni and, based on that knowledge, list potential additional sites and, finally, speculate on the future prospects of the Irish population.

HISTORY AND RECORDED DISTRIBUTION OF *OCHTHEBIUS NILSSONI* IN IRELAND

The first Irish specimens of *Ochthebius nilssoni* Hebauer 1986 were collected by Eoin O'Callaghan at Briskeen Lough, Co. Galway on 9 August 2006 (O'Callaghan et al. 2009). These were initially identified as *Ochthebius nanus* Stephens, 1829 but their true identity was uncovered by Garth Foster (GNF). Any specimen of *O. nilssoni* keyed correctly using Friday (1988), the standard identification guide to the British and Irish Hydraenidae, would be identified as the non-Irish *O. nanus*. The occurrence of *O. nanus* in Ireland noted in Friday (1988) is an error as explained in Nelson and Foster (2005).

Between 2007 and 2010, *O. nilssoni* was found at four additional sites in the eastern Burren as listed in Table 1 which provides all the records for the species that are held in the British and Irish water beetle dataset managed by the Balfour Browne Club. In 2011, Brian Nelson (BN) and Áine O Connor (ÁOC) found *O. nilssoni* in Lough Carra, Co. Mayo the first Irish records from outside the Burren region. The species was again collected by BN and ÁOC in Lough Carra on a visit with Philip Doddy (PD) in 2016. Full details of the Lough Carra records are as follows.

Mayo (VC H26)

M166736, Lough Carra shore at Kilkeeran townland, 8 August 2011, several individuals collected in shallow water with marl and biofilm encrusted rocks and cobbles and sparse *Phragmites australis* (Cav.) Trin. ex Steud., coll. ÁOC, det. ÁOC and BN.

M166742, Lough Carra shore at Portroyal townland, 8 August 2011, collected in shallow water over marl and biofilm encrusted gently shelving limestone bedrock (Figure 1), coll. BN, det. ÁOC and BN; and same site and habitat, 18 May 2016, 1 adult, coll. BN, det. BN.

Voucher specimens, from both 2011 and 2016, have been deposited in the insect collections of the National Museum of Ireland.

HABITAT OF THE SPECIES

The habitat of *O. nilssoni* in Ireland can broadly be described as highly oligotrophic, groundwater-fed, marl lakes with clear water in karst limestone catchments. Most of the sites have no permanent outlet streams. The known sites are amongst the best examples of the Habitats Directive Annex I habitat '3140 Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp.' in Ireland. All of the Irish sites show fluctuations in water levels,

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Table 1. Recorded distribution of *Octhebius nilssoni* Hebauer in Ireland.

Date	Grid Reference	Source
Briskeen Lough, Co. Galway (VC H15)		
9 August 2006	M41530061	O'Callaghan <i>et al.</i> (2009)
29 July 2007	M415006	O'Callaghan <i>et al.</i> (2009)
30 July 2007		O'Callaghan <i>et al.</i> (2009)
Cooloorta Lough, Co. Clare		
31 July 2007	R34849615	O'Callaghan <i>et al.</i> (2009)
Lough Gealáin, Co. Clare		
31 July 2007	R312946	O'Callaghan <i>et al.</i> (2009)
21 May 2010	R313945	Roy Anderson
22 May 2010	R31269458	Oscar Vorst
22 May 2010	R313947	Stephen McCormack
22 May 2010	R313947	Robert Aquilina
22 May 2010	R3295	G.N. Foster
Lough Bunny, Co. Clare		
22 May 2010	R37459628	G. van Ee
22 May 2010	R378259667	Robert Aquilina
23 May 2010	R37829668	P.J. Hodge
28 May 2010	R374962	G.N. Foster
30 May 2011	R374962	Brian Nelson
25 May 2013	R378966	Brian Nelson
Knockaunroe turlough, Co. Clare		
22 May 2010	R31359406	Oscar Vorst
Lough Carra, Co. Mayo (VC H26)		
8 August 2011	M166736	ÁOC, this paper
8 August 2011	M166742	BN, this paper
18 May 2016	M167740	BN, this paper

**Figure 1.** Collecting site for *Octhebius nilssoni* at Portroyal townland on shore of Lough Carra, Co Mayo, 8 August 2011, a view looking south from M166742. Photo: Brian Nelson.

for example at Coooororta and Lough Gealáin, where permanent basins of open water are part of larger turlough systems. With the probable exception of the record from Knockaunroe, all Irish specimens of *O. nilssoni* have been collected in areas of permanent open water.

