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FIRST REPORT OF *OECOPHORA BRACTELLA* (L.) (OECOPHORIDAE) IN NORTH AMERICA

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ABSTRACT. The first report of *Oecophora bractella* (L.) from North America is given, based on collection records from Washington and British Columbia. This species is found throughout Europe, but is generally rare to uncommon through most of its range. Larvae occur on rotting wood in association with certain fungi and are not expected to reach pest status. Adults were captured at nine locations, with the first record from Seattle, WA in 1998. This first record and some of the subsequent records are from sites immediately adjacent to or associated with international shipping routes. Other sites with *O. bractella* are from residential areas, two of which have established breeding populations. The introduction of this moth is surprising, particularly given the low interception rate at United States ports and its specialized feeding niche. A diagnosis and photographs of adults are provided to enable North American researchers to identify this species and to monitor its spread.

Additional key words: Lepidoptera, Red Data Book, specialist, exotic, introduced, Pacific Northwest

We report in this paper the surprising discovery of *Oecophora bractella* (Linnaeus, 1758) in Washington and British Columbia, apparently reflecting an introduction of this species to North America from Europe. *Oecophora bractella* is widely known in Europe, including the UK, as a strikingly beautiful, but infrequently seen, microlepidopteran occurring from the British Isles (but not Ireland) and the southern half of Scandinavia south to the Mediterranean and east to western Estonia and the Ukraine (Karsholt & Razowski 1996; Jürivete *et al*. 2000; Lvovsky 2003). *Oecophora bractella* has a provisional listing as rare ('pRDB3') in the UK's Red Data Book (Kimber 2007), has similar Red Data Book status in both Estonia (Commission for Nature Conservation of the Estonian Academy of Sciences, 2002) and the Austrian state of Carinthia (Wieser & Hümer 1999), and is considered 'regionally threatened' in continental Finland (K. Silvonen, pers. comm.). In many other parts of its range, *O. bractella* does not have a formal conservation listing, but it is generally characterized as being scarce or having a localized distribution (Lindsey 2006; de Prins & Steeman 2007). The exceptions to this general pattern are Sweden, where *O. bractella* is considered locally common (N. Ryrholm pers. comm.), and eastern Denmark, where it is generally common (Palm 1989).

The larvae of *O. bractella* feed in the bark of decaying wood, often in close association with the mycelia of fungi, especially honey fungus (*Armillaria mellea* (Vahl:Fr.) Kummer) (Sterling, 1984). It remains unclear whether the larvae eat these fungi (Harper *et al*. 2002). Larvae can be found in the bark of a variety of different tree species, including *Quercus, Betula, Fraxinus, Corylus, Prunus, Larix, Pinus, Picea*, and *Tsuga*, feeding from January to May in the UK. Larvae typically live under a loose layer of silk and frass (Harper *et al*. 2002). Between April and June, they pupate in their feeding sites, forming a cocoon also lined with silk and frass. Adults fly from late May to the end of July in the UK, where *O. bractella* is considered to be univoltine (Harper *et al*. 2002). In Denmark, the flight season is slightly longer (mid-May to mid-August), suggesting possible bivoltinism (Palm 1989). Adults are primarily crepuscular, being most active from the early morning

light to sunrise, as well as in the late afternoon and evening (Harper *et al*. 2002; Palm 1989). They are seldom found at lights (Kimber 2007) and spend most of the daylight hours in seclusion (de Prins & Steeman 2007).

The reliance of *O. bractella* on dead wood, coupled with its apparent association with specific fungi, may explain why this species is generally limited to ancient woodlands in the UK (Harper *et al*. 2002; Kimber 2007). Its scarcity in the UK may also be exacerbated by the common forestry practice of removing trees that are infected with *Armillaria mellea*, a policy motivated by the fact that the fungus can kill stressed trees (Sterling 1984).

