Botanica Pacifica. A journal of plant science and conservation. 2023. 12(1): 183–188
DOI: 10.17581/bp.2023.12118

Chromosome numbers in 31 taxa of Asteraceae, Brassicaceae, Poaceae, Hypericaceae, Lamiaceae, Fabaceae and Plantaginaceae from wetlands of Hamadan region in Iran

Hamideh Javadi[1]* & Keivan Safikhani [2]

Hamideh Javadi [1]*
e-mail: javadi@rifr-ac.ir

Keivan Safikhani [2]
e-mail: k.safikhani@areeo.ac.ir

[1] Gene Bank of Research Institute of Forests and Rangelands, Agricultural Research, Education and Extension Organization (AREEO), Tehran, Iran

[2] Forests and Rangelands Research Department, Hamedan Agricultural and Natural Resources Research and Education Center, Agricultural Research, Education and Extension Organization (AREEO), Hamedan, Iran

* corresponding author

Manuscript received: 27.02.2023
Review completed: 30.04.2023
Accepted for publication: 05.05.2023
Published online: 09.05.2023

ABSTRACT

In this study, we report the somatic chromosome numbers (2*n*) of 31 taxa belonging to Asteraceae, Brassicaceae, Poaceae, Lamiaceae, Fabaceae, Hypericaceae and Plantaginaceae families from wetlands of Hamadan region in Iran. The chromosome numbers of about half of these species have not been reported in the previous literature. Chromosome number of *Ononis spinosa* counted chromosomally for the first time at the world level and the chromosome numbers of *Erigeron acer*, *Pulicaria dysenterica*, *Arctium lappa*, *Xanthium strumarium*, *X. spinosum*, *Barbarea plantaginea*, *Brachypodium sylvaticum*, *Polypogon fugax*, *Prunella vulgaris* and *Lathyrus chloranthus*, are here reported for the first time from Iran. In all taxa 2*n* was 12, 14, 16, 18, 20, 24, 28, 30, 32 and 42, as a diploid, tetraploid and hexaploid levels. These newly available data are further compared with those previously published for the same or related species.

Keywords: chromosome number, cytogenetics, Hamadan, Iran, wetland plant

РЕЗЮМЕ

Джавади Х., Сафихани К. Профиль хромосомных чисел в 31 таксоне Asteraceae, Brassicaceae, Poaceae, Hypericaceae, Lamiaceae, Fabaceae и Plantaginaceae из водно-болотных угодий региона Хамадан в Иране. В данном исследовании мы сообщаем о соматических хромосомных числах (2*n*) 40 видов, принадлежащих к семействам Asteraceae, Brassicaceae, Poaceae, Lamiaceae, Fabaceae, Hypericaceae и Plantaginaceae из водно-болотных угодий региона Хамадан в Иране. Хромосомные числа примерно половины этих видов не были представлены в предыдущей литературе. Хромосомное число *Ononis spinosa* подсчитано впервые, а хромосомные числа *Erigeron acer*, *Pulicaria dysenterica*, *Arctium lappa*, *Xanthium strumarium*, *X. spinosum*, *Barbarea plantaginea*, *Brachypodium sylvaticum*, *Polypogon fugax*, *Prunella vulgaris* и *Lathyrus chloranthus* впервые сообщаются из Ирана. Во всех таксонах 2*n* было 12, 14, 16, 18, 20, 24, 28, 30, 32 и 42, как диплоидный, так тетраплоидный и гексаплоидный уровни. Эти вновь полученные данные далее сравниваются с ранее опубликованными для тех же или родственных видов.

Ключевые слова: число хромосом, цитогенетика, Хамадан, Иран, водно-болотное растение

Переведено редколлегией

Approaches to pasture ecosystem reproduction need to be developed for proper exploitation of the country's pastures and planning. Breeding plays a great role to increase pasture productivity. Cytogenetic studies are one of the first steps in the breeding process because the features of the chromosomes determine the choice of selection method (Arshi 2000). Cytogenetics also helps to understand the evolutionary history of plant species and to use this information in plant identification and classification. By comparing different chromosomes, we can gain useful information about the patterns and mechanisms of karyotype evolution and its importance in understanding diversity and speciation (Jang et al. 2013).

Determining the number of chromosomes is a laborious process, especially when studying a large set of samples. Since plants differing in ploidy can differ in growth patterns, attempts have been made to determine the ploidy level. The main aim of this work is to provide information on CN within Compositae, Cruciferae, Gramineae, Labiatae, Fabaceae, Hypericaceae and Plantaginaceae from wetlands of Hamadan region in Iran. For this purpose, 40 samples of 31 taxa from seven families were collected and the numbers of chromosomes in mitophase plates were determined.

MATERIAL AND METHODS

Plant material. Seeds and clones of plants were collected from various locations of Hamadan, Iran. The plants were identified by Flora Iranica (Rechinger 1977). Vouchers are deposited in gene bank RIFR (Research Institute of Forest and Rangelands) from Iran.