The pale substratum that coats the beds of the lakes where *O. nilssoni* occurs is often simplistically called marl, with the implication that it is an inorganic precipitate of calcium carbonate, whereas it actually contains a living diatom and cyanobacterial community (John *et al.* 1982, Pentecost 1981, 2009, Kennedy *et al.* 2012, Roden and Murphy 2013, PD unpublished). This crust can cover extensive areas of the littoral to c. 2m depth and can be many centimetres thick creating a spongy covering over gravel, cobbles, boulder and bedrock. This gives the shallow part of these lakes their highly distinctive bright, cream-yellow appearance, which is clearly visible on aerial imagery. This crust or biofilm has been termed *krustenstein* by Roden and Murphy (2013) a term that has been used since at least 1941 (Viles and Goudie 1990). The composition of the Irish *krustenstein* is under investigation but the cyanobacterium *Schizothrix fasciculata* Gomont ex Gomont, 1892 is considered to be an important component (Roden and Murphy 2013). *Krustenstein* is characteristic of the most-oligotrophic Irish hard water lakes on Carboniferous limestone and preliminary data suggest that the *krustenstein* is negatively impacted by nutrient pollution (Roden and Murphy 2013, PD and CR unpublished data.).

Macrophytes, other than sparse *Chara* spp. and open stands of Common Reed (*Phragmites australis*), are generally absent from *krustenstein* zones. It would appear from field observations and the habitat at the Irish sites, that *O. nilssoni* is associated with the *krustenstein*. O'Callaghan *et al.* (2009) stated that the species "was abundant but largely confined to 60-80cm depth over exposed marl" and that "unlike most species of the genus, the beetles proved to be negatively buoyant, meaning that they would not be detected by the usual method of disturbing the substratum to float them to the surface". In the experience of BN and ÁOC the most successful method of finding adults is by sweeping over the top of the rocks and boulders to dislodge the biofilm which is then examined in a collecting tray. The beetles have been observed by the authors to cling to fragments of crust in the sorting tray.

The type locality for *O. nilssoni* is Vastra Skärträsket, a very clear, cold-water, oligotrophic lake, in the northern Swedish province of Västerbotten (Hebauer 1986, Hjelm *et al.* 2000). The species was originally found in a slightly

sheltered bay at 0.5 m depth amongst sand and gravel. The beetle cannot be found in other lakes in the area (Anders Nilsson pers. comm. to GNF). DNA analysis of specimens from the Tagliamento River near Cannusio, in Udine Province, north-east Italy reported by Kahlen (2010) has shown this population to be conspecific with Irish and Swedish ones (Ignacio Ribera unpublished). These Italian specimens came from an area where the river valley is deeply covered in ooze derived from dolomitic limestone (Kahlen 2010). Lakes in the surrounding area have recently been searched without success by GNF. Thus, Ireland has the greatest number of known sites for this species. We consider that further searches in Sweden and Italy (and elsewhere) should be directed at sites that have the potential to hold *krustenstein*.

KNOWN IRISH SITES

The following is a brief description of the six known Irish sites for *O. nilssoni*.

Briskeen Lough, Co. Galway (M4100). This is a small groundwater-fed lake with extensive *Cladium mariscus* surrounded by improved and semi-improved grassland. O'Callaghan *et al.* (2009) said that the original specimens were taken in 2006 in a small side pool on "biofilm-encrusted marl" which suggests that *krustenstein* may be present in Briskeen. The 2007 specimens were found in "relatively deep water over semi-solid marl with little or no *Chara*" on the eastern shore of the lake.