The specialized life history (Sakai *et al*. 2001; Suarez *et al*. 2005), and scarcity of interception records for this species at U.S. ports (USDA, APHIS, PPQ Pest Interception Database (PestID), Riverdale, Maryland) suggests that *O. bractella* should be an unlikely species for inadvertent introduction. Nonetheless, we report herein its establishment in western North America. In addition, we describe the species and provide photographs of living and pinned specimens, both to facilitate recognition of this species, and to enable North American entomologists to monitor its spread. The introduction of this species

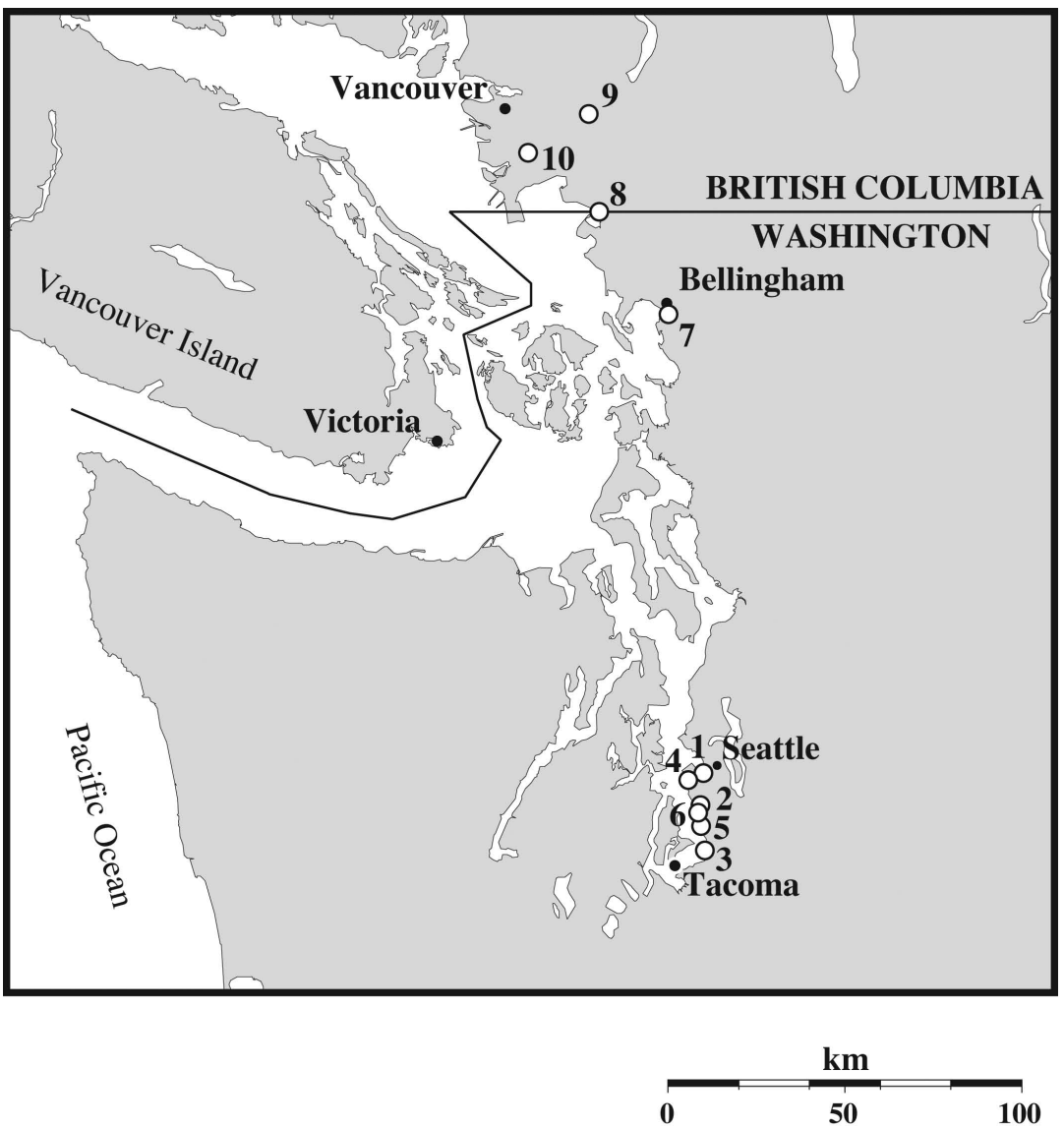

FIG. 1. Distribution of collection records for *O. bractella* in Washington and British Columbia. Open circles and site numbers correspond to the sites listed in Table 1. Closed circles indicate the location of cities. This map was generated with Online Map Creator (http://www.aquarius.geomar.de/make_map.html).

adds to a growing list of wood-associated oecophorids of European origin that have been introduced to this continent (Powell 1964, 1968; Hodges 1974).

***Oecophora bractella* in North America.** The first specimen of *O. bractella* found in North America was a male taken at a blacklight trap in the industrial area of Seattle, Washington on June 30, 1998. Two and a half weeks later, a second male was taken in this same trap. Subsequent to this collection, an additional eight specimens were collected in pheromone traps at five other south Seattle locations, most of which were in residential areas (Table 1). Interestingly, these moths were found in traps baited with four different pheromones. The pheromone-trap and light-trapping surveys in which these specimens were captured were annual projects funded in part by grants from USDA APHIS, as part of the national Cooperative Agricultural Pest Survey (CAPS) program. In addition to the Seattle-area specimens, numerous *O. bractella* specimens have been collected more recently at three locations N of Seattle, near the US/Canada border (Table 1). Four of these specimens were found in a residential neighborhood in Bellingham, one was found on a pallet upon inspection for U.S. import in Blaine, Washington, and the rest were captured in a residential neighborhood in Port Coquitlam, British Columbia