

**BOTANIKA INSTITUTI HUZURIDAGI ILMIY DARAJALAR
BERUVCHI DSc.02/30.12.2019.B.39.01 RAQAMLI ILMIY KENGASH**

BOTANIKA INSTITUTI

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***TULIPA L.* TURLARI HAQIDA YANGICHA QARASHLAR:
MORFOLOGIYASI, TARQALISHI, MOLEKULYAR TADQIQOT VA
MUHOFAZA MASALALARI**

03.00.05 – Botanika

**BIOLOGIYA FANLARI BO‘YICHA FAN DOKTORI (DSc)
DISSERTATSIYASI AVTOREFERATI**

Toshkent – 2023

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Biologiya fanlari bo'yicha fan doktori (DSc) dissertatsiyasi mavzusi O'zbekiston Respublikasi Oliy ta'lim, fan va innovatsiyalar vazirligi huzuridagi Oliy attestatsiya komissiyasida B2023.2.DSc/B 189 raqam bilan ro'yxatga olingan.

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KIRISH (fan doktori (DSc) dissertatsiyasi annotatsiyasi)

Dissertatsiya mavzusining dolzarbligi va zaruriyati. Dunyo bo'yicha lola (*Tulipa* L.) turlari yuqori darajadagi manzaraviy va estetik xususiyatga ega o'simliklar hisoblanadi. Yuqori darajadagi endemizm ko'rsatkichlari, aksariyat turlarining kamyob va yo'qolib ketish xavfi ostida ekanligi turkum turlarini morfo-va molekulyar usullar asosida taksonomik baholashni, fitogeografik va iqlim o'zgarishi sharoitlarida populyatsiyalar holati tahlilini hamda muhofaza choralarini ishlab chiqishni taqozo etadi. Turkum taksonomiyasida ayrim tasnifiy chalkashliklar, o'zaro duragaylanish jarayonining yuqoriligi va polimorfizm o'ziga xos murakkabliklarni keltirib chiqaradi. Shu sababli ayni paytgacha turlarning aniq soni ma'lum emas. Ohirigi ma'lumotlarga ko'ra (World Flora Online 2023), *Tulipa* turkumiga oid 376 ilmiy nom keltirilgan va ulardan 85 tasiga (23%) qabul qilingan tur, 266 tasiga (71%) tur sinonimi maqomi berilgan bo'lsa, 25 tasi (7%) taksonomik baholanmagan. O'z navbatida, 62 turni Tabiatni muhofaza qilish xalqaro tashkilotining yo'qolib ketish xavfi ostidagi turlarning qizil ro'yhatiga kiritilganligi (IUCN 2022) *Tulipa* turlari bo'yicha biogeografik tahlil va samarali muhofaza choralarini amalga oshirish muhim ilmiy-amaliy ahamiyatga ega.

Jahonda tabiiy floralardagi o'simlik turlari, jumladan, *Tulipa* bo'yicha biogeografik tadqiqotlar, iqlim o'zgarishining ta'siri, ularni muhofaza qilish hamda molekulyar tadqiqotlarga katta e'tibor qaratilmoqda. Shu jihatdan, *Tulipa* turlari taksonomiyasi va tarqalishining qaynoq markazlarini aniqlash dolzarb hisoblanadi. Noyob va yo'qolib borayotgan populyatsiyalarni turli iqlim o'zgarishi sharoitlarida kelajakdagi holatlarni modellashtirish, turlarni qulay o'sish va tarqalish omillarini aniqlash, ularga tashqi muhit omillari ta'sirini o'rganish hamda muhofaza strategiyalarini ishlab chiqish muhim ahamiyat kasb etadi.

O'rta Osiyo (WCVP 2023), shu jumladan O'zbekiston (Tojibaev et al. 2022) *Tulipa* turlari xilma-xilligiga boy markazlaridan biri hisoblanib, o'z navbatida 75 va 33 turlarni o'z ichiga oladi. *Tulipa* turlarining tirik o'simlik namunalari asoslangan morfologik tadqiqotlar "O'zbekiston florasi"ning kelgusi nashri uchun, molekulyar taxlillar turkum vakillarining struktural genomi va filogeniyasi bo'yicha yangicha ilmiy qarashlarni shakllanishida, iqlim o'zgarishlari, biogeografik izlanishlar va turlarni qulay o'sish va tarqalish sharoitlarini o'rganish samarali muhofaza choralarini amalga oshirish uchun xizmat qiladi. Shuningdek, populyatsiyalar maydonlarini qisqarishiga olib keluvchi tashqi muhit omillarining ta'siri, noyob va yo'qolib borayotgan turlarning hozirgi holati va dala tadqiqotlari kuzatuvlari *Tulipa* turlari uchun yangi muhofaza strategiyalarini ishlab chiqish uchun muhim ilmiy asos hisoblanadi.

Hozirda respublikamizda noyob va yo'qolib borayotgan o'simliklar, jumladan, bir urug'pallali geofitlarning taksonomiyasi, tarqalishi hamda muhofazasi borasida salmoqli ishlar amalga oshirilmoqda. Jumladan, *Allium* L. turkumi bo'yicha o'nlab yangi turlar (Sennikov et al. 2016), aynan *Tulipa* turkumidan esa fan uchun yangi 3 turni kashf etilganligi (Tojibaev 2014; de Groot va Tojibaev 2020), O'zbekistonda tarqalgan 24 turni Tabiatni muhofaza qilish xalqaro tashkilotining yo'qolib ketish xavfi ostidagi turlarning Qizil ro'yhatiga

(IUCN 2022) hamda 19 turni O‘zbekiston Respublikasi Qizil kitobiga (Khasanov 2019) kiritilganligi yaqqol misol bo‘la oladi.

O‘zbekiston Respublikasi Konstitutsiyasida “Davlat barqaror rivojlanish printsipligiga muvofiq, atrof-muhitni yaxshilash, tiklash va muhofaza qilish, ekologik muvozanatni saqlash bo‘yicha chora-tadbirlarni amalga oshiradi” vazifalari belgilab berilgan. Ushbu vazifalardan kelib chiqqan holda, *Tulipa* turlari asosida taksonomik va fitogeografik taxlillarni o‘tkazish, tashqi muhit omillari ta‘sirini o‘rganish, ayniqsa iqlim o‘zgarishi va antropogen omillarning salbiy ta‘sirini yumshatish hamda turkum uchun Milliy muhofaza strategiyasini ishlab chiqish ilmiy-amaliy ahamiyatga ega.

Ushbu dissertatsiya tadqiqoti O‘zbekiston Respublikasi Konstitutsiyasida atrof-muhitni muhofaza qilishga oid vazifalarni, O‘zbekiston Respublikasining 1992 yil 9 dekabrda 754-sonli “Tabiatni muhofaza qilish to‘g‘risida”gi Qonuni, O‘zbekiston Respublikasining 2016 yil 21 sentyabrda 409-sonli “O‘simlik dunyosini muhofaza qilish va undan foydalanish to‘g‘risida”gi Qonuni, O‘zbekiston Respublikasi Prezidentining 2017 yil 4 sentyabrda 3256-sonli “O‘zbekiston Respublikasi Fanlar Akademiyasi Botanika instituti va Zoologiya instituti faoliyatini tashkil etish chora-tadbirlari to‘g‘risida”gi Qarori, O‘zbekiston Respublikasi Prezidentining 2019 yil 30 oktyabrda 5863-sonli «2030 yilgacha bo‘lgan davrda O‘zbekiston Respublikasining atrof-muhitni muhofaza qilish kontsepsiyasini tasdiqlash to‘g‘risida»gi Farmoni hamda boshqa me‘yoriy-huquqiy hujjatlarda belgilangan vazifalarni amalga oshirishda muayyan darajada xizmat qiladi.

Tadqiqotning respublika fan va texnologiyalari rivojlanishining asosiy ustuvor yo‘nalishlariga mosligi. Mazkur tadqiqot respublika fan va texnologiyalar rivojlanishining V. «Qishloq xo‘jaligi, biotexnologiya, ekologiya va atrof-muhit muhofazasi» ustuvor yo‘nalishiga muvofiq bajarilgan.

Dissertatsiya mavzusi bo‘yicha xorijiy ilmiy-tadqiqotlar sharhi. *Tulipa* L. turlariga oid klassik va zamonaviy ilmiy-tadqiqotlar jahonning yetakchi ilmiy markazlari va oliy ta‘lim muassasalarida, jumladan, University of Cambridge (Buyuk Britaniya), Wageningen University va Leiden University (Niderlandiya), University of Pisa (Italiya), Abant İzzet Baysal University (Turkiya), Chungbuk National University (Janubiy Koreya), Zhejiang University (Xitoy), Research Center for Plant Sciences va Bu Ali Sina University (Eron), Botanika va fitointroduktsiya instituti (Qozog‘iston), Biologiya instituti (Qirg‘iziston) hamda Botanika institutida (O‘zbekiston) olib borilmoqda.

Muammoning o‘rganilganlik darajasi. Regel (1873), Baker (1874), Vvedenskiy (1935), Hall (1940), Bochantseva (1962), Vvedenskiy va Kovalevskaya (1971), Ivashenko (2005), Everett (2013), Tojibaev (2010; 2014), de Groot va Tojibaev (2020) tomonidan *Tulipa* L. turlarining morfologiyasi, taksonomiyasi hamda kariosistematikasiga oid tadqiqotlar olib borilgan.

Fitogeografiyaga oid ma‘lumotlar esa Bochantseva (1962), Vvedenskiy va Kovalevskaya (1971), Ivashenko (2005), Do‘gan va Akaydin (2011), Eker, Babaç va Koyuncu (2014) hamda Lazkov va Umralina (2015) tadqiqotlarida yoritilgan.

O‘simliklarni qulay o‘shishi va tarqalishidagi ekologik determinantlar hamda turli iqlim senariylarida populyatsiyalarni holatlari bo‘yicha tadqiqotlar Lioubimtseva (2009), Gaston (2009), Svenning (2009), Becklin (2016), Huang (2020), Nowak (2020), Wilson (2021) va Volis (2022) ishlarida yoritilgan.

Molekulyar tadqiqotlar natijalari Fay (2001), Zonneveld (2009), Yanagisawa (2012), Veldkamp va Zonneveld (2012), Christenhusz (2013), Li (2017), Kim (2018), Asgari (2020), Hajdari (2021), Li (2021), Lu (2021), Haerinasab (2021), Kiani (2021) va Wilson (2023) ishlarida o‘z ifodasini topgan.

Bioxilma-xillikni saqlash va ularni muhofaza qilishga oid tadqiqotlar Kassas (2002), Kumari (2021), Myers (2000), Squires (2013), Volis (2016), Hunter (2011), Eigenbrod (2009), Falkner (1997), Hale (1997), Heywood (1995), Kanwar (2010), Qiang (2003), Marchese (2015), Reynolds (2006), Schwartz (2000), Torquebiau (2000) tomonidan amalga oshirilgan.

Shuningdek, tadqiqotni bajarishda bir necha xalqaro tashkilotlar va ma‘lumotlar bazalari, jumladan BMT, Tabiatni Muhofaza qilish xalqaro birlashmasi (IUCN), Milliy Fan Fondi (NSF), Birlashgan Millatlar Atrof-muhit dasturi (UNEP), Jahon muhofaza qilinadigan hududlar (WDPA) hamda boshqa (GBIF, WCSP, IPNI, POWO, WFO) ma‘lumotlar bazalaridan foydalanilgan.

Biroq tirik o‘simlik namunalari asosida morfologik belgilarni o‘rganish, molekulyar-taksonomik taxlillarni amalga oshirish, O‘rta Osiyo va O‘zbekiston florasini turlarining qaynoq tarqalish hududlarini aniqlash, iqlim o‘zgarishi senariylarida populyatsiyalarning hozirgi va kelajakdagi holatini modellashtirish, turlar tarqalishi va qulay yashash muhitining asosiy determinantlari, populyatsiyalar va ularni areallarini qisqarishiga olib keluvchi stress omillar ta‘sirini o‘rganish, *Tulipa* turkumini muhofaza qilish strategiyasini ishlab chiqish kabi ilmiy-tadqiqotlar qisman olib borilgan yoki umuman olib borilmagan. Shunga ko‘ra, tirik namunalari asosida morfologik va genom tadqiqotlarini o‘tkazish, muhofaza strategiyasini ishlab chiqish uchun fitogeografik va ekoregional taxlillar, iqlim o‘zgarishi senariylarida populyatsiyalar holatini modellashtirish muhim ilmiy-amaliy ahamiyat kasb etadi.