Chromosome analyses. Mitotic chromosomes were studied in meristematic cells of root tips (1–2 cm in length) obtained from seeds and rooted cuttings at 20°C. Root tip meristems were pretreated with 0.5 % saturated Alphabromo-Naphthalene for 4 h at 4°C, fixed in Chromic acid 1 %, Formaldehyde 10 % (1:1) for 24 h at 25°C, then the root tips were rinsed in distilled water for 3 h, and were hydrolyzed in 1 M NaOH at 60°C for 5 min, and then rinsed in distilled water for 2-3 min. Finally, staining was carried out using Aceto-Iron-Hematoxylin for 5 h. at room

temperature. After staining, the root tips were washed in distilled water for 2 h. (Javadi 2006, Javadi et al. 2009, 2019). Then slides were prepared by squashing in a droplet of 45 % acetic acid, metaphases were captured using an optical microscope (BX41 Olympus supplemented Digital color video camera) at a magnification of about 2000x.

RESULTS

ASTERACEAE

Tripelurospemum disciforme (C.A. Mey) Schultz-Bip **2*n*=2*x*=18** (Fig. 1:1). IRN010_7431: Imamzadeh Mohsen to Alvand heights, Hamadan, at 2297 m a.s.l. (34°47'16.4"N 48°23'19.9"E).

— 2*n*=2*x*=18 (Fig. 1:2). IRN010_4511: From Ganjnameh to Shahrestaneh, Hamadan, at 2633 m a.s.l. (34°43'33"N 48°24'45.8"E).

Taxonomy and cytology studies is confused in Anthemideae, due to close morphology in the species (Inceer & Hayırlıoğlu-Ayaz 2010, 2014, Oberprieler & Voght 2006). Species of *Tripleurospermum* have the same basic CN, *x*=9, with different ploidy levels. In certain *Tripleurospermum* species, triploid, tetraploid and pentaploid populations also detected (Chehregani & Hajisadeghian 2009, Chehregani & Mehanfar 2008, Garcia et al. 2005, Inceer & Hayırlıoğlu-Ayaz 2010, 2014). Our results (2*n*=18), for accessions of *T. disciforme* confirm the previous records from Iran by Khayati et al. (2014).

Erigeron acer L. **2*n*=2*x*=18** (Fig. 1:3). IRN010_6543: From Ganjnameh to Shahrestaneh, Hamadan at 2719 m a.s.l. (34°43'34.9"N 48°25'25.1"E). This report for *E. acer* is a first time in Iran.

2*n*=2*x*=18 reported for *E. acer* and *E. annuus* from regions of Kashmir Himalayas (Tantray et al. 2021), for *E. canadensis* and *E. breviscapus* (He et al. 2020), but Gupta et al. (2017) and Kour & Singhal (2019) reported 2*n*=27 for *E. annuus* from Himachal Pradesh.

Pulicaria dysenterica (L.) Bernh. **2*n*=2*x*=18** (Fig. 1:4). IRN010_5204: Ekbatan road, between Yelfan and Aliabad, Hamadan, at 2013 m a.s.l. (34°43'19.7"N 48°36'56.8"E). This report is the first time in Iran for this genus.

— 2*n*=2*x*=18 (Fig. 1:5). IRN010_5269: Bahadurbik village, after Salehabad, Hamadan to Sanandaj, at 1815 m a.s.l. (34°56'13.4"N 48°18'09.7"E).

— 2*n*=2*x*=18 (Fig. 1:6). IRN010_4127: Galleh-bar region, Asadabad, Hamadan, at 2202 m a.s.l., (34°48'05"N 48°12'42.6"E).

This findings confirm the finding of Kamari et al. (1995).

Arctium lappa L. **2*n*=2*x*=18** (Fig. 1:7). IRN010_2691: Between Yelfan and Aliabad, Ekbatan road, Hamadan, at 2013 m a.s.l. 34°43'19.7"N; 48°36'56.8"E).

Our findings confirm reords by Yang et al. (2022) and Gupta et al. (2017) on *A. lappa* with 2*n*=18. Besides, Tantray et al. (2021) reported *n*=18 for *A. lappa*.

Centaurea iberica Trev.ex Speng. **2*n*=2*x*=16** (Fig. 1:8). IRN010_333: Imamzadeh Mohsen, Hamadan, at 2593 m a.s.l., (34°43'34.3"N 48°26'10.9"E).

Tasar et al. (2018) showed that different species of *Centaurea* from Turkey have different CN: 2*n*=16, 18, 20, 26 and 36, and Inceer et al. (2007) mentioned also CN 2*n*=28, 30, 32, 56 and 66. Different species of *Centaurea* with different CN (2n=16, 18, 20, 32, 34 and 36 with *x*=8 and 9) were reported by Carev et al. (2017) and Shamouni et al. (2020).

Xanthium strumarium L. **2*n*=2*x*=18** (Fig. 1:9). IRN010_5663: Bahadurbik village, after Salehabad, Hamadan to Sanandaj, at 1815 m a.s.l., (34°56'13.4"N 48°18'09.7"E). This report is the first time in Iran for this genus.

Xanthium spinosum L. **2*n*=2*x*=18** (Fig. 1:10). IRN010_5852: Bahadurbik village, after Salehabad, Hamadan to Sanandaj, and 1815 m a.s.l., (34°56, 13.4 N; 48°18, 09.7 E). This report is the first time in Iran for this genus.

Alam et al. (2011) proved that two forms of *X. strumarium* have 2*n*=36, but the results by Karna (2017) showed that CN in somatic cells recorded to be 2*n*=32 in *X. strumarium* using aceto-orceine squash technique. Likewise haploid CN in reproductive cells recorded to be *n*=16 in *X. strumarium*.