and a riparian area in Burnaby, British Columbia. The locations of all known North American collection sites for *O. bractella*, indicated in Fig. 1, are listed in Table 1, with collection and deposition data. A USDA, APHIS, PPQ Pest Interception Database query turned up no reports of interceptions of *O. bractella* at ports and airports other than the Blaine, WA specimen.

The initial identification of *O. bractella* was made by one of the authors (GSR) on the basis of a photograph of a live specimen from Bellingham, WA (Fig. 2). This identification was confirmed by another author (SP) upon comparison of two Seattle-area males with both a specimen of German origin and literature illustrations of the genitalia (Palm 1978).

Several lines of evidence suggest that *O. bractella* was inadvertently introduced to North America via shipments of bulk wood products. First, because the larvae feed on *Armillaria*-infected dead tree trunks, the shipment of raw timber and/or bulk wood products could easily facilitate introduction of this species. More importantly, several of the collection locations are near international shipping terminals. Indeed, the first specimens recorded from the region were from near Seattle's shipping terminal, and the specimen from Blaine, WA was found in a shipping container upon inspection for U.S. import. The container held wood pallets loaded with insulating bricks that were shipped from Denmark (Interception # APSWA061931374003, USDA, APHIS, PPQ Pest Interception Database (PestID), Riverdale, Maryland).

The establishment of breeding populations of *O. bractella* in North America has been confirmed at two locations (Bellingham, Washington, and Burnaby, British Columbia), where immatures were found in spring 2007. At Burnaby, a half dozen unknown larvae living under the peeling bark of a dying *Alnus rubra* were collected for rearing in March. On May 3 an adult male *O. bractella* was found in the rearing chamber. Subsequent collections in this riparian habitat yielded specimens on many different *A. rubra* offering similar larval habitats, as well as one ornamental *Acer* sp. in a nearby landscaped environment. Most collections were on dying standing trees, but some were on recently felled

Fig. 2. Live *O. bractella* female from Bellingham, Washington. Photograph by MAP.