Tadqiqotning dissertatsiya bajarilayotgan ilmiy-tadqiqot muassasining ilmiy-tadqiqot ishlari rejalari bilan bog‘liqligi. Dissertatsiya O‘zbekiston Respublikasi Fanlar akademiyasi Botanika instituti “O‘zbekiston florasini” laboratoriyasining “Janubi-G‘arbiy Hisor, Hisor-Darvoz va Panj okruglari florasining to‘r tizimli xaritalash (Surxondaryo viloyati qismi)” hamda “O‘zbekiston-Xitoy Molekulyar filogeniya va biogeografiya” xalqaro laboratoriyasining “Hayot daraxti: O‘zbekiston bir urug‘pallali o‘simliklari” davlat dasturlari, institutning A-FA-2021-427-raqamli “O‘zbekiston florasidagi polimorf oilalarning taksonomik reviziyasi”, MRB-AN-2019-30-raqamli O‘zbekiston-Belorussiya xalqaro ilmiy-texnik dasturi doirasidagi “DNK shtrixkodlash texnologiyasi asosida Belarus va O‘zbekistonning noyob va yo‘qolib borayotgan o‘simliklarini genetik inventarizatsiya qilish” ilmiy loyihalari hamda O‘zbekiston Respublikasi Fanlar akademiyasi Botanika instituti va Xitoy Fanlar Akademiyasi Shinjon Ekologiya va Geografiya instituti xamkorligidagi “Ecological

Management of Saline-Alkali Land in the Aral Sea Region, Central Asia Green Road Project 2 xalqaro ilmiy loyihasi doirasida bajarilgan.

Tadqiqotning maqsadi *Tulipa* turlari bo'yicha amaliy morfologik va biogeografik tadqiqotlar, plastom asosida molekulyar-taksonomik baholash, iqlim o'zgarishi senariylari bo'yicha bioiqlimiy modellashtirish va Milliy muhofaza strategiyasini ishlab chiqishdan iborat.

Tadqiqotning vazifalari:

tirik o'simlik namunalari asosida *Tulipa* turlari morfologiyasini o'rganish;

O'rta Osiyoda tarqalgan *Tulipa* turlarining solishtirma morfologiyasi va unga asoslangan filogeniyasini tadqiq etish;

O'zbekiston florasidagi *Tulipa* turlarining zamonaviy konspektini yaratish; turlarni to'r tizimli xaritalash asosida GAT xaritalarini yaratish, tarqalishning qaynoq nuqtalarini aniqlash va biogeografik taxlillarni amalga oshirish;

Tulipa turlarini qulay o'sish va tarqalishini belgilovchi muhim iqlimiy o'zgaruvchilar va omillarni aniqlash hamda ta'sirini tahlil qilish;

iqlim o'zgarishi senariylarida kamyob turlar populyatsiyalari holatlarini bioiqlimiy modellashtirish;

Tulipa turlari uchun plastid genomi xaritasini yaratish va genom tarkibini tadqiq etish;

Tulipa turlari uchun molekulyar filogenetik daraxtni ishlab chiqish va molekulyar-taksonomik baholash;

O'zbekistonda *Tulipa* turlarini muhofaza qilishning milliy strategiyasini ishlab chiqish.

Tadqiqotning ob'ekti sifatida *Tulipa* (Liliaceae) turkumi turlari tanlangan.

Tadqiqotning predmeti tirik o'simlik namunalari asosidagi morfologiya, biogeografik tahlillar, iqlim senariylari bo'yicha populyatsiyalar holatini modellashtirish, molekulyar tadqiqot uslublari va muhofaza qilish strategiyasini ishlab chiqish hisoblanadi.

Tadqiqotning usullari. Dissertatsiyada dala, kuzatuv, taqqoslash, xaritalash, taxlil, molekulyar-genetik va bioinformatik usullardan foydalanilgan.

Tadqiqotning ilmiy yangiligi quyidagilardan iborat:

tirik o'simlik namunalari morfologik tadqiq qilish asosida "O'zbekiston florasida"ning yangi nashri uchun *Tulipa* turkumining zamonaviy konspekti tuzilgan;

O'rta Osiyo florasida tarqalgan 48 turning solishtirma morfologiyasi o'rganilgan va 24 belgilar asosida filogenetik daraxt yaratilgan;

O'rta Osiyoning fitogeografik va ekoregional hududlari kesimida turlar xilma-xilligining qaynoq markazlari aniqlangan;

turkumning seksiyalari va turlari kesimida O'zbekiston hududida tarqalishini aks ettiruvchi to'r tizimli xaritalari yaratilgan;

iqlim o'zgarishining turli senariylari bo'yicha 3 ta geografik hududlarda tarqalgan turlarning bioiqlimiy modellari yaratilgan;

uch turga mansub iqlimiy o'zgaruvchilarning turlarni tarqalishidagi ahamiyati modellashtirilgan;

o'n to'qqiz ta *Tulipa* turlari uchun plastid genomining tuzilishi, tarkibi va

genlarning funksiyalari tadqiq qilingan;

yigirma to‘qqiz *Tulipa* turlarining molekulyar filogenetik daraxti ishlab chiqilgan va turlarning taksonomik maqomi taxlil qilingan;

tashqi muhit omillarini *Tulipa* turlariga salbiy ta'sirlari ochib berilgan;

O‘zbekistonda *Tulipa* turlarini muhofaza qilishning Milliy strategiyasi ishlab chiqilgan.

Tadqiqotning amaliy natijalari quyidagilardan iborat:

O‘zbekiston florasining kelgusi nashri uchun *Tulipa* turlarining 308 ta morfologik belgilar qo‘shish va taxrirlash tavsiya etilgan;

Tulipa turkumining O‘zbekiston florasida tarqalgan 5 seksiyaga mansub 33 turlari uchun geoaxborot tizimidagi tarqalish xaritalari ishlab chiqilgan;

O‘rta Osiyo, jumladan, O‘zbekiston hududlarida samarali muhofaza choralarini olib borish uchun turlar xilma-xilligi yuqori bo‘lgan fitogeografik hududlar va ekoregionlar aniqlangan. Turli iqlim senariylarida *Tulipa* kamyob populyatsiyalarning hozirgi va kelajakdagi holati modellashtirilgan;

O‘rta Osiyo florasidagi 53 tur, jumladan O‘zbekistonda tarqalgan 24 tur Tabiatni muhofaza qilish xalqaro tashkilotining (IUCN) yo‘qolib ketish xavfi ostidagi turlarning Qizil ro‘yhatiga kiritilgan va 3 tur (*T. borszczowii*, *T. hissarica*, *T. korshinskyi*) O‘zbekiston Respublikasi Qizil kitobining yangi nashriga kiritish uchun tavsiya qilingan.

O‘zbekiston sharoitida *Tulipa* turlarni muhofaza qilish uchun 14 ta uslublarni o‘z ichiga olgan 3 ta yondoshuvdan iborat milliy muhofaza strategiyasi yaratilgan.

Tadqiqot natijalarining ishonchliligi dissertatsiyada qo‘llanilgan zamonaviy usullar va ilmiy yondashuvlar asosida olingan natijalarning nazariy ma‘lumotlarga mos kelishi, natijalarning yetakchi ilmiy nashrlarda chop etilganligi, xalqaro va Respublika miqyosidagi konferensiyalarda muhokama qilinganligi, olingan xulosalarning asoslanganligi, shuningdek, dissertatsiya ishining amaliy natijalarini tegishli tashkilotlar tomonidan tasdiqlanganligi hamda amaliyotga joriy etilganligi bilan asoslanadi.

Tadqiqot natijalarining ilmiy va amaliy ahamiyati. Ishning ilmiy ahamiyati solishtirma morfologiyaga asoslangan filogeniya natijalarini molekulyar-genetik tadqiqot natijalari bilan uzviy bog‘liqligini chuqur tahlil etilganligi, o‘n to‘qqiz turlar uchun plastid genomi xaritasi va tarkibini aniqlanganligi, yigirma to‘qqiz turlar asosida molekulyar filogenetik daraxtni yaratilganligi, turlarni aniqlash uchun seksiya va turlar kesimidagi aniqlovchi kalitlarni ishlab chiqilganligi, O‘zbekistonda tarqalgan endemik *Tulipa* ro‘yhatini qayta shakllantirilganligi, populyatsiya sonlarini avvalgi (1970 yil) va hozirgi (2022 yil) holatini o‘rganilganligi, turlarni tarqalishida muhim ahamiyat kasb etuvchi omillarni aniqlanganligi, turli iqlim o‘zgarish senariylarida *Tulipa* populyatsiyalarining hozirgi va kelajakdagi holatlari modellashtirilganligi bilan ifodalanadi.

Tadqiqot natijalarining tirik o‘simlik materiallari asosida morfologik belgilarni o‘rganilganligi va O‘zbekiston florasining yangi nashri uchun tegishli ma‘lumotlarni tavsiya qilinganligi, biogeografik taxlillar natijasida O‘zbekistonda

tarqalgan 29 turga oid 37 yangi tarqalish manzillarini qayd etilganligi, samarali muhofaza choralari ishlab chiqish uchun turlarni fitogeografik va ekoregional tarqalishi chuqur taxlil etilganligi, xaritalarni ishlab chiqilganligi, 3 ta tashqi muhit omillariga oid 13 ta stress omillarning salbiy ta'siri yoritilganligi, 24 ta turni Tabiatni muhofaza qilish xalqaro tashkilotining (IUCN) yo'qolib ketish xavfi ostidagi turlarning Qizil ro'yhatiga kiritilganligi hamda 3 ta asosiy yo'nalishda 14 ta yondoshuvdan iborat turkumni milliy darajada muhofaza qilish strategiyasini ishlab chiqilganligi ishning amaliy ahamiyatini belgilaydi.

Tadqiqot natijalarining joriy qilinishi. O'rta Osiyo va O'zbekiston floralaridagi *Tulipa* turkumi turlarini o'rganish bo'yicha olingan natijalar asosida:

Tulipa turlarini tadqiq qilish va muhofaza choralari ko'rish maqsadida 32 turlarga oid ma'lumotlar GBIF (Global Biodiversity Information Facility) ma'lumotlar bazasiga kiritilgan va joriy qilingan (Global biologik xilma-xillik ma'lumotlar bazasining 2023 yil 26 iyundagi ma'lumotnomasi). Natijada O'zbekistonda tarqalgan turlarning tipi, morfologik tavsifi, tarqalishi, fenologiyasi va ekologiyasiga oid ma'lumotlar *Tulipa* turlarini seksiya va turlar kesimida bir-biridan farqlash, turlarni 1970 yildan avvalgi va hozirgi holatini baholash, turlarni tarqalishi va joylashuvi haqidagi ma'lumotlarni xalqaro darajada foydalanish imkonini bergan.

O'zbekiston Milliy Gerbariysi (TASH) uchun 26 turga mansub 200 dan ortiq gerbariy namunalari topshirilgan (O'zbekiston Respublikasi Fanlar Akademiyasining 2023 yil 9 iyundagi 4/1255-1277-sonli ma'lumotnomasi). Natijada O'zbekiston Qizil kitobiga kiritilgan noyob, yo'qolib borayotgan va endemik turlarning yangi gerbariy namunalari TASH ning O'rta Osiyo bo'limi kolleksiyasini sezilarli boyitgan va chuqurlashtirilgan morfologik hamda biogeografik izlanishlarni olib borish imkonini bergan.

O'zbekistonda tarqalgan 24 ta *Tulipa* turlari Tabiatni muhofaza qilish xalqaro tashkilotining yo'qolib ketish xavfi ostidagi turlarning Qizil ro'yhatiga (IUCN Red List) kiritilgan va muhofaza uchun joriylashtirilgan (Tabiatni muhofaza qilish xalqaro tashkilotining 2023 yil 27 iyundagi ma'lumotnomasi). Natijada *Tulipa* turlarini xalqaro darajada muhofaza qilish, ularni noyoblik darajasini baholash, biogeografik ma'lumotlardan global miqiyosda foydalanish va muhofaza qilish choralarni amaliyotda qo'llash imkonini bergan.

Tadqiqot natijalarining aprobatsiyasi. Tadqiqot natijalari 2 ta xalqaro va 4 ta respublika ilmiy-amaliy anjumanlarida muhokamadan o'tkazilgan.

Tadqiqot natijalarining e'lon qilinishi. Dissertatsiya mavzusi bo'yicha jami 22 ta ilmiy ish nashr etilgan va O'zbekiston Respublikasi Oliy Attestatsiya Komissiyasining doktorlik dissertatsiyalari asosiy ilmiy natijalarini chop etishga tavsiya etilgan ilmiy nashrlarda 16 ta ilmiy maqola, jumladan, 10 ta respublika va 6 ta xorijiy jurnallarda nashr etilgan.

