Distribution of Carex nakasimae Ohwi, a Korean endemic sedge (Cyperaceae)

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ABSTRACT: Carex nakasimae Ohwi (Cyperaceae) is an endemic species on the Korean peninsula. This study reports a new locality of the species, updating the distribution map. A new population of the species was found during field surveys in 2014 in a small swamp in Haman-gun, Gyeongsangnam-do province, located in the southeastern part of the Korean peninsula. In the flowering and fruiting periods of the species, the population is associated with ca. 91 vascular plant taxa from 40 families. To conserve the endemic species, maintaining the habitat is critical. Furthermore, taxonomic and phylogenetic positions of the species should be clarified to establish biological conservation strategies for the rare, endemic C. nakasimae.

Keywords: Carex, Carex nakasimae, endemic, Cyperaceae

Carex L. (Cyperaceae) is the most species rich genus in the Korean peninsula although the number of species recognized differs (157–ca.180) depending on the literature cited (Oh, 2007; Park et al., 2016). The genus is the most diverse in the temperate zone with more than 2,000 species worldwide and is often a dominant or co-dominant in various habitats such as deciduous or mixed forests, grasslands and wetlands (Ball and Reznicek, 2002; Global Carex Group, 2015). Out of approximately 180 taxa in Korea, around 10 are endemic, including C. nakasimae Ohwi (Park et al., 2016; Chung et al., 2017).

Carex nakasimae (Hwa-san-sa-cho) is an endemic, rare species described in 1944 from Hwaseong-si city (Gyeonggi-do province), a small city in middle of the Korean peninsula (Figs. 1, 2A) (Ohwi, 1944; Son et al., 2017). Since its description, the species has been barely recognized, possibly due to its rarity and lack of available data. Lee (2003) included the species in the Korean floristic diversity and mentioned that the type specimens was last. Son et al. (2017) designated a lectotype, choosing an isotype in National Museum of Nature and Science herbarium (Fig. 1). Park et al. (2016) placed the species in section Physocarpae Drejer ex L. H. Bailey as did Ohwi (1944) with four other Korean native taxa and considers C. vesicaria L. as the most similar species morphologically.

Carex nakasimae has long rhizomes, 2–3 terminal male spikes, and 2–3 lateral female spikes characterized by lanceolate perigynia with long, bifid, and curved beaks (1–2.5 mm) (Table 1, Figs. 1, 3D) (Lee, 2003; Park et al., 2016). Ohwi (1944) pointed out that the species was distinguished from C. vesicaria by narrow perigynia with bifid, curved beaks. Upo-neup wetland, a large wetland in Gyeongsangnam-do, is the only well-known habitat of the species (Park et al., 2016). This wetland is a nature conservation area composed of four swamps and is number 934 on the Ramsar List (Kim et al., 2011; https://rsis.ramsar.org/ris/934).

During field work in 2014, a new population of Carex...
nakasimae was found in a small swamp in Haman-gun, Gyeongsangnam-do province (Figs. 2B, 3). The swamp is about 2,328 m² and branched from Haman-cheon creek, connected with Nakdong-gang river. Nakdon-gang river, the longest river in South Korea, runs 506 km from the Taebaek Mountains to the South Sea or Korean Strait and passes Upo-neup wetland as well (Kim et al., 2011).

To understand the ecological features of the population’s habitat, associated species were surveyed from 2014 until 2019 during flowering and fruiting times of C. nakasimae. This study updates the distribution of C. nakasimae and reports a new population with the floristic composition of its habitat.

### Materials and Methods

#### Habitat survey

In the new population of C. nakasimae, associated vascular plant taxa were surveyed and collected in 2015, 2016, and 2019 during flowering and fruiting periods of the species (Fig. 2B). The resulting list of vascular plants follows the nomenclature of The Genera of Vascular Plants of Korea (Park, 2007). Identifications of the taxa were made based on Lee (2003), Park et al. (2016), and Hoshino et al. (2011). Scientific and Korean names of taxa follow the biodiversity portal (https://species.nibr.go.kr/index.do) provided by Korea National Institute of Biological Resources. Biological resources subject to overseas export approval, endemic, introduced, climate-sensitive biological indicator species, planted species, and floristic degrees of the species were also determined according to the portal. All voucher specimens and images are deposited at the Department of Division of Biological Science, Chonnam National University herbarium (CNU).
Distribution of *Carex nakasimae*

**Specimen examination**

To make a distribution map, *C. nakasimae* specimens at the Korean National Arboretum herbarium (KH) and National Institute of Biological Resources herbarium (KB) were examined. The KH houses *Carex* specimens collected through ‘Research on unidentified native plant name in Korea’ and ‘a taxonomic review of Cyperaceae in Korea’ projects. In addition, the KB stores voucher specimens for various biodiversity research projects such as ‘National Ecosystem Survey’ and ‘the survey of new and unrecorded taxa in vascular plants’. The identifications of all the specimens were evaluated, and 18 verified specimens were utilized for determining the distribution of the species.