Fig. 3. *O. bractella* female from Port Coquitlam, British Columbia. Photograph by DH.

trees. In this same vicinity, larvae were not found under peeling bark on completely dead trees with very little moisture content.

In Bellingham, larvae and pupae were found in a residential area on 29 May 2007 under the bark of 2"–4" diameter dead standing branches of *Laburnum anagyroides* Medik. (Fabaceae), an introduced ornamental commonly called Golden Chain Tree. Adults were subsequently reared from three of these larvae, and a fourth larva produced an unidentified tachinid. Also on 29 May 2007, adults were found on the bark of the dead branches as well as on nearby overhanging live branches of *L. anagyroides* and neighboring trees and bushes. From 29 May to 12 June 2007, 14–18 adults were associated with this *L. anagyroides* tree, with diminishing numbers thereafter until 17 July 2007. Larvae were present through the entire six week period.

Although breeding has not been documented at other sites from which adults have been collected, it is likely that this species is established outside of Burnaby and Bellingham. Notably, adults were found in two successive years at one site south of Seattle (Site 2) .

It remains unclear whether the Pacific Northwest populations of *O. bractella* are associated with *Armillaria mellea*, the fungus with which larvae are typically associated in Europe. The larvae found in Bellingham were on branches that had peeling bark under which the wood was blackened, perhaps from fungal infection. At Burnaby, the highest densities of larvae appeared to be associated with an unknown bracket fungus but fungal feeding was not evident. Larvae under bark did not appear to be in close association with visible fruiting bodies or mycelia and they appeared to be rasping or chewing the surface of the phloem which resulted in a colour change of the sapwood. This discoloration was a good indicator of larval presence as was their frass filled silk webbing. Although some authors suggest that *Armillaria mellea* occurs in the Pacific Northwest (Shaw 1973), the taxonomy of this group has been recently revised (Burdsall & Volk 1993). Under this revision, *A. mellea* is no longer considered to occur in Washington and Oregon, but other species of *Armillaria* are common in the region (Burdsall & Volk 1993), suggesting that the fungal associations of this species may include more than one *Armillaria* species. Indeed, given the recent taxonomic changes for *Armillaria* (Burdsall & Volk 1993), it is possible that some of the previously reported associations with *A. mellea* may be inaccurate. The fact that *A. mellea* is found in northern California and eastern North America (Burdsall & Volk 1993) suggests that *O. bractella* could become widespread in North America.

Formal nomenclature.

Oecophora bractella (Linnaeus, 1758)

Phalaena (Tinea) bractella Linnaeus, 1758, *Systema Naturae* (edn 10): 540, no. 280. Lectotype, ♀, ['Europa'] labelled *'bractella'* [by Linnaeus]/*'bractella* 894' [by J.E. Smith] designated by Robinson & Nielsen (1983: 204) (Linnean collection, London).

Phalaena bractella; Clerck, 1759, *Icones Insectorum Rariorum*, pl. 12, fig. 4.

Phalaena (Tinea) ‡bracteella; Linnaeus, 1761, *Fauna Svecica* (edn 2): 366, no. 1426 [incorrect subsequent spelling].

Oecophora bractella (L.); Meyrick, 1922, *Genera Insectorum* 180: 21.

It is likely that Clerck figured Linnaeus's specimen, as there are no specimens in the Clerck collection (Robinson & Nielsen, 1983). High-resolution digital images of the lectotype should be available shortly through the Linnean typification project on the Linnean Society's website: http://www.linnean.org.

During the latter part of the nineteenth and the early twentieth century *bractella* was placed in the genus Alabonia, which was synonymized with *Oecophora* by Meyrick (1922).