Dissertatsiyaning tuzilishi va hajmi. Dissertatsiya kirish, yetti bob, xulosa, adabiyotlar ro'yhati va ilovalardan iborat. Dissertatsiya hajmi 198 betni tashkil etadi.

DISSERTATSIYANING ASOSIY MAZMUNI

Kirish qismida dissertatsiya ishining dolzarbligi va zaruriyati asoslangan, tadqiqotning fan va texnologiyalari rivojlanishining ustuvor yo‘nalishlariga bog‘liqligi, dissertatsiya mavzusi bo‘yicha respublika va xorijiy ilmiy-tadqiqotlar sharhi, muammoning o‘rganilganlik darajasi, tadqiqotning maqsadi, vazifalari, ob‘ekti va predmeti, tadqiqot natijalarini amaliyotga joriy etilganligi, nashr etilgan ishlar va dissertatsiyaning tuzilishi to‘g‘risidagi ma‘lumotlar keltirilgan.

Dissertatsiyaning **“*Tulipa L.* turkumi turlarini o‘rganilish tarixi”** nomli birinchi bobi yovvoyi *Tulipa* turlarini taksonomiyasi, biogeografiyasi, bioiqlimiy o‘zgarishlarga oid tadqiqotlar va bioxilma-xillikni muhofazasiga bag‘ishlangan taxlillarni qamrab olgan.

Dissertatsiyaning **“Tadqiqot materiallari va uslublari”** nomli ikkinchi bobida tadqiqot hududining tabiiy-geografik tavsifi, dala tadqiqotlari, qo‘llanilgan tadqiqot metodlari, ularni amalga oshirish bosqichlari va jarayonlari batafsil yoritilgan.

Tadqiqot hududi 3 toifaga bo‘lingan: O‘rta Osiyo (mintaqaviy), O‘zbekiston Respublikasi (ma‘muriy) va Farg‘ona vodiysi (mahalliy). Dissertatsiya ishida lola turlarini solishtirma morfologiyasi, morfologiyaga asoslangan filogeniya, turlarni iqlim o‘zgarishi senariylari asosida bioiqlimiy modellashtirish, fitogeografik va ekoregional taxlillar, strukturaviy genom va molekulyar filogenetik tadqiqotlar mintaqaviy darajada, tirik o‘simlik namunalari asosidagi morfologiya, to‘r tizimli xaritalash asosida turlarni tarqalishi, turlar konspekti, turlar uchun qulay o‘shish sharoitlarini bashoratlash, tarqalishiga ta'sir etuvchi determinantlar, stress faktorlarini salbiy ta'sirini o‘rganish va muhofaza qilish strategiyasini ishlab chiqish ma‘muriy miqiyosda hamda Farg‘ona vodiysi *Tulipa* turlarining biogeografik tahlili eng qaynoq hudud sifatida mahalliy darajada tadqiq qilingan.

O‘rta Osiyo tabiiy-geografik jihatdan asosan cho‘l va yarim cho‘llardan iborat o‘ziga xos hudud (Lioubimtseva and Henebry 2009) bo‘lib, uning bioxilma-xilligi iqlim o‘zgarishiga juda sezgir hisoblanadi (Brooke 2014). Ayniqsa, suv resurslari hudud bioxilma-xilligini shakllanishi va saqlanishida muhim ahamiyat kasb etadi. Mintaqada suv resurslarini yetishmovchiligi va notekis taqsimotiga qaramasdan (Wang 2022), O‘rta Osiyo o‘simliklar bioxilma-xilligini, jumladan, endem turlarning (Tojibaev et al. 2020) qaynoq nuqtalaridan biridir (Myers et al. 2000; Nowak et al. 2020). O‘rta Osiyo tabiiy florasi 10 mingdan ortiq yuksak o‘simliklar turlarini o‘z ichiga oladi (Khasanov 2015). Mintaqa 75 *Tulipa* turlarini qamrab oladi.

O‘zbekiston botanik-geografik jihatdan tog‘li O‘rta Osiyo (Afg‘on-Turkiston) va Turon provinsiyalariga bo‘linadi (Tojibaev et al., 2016). Respublikaning sharqiy qismida g‘arbiy Tiyonshon va Pomir-Oloy tog‘ tizmalari joylashgan va bu hudud O‘zbekiston umumiy maydonining 12% qismini egallaydi. Markaziy va g‘arbiy qismlar Qizilqum cho‘llari va Ustyurt platosi bilan qoplangan. O‘simliklar bioxilma-xilligi hududning sharqiy va markaziy qismlaridan g‘arb tomon kamayib boradi. O‘zbekistonda 33 *Tulipa* turlari qayd etilgan.

Tulipa turlarining qaynoq markazi sifatida tadqiqotlar olib borilgan Farg‘ona vodiysining tabiiy-geografik hududi O‘zbekistonning sharqiy qismida joylashgan. Vodiy shimoliy-g‘arbiy tomondan Chotqol, shimoliy tomondan Qurama, janubiy tomondan Turkiston va Oloy, shimoliy-sharqiy tomondan Farg‘ona tog‘ tizmalari bilan o‘ralgan. Farg‘ona vodiysi piyozli geofitlarning global qaynoq markazi bo‘lib, tog‘li O‘rta Osiyo provinsiyasi florasida uchraydigan *Allium* L. turlarining 60% va O‘zbekistondagi *Eremurus* M. Bieb. turlarining 50% vodiy florasida qayd etilgan (Tojibaev et al., 2018). Hududda *Tulipa* turlarining 23 turi aniqlangan.

Dissertatsiyaning “***Tulipa* turlari morfologik belgilarining tahlili**” nomli uchinchi bobida tabiiy sharoitda o‘sayotgan tirik o‘simliklarining morfologik belgilarni o‘rganish, solishtirma morfologiya va u asosidagi filogenetik tadqiqotlar hamda O‘zbekiston florasida tarqalgan *Tulipa* turlarining zamonaviy konspekti, turlarni uchrash joylari, o‘shish sharoiti va noyoblik darajasi to‘g‘risidagi ma‘lumotlar yoritilgan.

Tirik o‘simlik namunalari asosidagi morfologik belgilarni o‘rganish natijasida *Lanatae*, *Kolpakowskianae*, *Vinistriatae*, *Spiranthera* va *Biflores* seksiyalariga oid 26 turning 200 dan ortiq nusxadagi gerbariy namunalari yig‘ildi va ilk bor ilmiy va amaliy maqsadlarga xizmat qiluvchi illyustratsiyalari tayyorlangan. “O‘zbekiston florasida”ning yangi nashri uchun 308 ta morfologik belgilar qo‘shish hamda tahrirlash uchun tavsiya etilgan.

O‘rta Osiyoflorasidagi tarqalgan *Lanatae*, *Kolpakowskianae*, *Vinistriatae*, *Spiranthera*, *Biflores*, *Clusianae*, *Orithyia* va *Multiflorae* seksiyalariga mansub 48 turning solishtirma morfologiyasi o‘rganilgan hamda 24 ta belgilar asosida morfologiyaga asoslangan filogenetik daraxt tuzilgan. Unda *Orithyia* va *Biflores* seksiyalari daraxtning asos va *Lanatae* seksiyasi daraxtning eng ustki qismida joylashgan. Filogenetik daraxtning bazal qismidagi seksiyalar vakillari arxaik va dastlabki divergensiyalanagan turlar hisoblanadi. Ushbu natija molekulyar tadqiqotlarga asoslangan Wilson (2023), Christenhusz et al. (2013) va Zonneveld (2009) tadqiqotlari natijalariga mos keladi.

“O‘zbekiston florasida”ning navbatdagi nashri uchun *Tulipa* ning zamonaviy konspektini tuzishda turlar taksonomik va nomenklaturaviy jihatdan qayta ishlandi. *Lanatae*, *Kolpakowskianae*, *Vinistriatae*, *Spiranthera* va *Biflores* seksiyalariga mansub bo‘lgan 33 turlarni aniqlash uchun dixotomik kalit, birinchi nashr etilgan manbasi, nomenklaturaviy tipi, fenologiyasi, ekologiyasi, kamyoblik darajasi, etimologiyasi, O‘zbekiston botanik-geografik rayonlarida tarqalishi va boshqa zarur ma‘lumotlar keltirilgan.

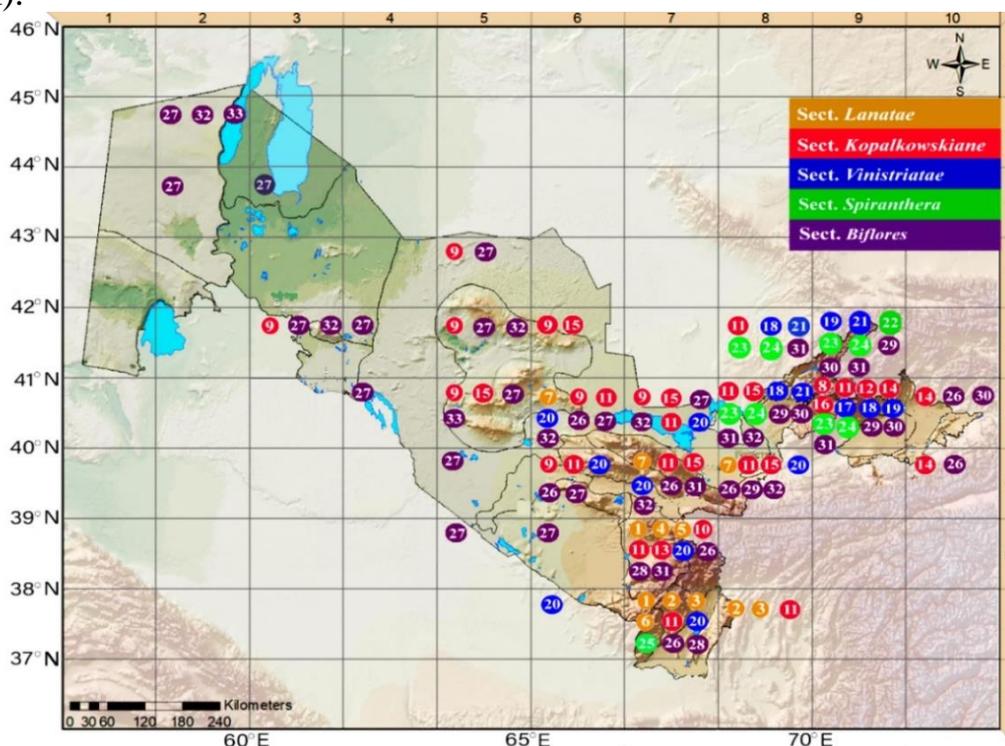
Dissertatsiyaning “**Tadqiqot hududlarida *Tulipa* turlari fitogeografiyasining asosiy xususiyatlari**” nomli to‘rtinchi bobida tadqiqot ob‘ektlarini (a) O‘rta Osiyo fitogeografik rayonlari va ekoregionlari bo‘yicha tarqalishi; (b) O‘zbekiston hududi bo‘yicha to‘r tizimli xaritada; muhofaza qilinadigan tabiiy hududlarda (v) hamda turlar xilma-xilligi hamda yuqori endemizm ko‘rsatkichi bilan alohida ajralib turadigan Farg‘ona vodiysida (g) *Tulipa* turlari tarqalishining asosiy xususiyatlari yoritilgan.

O‘rta Osiyo ekoregionlari o‘zining iqlimi, vegetatsiyasi, tuproq va boshqa ekologik xususiyatlari bilan ajralib turuvchi hududlardir. Ular o‘simliklarni tarqalishi, evolyutsiyasi va samarali muhofaza choralari ko‘rishda muhim ahamiyatga ega (Villarreal et al. 2019; Pandey et al. 2021). O‘rta Osiyo ekoregionlarining xaritasi Dinerstein va boshq. (2017) ishlariga asoslangan holda yaratilgan. Hisor-Oloy ochiq o‘rmonzolarida 41 *Tulipa* turlarini tarqalishi bu ekoregionni eng qaynoq, Tiyon-Shon arid dashtlari (19 tur), Pomir-Oloy, g‘arbiy Tiyon-Shon tog‘ tizmalari va Oloy-g‘arbiy Tiyon-Shon dashtlari (18 tur) nisbatan turlarga boy ekoregionlar ekanligi aniqlangan.

