On the distribution of the rare solitary bee *Coelioxys lanceolata* Nylander, 1852 (Hymenoptera, Megachilidae) in Norway

MARKUS ARNE KJÆR SYDENHAM, FRODE ØDEGAARD, KAJ-ANDREAS HANEVIK, DANIEL INGVAR JEUDERAN SKOOG, HELENE TOTLAND MÜLLER & MARI STEINERT

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Coelioxys lanceolata Nylander, 1852 is considered to be one of the rarest bee species in the Nordic countries, previously with only four unique observations registered for Norway. Here nine new unique observations of *C. lanceolata* for Norway, including three new county records are given and an updated map and discussion of its distribution in Norway is provided. The relative uncommonness of *C. lanceolata* compared to other bee species may be due to sampling biases. A sampling scheme that would allow assessing if such bias is influencing our knowledge of the status of Norwegian bees is therefore suggested.

Key words: Hymenoptera, Megachilidae, bees, Norway, distribution.

Markus Arne Kjær Sydenham, Kaj-Andreas Hanevik, Daniel Ingvar Jeuderan Skoog, Helene Totland Müller & Mari Steinert, Faculty of Environmental Sciences and Natural Resource Management, The Norwegian University of Life Sciences, P.O. Box 5003, 1432-Ås, Norway. E-mail: markus.sydenham@nmbu.no

Frode Ødegaard, Norwegian Institute for Nature Research, P.O.Box 5685 Torgarden, NO-7485 Trondheim, Norway.

Introduction

Of the 208 bee species recorded in Norway (Ødegaard, 2018a), *Coelioxys lanceolata* Nylander, 1852 (Figure 1) is among the rarest with only four unique (i.e. non-overlapping) recordings in the GBIF databases per 23 March 2018 (Ødegaard & Vang 2018, Natural History Museum University of Oslo 2018). Moreover, the observations vary in age with only one unique observation each year in 1993 (leg. A. Bakke, Telemark County), 1999 (leg. L.O. Hansen and D. Wisland, Telemark County), 2011 (leg. F. Ødegaard, Oppland county) and 2012 (leg. A. Sverdrup-Thygeson and A. Endrestøl, Aust-Agder County). *C. lanceolata* is currently Redlisted as endangered (EN) in Norway according to IUCN criteria (Henriksen & Hilmo 2015).

C. lanceolata is a cleptoparasite and instead of provisioning for their larvae, females lay their eggs in the nests of *Megachile nigriventris* Schenk, 1870 (Scheuchl & Willner 2016). Its distribution is therefore tightly linked to the distribution of the host *M. nigriventris*, a Fabaceae specialist that nests in self-excavated burrows in logs of dead wood (Westrich 1989). *C. lanceolata* is a widespread species and is distributed from Spain to Russia and in the Nordic countries: Norway, Sweden and Finland (Kuhlmann *et. al.* 2017) and is considered of least concern (LC) on the European IUCN redlist (Nieto *et al.* 2014). However, regionally *C. lanceolata* is a rare species

FIGURE 1. Female *Coelioxys lanceolata* Nylander, 1852 from Sør-Fron, Oppland county. Photo: Arnstein Staverløkk (NINA) – CCBY.

and is currently considered, vulnerable (VU) in Finland (Rassi *et al.* 2010), near threatened (NT) in Sweden (ArtDatabanken 2015) and critically endangered (category 2) in Germany (Scheuchl & Schwenninger 2015). In the Nordic countries only 42 unique observations, i.e. non-overlapping localities, are reported in the GBIF database (GBIF Secretariat 2017): 10 in Finland (4 since 1990), 26 in Sweden (13 since 1990), and four in Norway (all since 1990).

An updated distribution map for the species in Norway is here provided, based on three recent bee surveys, including the first observations for three counties. Potential reasons for the perceived rarity of the species and guidelines for future species inventories are discussed.

Methods

Survey 1 was conducted by Anne Lene Aase in 2010 when bees were sweep netted on flowers in and around Hobøl in Østfold county. Survey 2 was a specific project for mapping of Aculeate Hymenoptera (INVENT-ART) with a focus on biodiversity of sandy areas in southern Norway (Ødegaard, 2018b). In this project, specimens were collected using malaise traps, yellow pan traps and sweep netting. Survey 3 was conducted as part of a large-scale field study conducted in 19 power line clearings in SE Norway where the insect fauna was sampled using flight interception traps over a three-year period (2013–2015). All study sites were located in predominantly forested

landscapes and sampling took place in the same sites in 2013, 2014 and 2015 (see Sydenham *et al.* (2016) for a complete description of the study design). Survey 4 was a project (PYROBUG) for mapping insects' successions after a particular forest fire in Froland in Aust-Agder county in 2008 (Ødegaard 2018c).