**Results and Discussion**

In the new population of *Carex nakasimae*, about 91 taxa in 70 genera and 40 families grow during the flowering and fruiting periods of the species (Appendix 1). Cyperaceae is the most dominant with about eight taxa, and Fabaceae and Polygonaceae follow with seven taxa each. For such a small swamp, the site includes important vascular plants from floristic and environmental points of view; it is big enough to provide dynamic micro-habitats. There are nine biological resources subject to overseas export approval taxa and one climate-sensitive Biological Indicator Species designated by Korea Ministry of Environment. Furthermore, two Korean endemic species grow in the swamp: *C. nakasimae* and *Hemerocallis hakuunensis* Nakai. Both endemic species are not common and only occur in southern parts of the Korean Peninsula.

In the habitat, tall trees such as *Salix chaenomeloides* Kimura and *S. koreensis* Andersson shade on some areas in the swamp. However, some areas are more open and have shallow streams where *C. nakasimae* grows, as it prefers sunny, wet sites. The *C. nakasimae* population is in northwest side of swamp, which can only be accessed from the southeastern and northeastern sides, making hard to find it. Although many swamps in Haman-gun have been disturbed by wastewater from pig breeding and agricultural activities, this swamp might have avoided such disturbances.

Currently the distribution of *C. nakasimae* is restricted to a southeastern province, Gyeongsangnam-do, in Korea although the type locality of *C. nakasimae* is in a middle region of Korea.

![Fig. 3. New population in Haman-gun, Gyeongsangnam-do. A. Habitat in April 2016. B. Habitat in June 2016. C. Population in May 2019, red arrows indicate *C. nakasimae* individuals. D. *C. nakasimae* inflorescences with mature perigynia in May 2019.](image-url)
(Gyeonggi-do province) (Fig. 2A). Park et al. (2016) notes a C. nakasimae collection made in Seoul (Mok-dong) with voucher specimen information (Park s.n., without date, KH). However, we failed to locate the voucher specimen at KH, and none of the specimens found are from Gyeonggi-do province. It is suspected that the type locality and other possible habitats in Gyeonggi-do and Seoul have been destroyed by urbanization (Park et al., 2016). All the habitats of C. nakasimae are wet such as swamps, wetlands, or lakesides. Nakdon-gang river seems to play a very important role for the plant distribution, assisting dispersal and establishment.

The phylogenetic position of C. nakasimae has not been studied although Ohwi (1944) and Park et al. (2016) place the species in Carex section Physocarpace Drejer ex L. H. Bailey. Among five Korean species in the section (C. rhynchophylla C. A. Mey, C. vesicaria L., C. nakasimae, C. rostrata var. borealis (Hartms.) Kük, and C. dickinsii Franch. & Sav.), C. vesicaria assembles with C. nakasimae (Park et al., 2016). C. vesicaria is broadly distributed in Asia, Europe, and North America in wet places (Ball and Reznicek. 2002; Dai et al., 2010). The treatment of the species in Carex section Vesicariae (Heuffel) J. Carey (Reznicek and Ford, 2002; Hoshino et al., 2011) suggests taxonomic research on the entirety of the two sections Physocarpace and Vesicariae is required. Phylogenetic work on Carex section Vesicariae proposes sub-sectional systems (Shekhovtsov et al., 2012), but the study does not include C. nakasimae. The taxonomic and phylogenetic positions of C. nakasimae need to be clarified.

Carex nakasimae is endemic to the Korea peninsula (Park et al., 2016), but it has been under-reported. The species is not included in recent Korea endemic vascular plant diversity studies such as Chung et al. (2017). To establish biological conservation strategies for the species, further research on ecological, taxonomic, and phylogenetic features of C. nakasimae should be conducted. In addition, the new habitat in Haman-gun, Gyeongsangnam-do should be well conserved for the conservation of the Korean rare, endemic taxa (C. nakasimae and Hemerocallis hakuunensis) in nature.

