J. Jpn. Bot. **90**: 129–133 (2015)

Koki TANAKA[a,*], Akira YAMAWO[b] and Okihito YANO[c]: **Seed Dispersal by Ants in *Carex oxyandra* var. *oxyandra* (*Cyperaceae*) from Japan**

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Summary: Seed dispersal by ants, myrmecochory, is reported for the first time for *Carex oxyandra* (Franch. & Sav.) Kudô var. *oxyandra* (*Cyperaceae*) from Japan. We found utricles of *C. oxyandra* with elaiosomes and the removal of diaspores (achenes enclosed by urticles) by the ant, *Lasius japonicus* Santschi (*Formicinae*) in grassland. In the laboratories *L. japonicus* only bites off the elaiosome and leaves other parts of the diaspore intact. These results indicate the occurrence of myrmecochory in *C. oxyandra*. This is the first report of myrmecochory from Japanese section *Acrocystis* in *Carex*.

Seed dispersal by ants, myrmecochory, is one of the dispersal modes in flowering plants (Sernander 1906, Beattie and Culver 1981, Lengyel et al. 2010). Ant-dispersed plants typically have an oily seed appendage called an 'elaiosome', which contains chemical substances attractive to ants (Fischer et al. 2008). A worker ant carries the seed to the nest, consumes the elaiosome, and then abandons the unharmed seed either outside or within the nest, thus dispersing the seed (Handel 1990). Some studies have demonstrated that myrmecochory provides some critical benefits for plants such as the avoidance of both intraspecific competition (Kjellsson 1991) and post-dispersal seed predation (Manzaneda et al. 2005), as well as directed dispersal of seed to suitable habitats (Hanzawa et al. 1988, Gibson 1993). Myrmecochory has thus contriubuted to the diversification of flowering plants (Latimer et al. 2005, Lengyel et al. 2009), and so the presence or absence of myrmecochory is an important feature of species of flowering plants both in terms of their ecology and evolution.

Carex L. (*Cyperaceae*) is one of the largest genera of flowering plants, and comprises more than 2,000 species (Ball and Reznicek 2002). In *Carex*, myrmecochory has been reported by Sernander (1906), Bresinsky (1963), Handel (1976, 1978), Beattie and Culver (1981), Kjellsson (1985), Nakanishi (1988), and Leck and Schütz (2005) (Table 1). The utricles of myrmecochorous *Carex* species are partially modified to form an oily and creamy appendage, which functions as the elaiosome (Kjellsson 1985, Nakanishi 1988). However, myrmecochory has so far been reported for only 17 species in *Carex* (Table 1). Nakanishi (2001) enumerated the myrmecochory of Japanese *Carex*, but he mostly reported this at sectional levels of *Carex* (sect. *Digitatae* (Fr.) H. Christ (= *Clandestinae* G. Don), *Ferrugineae* Tuck., *Mitratae* Kük., *Siderostictae* Franch.) (Table 1). Accurate myrmecochorous studies including many species and at the species level are necessary for understanding the role of myrmecochory on diversification in this largest genus.

In 2014, we discovered utricles with elaiosomes in *C. oxyandra* (Franch. & Sav.) Kudô var. *oxyandra* (Sect. *Acrocystis* Dumort.) for the first time (Fig. 1a). The elaiosome was the lower portion of the utricle (Fig. 1a, the area indicated by bracket). It was white, spongy