BRASSICACEAE

Barbarea plantaginea DC. **2*n*=2*x*=16** (Fig. 1:11). IRN010_6111: From Imamzadeh Mohsen to Alvand heights, Hamadan, at 2297 m a.s.l., (34°47'16.4"N 48°23'19.9"E).

— 2*n*=2*x*=16 (Fig. 1:12). IRN010_6111: From Ganjnameh to Shahrestaneh, Hamadan, at 2200 m a.s.l. (34°45'24.7"N 48°26'17.3"E).

B. vulgaris showed 2*n*=16 & 18, *B. stricta*, *B. verna* and *B. intermedia* showed 2*n*=16 (Orgaard & Linde-Laursen 2007). The studies on *Barbarea* taxa such as *B. vulgaris*, *B. verna*, *B. sicula*, *B. trichopoda*, *B. auriculata*, *B. plantaginea* and *B. brachycarpa* from Turkey reported 2*n*=16 for all taxa (Martin et al. 2009).

POACEAE

Brachypodium sylvaticum (Huds.) P. Beauv. **2*n*=2*x*=18** (Fig. 1:13). IRN010_6072: Galleh-bar region, Asadabad, Hamadan, at 2202 m a.s.l. (34°48'05"N 48°12'42.6"E). This report is the first time in Iran for this genus.

— (Huds.) P. Beauv. **2*n*=2*x*=18** (Fig. 1:14). IRN010_476: Near the Ganjnameh River, Ganjnameh to Shahrestaneh, Hamadan, at 2200 m a.s.l. (34°45'24.7"N 48°26'17.3"E).

Lusinska et al. (2019) reported 2*n*=2*x*=18 and 10, respectively, for *B. sylvaticum* and *B. distachyon*. Also 2*n*=10, 18, 20 and 30 were counted in different species of *Brachypodium* by Lusinska et al. (2018), Wang et al. (2019) and Probatova et al. (2015).

Catabrosa aquatica Beauv. **2*n*=2*x*=20** (Fig. 1:15). IRN010_265: From Ganjnameh to Shahrestaneh, Hamadan, at 2719 m a.s.l. (34°43'34.9"N 48°25'25.1"E).

The chromosomes of the genus *Catabrosa* were counted among 10 accessions belonging to two putative species, only 2*n*=20 observed among the materials studied (Saeidi & Rahmati 2012), but in other work, *Catabrosa aquatica* and *C. capusii* showed 2*n*=4x=20 (Sheidai et al. 2009).

Dactylis glomerata L. **2*n*=2*x*=28** (Fig. 1:16). IRN010_1818: From Imamzadeh Mohsen to Alvand heights, Hamadan, at 2297 m a.s.l. (34°47'16.4"N 48°23'19.9"E).

This finding confirms reports by Rezaei et al. (2020) and Kamari et al. (1995).

Lolium arundinaceum (Schreb.) Darbysh. **2*n*=2*x*=14** (Fig. 1:17). IRN010_8341: From Imamzadeh Mohsen to Alvand heights, Hamadan, at 2297 m a.s.l. (34°47'16.4"N 48°23'19.9"E).

— 2*n*=2*x*=14 (Fig. 1:18). IRN010_8342: Between Yelfan and Aliabad, Ekbatan road, Hamadan, at 2013 m a.s.l. (34°43'19.7"N 48°36'56.8"E).

In 13 accessions of *Lolium multiflorum* by using cytogenetical traits, six accessions were diploid and seven accessions were tetraploid, the basic chromosome number was *x*=7 (Abbaszadeh et al. 2017). Other studies showed all *Lolium* species were naturally diploid containing 2*n*=2*x*=14 chromosomes but can be easily induced to tetraploid 2*n*=4*x*=28 (Humphreys et al. 2010).

Poa pratensis L. **2*n*=2*x*=14** (Fig. 1:19). IRN010_8999: From Ganjnameh to Shahrestaneh, Hamadan, at 2264 m a.s.l. (34°45'34.1"N 48°26'36.3"E).