**Specimens examined.** KOREA. Gyeongsangnam-do: Changnyeong-gun, Ibang-myeon, Okcheon-ri, Uponeup (swamp), 6 Jun 2013, J.-H. Kim 13-38 (KB); 27 May 2012, J.-H. Kim Carex-Kim199 (KB); 1 Jun 2011, Y. Cho WR-20110601-002 (KH); 1 Jun 2013, Y. Cho 1207 (KH); 6 Jun 2013, Y. Cho et al. UK_2013038 (KH); Daehap-myeon, Jumae-ri, Uponeup (swamp), 17 May 2009, J.-H. Kim 139 (KB); Yuese-myeon, Sejin-ri, Uponeup (swamp), 28 Jun 2012, H. J. Choi Changmyeong-gun (Uponeup)-120628-001 (KH); Haman-gun, Daesan-myeon, Seochon-ri, 14 Jun 2014, J.-H. Kim 141057 (KB); Gaya-eup, Sanseo-ri, 31 May 2015, K.-S. Chung 1207 (CNU, KH); 22 May 2016, T. Hoshino et al. OKAY-24745 (OKAY); Miryang-si, Sanmangjin-eup, Sanmang-ri, Milyanggang (river), 11 May 2018, J.-S. Kim MR0082 (KB); Yangsan-si, Wondong-myeon, Yongdang-ri, Wondong (wetland), J.-H. Kim 13-36 (KB).

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**Conflict of Interest**

The authors declare that there are no conflicts of interest.

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Appendix 1. Vascular plants in the new population with images and voucher specimens.

| Scientific name (Korean name) | Voucher specimen | Note*
|-----------------------------|------------------|-----|
| Equisetaceae (속새과) | Equisetum arvense (쇠뜨기) | Lee001 |
| Athyriaceae (개고사리과) | Athyrium niponicum (개고사리) | Lee002 |
| Lauraceae (녹나무과) | Lindera glauca (감태나무) |
| Ranunculaceae (미나리아재비과) | Ranunculus chinensis (젓가락나물) | Chung et al. H005, H004, H003, H002, H001 |
| Papaveraceae (양귀비과) | Chelidonium majus var. asiaticum (애기똥풀) | Chung et al. H045 |
| Ulmaceae (팽나무과) | Celtis sinensis Pers. (팽나무) | Chung et al. H043 |
| | Ulmus parvifolia Jacq. (참느릅나무) | Chung et al. H049 |
| | Degree 1 |
| Cannabinaceae (삼과) | Humulus japonicus Siebold & Zucc. (환삼덩굴) | Chung et al. H040 |
| Moraceae (뽕나무과) | Morus bombycis Koidz. (산뽕나무) | Chung et al. H010, H009 |
| Urticaceae (쑥과) | Boehmeria spicata (Thunb.) Thunb. (.mkdirs론나무) |
| Fagaceae (참나무과) | Quercus aliena Blume (갈참나무) |
### Appendix 1. Continued.