Table 1. Previous reports of myrmecochory in *Carex*

Taxon	Ant species	Locality	Reference
Carex L.			
Sect. *Acrocystis* Dumort.			
C. communis L. H. Bailey	*Aphaenogaster rudis* Emery	N America	Handel (1978)
C. ericetorum Pollich	–	Europe	Sernander (1906)
C. montana L.	–	Europe	Sernander (1906), Leck and Schütz (2005)
C. pilulifera L.	*Myrmica ruginodis* Nylander	Europe (Denmark)	Kjellsson (1985), Leck and Schütz (2005)
C. umbellata Willd.	*A. rudis*	N America	Handel (1978)
Sect. *Ammoglochin* Dumort.			
C. praecox Schreb.	–	Europe	Sernander (1906), Leck and Schütz (2005)
Sect. *Careyanae* Tuck. ex Kük.			
C. laxiculmis Schwein.	*A. rudis*, *A. tennesseensis* Mayr	N America (USA)	Beattie and Culver (1981)
C. platyphylla Carey	–	N America (USA)	Beattie and Culver (1981)
Sect. *Digitatae* (Fr.) H. Christ (= Sect. *Clandestinae* G. Don)			
C. digitata L.	–	Europe	Sernander (1906), Leck and Schütz (2005)
C. humilis Leyss.	–	Europe	Bresinsky (1963), Handel (1976), Leck and Schütz (2005)
C. pedunculata Muhl. ex Willd.	*A. rudis*	N America (USA)	Handel (1976), Leck and Schütz (2005)
Carex sp.	*Pheidole noda* Smith or *A. famelica* Smith	Japan	Nakanishi (2001)
Sect. *Ferrugineae* Tuck.			
Carex sp.	*P. noda* or *A. famelica*	Japan	Nakanishi (2001)
Sect. *Griseae* (L. H. Bailey) Kük.			
C. oligocarpa Willd.	*Tapinoma sessile* Say	N America (USA)	Beattie and Culver (1981)
Sect. *Mitratae* Kük.			
C. leucochlora Bunge	*P. noda* or *A. famelica*	Japan	Nakanishi (1988)
C. rugata Ohwi	*P. noda* or *A. famelica*	Japan	Nakanishi (1988)
C. tristachya Thunb.	*P. noda* or *A. famelica*	Japan	Nakanishi (1988)
Carex sp.	*P. noda* or *A. famelica*	Japan	Nakanishi (2001)
Sect. *Porocystis* Dumort.			
C. pallescens L.	–	Europe	Sernander (1906), Leck and Schütz (2005)
Sect. *Phyllostachyae* Tuck. ex Kük.			
C. jamesii Schwein.	*A. rudis*, *M. punctiventris* Roger, *Formica difficilis* Emery, *F. subsericea* Say	N America (USA)	Beattie and Culver (1981)
Sect. *Siderostictae* Franch.			
Carex sp.	*P. noda* or *A. famelica*	Japan	Nakanishi (2001)

and plump, as noted for *C. pedunculata* Muhl. ex Willd. by Handel (1976). We observed the transportation of diaspores (achenes enclosed by urticles) by ant workers, *Lasius japonicus* Santschi (*Formicinae*), in the montane grassland of Mt. Kujû-san, Oita Prefecture, Kyushu, Japan. We also placed several freshly matured diaspores on the ground between the two individuals of *C. oxyandra* at least one meter distant, and all the offered diaspores were removed by *L. japonicus*

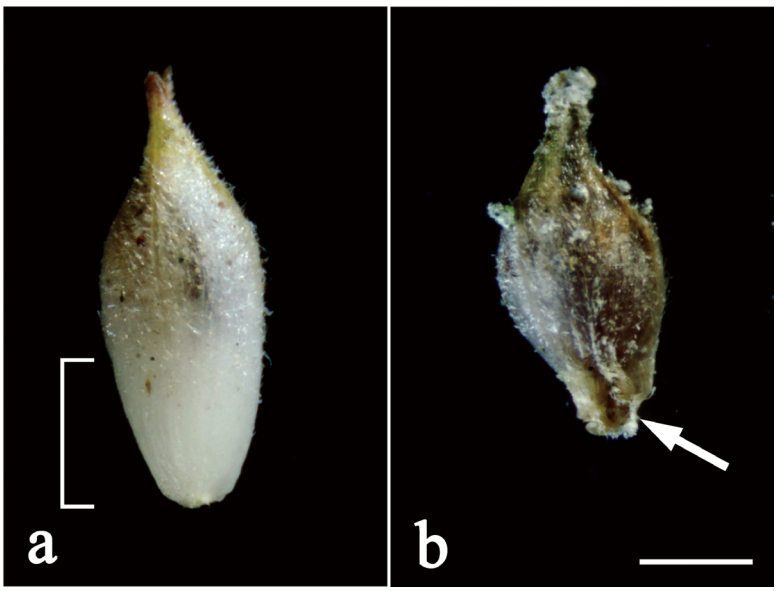

Fig. 1. Diaspore of *Carex oxyandra*. a. Utricle with elaiosome. The lower smooth part indicated by a bracket is the elaiosome. b. Diaspore whose elaiosome was partially bitten off by *Lasius japonicus*. Arrow indicates an eaten part of diaspore. Bar = 1 mm.

in the field (Fig. 2).