O‘rta Osiyo botanik-geografik rayonlarida (Kamelin 2021) *Tulipa* turlarini tarqalishi tahlili, Farg‘ona vodiysining eng turlarga boy (25 tur) hamda Mo‘goltog‘-Qurama (13 tur), Ko‘histon (10 tur), Hisor, Darvoz va Ko‘hitang-Boysun (har biri 9 turdan) geografik rayonlarini o‘rtacha tur boyligiga ega ekanligini ko‘rsatgan.

Biogeografik tahlillar natijasiga ko‘ra, O‘rta Osiyo ekoregionlari va fitogeografik rayonlarida *T. altaica* va *T. turkestanica* (6 ta ekoregionda) hamda *T. korolkowii* va *T. turkestanica* (10 ta fitogeografik rayonda) eng keng tarqalgan turlar sifatida qayd etilgan. Faqat bitta ekoregion (24 tur) yoki fitogeografik rayonda (22 tur) turlar tarqalishining taxlili mikro-endemizm hodisasi kuchli ekanligi ya‘ni bitta ekoregion (66%) yoki fitogeografik (72%) rayonda tarqalgan *Tulipa* turlarini asosiy qismi endemik turlar ekanligi aniqlangan.

O‘zbekistonda tarqalgan *Tulipa* turlarini to‘r tizimli xaritalarida tarqalishini aks ettirish uchun tadqiqot hududi 10 ta uzunlik (1, 2, 3... va 10) va 10 ta kenglik (A, B, C... va J) komponentlardan iborat jami 100 ta to‘r kataklarga bo‘lingan (1-rasm).



1-rasm. O‘zbekistonda hududida *Tulipa* turlarini to‘r tizimli xaritalash asosida tarqalishi

Ajratilgan kataklarning turlarga boyligiga ko'ra: (a) hududning g'arbiy qismida joylashgan turlar kam uchraydigan (1–3 tur) – 16 ta kataklar; (b) hududning shimoli-g'arbiy joylashgan o'rtacha turlar boyligiga ega (4–6 tur) – 5 ta kataklar va (v) turlarning qaynoq markazlari (7–13 tur) toifalarga ajratildi. Turlarga boy 8 ta kataklar hududning janubiy, shimoli-sharqiy va sharqiy qismida joylashgan (F6, G6, H6, I6, F8, G8, E9, F9).

O'zbekiston botanik-geografik rayonlarida turlar boyligini o'rganishga qaratilgan tadqiqotlar okruglar darajasida G'arbiy Tiyonshon (14 tur) va G'arbiy Hisor (13 tur) okruglari hamda rayonlar kesimida G'arbiy Chotqol, Qurama, Boysun, Sangardak-To'palang rayonlarini yetakchilik o'rnini ko'rsatdi.

Botanik-geografik rayonlar bo'ylab eng keng tarqalgan turlar qatoriga *T. korolkowii* (7 ta rayonda), *T. sogdiana* va *T. turkestanica* (5 ta) kiradi. 14 tur faqat 1 ta rayonda uchraydi. Bu boradagi batafsil ma'lumotlar dissertatsiyada keltirilgan.

Tadqiqot ob'ektlarining O'zbekistonda tarqalishini taxlil qilish natijasida *T. bactriana*, *T. butkovii*, *T. sharipovii*, *T. intermedia* va *T. uzbekistanica* O'zbekiston florasining milliy endemlari maqomi yana bir bor tasdiqlandi. Milliy endem tur qatoriga kiritilgan *T. intermedia* mahalliy tadqiqotchi kuzatuvlari bo'yicha (Farg'ona vodiysining Qirg'iziston Respublikasi qismida, G.A. Lazkov ma'lumoti) O'zbekiston hududidan tashqarida uchrashini qayd etgan bo'lsada, rasmiy manbalarda chop etilmagan.

Tulipa turlarini O'zbekiston hududida 1970 yildan avval va hozirgi paytdagi tarqalishining holati mavjud gerbariy ma'lumotlari va dala tadqiqotlarida to'plangan ma'lumotlarni xaritalash asosida o'rganilgan. Natijalarga ko'ra, populyatsiyalar sonini qisqarganligi kuzatilgan.

BMTning Oziq-ovqat va qishloq xo'jaligi tashkiloti tomonidan tuproq tiplarining butunjahon xaritalarini yaratilgan (Fischer et al. 2008). Tuproq tiplari bir-biridan mexanik tarkibi, kimyoviy xossalari va boshqa jihatlari bilan farqlanadi. Ushbu ma'lumot bazasi asosida O'zbekiston florasidagi *Tulipa* turlarini tuproq tiplarida tarqalish xaritasi ishlab chiqilgan. *Tulipa* turlarini tarqalishini tahlil qilish 25 turni litozol (I), 17 tur kaltsiy kserozol (Xk), 9 ta tur kaltsiy yermozol (Yk), 8 tur kalkarik gleyzol (Gc) va 7 tur eutrik gleyzol (Ge) tuproq tiplarida uchrashi aniqlangan. Turlarni asosan litozol va kaltsiy kserozol tuproq tiplarida keng tarqalganligi, ushbu hududlarni *Tulipa* ning qaynoq nuqtalari hisoblangan g'arbiy Tiyon-Shon va Pomir-Oloy tog' tizmalariga to'g'ri kelishi bilan izohlanadi.

Bioxilma-xillikni muhofaza qilishda tabiiy qo'riqlanadigan hududlarni tashkil etish muhim hisoblanadi (Laguna 2004; Hernandez et al. 2021). O'zbekiston florasidagi *Tulipa* turlarining asosiy qismi (82%) ushbu hududlarda, ya'ni 27 lola turi 7 ta davlat qo'riqxonalari va 2 ta biosfera rezervatida hamda 19 tur Milliy tabiat bog'lari floralari tarkibida muhofaza etiladi. Tog'li hududlarda joylashgan Hisor (9 tur) va Surxon (8 tur) davlat qo'riqxonalari hamda Ugom-Chotqol milliy tabiat bog'i (10 tur) *Tulipa* turlari soni bo'yicha yetakchilik qiladi. Quyi Amudaryo davlat biosfera rezervati, Oqtog'-Tomdi qo'riqxonasi va Orolqum milliy tabiat bog'i esa *Tulipa* turlari eng kam tarqalgan hududlar hisoblanadi.

Fargʻona vodiysining tabiiy-geografik hududi Oʻrta Osiyoda *Tulipa* turlarining eng qaynoq markazlaridan biri boʻlib, hududda 5 seksiyaga oid 23 turlar qayd etilgan. Ushbu tadqiqotda turlarning tarqalishini aks ettiruvchi toʻr tizimli xaritalari ishlab chiqilgan va geografik taxlili amalga oshirilgan, endemizm darajasi baholangan, IUCN (2022) tamoyillari asosida kamyoblik maqomi belgilangan va muhofaza choralari ishlab chiqilgan. Vodiyni oʻrab turuvchi togʻ tizmalari orasida Qurama (12 tur), Turkiston va Chotqol (10 tadan tur) tizmalari *Tulipa* turlariga boyligi bilan ajralib turadi. Maʼmuriy hududlar kesimida Qirgʻiziston florasi ustunlik qiladi (6 tur). Keyingi oʻrinlarda keluvchi Oʻzbekiston (5 tur) va Tojikiston (4 tur) floralari bir-biriga yaqin koʻrsatkichlarga ega. Barcha maʼmuriy hududlar boʻylab tarqalgan turlar soni 8 tani tashkil etadi. Fargʻona vodiysining muhofaza etiladigan hududlari orasida Sari-Chelak qoʻriqxonasi (4 tur), Pop milliy bogʻi (3 tur) va Oqtosh (3 tur) qoʻriqxonalari *Tulipa* turlari muhofazasida muhim oʻrin tutadi.

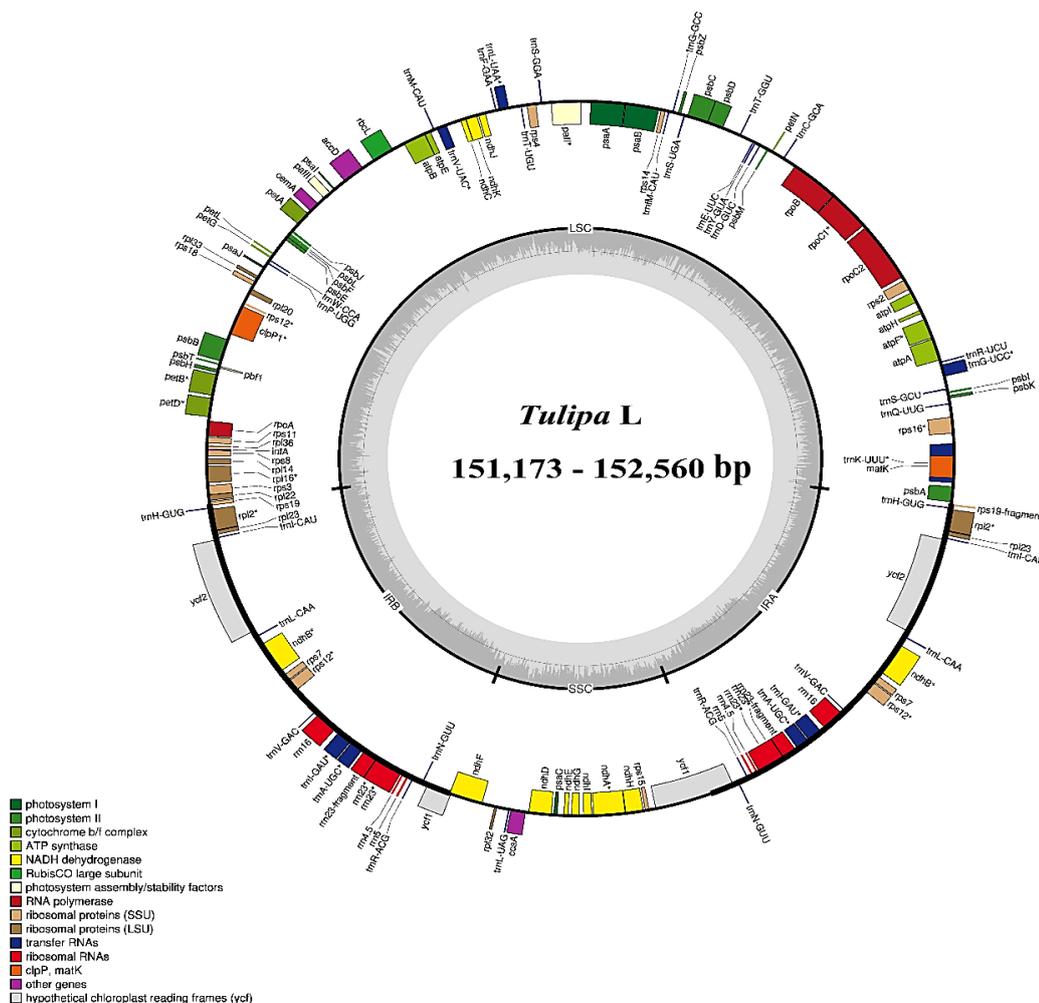
Ishning **“*Tulipa* turkumi turlarining plastom strukturasi va filogeniyasi”** nomli beshinchi bobida *Tulipa* turlari plastida genomlarining tuzilishi, genlar kategoriyasi, nomlari, funksiyalari, nukleotid tarkibi, ekzonlardagi nukleotidlar oʻzgaruvchanligi aniqlangan hamda turlarning molekulyar filogeniyasi ishlab chiqilgan va ularning taksonomik maqomi tavsiya etilgan.

Oʻzbekiston florasida tarqalgan 19 *Tulipa* turlarining plastom strukturasi oʻrganish ularni boshqa yopiq urugʻli oʻsimliklar kabi 4 qismdan (2 ta IR, LSC va SSC) iborat ekanligi aniqlangan (2-rasm).

Genomda G+C nukleotidlarining ulushi 36.6-36.7% ni tashkil qilgan boʻlsa, LSC 34.6%, SSC 30.1-30.2% va IR qismlari 42.1% ni tashkil etgan.