| Scientific name (Korean name) | Voucher specimen | Note* |
|------------------------------|------------------|-------|
| 
**Quercus acutissima** Carruth. (상수리나무) | Chung et al. H064, H063 |     |
| **Phytolaccaceae (자리공과)** | |     |
| Phytolacca americana L. (미국자리공) | Chung et al. H047 | In |
| **Amaranthaceae (쇄묵과)** | |     |
| Achyranthes japonica (Miq.) Nakai (쇄묵) | Chung et al. H064, H063 |     |
| **Caryophyllaceae (석죽과)** | |     |
| Sellaria quatica (L.) Scop. (쇠별꽃) | Chung et al. H021, H006 |     |
| **Polygonaceae (마디풀과)** | |     |
| Fallopia dumetorum (L.) Holub (닭의덩굴) | Chung et al. H034, H022 |     |
| Persicaria japonica (Meisn.) H. Gross ex Nakai (흰꽃여뀌) | Chung et al. H018 |     |
| Persicaria maackiana (Regel) Nakai ex T. Mori (나도미꾸리낚시) | Chung et al. H015, H007 |     |
| Persicaria perfoliata (L.) H. Gross (머느리배꼽) | Chung et al. H060 |     |
| Persicaria senticosa (Meisn.) H. Gross ex Nakai (머느리말שוט게) | Chung et al. H009 |     |
| Persicaria thunbergii (Siebold & Zucc.) H. Gross (고마리) | Chung et al. H020 |     |
| Rumex crispus L. (소리쟁이) | Chung et al. H059 | In |
| **Violaceae (제비꽃과)** | |     |
| Viola verecunda A. Gray (콩제비꽃) | Chung et al. H029 |     |
| **Cucurbitaceae (박과)** | |     |
| Actinostemma lobatum (Maxim.) Franch. & Sav. (두쟁등덩굴) | Chung et al. H076, H075, H074, H073, H072, H071 | Degree 1 |
| **Salicaceae (버드나무과)** | |     |
| Populus deltoides Marsh (미유나무) | Chung et al. H076, H075, H074, H073, H072, H071 | PI |
| Salix caprea L. (호랑버들) | Chung et al. H069 |     |
| Salix chaenomeloides Kimura (왕버들) | Chung et al. H070 | Degree 1 |
| Salix graciliflora Nakai (눈썹버들) | Chung et al. H068 |     |
| Salix koreensis Andersson (버드나무) | Chung et al. H053, H052, H051, H050 |     |
| **Brassicaceae (십자화과)** | |     |
| Capsella bursa-pastoris (L.) Medik. (멸이) | Chung et al. H076, H075, H074, H073, H072, H071 |     |
| Cardamine flexuosa With. (황새냉이) | Chung et al. H076, H075, H074, H073, H072, H071 |     |
| Thlaspi arvense L. (말냉이) | Chung et al. H069 |     |
| **Styracaceae (때죽나무과)** | |     |
| Styrax japonicus Siebold & Zucc. (때죽나무) | Chung et al. H053, H052, H051, H050 | BSOA |
| **Rosaceae (장미과)** | |     |
| Dachesnea chrysantha (Zoll. et Morr.) Miq. (봄딸기) | Lee003 |     |
| Prunus jamasakura Siebold ex Koidz. (벚나무) | Lee004 |     |
| Rosa multiflora Thunb. (벚나무) | Chung et al. H019 |     |
| Rubus crataegifolius Bunge (산딸기) | Chung et al. H068, H067 |     |
| Rubus parvifolius L. (망벚나무) | Chung et al. H019 |     |
| Spiraea prunifolia var. simpliciflora (Nakai) Nakai (조팝나무) | Lee005 | BSOA |
| **Fabaceae (콩과)** | |     |
### Appendix 1. Continued.

| Scientific name (Korean name) | Voucher specimen | Note* |
|------------------------------|------------------|-------|
| Amphicarpaea bracteata subsp. edgeworthii (Benth.) H. Ohashi (새콩) | | |
| Astragalus sinicus L. (자운영) | | |
| Glycine soja Siebold & Zucc. (돌콩) | BSOA | |
| Lespedeza cuneata (Dum. Cours.) G. Don. (비수리) | Chung et al. H012, H011 | BSOA |
| Vicia amoena Fisch. ex Ser. (갈퀴나물) | | |
| Vicia sativa L. (사갈퀴) | | |
| Vicia tetrasperma (L.) Schreb. (얼치기완두) | | |
| Vitaceae (포도과) | | |
| Vitis flexuosa Thunb. (세바루) | | |
| Aceraceae (단풍나무과) | | |
| Acer buergerianum Miq. (중국단풍) | Chung et al. H044 | Pl |
| Acer palmatum Thunb. (단풍나무) | Chung et al. H048, H036 | BSOA, Degree III |
| Rutaceae (운향과) | | |
| Zanthoxylum schinifolium Siebold & Zucc. (산초나무) | BSOA | |
| Zanthoxylum piperitum DC. (초파나무) | BSOA | |
| Apiaceae (미나리과) | | |
| Oenanthe javanica (Blume) DC. (미나리) | Lee006 | BSOA |
| Torilis japonica (Houtt.) DC. (사상자) | Chung et al. H061, H058, H057 | |
| Boraginaceae (지치과) | | |
| Trigonotis peduncularis (Trevir.) Steven ex Palib. (꽃마리) | | |
| Lamiaceae (꿀풀과) | | |
| Agastache rugosa (Fisch. & C. A. Mey.) Kuntze (배초항) | | |
| Leonurus japonicus Houtt. (익모초) | Chung et al. H015, H014 | |
| Mosla dianthera (Buch.-Ham. ex Roxb.) Maxim. (취매콤) | Lee007 | |
| Oleaceae (물푸레나무과) | | |
| Ligustrum obtusifolium Siebold & Zucc. (취동나무) | Chung et al. H035 | |
| Scrophulariaceae (현삼과) | | |
| Veronica persica Poir. (큰개불알풀) | Lee008 | CBIS |
| Rubiaceae (꼭두선이과) | | |
| Galium pannonanthum Franch. & Sav. (산갈퀴) | | |
| Galium spurium L. (갈퀴렇레 stopwatch) | Lee009 | |
| Paederia foetida L. (게오동) | | |
| Rubia argyi (H. Lév. & Vaniot) H. Hara ex Lauener & D. K. Ferguson (꼭두선이) | | |
| Asteraceae (국화과) | | |
| Artemisia princeps Pamp. (쑥) | Chung et al. H031 | |
| Crepidostromum sonchifolium (Bunge) Pak & Kawano (고들레기) | Chung et al. H032 | |
| Erigeron annuus (L.) Pers. (개량초) | Chung et al. H028 | In |
| Hemistepta lyrata Bunge (지칭개) | Lee010 | |
| Lactuca indica L. (왕고들레기) | Chung et al. H037 | |