Diagnosis. The adults and immature stages are described in detail elsewhere in the literature (e.g. Meyrick 1922; Toll 1964; Fetz 1994; Harper *et al*. 2002; Patočka & M. Turčáni 2005). Here, we discuss the diagnostic features of *O. bractella* adults (see also Figs. 2, 3) to allow identification by North American researchers. *Head and thorax*: The head and thorax are covered with bright yellow, appressed scales. The long, recurved labial palps are mostly dark fuscous, with pale tips and some yellow on the inner and ventral surfaces. The legs are dark fuscous with white tarsal and tibial rings. *Wings*: The forewings (5.5–7.5mm wing length) of *O. bractella* are dark brown or gray to black, patterned with bright yellow and metallic blue or purple patches. The basal 1/3 of the forewings is bright yellow, except along the costal margin, which is dark brown to black. Just distal to the basal yellow area is a band of metallic blue or purple scales, running straight from the costa to the dorsum, and separated from the yellow basal area by a thin band of dark fuscous to black. The forewing also features a single smaller anteapical yellow spot along the costal margin. Basal and medial to this spot is a short band of metallic blue or purple scales that does not reach the margin of either wing. The distal margin of the forewing features metallic blue or purple scaling. The fringe scales are generally dark fuscous to black, with those near the apex tipped with white. The

TABLE 1. Collection and deposition data for all known *Oecophora bractella* specimens from North America.

Locality	Date	Method	Collector	Determination	Number & Deposition[1]
USA: Washington					
1) King Co., Seattle, 47.57°N 122.34°W; industrial/port	30 June 1998	Blacklight	M. Allen	E.H. LaGasa	1 male; WSDA
	17 July 1998	Blacklight	M. Allen	S. Passoa	1 male; USNM
2) King Co., 4.8km N of Burien, 47.488°N 122.351°W; residential	8 August 2000	European Corn Borer lure trap[2]	P. Hertzog	S. Passoa	1 male; USDA
	2 July 2001	*Proeulia* lure trap[2]	P. Hertzog	E.H. LaGasa	1 sex unknown (missing abdomen & hindwings); WSDA
3) King Co., Saltwater State Park, Des Moines, 47.375°N 122.322°W; park/residential	2 August 2001	*Proeulia* lure trap[2]	P. Hertzog	E.H. LaGasa	2 males; WSDA (only one specimen retained)
	7 August 2001	*Proeulia* lure trap[2]	P. Hertzog	E.H. LaGasa	1 female; WSDA
4) King Co., West Seattle, 47.552°N 122.398°W; residential	8 July 2002	Leek moth lure trap[2]	S. Williams	E.H. LaGasa	1 male; specimen not kept
5) King Co., Normandy Park, 47.433°N 122.348°W; residential	17 July 2002	Plum fruit moth lure trap[2]	S. Williams	E.H. LaGasa	1 male; specimen not kept
6) King Co., Burien, 47.467°N, 122.361°W; urban	17 July 2002	Plum fruit moth lure trap[2]	S. Williams	E.H. LaGasa	1 male; specimen not kept
7) Whatcom Co., Bellingham, 48.741°N 122.474°W; residential	17 June 2006	At window of house	M. Peterson	G. Robinson	1 female; WWU
	29 May 2007	Dead branches of *Laburnum anagyroides*	M. Peterson	M. Peterson	2 females, 1 male; WWU
8) Whatcom Co., Blaine, 49.000°N122.738°W; import inspection station	11 July 2006	Shipping container	J. Boyer	S. Passoa	1 female; USDA
CANADA: British Columbia					
9) Port Coquitlam, 49.244° N 122.778°W; residential	23 June 2006	Mercury vapor lamp	D. Holden	G. Pohl	1 female; DH
	26 June 2006	Mercury vapor lamp	D. Holden	G. Pohl	2 females; CNC
	1 June 2007	Mercury vapor lamp	D. Holden	D. Holden	1 female; DH
	2 June 2007	Mercury vapor lamp	D. Holden	D. Holden	2 females; DH
	27 June 2007	Mercury vapor lamp	D. Holden	D. Holden	1 female; DH
	28 June 2007	Mercury vapor lamp	D. Holden	D. Holden	2 females; DH
	2 July 2007	Mercury vapor lamp	D. Holden	D. Holden	1 female; DH
	4 July 2007	Mercury vapor lamp	D. Holden	D. Holden	1 male; DH
10) Burnaby, 49.15° N 123.00°W; riparian near commercial development	30 May 2007	Sweep net	D. Holden	D. Holden	1 male; DH
	3 May 2007 to 12 June 2007	Reared from bark of *Alnus rubra* & *Acer sp.*	D. Holden	D. Holden	22 males; 20 females, DH