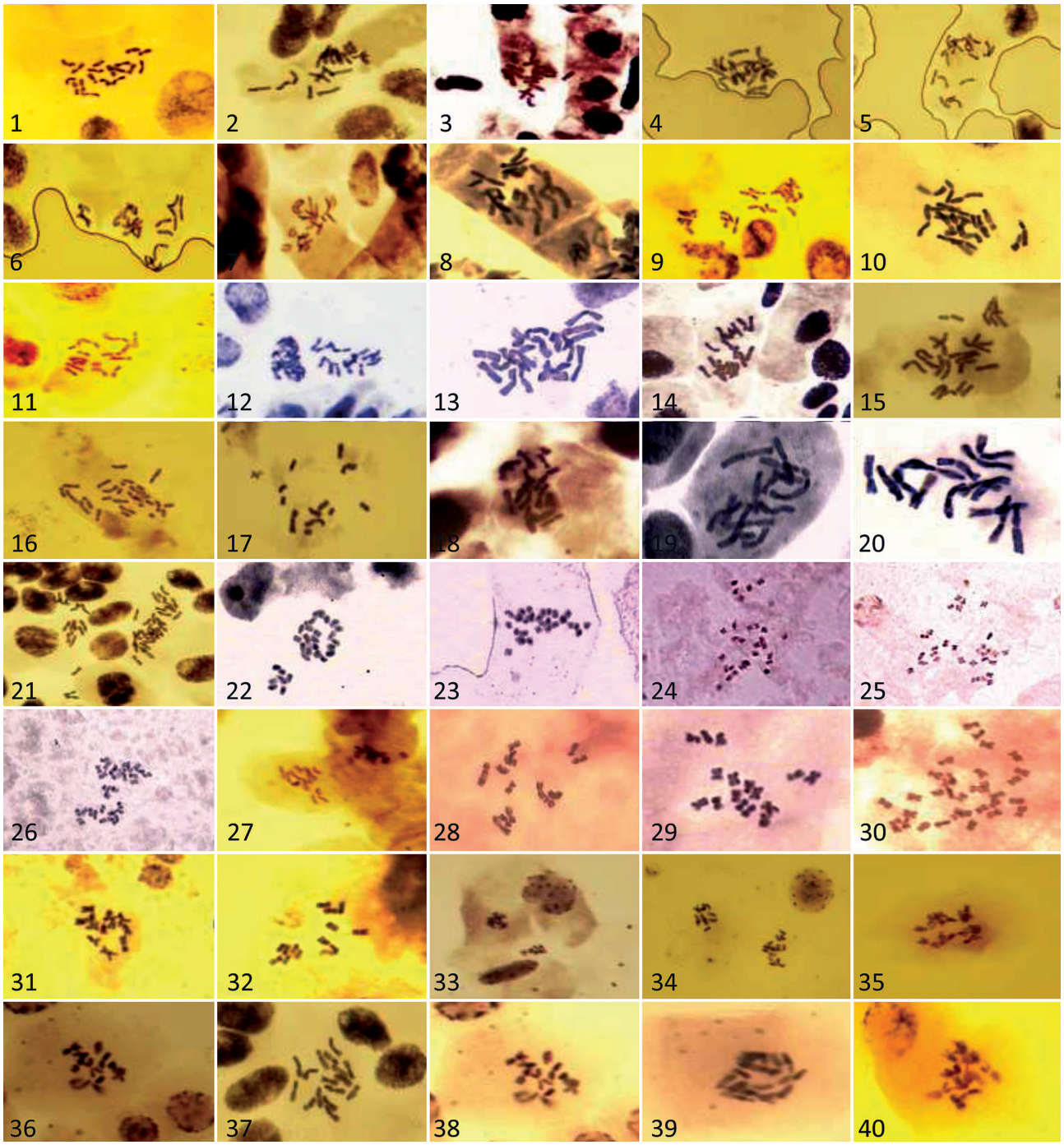

Figure 1 Somatic metaphase chromosomes in 40 studied samples: 1 – *Tripelurospemum disciforme* (C.A. Mey) Schultz-Bip. [1] 2*n*=2*x*=18; 2 – *T. disciforme* [2] 2*n*=2*x*=18; 3 – *Erigeron acer* L. 2*n*=2*x*=18; 4 – *Pulicaria dysenterica* (L.) Bernh. [1] 2*n*=2*x*=18; 5 – *P. dysenterica* [2] 2*n*=2*x*=18; 6 – *P. dysenterica* [3] 2*n*=2*x*=18; 7 – *Arctium lappa* L. 2*n*=2*x*=18; 8 – *Centaurea iberica* Trev.ex Speng. 2*n*=2*x*=16; 9 – *Xanthium strumaium* L. 2*n*=2*x*=18; 10 – *X. spinosum* L. 2*n*=2*x*=18; 11 – *Barbarea plantaginea* DC. [1] 2*n*=2*x*=16; 12 – *B. plantaginea* [2] 2*n*=2*x*=16; 13 – *Brachypodium sylvaticum* P. Beauv. [1] 2*n*=2*x*=18; 14 – *B. sylvaticum* [2] 2*n*=2*x*=18; 15 – *Catabrosa aquatica* Beauv. 2*n*=2*x*=20; 16 – *Dactylis glomerata* L. 2*n*=4*x*=28; 17 – *Lolium arundinaceum* (Schreb.) Darbysh. [1] 2*n*=2*x*=14; 18 – *L. arundinaceum* [2] 2*n*=2*x*=14; 19 – *Poa pratensis* L. 2*n*=2*x*=14; 20 – *P. trivialis* L. 2*n*=2*x*=14; 21 – *Polypogon fugax* Nees ex Steud. 2*n*=6*x*=42; 22 – *Mentha longifolia* (L.) Huds. 2*n*=2*x*=24; 23 – *Prunella vulgaris* L. [1] 2*n*=2*x*=24; 24 – *P. vulgaris* [2] 2*n*=2*x*=28; 25 – *Stachys setifera* C.A. Mey. [1] 2*n*=2*x*=30; 26 – *S. setifera* [2] 2*n*=2*x*=30; 27 – *Trifolium pratense* L. 2*n*=2*x*=14; 28 – *T. campesture* Schreb. 2*n*=2*x*=14; 29 – *T. repens* L. 2*n*=2*x*=16; 30 – *T. tumens* Stev. ex M. Bieb. 2*n*=4*x*=32; 31 – *Lotus corniculatus* L. 2*n*=2*x*=12; 32 – *Lathyrus chloranthus* Boiss. 2*n*=2*x*=14; 33 – *Ononis spinosa* L. [1] 2*n*=2*x*=14; 34 – *O. spinosa* [2] 2*n*=2*x*=14; 35 – *O. spinosa* [3] 2*n*=2*x*=14; 36 – *O. spinosa* [4] 2*n*=2*x*=14; 37 – *Hypericum perforatum* L. 2*n*=2*x*=16; 38 – *Plantago lanceolata* L. 2*n*=2*x*=12; 39 – *Plantago major* L. [1] 2*n*=2*x*=12; 40 – *P. major* [2] 2*n*=2*x*=12

Poa trivialis L. **2*n*=2*x*=14** (Fig. 1:20). IRN010_1165: From Imamzadeh Mohsen to Alvand heights, Hamadan, at 2297 m a.s.l. (34°47'16.4"N 48°23'19.9"E).