Tulipa turlari plastida genomi jami 134 ta genlardan iborat boʻlib, 112 tasi bevosita sintez jarayonlarida, jumladan, 78 ta oqsil, 4 tasi rRNK, 30 ta tRNK sintezida ishtirok etsa, 4 tasi psevdogenlar ekanligi aniqlangan. Genlarning 18 tasi esa genomning IR qismida duplikatlangan boʻlib, 6 tasi oqsillarni (*ndhB*, *rpl2*, *rpl23*, *rps7*, *rps12*, va *ycf2*), 4 tasi rRNK (*rrn4.5*, *rrn5*, *rrn16*, va *rrn23*), 8 tasi tRNK (*trnA-UGC*, *trnH-GUG*, *trnI-CAU*, *trnI-GAU*, *trnL-CAA*, *trnN-GUU*, *trnR-ACG*, va *trnV-GAC*) sintezini kodlovchi va 4 ta (*ycf1*, *rps19*, va 2 ta *ycf68*) psevdogenlardan iborat.

rps19 va *ycf1* genlari genomning IR qismi chegarasida joylashgan boʻlib, ularning oqsillarni kodlash qobiliyati qisman gen duplikatsiyasi tufayli yoʻqolgan. Shuningdek, *ycf68* va *ycf15* genlarni psevdogenligi hamda *infA* genida nukleotid yetishmovchiligi sababli genlarni ekspressiya xususiyati yoʻqolgan. *ycf68* va *ycf15* psevdogenlarining kodlash qobiliyatini yoʻqolganligi avval ham oʻrganilgan (Li et al. 2017, Lu et al. 2017) boʻlsada, mazkur tadqiqotda *ycf68* va *ycf15* kodlash qobiliyatini qisman yoʻqolganligi genlarni ortiqchaligi (gene redundancy) bilan tushuntiriladi. Translyatsiya initsiatsiyasi faktori 1 sintezini kodlovchi *infA* genining kodlash qobiliyatini toʻliq yoʻqolganligi evolyutsiya davomida bu funktsiyani boshqa gen bajarayotgani yoki bu oqsil tur uchun oʻz ahamiyatini yoʻqotganligi bilan ifodalanadi (Li et al. 2017).



2-rasm. *Tulipa* turlaning plastom strukturasi

Plastomda takrorlanuvchi nukleotid birikmalarini uchrashi 6 ta kategoriyada (mono-, di-, tri-, tetra-, penta- va geksanukleotid takrorlar) 61 tadan (*T. scharipovii*) 89 tagacha (*T. sogdiana*) takrorlanishi aniqlanib, ulardan mononukleotid takrorlar eng ko‘p uchragan.

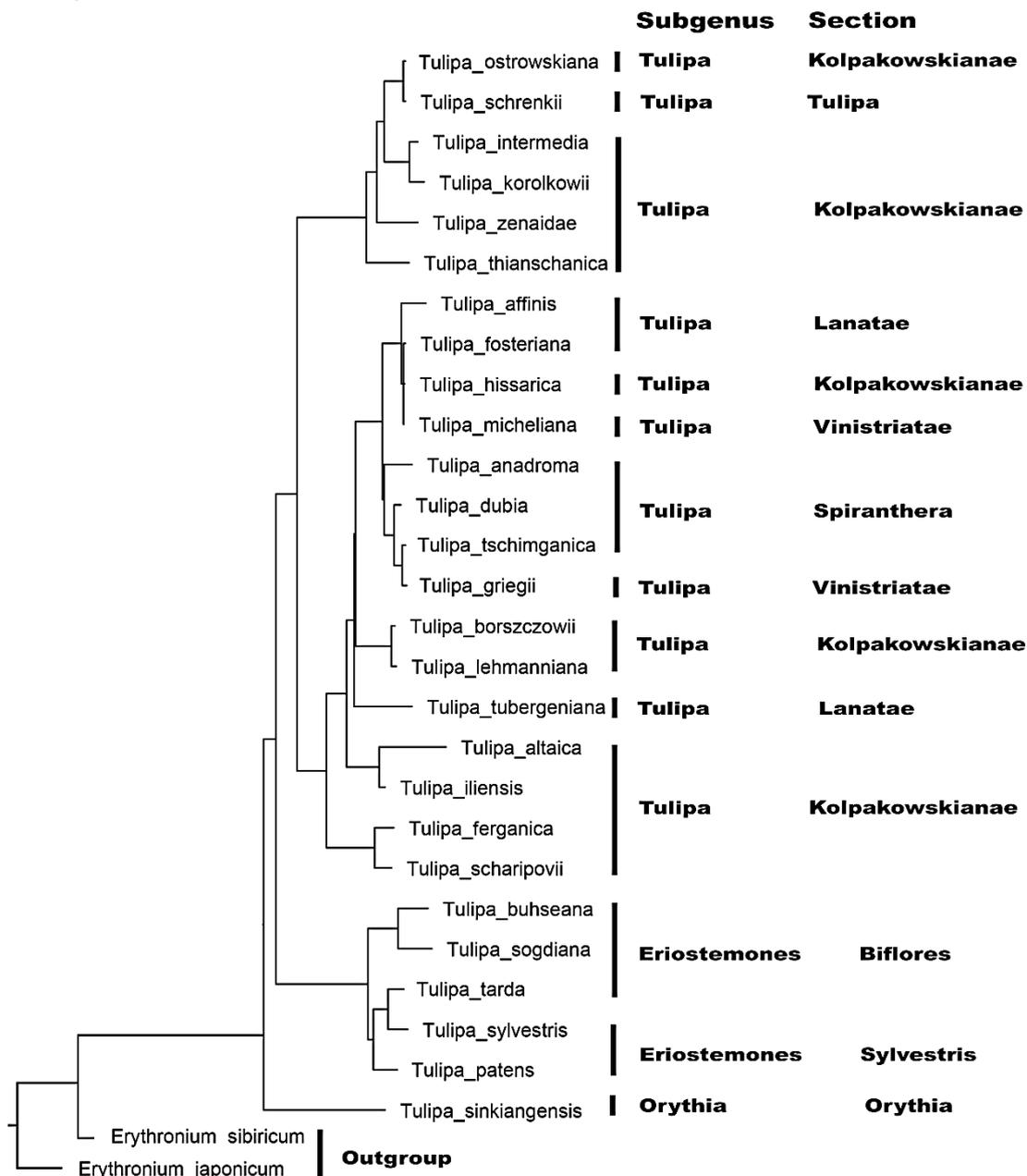
Natijalarga ko‘ra, *rpoB-trnC*, *petA-psbJ*, *rpl33-rps18*, *rpoA-rps11*, *ndhF-ndhD*, *rps15-ycf1*, *psaJ* genlari yuqori polimorf xususiyatini namoyon etgan va *Tulipa* turlari uchun populyatsion genetik taxlillar uchun tavsiya etiladi.

Tadqiq etilgan *Tulipa* plastom genlari orasida *psaJ* genini nukleotidlar xilma-xilligiga boy ekanligi aniqlangan.

Tulipa turlarining molekulyar filogeniyasi O‘rta Osiyoda tarqalgan 29 tur plastid genomlarining 76 ta oqsil sintezida ishtirok etuvchi genlari asosida olib borildi (3-rasm). Tashqi guruh sifatida *E. japonicum* and *E. sibiricum* foydalanilgan. Qo‘llanilgan 3 ta uslublarning barchasida (Bayesian inference, maximum parsimony va maximum likelihood) o‘xshash topologiya kuzatilgan.

Boshqa tadqiqot natijalariga (Christenhusz et al. 2013; Wilson 2023) o‘xshash holda, *Kolpakowskianae* seksiyasi turlari daraxtda tarqoq joylashgan. Jumladan, *T. ostrowskiana*, *T. intermedia*, *T. korolkowii*, *T. zenaidae* va *T. thianschanica* seksiyaning boshqa turlariga nisbatan alohida klad hosil qilgan va kuchli qo‘llab-quvvatlangan. Bu klad ichida *Tulipa* seksiyasiga mansub *T. schrenkii* (*T.*

suaveolens ning sinonimi) *T. ostrowskiana* (*Kolpakowskianae* seksiyasi) bilan juda yaqin joylashgan. Molekulyar va morfologik natijalar taxlili asosida *T. schrenkii*, *T. suaveolens* va *T. ostrowskiana* turlarini sinonimlashtirish, bitta *T. ostrowskiana* turi deb yuritilish taklif etiladi.



3-rasm. *Tulipa* turlarining molekulyar filogenetik dendrogrammasi

T. intermedia va *T. korolkowii* filogenetik daraxtda juda yaqin joylashgan. Plastom asosidagi natijalar, biogeografik va morfologik o'xshashlik hamda mavjud ma'lumotlar (Wilson 2023) asosida bu turlarni bir nomga birlashtirish va uni *T. korolkowii* nomi bilan yuritish tavsiya etiladi.

Molekulyar va morfologik tadqiqot natijalariga ko'ra (Christenhusz et al. 2013; van Raamsdonk 1995; Everett 2013), *T. zenaidae* *T. lehmanniana* ning gibridi sifatida keltirilishiga qaramay ushbu turlar alohida kladlarda joylashgan va ularni molekulyar, biogeografik va morfologik jihatdan farqlanishlarini hisobga olib mustaqil turlar deb yuritish tavsiya etiladi.

Hall (1940) gerbariy materiallari asosida *T. thianshanica* va *T. iliensis* turlarini *T. altaica* ga birlashtirgan va ushbu turlarni *Orithya* turkumostiga tegishli deb hisoblagan. Bir qancha tadqiqot natijalarida *T. thianshanica* mustaqil (Czerepanov 1995; Nikitina 1951; Zhengyi 2000; Zonneveld 2009) yoki boshqa turning sinonimi (Christenhusz et al. 2013, Everett 2013) deb keltirilgan. *T. altaica* va *T. iliensis* filogenetik daraxtdagi joylashuvi nukleotidlar almashinuvi natijasida yuzaga kelganligini hisobga olib, kelgusida qayta taksonomik baholash lozim.

Christenhusz va boshq. (2013) *T. affinis* ni *T. fosteriana* ga sinonim sifatida keltirilgan. Biroq turlar o'rtasida morfologik farqlar ushbu turlarni kelgusida qayta taksonomik baholash zarurligini ko'rsatadi.

Christenhusz va boshq. (2013) ishlarida *T. borszczowii* va *T. lehmanniana* filogenetik daraxtda yaqin joylashgan va mustaqil tur sifatida qabul qilingan (accepted species). Molekulyar tadqiqot natijasi, aniq biogeografik aloxidalanishning mavjud emasligi, morfologik yaqinlik va yashash muhitini o'xshash ekanligini hisobga olib, ushbu turlarni bitta turga birlashtirish va *T. lehmanniana* deb nomlash tavsiya etiladi.

T. scharipovii va *T. ferganica* ni filogenetik daraxtda yaqin joylashuviga qaramasdan bir qator muhim farqlanuvchi belgilarga ega. Birinchidan, turlarni yashash muhitlari bir-biridan to'liq ajralgan bo'lib, *T. scharipovii* Chap adirliklarining bo'z tuproqlarida, *T. ferganica* esa asosan Farg'ona vodiysini o'rab turuvchi o'rta tog'larining toshli-shag'alli tuproqlarida tarqalgan. Ikkinchidan, o'simlikning piyoz tuzilishi, vegetativ va generativ organlarning tuklanishi, generativ organlar tuzilishidagi farqlar hamda molekulyar tadqiqot natijalarini hisobga olgan holda, ushbu turlarni mustaqil tur sifatida qabul qilish tavsiya etiladi.

T. buhseana va *T. sogdiana* turlarining yashash muhiti va umumiy ko'rinishi o'xshash. Ko'p tadqiqotlarda bu turlar (Christenhusz 2013; Everett 2013; Zhengyi 2000; Zonneveld 2009) *T. biflora* ning sinonimi sifatida keltirilgan. Lekin turlarning piyozchasi, barg joylashuvi, poyadagi gullar soni, changchi ipining tuklanishi, tashqi va ichki gultojibarglarining tuklanishidagi farqlar hamda molekulyar tadqiqot natijalarini hisobga olib, *T. buhseana* va *T. sogdiana* ni mustaqil turlar sifatida qabul qilish tavsiya etiladi.

Seksiya darajasida *Orithya*, *Sylvestris* va *Biflores* seksiyalarini filogenetik daraxtning asosida joylashuvi ularni arxaik va dastlab divergensiyangan seksiyalar ekanligini hamda morfologiyaga asoslangan va boshqa molekulyar (Christenhusz 2013; Wilson 2023) filogeniya tadqiqot natijalariga mos kelishini ko'rsatgan.

Tadqiqotning **“*Tulipa* L. turlari ekologik masalalarini modellashtirish va taxlil qilish”** nomli oltinchi bobi turlarni yashash muhiti bilan o'zaro munosabati, noyob turlarni turli iqlim o'zgarish senariylaridagi holatlari, turlar tarqalishini modellashtirish va qulay o'sish muhitini bashoratlash masalalarini o'z ichiga oladi.