[1] WSDA = Washington State Department of Agriculture, Olympia, WA; USDA = U.S. Dept. of Agriculture, APHIS-PPQ, The Ohio State University, Museum of Biodiversity, Columbus, OH; USNM = Smithsonian Institution; WWU = Biology Department, Western Washington University, Bellingham, WA; DH = David Holden, personal collection; CNC = Canadian National Collection, Ottawa, ON.

[2] Pheromone lure traps consisted of gray rubber septa (West Co., Lionville, PA, cat. no. 1060-0275) loaded with specific pheromone lures, in a Pherocon 2 type trap. European Corn Borer lure: 0.5mg Z-11-14:AC, 0.5mg E-11-14:AC; *Proeulia* lure: 0.1mg E-11-14:OH; Leek Moth lure: 1 mg Z-11-16:AL, Plum Fruit Moth lure: 0.1mg Z-8-12:AC, 0.004mg E-8-12:AC, 0.025mg Z-8-14:AC, 0.005mg Z-10-14:AC, 0.2mg 14:AC.

hindwing is uniformly dark gray. *Rectiostoma fernaldella* (Riley, 1889) is the only gelechioid in western North America that could perhaps be confused with *O. bractella*. This species, occurring only in the SW U.S., is superficially similar to *O. bractella*, but the basal area of the forewing of *R. fernaldella* is dull (not bright) yellow, the forewing lacks an anteapical yellow spot, the apex of the forewing is strongly squared off (not rounded), and the hindwings are broader than in *O. bractella*. The somewhat dorsoventrally-flattened larvae of *O. bractella* are grayish brown, with darker gray thoracic segments and terminal abdominal segment, and a brown head capsule. Each abdominal segment has a subdorsal furrow.

Pest Status. *O. bractella* is unlikely to attain pest status in North America, as its larvae feed in the bark of decaying wood. Although *O. bractella* is unlikely to have any economic effects, it is possible that its establishment could have minor ecological ramifications, through its impact on detritivore food webs. Perhaps of broader interest is that fact that the arrival of *O. bractella* underscores the ease with which species can exploit the colonization opportunities afforded by international shipping. Given the profound economic and environmental costs associated with invasive species that do attain pest status (Wilcove *et al*. 1998; Mack *et al*. 2000; Pimentel *et al*. 2001), the introduction of this rather uncommon and specialized species is alarming. Furthermore, this introduction underscores the difficulty in making generalities regarding which insects are most likely to be introduced (Simberloff 1989).

Relevance to Conservation Efforts. The residential and urban locales in Washington and British Columbia from which *O. bractella* has been recorded are unlike the habitats this species exploits in its native range. Through most of its range, *O. bractella* is generally restricted to forests and other wooded regions (Novák & Severa 1980; Palm 1989), while in the UK, it is generally restricted to ancient forests (Harper *et al*. 2002; Kimber 2007), and in Estonia, it is found only in sparse juniper woodlands on limestone with sparse vegetation (M. Martin, pers. comm.). However, in some regions this species is found in managed habitats such as hedgerows (Lindsey 2006). The ability of *O. bractella* to occupy residential habitats in North America suggests that further research on this species in North America may provide insights into managing habitat for this species in portions of its native range in which it is of conservation concern. Furthermore, the discovery that *O. bractella* can be taken by pheromone traps reveals that such traps may enable better monitoring of this species in its native range.

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