The basic CN for this genus was seven, with a few diploid (2*n*=14), tetraploid (2*n*=4*x*=28) (Spinnler & Stocklin 2018), and some species 2*n*=42, 56 and 2*n*=ca. 70 (Moghimifam & Razban Haghighi 2012, Probatova et al. 2015).

Polypogon fugax Nees ex Steud. **2*n*=6*x*=42** (Fig. 1:21). IRN010_2695: Bahadurbik village, after Salehabad, Hamadan to Sanandaj, at 1815 m a.s.l. (34°56'13.4"N 48°18'09.7"E).

This report is the first time in Iran for this genus.

Ghukasyan (2004) reported 2*n*=28 for *P. monspeliensis* and 42 for *P. fugax*. *Polypogon viridis* and *P. fugax* were found at different ploidy levels (2*n*=14 and 21).

HYPERICACEAE

Hypericum perforatum L. **2*n*=2*x*=16** (Fig. 1:37). IRN010_702: Imamzadeh Mohsen, Hamadan, at 2593 m a.s.l. (34°43'34.3"N 48°26'10.9"E).

Brutovska et al. (2000) determined *x*=8 in *H. perforatum* with haploid, diploid, triploid and tetraploid combitations. *H. perforatum* is usually reported as tetraploid (2*n*=32), however diploid (2*n*=16) and hexaploid (2*n*=48) also occur. Some variery in basic CN (*x*=18, 16, 12, 10, 9, 8, 7) appear in different sources (Kamari et al. 2001). Our results confirm report by Mehravi (2013).

LAMIACEAE

Mentha longifolia (L.) Huds. **2*n*=2*x*=24** (Fig. 1:22). IRN010_4129: Galleh-bar region, Asadabad, Hamadan, at 2202 m a.s.l. (34°48'05"N; 48°12'42.6"E).

Several cytological investigations suggested that *Mentha* is a group of polyploids, with different CN reported for each species. This may be due to taxonomic confusion among the species or due to species complexes having cytotypes with different chromosome numbers. *M. longifolia* consistently contained 24 chromosomes (Devi & Sharma 2022). Results showing the CN 24 in three genotype of *M. longifolia* reported by Zeynali et al. (2008).

Prunella vulgars L. **2*n*=2*x*=24** (Fig. 1.23). IRN010_2713: From Ganjnameh to Shahrestaneh, Hamadan, at 2348 m a.s.l. (34°44'55.4N 48°26'25.8E). This report is the first time in Iran for this genus.

— 2*n*=2*x*=28 (Fig. 1.24). IRN010_4037: Imamzadeh Mohsen, Hamadan, at 2455 m a.s.l. (34°46'37.5"N 48°23'07.7"E).

2*n*=28 was proved in several reports (Saggoo & Bir 1986, Lovkvist & Hultgard 1999).

Stachys setifera C.A. Mey. **2*n*=2*x*=30** (Fig. 1.25). IRN010_7493: From Imamzadeh Mohsen to Alvand heights, Hamadan, at 2297 m a.s.l. (34°47'16.4"N 48°23'19.9"E).

— 2*n*=2*x*=30 (Fig. 1:26). IRN010_7715: Imamzadeh Mohsen, Hamadan, at 2593 m a.s.l. (34°43'34.3"N 48°26'10.9"E).

Rajabi Mazaher et al. (2021) proved two different CN *x*=15 and *x*=17 as a diploid level within the genus *Stachys*. Chromosome counts of two species including *S. benthamiana* and *S. setifera* (2*n*=34) reported for the first time, while the CN of *S. byzantina* (2*n*=30) confirmed. Somatic CN of 26 *Stachys* taxa, collected from different localities in Turkey, showed 2*n*=30 (Martin et al. 2011).

FABACEAE

Trifolium pratense L. **2*n*=2*x*=14** (Fig. 1:27). IRN010_5149: From Ganjnameh to Shahrestaneh, Hamadan, at 2264 m a.s.l. (34°45'34.1"N 48°26'36.3"E).

Trifolium campestre Schreb. **2*n*=2*x*=14** (Fig. 1.28). IRN010_4504: From Ganjnameh to Shahrestaneh, Hamadan, at 2633 m a.s.l. (34°43'33"N 48°24'45.8"E).

Trifolium repens L. **2*n*=2*x*=16** (Fig. 1:29). IRN010_2727: From Imamzadeh Mohsen, Hamadan, at 2593 m a.s.l. (34°43'34.3"N 48°26'10.9"E).

T. repens with *n*=16 was also proved by Kaur & Singhal (2019). In study by Riasat & Sadeghian (2019), *T. repens* showed tetraploid levels (2*n*=4*x*=32).

Trifolium tumens Stev. ex M. Bieb. **2*n*=4*x*=32** (Fig. 1:30). IRN010_2328: From Ganjnameh to Shahrestaneh, Hamadan, at 2633 m a.s.l. (34°43'33"N 48°24'45.8"E).