Dissertatsiya tadqiqoti doirasida O'rta Osiyoda tarqalgan kamyob turlar sifatida Qizil Kitobga kiritilgan *Tulipa* turlarining muhim iqlimiy o'zgaruvchilari turlarni tarqalishi bo'yicha 3 ta geografik hududlarga (g'arbiy Tiyon-Shon, Pomir-Oloy va keng tarqalgan) bo'lingan holda o'rganilgan. Unga ko'ra, Farg'ona vodiysining ***g'arbiy Tiyon-Shon*** qismida tarqalgan *Tulipa intermedia*,

T. scharipovii va *T. ferganica* turlari uchun ClimaticMoistureIndex, PetWettestQuarter, PetColdestQuarter iqlimiy o'zgaruvchilar muhim deb topilgan. Ushbu turlarning turli iqlim senariylari bo'yicha kelajakda tarqalish areallari va o'sishi uchun qulay muhit ularning hozirgi tarqalgan joyiga juda yaqin joylashgan.

Pomir-Oloy tog' tizmalarida tarqalgan turlarni iqlim o'zgarishiga munobatini o'rganish uchun *Tulipa affinis*, *T. carinata*, *T. ingens*, *T. lanata* va *T. tubergeniana* tanlab olingan. Ulardan O'zbekistonning janubiy qismidagi o'rta tog' mintaqasida uchrovchi *T. carinata*, *T. ingens* va *T. lanata* tularining barchasi uchun o'rtacha oylik harorat (BIO2 = Mean Diurnal Range) eng muhim iqlimiy o'zgaruvchi ekanligi aniqlangan. Turlarni yashash muhiti va geografik mintaqada tarqalishi ularning bioiqlimiy o'zgaruvchanlari turlicha bo'lishini ko'rsatgan. Masalan, asosan bo'z tuproqlarida tarqalgan *T. tubergeniana* va Nurota qoldiq tog'larining toshli tuproqlarida uchraydigan *T. affinis* larning iqlimiy o'zgaruvchilari yuqoridagi turlardan farq qilgan. Shuningdek, SSPs 5.85 senariysi bo'yicha 2081–2100 yillarga borib *T. tubergeniana* va *T. lanata* eng qulay o'sish areallari o'z navbatida 24 va 12.5 marta qisqarishi mumkinligi modellashtirilgan.

Tadqiqot hududining adirlik va o'rta tog'larida **keng tarqalgan** turlar sifatida tanlangan *T. korolkowii* va *T. lehmanniana* uchun iqlimiy o'zgaruvchilar (Bio06, Bio15, Bio19 va PET Seasonality) deyarli o'xshash bo'lgan. SSPs 5.85 senariysi bo'yicha 2100 yilga borib *T. korolkowii* uchun eng qulay o'sish arealini 2.7 marotaba va *T. lehmanniana* areali 373 marta qisqarishi turlar uchun amaliy muhofaza choralarini ko'rishni talab qiladi.

O'rta Osiyo, jumladan O'zbekiston florasidagi *Tulipa* turlari uchun qulay o'sish muhiti va turlar tarqalishining qaynoq balandlik mintaqasi dengiz sathidan 700–2200 m balandlik oraliqlarida joylashgan. Shularni hisobga olgan holda, tarixiy geologik davrlarda turkum ajdodlari iqlimiy o'zgarishlar, masalan, muzlik davrida ushbu balandlik oraliqlarida saqlanib qolgan, yashagan va keyinchalik ham quruq va xarorati yuqori bo'lgan (cho'l va adirliklar), nisbatan sernam va sovuq (yuqori tog') iqlim muhitlarga tarqalgan bo'lishi mumkin. Tur tarqalgan balandlik diapazonini kengayishi populyatsiyalar soniga ($r = 0.50$, $p < 0.05$) va AOO ($r = 0.57$, $p < 0.05$) ijobiy korrelyatsiyalanadi, ya'ni turlar qanchalik turli ekologik sharoitlar, jumladan xilma-xil iqlimiy muhitga moslashishi, turlarni yashab qolish imkoniyatini oshiradi, populyatsiyalar sonini ortishi va keyinchalik AOO ko'rsatkichini kengayishiga olib keladi.

Turlar tarqalishida topografiya, iqlim o'zgarishi va tuproq omillari muhim ahamiyat kasb etadi. Topografiya o'simliklarga quyosh nurini yetib borishi, tuproqni isishi, suv va oziqa taqsimotida hamda o'ziga xos mikro muhit yaratilishida muhim o'rin tutadi (Costa et al. 2015; Lassueur et al. 2006; Macek et al. 2019; Svenning et al. 2009). Topografiya omilini 11 ta adirlik va cho'l mintaqalarda tarqalgan Qizil Kitobga kiritilgan turlar uchun muhimligi aniqlangan. Shuningdek, *T. hissarica*, *T. vvedenskyi*, *T. carinata*, *T. ingens*, *T. affinis*, *T. micheliana*, *T. korolkowii* turlarini *ex-situ* sharoitida muhofaza qilishda topografik kriteriyalarga e'tibor berishni talab qiladi. Tuproq omili *T. uzbekistanica*, *T. butkovii* va *T. lanata* ning tarqalishida asosiy omil sifatida

ahamiyatli bo'lsa, iqlim omili barcha turlarni tarqalishida muhim o'rin tutadi.

Dissertatsiyaning “**O‘zbekiston florasidagi *Tulipa* turlarini muhofaza strategiyasini ishlab chiqish**” nomli yettinchi bobi turkum populyatsiyalarini qisqarishiga ta'sir etuvchi tashqi muhit omillari, ularni muhofaza qilish strategiyasini ishlab chiqish bo'yicha natijalar keltirilgan.

Abiotik omillarning salbiy ta'sirini Ustyurt platosi va Qizilqumda *T. biflora*, *T. buhseana* va *T. sogdiana* yog'ingarchilik kam bo'lgan yillarda suv yetishmovchiligi va yuqori xarorat ta'sirida vegetatsiyasini ohirigacha yetmaslik, yog'in rejimining buzilishi *T. bactriana* ni *locus classicus* dan hozirgacha qayd etilmaganligi, *T. uzbekistanica* arellarini keskin qisqarganligi hamda tabiiy ofat natijasida *T. borszczowii* populyatsiyalarini keskin qisqarganligida kuzatish mumkin. *Tulipa* turlarini abiotik stress faktorlari sifatida tanlangan tuproq, yuqori xarorat, yog'in miqdori va tabiiy ofat omillari jami 7 ta turlar populyatsiyalari soni va arellarini qisqarishiga olib kelishi aniqlangan.

Tulipa turlariga biotik stress faktorlar sifatida tadqiqot hududida kuzatilgan parazitizm, xayvonlar tomonidan iste'mol va turlararo kurash omillari keltirilgan. Xasharot va mikroorganizmlarning salbiy ta'siri 7 ta turlarda (*T. lehmanniana*, *T. tubergeniana*, *T. ingens*, *T. affinis*, *T. greigii*, *T. albertii* va *T. kolpakowskiana*), yovvoyi hayvonlar tomonidan piyozlarni iste'mol qilishi Toshkent viloyatida *T. vvedenskyi*, *T. dubia* hamda Surxondaryo viloyatida *T. lanata* va *T. ingens* turlarida aniqlangan. Turlararo kurash asosan o'rmon elementlari mavjud muhitlarda o'suvchi 9 ta *Tulipa* turlari bilan uchrab, ularning gullash vaqti muhitdagi boshqa o'simlik jamoalarining vegetatsiyalari ayni avj olgan paytga to'g'ri keladi va raqobat quyosh nuri, tuproqdagi mikro va makroelementlar uchun kechadi.

Antropogen faktorlar bioxilma-xillikka salbiy ta'sir etuvchi omil hisoblanadi. Quyida O'zbekistonda tarqalgan *Tulipa* turlariga antropogen omillar ta'siri yoritilgan.

Urbanizatsiya. Aholi sonini ortishi va urbanizatsiya adirliklar va o'rta tog' hududlarida tarqalgan bioxilma-xillikka jiddiy zarar yetkazmoqda. Ma'lumotlarga ko'ra (Statistika qo'mitasi ma'ruzasi 2022), 2022 yili O'zbekiston aholisi sonini o'sishi 2021 yilga nisbatan 17% ga o'sgan. O'zbekistonda aholi zichligi eng yuqori bo'lgan Farg'ona vodiysi va Toshkent viloyati hududlari *Tulipa* turlarining qaynoq nuqtalari hisoblanadi. Geobog'langan ma'lumotlarga ko'ra, Bo'stonliq tumanida *T. greigii* ning 44% va Sherobod tumanida *T. tubergeniana* ning 38% populyatsiyalari tarqalgan maydonlar 2013-2017 yillar davomida aholi tomonidan ishg'ol etilgan. Urbanizatsiya jami 11 ta Qizil kitobga kiritilgan *Tulipa* turlariga salbiy ta'sir etishi aniqlangan.

O'zbekistonda *Tulipa* tarqalgan maydonlarni **qishloq ho'jaligi maqsadlarida o'zlashtirilishini** aholi zichligi yuqori va rivojlangan dehqonchilik an'alariga ega Farg'ona vodiysi, Toshkent va Surxondaryo viloyatlarida yaqqol kuzatish mumkin. *T. scharipovii*, *T. intermedia* va *T. bifloriformis* Qurama tizmasi etaklarida, *T. ferganica* va *T. turkestanica* Janubiy Chotqol tizmasi adirliklarida, *Lanatae* seksiyasi vakillarini Pomir-Oloy tog' tizmalarining Qashqadaryo va

Surxondaryo viloyatlarida hamda *Kopalkowskianae* va *Biflores* seksiyasi turlarini Qizilqum cho'llarida populyatsiyalar egallagan maydonlarni o'zlashtirishi aniqlangan. Ushbu omil jami 11 ta Qizil kitobga kiritilgan *Tulipa* turlariga salbiy ta'sir etishi aniqlangan.

Fragmentatsiya. Populyatsiyalarni fragmentatsiyalanishi bevosita ijtimoiy-iqtisodiy islohotlarga bog'liq. Ma'lumotlarga ko'ra, (Statistika qo'mitasi ma'ruzasi, 2021), O'zbekistonda 570 100 ta korxonalar mavjud bo'lib, bu son oyiga 15000 tadan ko'payib bormoqda. Geobog'langan ma'lumotlar Respublikaning *Tulipa* tarqalgan adirlik va past tog'li hududlarida, misol tariqasida, *T. lanata* ning 10 ta, *T. greigii* ning 25 ta va *T. turkestanica* ning 21 ta populyatsiyalarni fragmentatsiyaga uchraganligini ko'rsatgan.

***Tulipa* turlaridan ko'p miqdorda foydalanishni** Qamchiq dovonida *T. vvedenskyi* va *T. kaufmanniana*, Chimyonda *T. tschimganica*, *T. greigii*, va *T. kaufmanniana*, *T. fosteriana* Taxtaqoracha dovonida hamda *Lanatae* seksiyasining bir qancha vakillari Surxondaryo viloyatida kuzatish mumkin.

Chorvachilik. 2022 ning yanvar oyi statistikasiga ko'ra (Statistika qo'mitasi ma'ruzasi, 2021), Respublikada 23074300 bosh qo'y, 13555800 bosh mol va 260700 bosh ot qayd qilingan. Chorvachilik chekka hududlarda maxalliy aholining asosiy daromad manbasi bo'lganligi sababli *Tulipa* turlari barcha balandlik mintaqalarida chorvachilikni salbiy ta'siridan zarar ko'rmoqda.

Qurilish materiallari xom-ashyolarini olish va konchilik maqsadlarida *Tulipa* turlari o'sayotgan ***muhitni vayron qilinishi*** respublikaning markaziy qismida yaqqol ko'zga tashlanadi. Masalan, Nurota relik tog'liklaridan qurilish materiali sifatida foydalanish *T. affinis*, *T. micheliana* va *T. lehmanniana*, Namangan viloyatining Varzik va G'ova qishloqlaridagi tog'liklarni ohaktosh sifatida foydalanish *T. intermedia* va *T. biflorifirmis* populyatsiyalarini qisqarishiga olib kelmoqda.

in situ sharoitida turlarni muhofaza qilish 6 ta yo'nalish bo'yicha olib borilgan va *Tulipa* turlarini muhofaza qilishning keng ko'lamli va samarali usuli deb hisoblangan. O'simliklarni muhofaza qilishda "***Fenologiyaga asoslangan chorvachilik***" yondoshuvi O'zbekiston botanik-geografik rayonlarida tarqalgan lolalarning gullash va mevalash davrida belgilangan muddatlarda chorvachilik faoliyatini to'xtatish, noyob va yo'qolib borayotgan o'simliklar tarqalgan hududlarni navbati bilan rotatsiya qilib turish masalalari yoritilgan.