Coooororta, Co. Clare (R3496). *Ochthebius nilssoni* was found at Coooororta in a small permanent lake basin in limestone pavement. The site is within a turlough system that has a complex of aquatic habitats (Goodwillie *et al.* 1997). *Krustenstein* is well developed in this high quality site (PD and CR unpublished).

Lough Gealáin, Co. Clare (R3194). Lough Gealáin is a turlough with a permanent marl lake in a single deep basin that is described as a collapsed doline (Byrne and Reynolds 1982). The shallows have well-developed *krustenstein*. Gealáin merges with Knockaunroe (see below) at high water levels.

Knockaunroe Turlough, Co. Clare (R3194). This is perhaps the most sampled turlough for invertebrates in Ireland (*e.g.* Bilton 1988, Regan 2005, Reynolds 1985) but has produced just a single record of *O. nilssoni*. It is hydrologically linked to Lough Gealáin. The bed of the turlough comprises short *Carex* fen and wet grassland with mosses, charophytes and other aquatics ('marl

pond' communities) (Goodwillie 1992, Waldren 2015). There is no deep area of permanent water and no information on the occurrence of krustenstein or other biofilms. It is unlikely that this site is a permanent one for the species. Possible explanations for its occurrence here are that it may have travelled from Lough Gealain, through underground channels or at high water, or that the record resulted from mislabelling or accidental contamination.

Lough Bunny, Co. Clare (R3796). Roden (2001), Pybus *et al.* (2003) and Roden and Murphy (2013) describe this lake which is one of the larger permanent lakes in the eastern Burren. It is relatively well collected for water beetles. *O. nilssoni* was only discovered here in May 2010 when it was abundant on the gently shelving and krustenstein-covered eastern shore. However, the abundance of the species does appear to vary enormously and in our experience the beetle can also be impossible to find at this location. Whether this is related to weather conditions or seasonal behaviour of the species needs investigation.

Lough Carra, Co. Mayo (M1674) is a permanent marl lake in south Mayo that is part of the Mask/Corrib system. The catchment is entirely limestone although much is covered in drift but the lake is predominantly groundwater fed (Huxley and Huxley 2015). The area of the lake is c.15.6 km² so it is significantly larger than the Burren *O. nilssoni* sites. The lake has three main sections, each containing several deep basins around which there are extensive areas of shallow water (<6 m) (Roden and Murphy 2013). Wave-washed boulders and cobbles covered in krustenstein are common in shallow water. Less exposed areas have fine, silty marl. In a few places, such as Portroyal, the shore topography is strikingly similar to the Lough Bunny site, consisting of gently shelving limestone bedrock (Fig. 1). Krustenstein is very extensive in Lough Carra covering much of the shallow water (Roden and Murphy 2013). *O. nilssoni* has only been recorded in the central Castle Carra section, the only one of the three considered to be in favourable conservation condition (Roden and Murphy 2013). A water beetle list from Lough Carra is provided by McGoff and Irvine (2009) but does not include this species.

POTENTIAL SITES

Hard water lakes can be found in western and midland counties of Ireland mainly to the north and west of a line from the Shannon Estuary to Dundalk Bay (see NPWS 2013a, b). Suitable

sites for *O. nilssoni* are at the extreme end of the marl lake spectrum, being the most nutrient poor, least impacted and highest conservation value examples. Extensive areas of shallow water with krustenstein would appear necessary for *O. nilssoni*. Lakes that have the greatest potential to support *O. nilssoni* are listed in Table 2. All the listed sites have been sampled at least once for water beetles. However, the surveyors at the time may have had no knowledge of the species and, crucially, lacked field experience of how to look for it. Some of the sites have not, to our knowledge, been visited since 2007.