To confirm that the diaspores removed by the ants contribute to the seed dispersal and do not result in granivory, we offered several diaspores to three colonies of *L. japonicus* in the laboratory, and following three days checked the status of diaspores after the consumption by *L. japonicus*. Of the three colonies containing broods, two were queen-less and the other included a queen. In the laboratory colonies, diaspores were transported into the nest and several days later transported outside the nest after part of the elaiosome was bitten off (Fig. 1b). Furthermore, *L. japonicus* left other parts of the diaspores including the achenes intact. These results indicated the occurrence of myrmecochory in *C. oxyandra*. This is the first report of myrmecochory for this species, and from the Japanese section *Acrocystis*. Our result is also the first record of dispersal of the diaspore of Japanese *C. oxyandra* by *Lasius* ants.

Carex oxyandra is a pioneer sedge often growing on nutrient-poor grasslands (Tsujimura 1987). In such a habitat, myrmecochory is crucial for regeneration because it enables the avoidance of aggregation of conspecific plants and subsequent competition for limiting resources among them (Kjellsson 1991). Moreover, as the soil around ant nests is often enriched with nutrients owing to the waste matter of ants, seeds dispersed by ants will enjoy improved growth (Passos and Oliveira 2002, Manzaneda and Rey 2012). Thus, the reliance on myrmecochory could be especially strong in *C. oxyandra* compared with other myrmecochores growing in less harsh habitats. Future studies are needed including more data about the species composition of disperser ants and the quality of dispersal services in order to fully understand the adaptive significance of myrmecochory in *Carex*.

Voucher specimen

Carex oxyandra var. ***oxyandra***

JAPAN. Kyushu, Oita Pref., Kokonoe-machi, Mt. Kujû-san, 33°08′36″N 131°16′06″E, 883 m alt., 20 June 2014, O. Yano, K. Tanaka & A. Yamawo 14062001 (OKAY).

Fig. 2. A worker of *Lasius japonicus* carrying the diaspore of *Carex oxyandra*.

Lasius japonicus

JAPAN. Kyushu, Oita Pref., Kokonoe-machi, Mt. Kujû-san, 33°08′36″N 131°16′06″E, 883 m alt., 20 June 2014, K. Tanaka, A. Yamawo & O. Yano s.n. (Laboratory of Systems Ecology, Saga University).

The authors thank Mr. S. Adachi (Saga University) and Mr. I. Kuroki (Okayama University of Science) for their help for providing three colonies of *L. japonicus* in laboratory. We also thank Dr. Mark F. Watson (Royal Botanic Garden Edinburgh) for his help for checking English of the manuscript. This study was partly supported by JSPS KAKENHI Grant Number 25840136 (to O.Y.).

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田中弘毅[a]，山尾　僚[b]，矢野興一[c]：**日本産スゲ属ヒメスゲ（カヤツリグサ科）のアリ散布**

アリによる種子散布（アリ散布）は多くの被子植物にみられる種子散布様式の一つであるが，カヤツリグサ科スゲ属においては報告例が少ない．2014 年の大分県九重山における調査で，スゲ属ヒメスゲ節のヒメスゲの果胞の一部がエライオソームになっており，アリ（トビイロケアリ）が散布体（果胞に包まれた痩果）を運搬することを発見した．その後，実験室内で飼育下のトビイロケアリのコロニーにヒメスゲの散布体を与えた．アリが散布体を巣に持ち帰って数日後に散布体を観察したところ，果胞のエライオソーム部分だけが消費され，痩果自体には損傷がみられなかった．このことは，アリによる散布体の運搬が種子散布として成立することを示す．本研究は，ヒメスゲがアリ散布植物であることを示すと同時に，日本産ヒメスゲ節におけるアリ散布，およびヒメスゲの種子散布にケアリ属のアリが関与することを示す初の報告である．

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