O'zbekiston atrof-muhit va bioxilma-xillikni saqlash sohasidagi tashkilotlarga a'zoligi va mavjud bioxilma-xillikni saqlash bo'yicha majburiyatlarni olganligini hisobga olib, *Tulipa* turlarini ***Qizil kitobga kiritish*** muhim ahamiyatga ega. Shu masalada, O'zbekiston Respublikasi Qizil Kitobiga 19 ta (Hasanov 2019) hamda Respublikada tarqalgan 24 ta tur Tabiatni muhofaza qilish xalqaro tashkilotining (IUCN 2022) yo'qolib ketish xavfi ostidagi turlarning Qizil ro'yhatiga kiritilgan. O'rganishlar natijasida 3 turni (*T. borszczowii*, *T. hissarica*, *T. korshinskyi*) O'zbekiston Respublikasi Qizil kitobining yangi nashriga kiritish tavsiya etilgan.

Respublikada kamyob o'simliklar tarqalgan hududlarni muhofaza qilish maqsadida xususiylashtirish amaliyoti mavjud emas. Shuning uchun *Tulipa* va

boshqa kamyob o‘simliklar tarqalgan **qaynoq nuqtalarni xususiyashtirish** tavsiya etilgan va jarayonni amalga oshirish bo‘yicha ketma-ketlik ishlab chiqilgan. Bunday hududlar Toshkent viloyatidagi Chimyon tog‘lari, Surxondaryo viloyatidagi Chaqnoq va Bog‘cha qishloqlari, Andijon viloyatidagi Imom ota va Bog‘ishamol dam olish maskani va boshqa qaynoq hududlarda tashkil etish tavsiya etilgan.

Bog‘-uy muhofazasini *in-situ* va *ex-situ* sharoitlarida olib borish mumkin. O‘rganish natijalari *in-situ* sharoitida *T. fosteriana* (Kitob tumani, Qashqadaryo viloyati), *T. tubergeniana* (Pashxurt qishlog‘i, Surxondaryo viloyati), *T. intermedia* va *T. bifloriformis* (G‘ova qishlog‘i, Namangan viloyati) va *T. lehmaniana* (Qizilqum, Navoiy viloyati), *ex-situ* sharoitida esa *T. fosteriana* (Kitob tumani, Qashqadaryo viloyati) va *T. ingens* (Omonqo‘ton, Samarqand viloyati) turlari muhofaza etilayotganligi aniqlangan.

O‘zbekistonda **mikro-qo‘riqxonalarini tashkil etish** amaliyoti mavjud emasligidan kelib chiqqan holda, 6 ta qaynoq nuqtalarda mikro-qo‘riqxonalar tashkil etish tavsiya etilgan.

Samarali menejment sifatida hududlarning noyob va yo‘qolib borayotgan turlar boyligiga ko‘ra va aholi bilan tutash zonalarida maxsus chegaralarni o‘rnatish, atrof-muhitni muhofaza qilish tashkilotlari xodimlari uchun o‘simliklar biomorfologiyasi bo‘yicha tizimli seminar va malaka oshirish kurslarini tashkil qilish tavsiya qilingan. Jumladan, Qamchiq dovonida *T. kaufmanniana* ning sariq-qizil tojibargli formasini boshqa tur deb hisoblash natijasida aholi tomonidan ko‘plab terilishining asosiy sababi amaldagi O‘zbekiston Qizil kitobida (Hasanov 2019) ushbu turning oq tojibargli shakli berilgan.

Turlarni *ex-situ* sharoitida muhofaza qilishning samarali yondoshuvlaridan biri bu **Botanika bog‘laridir**. Ayni paytda Toshkent botanika bog‘ida 2394 ta turlar, jumladan, 33 tur *Tulipa* muhofaza qilinmoqda. Shuningdek, Qo‘qon shaxrida tashkil etilgan Botanika bog‘ida 62 turkumga oid 68 turlar muhofaza qilinayotganligidan kelib chiqib, tuproq-iqlim sharoitini hisobga olgan holda, respublikaning boshqa hududlarida ham Botanika bog‘larini tashkil etish tavsiya etiladi.

Urug‘ banki va irsiy materialni saqlash. O‘zbekiston Fanlar Akademiyasi Botanika instituti tomonidan 1232 turdagi o‘simliklarni jumladan 23 ta tur *Tulipa* urug‘lari saqlangan (Pechenitsyn, 2020) va 19 ta noyob va yo‘qolib borayotgan turlarning irsiy materiallari ajratib olingan va olingan natijalar Barcode of Life Data System (2022) ma‘lumotlar bazasiga joylangan.

in vitro sharoitida turlarni ko‘paytirish usuli noyob va yo‘qolib borayotgan o‘simliklarni nafaqat saqlab qolish balki ularni yangi populyatsiyalarini yaratishga imkon beradi. Ayni paytda dekorativ madaniy lolalarning ajdodi hisoblangan *T. fosteriana* and *T. ingens* turlarining piyozchalaridan hamda urug‘laridan ko‘paytirish texnologiyasi ishlab chiqilgan (Sukrullozoda 2023).

Atrof-muhit hamda bioxilma-xillikni muhofaza qilish bo‘yicha **fuqarolarda javobgarlik hissini oshirish** va yosh avlodni tabiatga nisbatan do‘stona munosabatda tarbiyalash muhim omil ekanligini Nelson Mandela “Ta‘lim-tarbiya

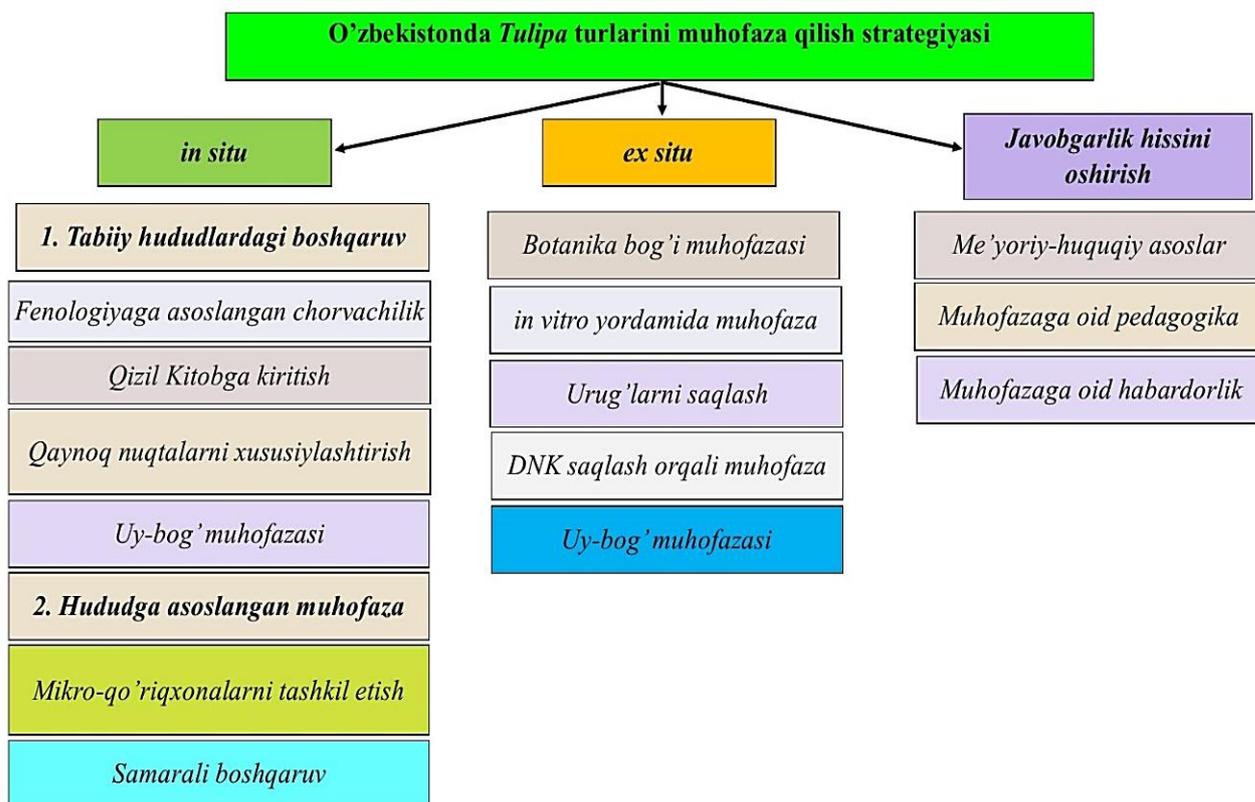
dunyoni qutqarib qoluvchi kuchli qurol”dir deb ifodalagan (Mandela et al., 2012). Barcha muhofaza choralari ta'sirchanligi va ko'lami bevosita inson omiliga bog'liq ekanligini hisobga olib, fuqarolarda muhofazaga oid savodxonlik va javobgarlik hissini oshirish alohida strategik komponent sifatida kiritilgan.

O'zbekiston Respublikasida *me'yoriy-xuquqiy bazani* shakllantirish va amalga kiritishni 2 ta komponentga ajratish mumkin: me'yoriy-huquqiy hujjatlarni muhokamasi va tegishli takliflar berish portali (Normativ-huquqiy hujjatlar loyihalari portali, 2022) va barcha amalga kiritilgan me'yoriy-huquqiy hujjatlardan (O'zbekiston Respublikasi Qonunchilik Ma'lumotlar Milliy Bazasi) foydalanish imkonini beruvchi baza. Ushbu qonunchilik bazalari bioxilma-xillikdan qonunga xilof ravishda foydalanish yoki ularni yashash muhitlariga zarar yetkazishga qarshi kurashda samarali chora hisoblanadi. Masalan, yuqoridagi holatlar bo'yicha 2010-2018 yillarda qonun buzilishlarining umumiy holatlari ichida brakonerlik, noqonuniy yig'ish (59,6 %) va yashash joylariga zarar yetkazish (22,8%) eng ko'p kuzatilgan (Atrof-muhit muhofazasi samaradorligini baholash, 2020) va ushbu holatlar belgilangan tartibda Vazirlar Mahkamasining (2014 yil) qaroriga binoan ko'rib chiqilgan.

Atrof-muhit muhofazasiga yo'naltirilgan ta'lim raqobatbardosh kadrlar tayyorlash, biologik xilma-xillikni saqlash va yoshlarni tabiatni muhofaza qilish ruhida tarbiyalashni kabi vazifalarni o'z ichiga oladi. O'zbekistonning uzluksiz ta'lim tizimida bu soha amalga oshirilayotgan islohotlar va ularni bioxilma-xillikni muhofaza qilishdagi ahamiyati dissertatsiyada batafsil yoritilgan.

Muhofazaga oid xabardorlik yondoshuvida Respublikaning 4 ta hududida “*Lolazorlarni muhofaza qilish*” va “*Lolalarni muhofaza oyligi*”ni tashkil etish loyihasi, *ex-situ* va *in-situ* integratsion yondoshuvi asosida Isroil (Volis, 2016) va Germaniya (2022) tajribalarini amaliyotga joriy etish tavsiya etilgan.

Natijalarni umumlashtirgan holda, O'zbekistonda tarqalgan *Tulipa* turlari misolida, noyob va yo'qolib borayotgan o'simliklarni muhofaza strategiyasi ishlab chiqilgan (4-rasm) va O'rta Osiyoda noyob va yo'qolib borayotgan o'simliklarni muhofaza qilish uchun tavsiya etiladi.