*Note: In = Inhabited.
Appendix 1. Continued.

| Scientific name (Korean name) | Voucher specimen | Note* |
|-------------------------------|------------------|-------|
| *Youngia japonica* subsp. *elstonii* (Hoeh.) Babe. & Stebbins (뽀리뱅이) | Chung et al. H042, H041 |       |
| **Potamogetonaceae** (가래과) |                  |       |
| Potamogeton crispus L. (말لزم) | Lee011, Lee012 |       |
| **Hydrocharitaceae** (자라풀과) |                  |       |
| Hydrilla verticillata (L.f.) Royle (검정말) | Chung et al. H039 |       |
| **Lemnaceae** (개구리밥과) |                  |       |
| Spirodela polyrhiza (L.) Schleid. (개구리밥) | Chung et al. H039 |       |
| **Commelinaceae** (달의장풍과) |                  |       |
| Commelia communis L. (달의장풍) | Chung et al. H033 |       |
| **Cyperaceae** (사초과) |                  |       |
| Carex breviculmis R. Br. (청사초) | Chung6196 |       |
| Carex cinerascens Kük. (회색사초) | Chung6196 |       |
| Carex dimorpholepis Steud. (이삭사초) | Chung6196 |       |
| Carex dispalata Boott (삿갓사초) | Chung6196 |       |
| Carex maackii Maxim. (타래사초) | Chung6196 |       |
| Carex nakasimae Ohwi (화산사초) | Chung6196 | En    |
| Carex transversa Boott (화살사초) | Chung6196 |       |
| Eleocharis sp. (바늘굴뚝) | Chung et al. H030 |       |
| **Poaceae** (벼과) |                  |       |
| Arthraxon hispidus (Thunb.) Makino (조개풀) | Chung et al. H008 |       |
| Beckmannia syzigachne (Steu.) Fernald (개피) | Chung et al. H062 |       |
| Miscanthus sinensis Andersson (억새) | Chung et al. H046 |       |
| Opismenus undulatifolius (Ard.) Roem. & Schult. (주름조개풀) | Chung et al. H023 |       |
| Phalaris arundinacea L. (갈풀) | Chung et al. H065 |       |
| Phragmites australis (Cav.) Trin. ex Steud. (갈대) | Chung et al. H056, H055, H054 |       |
| **Liliaceae** (백합과) |                  |       |
| Hemerocallis hakuunensis Nakai (백운산원추리) | Chung et al. H038, H024 | En, BSOA |
| **Iridaceae** (붓꽃과) |                  |       |
| Iris ensata var. spontanea (Mak.) Nakai (붓꽃) | Lee013 |       |
| **Dioscoreaceae** (마과) |                  |       |
| Dioscorea batatas Decne. (마다) | Chung et al. H025 |       |
| Dioscorea tokoro Makino (도로모마) | Chung et al. H027 |       |

*BSOA: Biological resources subject to overseas export approval; En: Endemic; In: Introduced; CBIS: Climate-sensitive Biological Indicator Species; Pl: Planted.*