Lotus cornicolatus L. **2*n*=2*x*=12** (Fig. 1:31). IRN010_7919: Galleh-bar region, Asadabad, Hamadan, at 2202 m a.s.l., (34°48'05"N 48°12'42.6"E).

All karyologically studied species of the genus *Lotus* showed a basic CN *x*=6, as 2*n*=12, 14 and 24 (Tanaka et al. 2016). Kaur & Singhal (2019), and Mirzadeh Vaghefi & Jalili (2019) reported chromosome count 2*n*=12 for *Lotus corniculatus*.

Lathyrus chloranthus Boiss. **2*n*=2*x*=14** (Fig. 1:32). IRN010_4443: Ekbatan Road, between Yelfan and Aliabad, Hamadan, at 2013 m a.s.l. (34°43'19.7"N 48°36'56.8"E). This report is the first time in Iran for this species.

CN 2*n*=14 (*x*=7) for this spesies is also reported by Barpete et al. (2012) and Sahin et al. (2000).

Ononis spinosa L. **2*n*=2*x*=14** (Fig. 1:33). IRN010_1972: From Zarrinbagh village to Balotzar, Nahavand (34°17'03.5"N 48°03'18.7"E). This report is the first time in Iran for this species.

— 2*n*=2*x*=14 (Fig. 1:34). IRN010_841: From Ganjnameh to Shahrestaneh, Hamadan, at 2633 m a.s.l. (34°43'33"N 48°24'45.8"E).

— 2*n*=2*x*=14 (Fig. 1:35). IRN010_1498: Ekbatan road, between Yelfan and Aliabad, Hamadan, at 2013 m a.s.l. (34°43'19.7"N 48°36'56.8"E).

— 2*n*=2*x*=14 (Fig. 1:36). IRN010_5129: Imamzadeh Mohsen, Hamadan, at 2455 m.a.s.l. (34°46'37.5"N; 48°23'07.7"E).

CN 2*n*=14 for *O. spinosa* is a first record in the world. Another studies found 2*n*=30 & 4*x*=60 for this species (Kloda et al. 2008)

PLANTAGINACEAE

Plantago lanceolata L. **2*n*=2*x*=12** (Fig. 1:38). IRN010_5241: From Ganjnameh to Shahrestaneh, Hamadan, at 2348 m a.s.l. (34°44'55.4"N 48°26'25.8"E).

Plantago major L. **2*n*=2*x*=12** (Fig. 1:39). IRN010_5357: From Ganjnameh to Shahrestaneh, Hamedan, at 2348 m a.s.l. (34°44'55.4"N 48°26'25.8"E).

— 2*n*=2*x*=12 (Fig. 1:40). IRN010_5854: Bahadurbik village, after Salehabad, Hamadan to Sanandaj, at 1815 m a.s.l. (34°56'13.4"N 48°18'09.7"E).

CN of 15 species of *Plantago* of Iran varied between 2*n*=8, 10, 20 and 2*n*=24. Our results confirms the previous records by Mohsenzadeh et al. (2008), Bala & Gupta (2011) and Pietro et al. (2020).

CONCLUSION

The results of the present study for 31 taxa belonging to Compositae, Cruciferae, Gramineae, Labiatae, Fabaceae, Hypericaceae and Plantaginaceae families from wetlands of Hamadan, Iran, illustrated 2n=12, 14, 16, 18, 20, 24, 28, 30, 32 and 42 with three ploidy levels (di-, tetra- & hexaploids).

ACKNOWLEDGEMENTS

The authors thank Dr. P. Salehi Shanjani, the director of Gene Bank for making the lab facilities available for our study and RIFR in Iran for financial support.

LITERATURE CITED

Abbaszade, S., A.A. Jafari, H. Safari & H. Shirvani 2017. Genetic variability and karyotype analysis for 13 accessions of L*olium multiflorum*. *Journal of Ornamental Plants* 7(1):1–8.

Alam, Sh., M.B. Sukur & Md.Y. Zaman 2011. Karyotype analysis in 2 morphological forms of *Xanthium strumarium* L. *Cytologia* 76(4):483–488.

Arshi, A. 2000. *Genetic modification of crops*. Translation. Publication of Jahad-e-Daneshgahi, Shiraz.

Bala, S. & R.C. Gupta 2011. Chromosomal diversity in some species of *Plantago* (Plantaginaceae) from North India. *International Journal of Botany* 7(1): 82–89.

Barpete, S., D. Parmar, N.C. Sharma & S. Kumar 2012. Karyotype analysis in grass pea (*Lathyrus sativus* L.). *Journal of Food Legumes* 25(1):14–17.

Brutovska, R., P. Kusnirikova, E. Bogyiova & E. Cellarova 2000. Karyotype analysis of *Hypericum perforatum* L. *Biologia Plantarum* 43(1):133–136.

Carev, I., F. Pustahija, M. Ruščić & S. Siljak-Yakovlev 2017. Chromosome number and ploidy level in seven *Centaurea* species from Croati. *Flora Mediterranea* 27:289–294.

Chehregani, A. & N. Mehanfar 2008. New chromosome counts in the tribe *Anthemideae* (Astraceae) from Iran. *Cytologia* 73(2):189–196.

Chehregani, A. & S. Hajisadeghian 2009. New chromosome counts in some species of Asteraceae from Iran. *Nordic Journal of Botany* 27:247–250.