All collected specimens from Surveys 1 and 3 were identified by the first author. The specimen collected in Survey 1 was verified by the second author. All specimens were identified using regional identification guides (Amiet 2004, Scheuchl 2006). Specimens from surveys 1, 2 and 4 are stored at the Entomological collection at the Norwegian Institute for Nature Research and specimens from survey 3 are stored at the Entomological collection at the Norwegian University of Life Sciences.

All data processing and maps were produced using the free statistical software R (R development core team 2014) and the 'Raster' (Hijmans *et al.* 2016) and "RgoogleMaps" (Loecher & Ropkins 2015) libraries. Corine land cover (CLC) type (Feranec *et al.* 2016) and elevation (Geonorge 2018) were extracted for each record to identify the most common landscape type in which the species had been found.

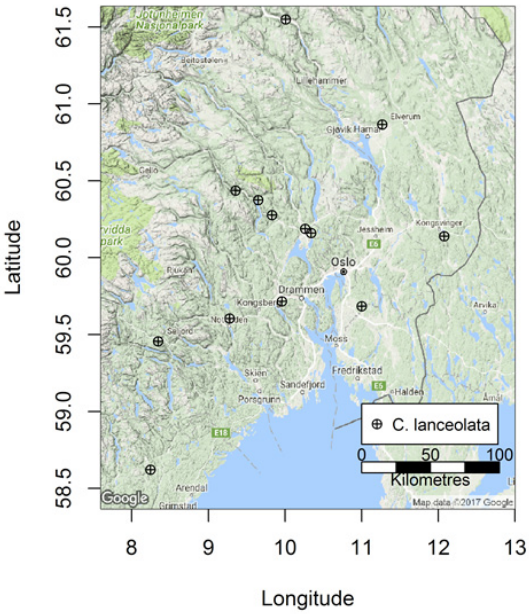

FIGURE 2. The updated distribution map of *Coelioxys lanceolata* Nylander, 1852 in South eastern Norway. See Table 1 for details on sampling year, habitat type, and sampling method for each site.

Results

The three surveys resulted in a total of nine new unique observations of *C. lanceolata* (Table 1) bringing the Norwegian total up to 13 records (Figure 2). These observations include new County recordings for Buskerud (Survey 3), Østfold (Survey 1) and Hedmark (Surveys 2 and 3) as well as a good coverage of Hallingdalen-Hønefoss in Buskerud where the species was found at five locations (Survey 3). In survey 3 *C. lanceolata* was found in two or more years at three sites (Table 1). All records were conducted below 405 m a.s.l. The dominant landcover type within a 100 m radius of the locations where records had been made were: Coniferous forests; Transitional woodland-shrub; Agricultural land but with high amounts of seminatural habitats; Broad-leaved forests. All collections were made in open patches of land, e.g. power line clearings (Survey 2), grazed lands or burnt areas, all with ample amounts of dead wood (pers. obs.).

Discussion

Based on the findings *C. lanceolata* seems to be widely distributed, at least in South Eastern Norway and may be associated with coniferous forests (Table 1). The fact that it was rediscovered at three sites in separate years suggests that it may be at least locally common. Given the dependency of *C. lanceolata* on its host *M. nigriventris,* which in turn depends on habitats with ample amounts of dead trees (logs and snags), and Fabaceae (in particular *Vicia sylvatica*), power line clearings appear to be suitable habitats for *C. lanceolata*, because dead wood accumulates along the sides of the power line corridor. In addition, the power lines provide warm and light microclimates that satisfy the temperature requirements of the bees. On the other hand, the species seems to be

TABLE 1. Observations of *Coelioxys lanceolata* Nylander, 1852 in Norway. The table shows the number of individuals (Ind.) sampled at each study site during every year the surveys took place, the corine land cover (CLC) codes and elevation (m a.s.l.) for each site. CLC codes refer to: Complex agricultural landscapes (CLC 21); Broad-leaved forests (CLC 23); Coniferous forests (CLC 24); and Transitional woodland-shrub (CLC 29). Spatial coordinates are shown in Northern and Eastern latitudinal and longitudinal degrees following the World Geodetic System (84). Institutions responsible for the surveys were: The Norwegian University of Life Sciences (NMBU) and The Norwegian Institute for Nature Research (NINA), and the Natural History Museum at the University of Oslo (UIO). Collectors were: Anne Lene Aase (A.L.Aa), Alf Bakke (A.B.), Anders Endrestøl (A.E), Anne Sverdrup-Thygeson (A. S-T), Frode Ødegaard (F.Ø.), Irene Hermansen (I.H.), Jenny B. Lorange (J.B.L), and Lars Ove Hansen (L.H). Specimens were identified by (Det.) Frode Ødegaard (F.Ø.), Lars Norén (L.N.), and Markus A. K. Sydenham (M.A.K.S). For some records, information of the sex of the recorded specimens could not be retrieved from the GBIF database (NA).