FUTURE PROSPECTS OF *OCHTHEBIUS NILSSONI* IN IRELAND AND RESEARCH NEEDS

The association of *O. nilssoni* with extreme hard water conditions and, in particular, the krustenstein biofilm seems a reasonable hypothesis based on our experience of it in its Irish sites. Confirmation and further elucidation of this ecological link is desirable. Aspects of the biology of *O. nilssoni* that require research are the description of the larvae and pupal stage, its life history and dietary studies of both adults and larvae. Research into the krustenstein is ongoing to investigate its composition and response to changing nutrient levels and the relationship between Irish krustenstein and that found in other parts of the world.

Krustenstein appears to be a habitat that has been lost from other parts of Ireland and Britain and perhaps elsewhere (Pentecost 2009, Roden and Murphy 2013). The pressures that hard water lakes face in Ireland are discussed in NPWS (2013b) and O Connor (2015) and in England by Wiik *et al.* (2015). Many of these pressures are significant in Lough Carra (Hobbs *et al.* 2005, Huxley 2007, Huxley and Thornton 2008, Irvine *et al.* 2008, Kennedy *et al.* 2012, Roden and Murphy 2013) and the population of *O. nilssoni* in the lake may be threatened, along with the krustenstein and the other red listed species of water beetle. As Ireland contains the majority of the global population of the species, the country has a responsibility to protect it.

ACKNOWLEDGMENTS

We are grateful to an anonymous referee for suggesting improvements to this paper. Thanks are due to Ignacio Ribera (Institut de Biologia Evolutiva, Consejo Superior de Investigaciones Científicas, Barcelona) for sharing preliminary data and to the water beetle recorders who have supplied records of the species.

Table 2. List of lakes that are known to have krustenstein and are considered potential sites for *Ochthebius nilssoni* in Ireland. The presence and status of krustenstein is unpublished data from CR and PD.

Lake	Comments on status of Krustenstein and suitability for <i>O. nilssoni</i>
Lough Corrib Cos Galway/Mayo	Krustenstein was in good condition in 2004 but poor or absent by 2012. Suitable habitat for <i>O. nilssoni</i> may be present on the eastern side at Annaghdown, Ballinduff Bay and Inchiquin Island.
Lough Mask Cos Galway/Mayo	No living biofilms were observed in 2012. There are areas of potentially suitable shoreline habitat in the south-east and additionally, perhaps, in the north east.
Annaghmore Lough Co. Roscommon	Extensive and well developed krustenstein. The lake has been sampled for water beetles but not in a method that is suitable for detecting <i>O. nilssoni</i> .
Muckanagh Lough Co. Clare	Extensive and thick krustenstein present. This was sampled for <i>O. nilssoni</i> in October 2017. The area sampled for water beetles in 2007 lacked good quality krustenstein.
Lough Rea Co. Galway	This lake has been sampled several times for water beetles but <i>O. nilssoni</i> has not been recorded. The extensive krustenstein found by PD and CR is not accessible from the shore.
Lough Owel Co. Westmeath	Krustenstein is common in the lake, especially on the east and west shores. There has been some recording of water beetles but mainly from accessible areas of the southern shore which have no krustenstein.
Ballyeighter Loughs Co. Clare	Krustenstein is present in these charophyte-dominated marl lakes.
Lough Cullaun Co. Clare	Krustenstein is well developed in shallow water and the lake has a shallow euphotic zone, possibly due to peat staining.
Brick Lough Co. Galway	Krustenstein was observed on a boulder, however hard surfaces are rare and the shoreline is steeply sloped.
Bleach Lough Co. Limerick	Krustenstein is well developed on the few exposed rocks and there is high water transparency.
Walshpool Lough Co. Mayo	Krustenstein is well-developed despite the shallow euphotic zone.
Errit Lough Co. Roscommon	Krustenstein is present on rocks in shallow water in Errit Lough, which is heavily peat-stained with very shallow euphotic zone and secchi depth.
Lough Bane Co. Westmeath	Krustenstein is present.
Lough Ennell Co. Westmeath	Appears to be recovering from eutrophication with good development of krustenstein on rocks.
Lough Lene Co. Westmeath	A clear water lake with well-developed krustenstein.
White Lough Co. Westmeath	Krustenstein is present.

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