Devi, A. & G. Sharma 2022. Morphological, phonological and cytological comparison of *Mentha longifolia* and *M. spicata* from sub-tropical and temperate regions of Jammu province. *Vegetos* 35(1): 179–187.

Gupta, H., R.C. Gupta, R. Kumar & V.K. Singhal 2017. A profile of chromosome counts, male meiosis and pollen fertility in 45 species of Asteraceae from Parvati Valley in Kullu district, Himachal Pradesh. *Caryologia* 70(2):128–140.

Ghukasyan, A. 2004. Extent of karyological study of Armenian grasses (Poaceae). *Flora i Rastitel'nye Resursy Armenii* 15:74–84 (in Russian). [Гукасян А.Г. 2004. Кариологическая изученность злаков (Poaceae) Армении // Флора и растительные ресурсы Армении. Вып. 15. С. 74–84].

He, S., X. Dong, G. Zhang, W. Fan, S. Duan, H. Shi, D. Li, R. Li, G. Chen, G. Long, ... & S. Yang 2020. High quality genome of *Erigeron breviscapus* provides a reference for herbal plants in Asteraceae. *Molecular Ecology Resources* 153–169.

Humphreys, M., U. Feuerstein, M. Vandewalle & J. Baert 2010. Ryegrasses. In: *Handbook of Plant Breeding* (Boller, B., P. Ulrich & F. Veronesi, eds), pp. 211–260, Springer.

Inceer, H. & S. Hayirlioglu-Ayaz 2010. Chromosome numbers in *Tripleurospermum* Sch. Bip. (Asteraceae) and closely related genera: relationships between ploidy level and stomatal length. *Plant Systematics and Evolution* 285(3–4): 149–157.

Inceer, H. & S. Hayirlioglu-Ayaz 2014. *Tripleurospermum insularum* (Asteraceae, Anthemideae), a new species from Turkey. *Annual Botany Fennici* 51:49–53.

Inceer, H., S. Hayirlioglu-Ayaz & O. Melahat 2007. Chromosome numbers of the twenty-two Turkish plant species. *Caryologia* 60(4):349–357.

Jang, T.S., Kh. Emadzade, J. Parker, E.M. Temsch, A.R. Leitch, F. Speta & H. Weiss-Schneeweiss 2013. Chromosomal diversification and karyotype evolution of diploids in the cytologically diverse genus *Prospero* (Hyacinthaceae). *BMC Evolutionary Biology* 13(136):1–17.

Javadi, H. 2006. Study of karyotype in three *Astragalus* species. *Pajouhesh and Sazandegi* 73:131–135 (in Farsi).

Javadi, H., S.M. Hesamzadeh-Hejazi & M.Sh. Babayev 2009. Karyotypic studies of three *Thymus* (Lamiaceae) species and populations in Iran. *Caryologia* 62:316–325.

Javadi, H., P. Salehi Shanjani & S.R. Savafi 2019. Chromosome counts and karyomorphology of some species of *Astragalus* (Fabaceae) from Iran. *Chromosome Science* 22(1–4):3–12.

Kamari, G., F. Felber & F. Garbari 1995. *Flora Mediterraanea* 5:261–373.

Kamari, G., C. Blanche & F. Garbari 2001. Mediterraanean chromosome number reports-11. *Flora Mediterranea* 11:435–488.

Karna, P. 2017. Cytological studies on two species, *Xanthium strumarium* Linn. and *Bidens pilosa* Linn. var. *minor* (Blume) Sherff (Asteraceae–Heliantheae) from Nepal. *International Journal of Apply Science Biotechnology* 5(1):66–71.

Kaur, D. &V.K. Singhal 2019. Meiotic abnormalities affect genetic constitution and pollen viability in dicots from Indian cold deserts. *BMC Plant Biology* 19(10):1–11.

Khayati, A., A. Tavassoli & M. Pakravan 2014. Chromosome numbers in some *Tripleurospermum* (Asteraceae) species from Iran. *Iranian Journal of Botany* 20 (2): 233–235.

Kloda, J.M., P.D.G. Dean, C. Maddren, D.W. MacDonald & S. Mayes 2008. Using principle component analysis to compare genetic diversity across polyploidy levels within plant complexes: an example from British restharrows (*Ononis spinosa* and *Ononis repens*). *Heredity* 100:253–260.

Lovkvist, B. & U.M. Hultgard 1999. Chromosome numbers in south Swedish vascular plants. *Opera Botany* 137:1–42.

Lusinska, J., A. Betekhtin, D. Lopez-Alvarez, P. Catalan, G. Jenkins, E. Wolny & R. Hasterok 2019. Comparatively barcoded chromosomes of *Brachypodium* perennials tell the story of their karyotype structure and evolution. *International Journal of Molecular Science* 20(5557):1–19.

Lusinska, J., J. Majka, A. Betekhtin, K. Susek, E. Wolny & R. Hasterok 2018. Chromosome identification and reconstruction of evolutionary rearrangements in *Brachypodium distachyon*, *B. stacei* and *B. hybridum*. *Annals of Botany* 122:445–459.

Martin, E., Ö. Çetin, E. Akçiçek & T. Dirmenci 2011. New chromosome counts of genus *Stachys* (Lamiaceae) from Turkey. *Turkish Journal of Botany* 35:671–680.

Martin, E. A. Savran & Y. Bağci 2009. Karyomorphological studies of ten taxa of *Barbarea* (Cruciferae) from Turkey. *Journal of Applied Biological Science* 3(2):135–141.