Survey	Year	Ind:Sex	CLC	m.a.s.l.	Lon.	Lat.	County	Locality	Inst.	Collector	Trap type	Det.
GBIF	1993	1:NA	21	135	9.27827	59.60428	Telemark	Notodden	UIO	A.B	NA	L.N.
GBIF	1999	2:NA	29	404	8.34284	59.45552	Telemark	Kviteseid	UIO	L.H., & D. W.	NA	L.N.
1	2010	1:♂	24	195	10.99872	59.68397	Østfold	Hobøl	NMBU	A.L.Aa.	Sweep net	F.Ø
GBIF (2)	2011	1:♀,1:♂	23	232	10.01002	61.54981	Oppland	Sør-Fron	NINA	F.Ø.	Sweep net	F.Ø.
2	2011	1:♀	24	166	12.07557	60.13999	Hedmark	Kongsvinger	NINA	F.Ø.	Malaise trap	F.Ø.
GBIF (4)	2012	1:♀	24	329	8.244618	58.62083	Aust-Agder	Froland	NINA	A.S-T., & A.E.	Malaise trap	F.Ø.
3	2013	1:♂	24	248	9.829507	60.27687	Buskerud	Ringerike	NMBU	I.H., & j.B.L.	Window trap	M.A.K.S
3	2013	3:♀	24	200	9.354312	60.43605	Buskerud	Flå	NMBU	I.H., & j.B.L.	Window trap	M.A.K.S
3	2014	1:♀	24	266	9.648703	60.37454	Buskerud	Flå	NMBU	I.H., & j.B.L.	Window trap	M.A.K.S
3	2014	1:♀,2:♂	24	120	10.26256	60.18785	Buskerud	Ringerike	NMBU	I.H., & j.B.L.	Window trap	M.A.K.S
3	2015	1:♂	24	375	9.957925	59.7153	Buskerud	Øvre Eiker	NMBU	I.H., & j.B.L.	Window trap	M.A.K.S
3	2015	1:♀,1:♂	29	325	11.26649	60.86579	Hedmark	Hamar	NMBU	I.H., & j.B.L.	Window trap	M.A.K.S
3	2015	1:♀	24	248	9.829507	60.27687	Buskerud	Ringerike	NMBU	I.H., & j.B.L.	Window trap	M.A.K.S
3	2015	1:♀	24	100	9.354312	60.43605	Buskerud	Flå	NMBU	I.H., & j.B.L.	Window trap	M.A.K.S
3	2015	1:♂	24	120	10.26256	60.18785	Buskerud	Ringerike	NMBU	I.H., & j.B.L.	Window trap	M.A.K.S
3	2015	2:♀,1:♂	24	301	10.33913	60.16046	Buskerud	Ringerike	NMBU	I.H., & j.B.L..	Window trap	M.A.K.S

sporadically occurring in several types of clearings in forested landscapes. Particularly burned areas may be suitable in the successional phases when legumes are flourishing and dead wood are in proper decaying phase (Survey 4). Other habitats may be open seasonally grazed forest in south faced slopes (Survey 2) or areas with wind fallen trees in edges of sandy areas or clear cuts (Survey 2).

Two reasons or a combination of these may explain the relative scarcity of records of *C. lanceolata* in the GBIF database. Firstly, *C. lanceolata* may be widespread but locally uncommon, relative to other bees, and therefore unlikely to be observed by naturalists conducting bee surveys. Moreover, flight interception traps, as used in Survey 3 may be particularly efficient in sampling *C. lanceolata* compared to other sampling methods, e.g. pan traps (Westphal *et al.* 2008). Secondly, because *C. lanceolata* is affiliated with openings in forested habitats it may be overlooked if bee surveys are typically conducted in predominantly sandy areas or agricultural as well as sub-/urban landscapes. In this case, the knowledge of the distribution of *C. lanceolata* may be biased due to an undersampling of its habitats. Such biases in species distribution records is well known (Beck *et al.* 2014) and databases are often both spatially, environmentally, and temporally biased (Soberón *et al.* 2000, Newbold 2010). Species observation records are therefore unlikely to reflect the fundamental niche and commonness of species linked to under-sampled habitats.

Due to the biases in databases containing records of species observations it is important they are continuously updated. This is particularly so because such databases are used when evaluating species for the IUCN Redlist (Bachman *et al.* 2011), and by decision-makers when assessing how area-development will impact rare and

prioritized species (Bennun *et al.* 2018). The findings of *C. lanceolata* provide an example of how sampling bees in forested landscapes can improve our knowledge of the distribution of species. Therefore, it is recommended that future species inventories, whose aim is to estimate the relative commonness of Norwegian bee species, should aim to standardize sampling so that different landscape/habitat types are sampled according to their relative dominance in Norway.

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