



## A revised infrageneric classification for *Gagea* Salisb. (Tulipeae; Liliaceae): insights from DNA sequence and morphological data

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### Abstract

A revised subgeneric classification for *Gagea sensu lato* (including *Lloydia*) is presented. The status of *Lloydia* relative to *Gagea sensu stricto* is discussed, as are the existing infrageneric taxa of *Gagea sensu stricto*. The new classification is based on all available data and divides the genus into seven sections. The circumscription of some previously defined sections has been changed and some species are shifted from one section to another. *Lloydia* sect. *Tricholloydia* is transferred to *Gagea* sect. *Tricholloydia*.

### Introduction

*Gagea* Salisbury (1806: 555), *sensu lato* including *Lloydia* Salisb. ex Reichenbach (1830: 102) has been the subject of numerous morphological and molecular systematic studies during the last 30 years (reviewed in Peruzzi *et al.* 2008a, Zarrei & Zarre 2005, Zarrei *et al.*, 2007, 2009, 2010a, b, c, d, 2011). Most of these studies were region-specific and did not cover the complete geographical range of the genus. *Gagea* has not been well studied worldwide, possibly due to the short and early growth phase (= ephemeral) of these species, the lack of an up-to-date monograph and insufficient and incomplete herbarium specimens. Their short habit and inconspicuous appearance mean that they have often been ignored by collectors so that there is a shortage of herbarium specimens. Moreover, the range of variation in morphological character is limited, making species recognition more difficult. Polyploidy, hybridization and convergent evolution all make species boundaries unclear. The overall lack of understanding of this large genus is one among several reasons for the different counts of species and subgeneric classifications. As a result, the number of species of *Gagea* is not clear; estimates range from 50–275 (reviewed in Zarrei *et al.* 2007, 2009).

Several new classifications for *Gagea sensu stricto* have been published since the benchmark monographs of Pascher (1907), Stroh (1937) and Uphof (1958–1960; reviewed in Zarrei *et al.* 2009). However, all these treatments are limited in geographical or taxonomic coverage, and a classification including all *Gagea* species is urgently required. Recently published studies (Peterson *et al.* 2008, Zarrei *et al.* 2009) have shown that *Lloydia* is not monophyletic and should be merged with *Gagea*. The aim of the present paper is to discuss all available relevant systematic data and use them to present an updated infrageneric classification for *Gagea sensu lato*.