Mehravi, Sh. 2013. *Study on morphological and cytogenetic variation in some (Hypericum perforatum) medicinal plant Iraniane ecotypes*. Thesis of M.S., Faculty of Agriculture, Department of Biotechnology and Plant Breeding, Tarbiat Modares University, Tehran, Iran (in Farsi).

Mirzadeh Vaghefi, S.S. & A. Jalili 2019. Chromosome numbers of some vascular plant species from Iran. *Iranian Journal of Botany* 25(2):140–144.

Mohsenzadeh, S., V. Nazeri & M.S. Mirtadzadini 2008. Chromosome numbers of fifteen species of *Plantago* L. (Plantaginaceae) from Iran. *Iranian Journal of Botany* 14(1):47–53.

Moghimifam, R. & A. Razban Haghighi 2012. Karyotype variation in 4 species of *Poa* L. *Iranian Journal of Rangelands and Forests Plant Breeding and Genetic Research* 20(2:40): 295–303.

Oberprieler, C. & R. Voght 2006. The taxonomic position of *Matricaria macrotis* (Compositae–Anthemideae). *Willdenowia* 36:329–338.

Ørgaard, M. & I. Linde-Laursen 2007. Cytogenetics of Danish species of *Barbarea* (Brassicaceae): chromocentres, chromosomes and rDNA sites. *Hereditas* 144:159–170.

Pietro, R.D., A.L. Conte, P. Fortini, G.D Amato & G. Astuti 2020. Chromosome numbers for the Italian flora: 10. *Italian Botanist* 10:113–122.

Probatova, N.S., V.P. Seledets & V.Y. Barkalov 2015. Chromosome numbers in some species of Poaceae from Russia. *Botanica Pacifica* 4(1):1–9.

Rajabi Mazaher, A. S.M. Miri & A. Mohammadi 2021. A new chromosome number report in *Stachys* L. species by use of karyological analysis. *Journal of Genetic Resources* 7(1):29–35.

Rechinger, K.H. 1977. *Scorzonera* L. In: *Flora Iranica, vol. 122* (K.H. Rechinger, ed.), pp. 16–79, Akademische Druck-u, Verlagsanstalt, Austria.

Rezaei, E., H. Saeidi & M.R. Rahiminejad 2020. A taxonomic revision of genus *Dactylis* in Iran. *Journal of Plant Research (Iranian Journal of Biology)* 33(4):867–878.

Riasat, M. & S. Sadeghian 2019. Karyology study of ten *Trifolium* species in Fars Province. *Journal of Genetic Resources* 5(2):136–142.

Sahin, A., H. Genc & E. Bagci 2000. Cytotaxonomic investigations on some *Lathyrus* L. species growing in eastern Mediterrenean and southern Aegean regions-II. *Acta Botanica Gallica* 147(3):243–256.

Sheidai, M., S. Jafari, P. Taleban & M. Keshavarzi 2009. Cytomixis and unreduced pollen grain formation in *Alopecurus* L. and *Catbrosa* Beauv. (Poaceae). *Cytologia* 74(1):31–41.

Saeidi, H. & F. Rahmati 2012. A cytotaxonomic study of *Catabrosa* P. Beauv. (Poaceae) in Iran. *Journal of Taxonomy and Biosistematics* 4(12):37–42.

Saggoo, M.I. & S.S. Bir 1986. Meiotic studies on some east Himalayan members of family Labiatae. *Journal of Indian Botanical Society* 65:304–309.

Shamouni, S., M.R. Parishani & K. Negaresh 2020. Chromosome count of some species of *Cynaroides* Boiss. section of *Centaurea* L. "Aseracaea" genus in Iran. *Archives of Pharmacy Practice* 11(4):131–141.

Spinnler, F. & J. Stocklin 2018. DNA-content and chromosome number in populations of *Poa alpina* in the Alps reflect land use history. *Flora* 9:246–247.

Tantray, R., Y.I. Jan, M. Saleem Wani, V. Kumar Singhal & R.C. Gupta 2021. Chromosome numbers and meiotic behavior in some species of Asteraceae from high altitudinal regions of Kashmir Himalayas. *Journal of Asia-Pacific Biodiversity* 14:590–606.

Tasar, N., G. Dogan & Y. Kiran 2018. Karyological investigation on seven *Centaurea* L. (Asteraceae) taxa from Turkey. *Cytologia* 83(3):317–321.

Wang, Z., J. Wang, Y. Pan, T. Lei, G. Weina, L. Wang, L. Zhang, Y. Li, K. Zhao, T. Liu, ... & X. Wang 2019. Reconstruction of evolutionary trajectories of chromosomes unraveled independent genomic repatterning between *Triticeae* and *Brachypodium*. *BMC Genomics* 20(180):1–10.

Yang, Y., S. Li, Y. Xing, Z. Zhang, T. Liu, W. Ao, G. Bao, Z. Zhan, R. Zhao, T. Zhang, ... & T. Kang 2022. The first high-quality chromosomal genome assembly of a medicinal and edible plant *Arctium lappa*. *Molecular Ecology Resources* 22(4):1493–1507.

Zeynali, H., A. Arzani, Kh. Razmjou & M.B. Rezaei 2008. Study of cytogenetic in *Mentha spicata* and *M. longifolia*. Pajouhesh va Sazandegi 21(1):34–40 (in Farsi).