4-rasm. O'zbekistonda *Tulipa* L. turlarini muhofaza qilish strategiyasi

XULOSALAR

“*Tulipa* L. turlari haqida yangicha qarashlar: morfologiyasi, tarqalishi, molekulyar tadqiqot va muhofaza masalalari” mavzusidagi fan doktori (DSc) dissertatsiyasi yuzasidan amalga oshirilgan tadqiqot natijasida quyidagi xulosalar taqdim etildi:

1. Tirik o'simlik namunalari asosidagi morfologiyasi natijalari asosida 308 ta morfologik belgilar “O'zbekiston florasini”ning kelgusi nashriga kiritish uchun tavsiya etildi.
2. 24 ta belgilar asosida O'rta Osiyo florasidagi 48 turdagi lolalarning solishtirma morfologiyasi va morfologiyaga asoslangan filogeniyasi o'rganildi. Seksiya turlarida farqlanuvchi morfologik belgilar o'sish sharoiti xilma-xilligi bilan to'g'ri korrelyatsiyalanadi. *Orithya* va *Biflores* seksiyalari arxaik va dastlab divergensiyaga uchragan seksiyalar ekanligi aniqlangan.
3. O'zbekiston florasining yangi nashri uchun turkumning yangi konspekti tuzildi va seksiyalar va turlarini aniqlash uchun yangi dixotomik kalitlar ishlab chiqildi.
4. O'rta Osiyo florasidagi *Tulipa* turlarini fitogeografik rayonlar va ekoregionlar kesimida tarqalishining tahlili Hisor-Oloy o'rmonlari (41 tur) hamda Farg'ona vodiysi (25 tur) turlarga eng boy hududlar ekanligini ko'rsatdi.
5. Mavjud turlarning tadqiqot hududi bo'ylab tarqalishini aks ettiruvchi to'r tizimli xaritalar yaratildi. Taxlillar O'zbekistonda 5 ta turlar endemik turlar borligini ko'rsatgan.
6. Ilk bor *Tulipa* turlarning tuproq tiplari bo'yicha taqsimlanishi tahlil qilinib, litozol (25 tur) va kaltsiy kserozol (17 tur) tuproqlarning yetakchilik o'rni aniqlandi.
7. Barcha turlarning aniqlangan manzillari soni 1970 yildan keyin qisqarganligi isbotlangan. 27 ta (82 %) *Tulipa* turlari 19 ta maxsus qo'riqlanadigan hududlarda

- muhofaza qilinayotganligi aniqlangan.
8. Fargʻona vodiysi tabiiy-geografik hududi Oʻrta Osiyoda *Tulipa* ning qaynoq nuqtasi sifatida 23 ta turlar qayd etilgan va toʻr-tizimli xaritalari ishlab chiqilgan.
 9. Oʻrta Osiyoda tarqalgan *Tulipa* turkumi kamyob turlarini global iqlim oʻzgarishi senariylari boʻyicha holatlari oʻrganilgan. Gʻarbiy Tiyon-Shon turlarining kelajakdagi tarqalish areallari va qulay oʻsish muhitlari ularning hozirgi tarqalgan joylariga yaqinligi aniqlangan. Pomir-Oloy togʻ tizmalarida tarqalgan turlarni iqlim oʻzgarishiga munosabati ular oʻsayotgan geografik sharoitga bogʻliqligi kuzatilgan. Aksariyat turlarning kelajakdagi areallari qisqarishi mumkinligi bashoratlangan.
 10. Oʻrta Osiyoda *Tulipa* turlarining tabiiy-tarixiy shakllanishi va tarqalishida dengiz satxidan 700-2200 m balandlik mintaqalari muhim ahamiyatga ega boʻlgan va zamonaviy bosqichda aynan shu balandlik diapozoni turlar konsentratsiyasi yuqori boʻlgan optimum hisoblanadi. Turlarni tarqalishida topografiya omili va iqlim oʻzgarishi omili muhim tashqi muhit omili deb topilgan.
 11. Oʻrta Osiyoda tarqalgan *Tulipa* turlarining plastid genomi strukturasi oʻrganilgan.
 12. va molekulyar filogenetik daraxti ishlab chiqilgan. Morfologik, biogeografik va molekulyar taxlil natijalariga asoslanib turlarga taksonomik baho berilgan.
 13. Tashqi muhit omillarining turlarga salbiy taʼsirini oʻrgani natijasida *Tulipa* L. turkumi uchun Milliy muhofaza strategiyasining modeli ishlab chiqilgan va Oʻrta Osiyoda noyob va yoʻqolib borayotgan oʻsimliklarni muhofaza qilish uchun tavsiya etilgan.

**SCIENTIFIC COUNCIL DSc.02/30.12.2019.B.39.01 ON AWARD OF
SCIENTIFIC DEGREES AT THE INSTITUTE BOTANY
INSTITUTE OF BOTANY**

DEKHKONOV DAVRON BURXONOVICH

**NEW INSIGHTS INTO THE SPECIES OF *TULIPA* L.:
MORPHOLOGY, DISTRIBUTION, MOLECULAR AND
CONSERVATION ISSUES**

03.00.05 – Botany

**DISSERTATION ABSTRACT OF THE DOCTOR OF SCIENCE (DSc)
ON BIOLOGICAL SCIENCES**

Tashkent – 2023

The title of the doctoral dissertation (DSc) has been registered by the Supreme Attestation Commission at the Ministry of higher education, science and innovations of the Republic of Uzbekistan with the registration number of B2023.2.DSc/B 189.

The dissertation has been carried out at the Institute of Botany.

The abstract of the dissertation is posted in three languages (Uzbek, English, Russian (resume)) on the webpage of the Scientific Council (www.botany.uz) and on the website of the Information-educational portal "ZiyoNET" (www.ziyo.net).

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The defense of the dissertation will take place on «8 September, 2023 in 3pm» at the meeting of Scientific council DSc 02/30.12.2019.B 39.01 on award of scientific degrees at the Institute of Botany (Address: 32 Durmon yuli str., Tashkent, 100125, Uzbekistan. Conference hall of the Institute of Botany. Phone.: (99871) 262-37-95; Fax: (+99871) 262-79-38; E-mail: botany@academy.uz).

The dissertation has been registered at the Informational Resource Centre of the Institute of Botany under (Address: 32 Durmon yuli str., Tashkent, 100125, Uzbekistan. Phone.: (+99871) 262-37-95).

The abstract of the dissertation has been disseminated on «17 August, 2023.
Protocol at the register 4 dated «17 August, 2023.



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Introduction (abstract of DSc thesis)

Actuality and importance of the topic of the dissertation. *Tulipa* L. (Liliaceae) exhibits considerable ornamental and aesthetic value worldwide. The species possess a high level of endemism, with most species rare or on the verge of extinction. They require morphological and molecular taxonomic assessment, phytogeographic analyses, studies of the effects of climate change and the development of the conservation measures. The exact number of species of *Tulipa* is unknown due to difficulties in the taxonomy, confusion in their classification, the high rate of interspecific hybridization and polymorphism. According to World Flora Online (2023), 376 names have been assigned to the 85 (23%) accepted species of *Tulipa*; 266 (71%) names are in synonymy and 25 (7%) names have not been assessed. Consequently, the inclusion of 62 species in the IUCN Red List of Threatened Species (2022) calls for further analysis and the development of effective conservation measures based on scientific principles and practical evaluation.

Currently, plants of the globe including *Tulipa* are being evaluated based on molecular-genetic studies, biogeographic analyses, status of populations under different climatic scenarios and conservation issues. Hence, both a taxonomy and identification of hotspots of the species of *Tulipa* are needed. Modelling and predicting the future state of rare and endangered species under changing climatic conditions, defining optimal distribution factors and suitable habitats, studying the negative impact of stress factors and development of conservation measures are considered to be important issues.

Central Asia (75 species; WCVP 2023), including Uzbekistan (33 species; Tojibaev et al., 2022) is considered to be a hotspot of *Tulipa* diversity. Morphological studies for the forthcoming edition of the “Flora of Uzbekistan”, genomic studies that might provide new insights in the structural genome, molecular phylogenetic studies, consideration of climate change and biogeographic analyses and suitable habitat prediction in the implementation of effective conservation measures are important. Also, studies on the negative results of stress factors, the current state of rare and endangered species in protected areas and observations during field surveys serve as core data for the development of new conservation strategies for the species of *Tulipa*.

Currently, valuable contributions are being made in the taxonomy, distribution patterns and conservation of rare and endangered species, including monocot geophytes in the Republic of Uzbekistan. Descriptions of a dozen new species of *Allium* L. were published by Sennikov et al. (2016). Three new species were published by Tojibaev (2014) and de Groot and Tojibaev (2020). Twenty-four rare species are in the IUCN Red List of Threatened Species (IUCN 2022) and 19 species are in the Red Data Book of Uzbekistan (Khassanov 2019) have been involved.

In the Constitution of the Republic of Uzbekistan, the task “In accordance with the principle of sustainable development the state implements measures to improve, restore and protect the environment, maintain ecological balance”. Based

on the task, taxonomic and biogeographical studies, modelling of the species distribution in the different climate scenarios, defining the determinants affecting the distribution, studying the effects of stress factors, mitigating the negative impacts of anthropogenic factors and development of conservation strategy for *Tulipa* species possess important scientific and practical significance.

The results of the dissertation serves to a certain extent, strived to implement of tasks related to environmental protection according to the Constitution of the Republic of Uzbekistan, the Law of the Republic of Uzbekistan "On Nature Protection" No. 754, December 9, 1992, the Law of the Republic of Uzbekistan "On the Protection and Use of Flora" No. 409, September 21, 2016, Decree of the President of the Republic of Uzbekistan "On measures to organize the activities of the Institute of Botany and Institute of Zoology of the Academy of Sciences of the Republic of Uzbekistan" No. 3256, September 4, 2017, Decree of the President of the Republic of Uzbekistan "On approval of the concept of environmental protection until 2030 " No. 5863, October 30, 2019 and in other regulatory legal documents.

Compliance of the research with the main priorities of the development of science and technology of the Republic. The study was carried out in accordance with the priority direction of the development of science and technology of the Republic. #V. "Agriculture, biotechnology, ecology and environmental protection".

Review of foreign research on dissertation topic. Classic and contemporary investigations on *Tulipa* L. have been carrying in some leading research centers and higher education organizations such as University of Cambridge (Great Britain), Wageningen University and Leiden University (Netherlands), University of Pisa (Italy), Abant İzzet Baysal University (Turkey), Chungbuk National University (South Korea), Zhejiang University (China), Research Center for Plant Sciences and Bu Ali Sina University (Iran), Institute of Botany and Phytointroduction (Kazakhstan), Institute of Biology (Kyrgyzstan) and Institute of Botany (Uzbekistan).

The degree of awareness of the problem. Morphology, taxonomy and caryosystematic investigations of species of *Tulipa* L. conducted by Regel (1873), Baker (1874), Vvedensky (1935), Hall (1940), Botschantzeva (1962), Vvedensky and Kovalevskaya (1971), Ivashenko (2005), Everett (2013), Tojibaev (2010; 2014), De Groot and Tojibaev (2020).

The phytogeographic patterns in *Tulipa* presented by Botschantzeva (1962), Vvedensky and Kovalevskaya (1971), Ivashenko (2005), Doğan and Akaydin (2011), Eker, Babaç and Koyuncu (2014) and Lazkov and Umralina (2015).

Research on suitable habitat, ecologic variables and the states of the species in climate change scenarios presented by Lioubimtseva (2009), Gaston (2009), Svenning (2009), Becklin (2016), Huang (2020), Nowak (2020), Wilson (2021) and Volis (2022).

Results of molecular investigations demonstrated by Fay (2001), Zonneveld (2009), Yanagisawa (2012), Veldkamp and Zonneveld (2012), Christenhusz

(2013), Li (2017), Kim (2018), Asgari (2020), Hajdari (2021), Li (2021), Lu (2021), Haerinasab (2021), Kiani (2021) and Wilson (2023).

Research on issues of conservation of biodiversity carried out by Kassas (2002), Kumari (2021), Myers (2000), Squires (2013), Volis (2016), Hunter (2011), Eigenbrod (2009), Falkner (1997), Hale (1997), Heywood (1995), Kanwar (2010), Qiang (2003), Marchese (2015), Reynolds (2006), Schwartz (2000), Torquebiau (2000).

This study presents information from such international organizations, as The United Nations (UN), The International Union for Conservation of Nature (IUCN), National Science Foundation (NSF), The United Nations Environment Programme (UNEP), The World Database on Protected Areas (WDPA) and databases (GBIF, WCSP, IPNI, POWO, WFO).

Studies of morphology based on living plant specimens, molecular taxonomic investigations, identification of hotspots of the floras of Central Asia and Uzbekistan, current and future states under various climate scenarios, determinants for the distribution of species and their suitable habitats, investigation of the impact of stress factors leading to a decrease in populations and development of conservation strategies for *Tulipa* were incomplete or not determined. Hence, investigation of morphology based on living specimens, phytogeographic and ecoregional analyses for the development of effective conservation aims, genome studies, modelling of populations under climate change scenarios and development of conservation strategies for the genus were of significant scientific and practical importance.

The connection of the research with the research plans of the research institution where the dissertation was completed. Dissertation fulfilled the requirements within the framework of the state programs "Grid mapping of the flora of southwest Hissar, Hissar-Darvoz and Panj districts (Surkhondaryo region)" of the laboratory of "Flora of Uzbekistan" and "Tree of Life: Monocotyledons of Uzbekistan" of the international Uzbekistan-China joint "Molecular phylogeny and biogeography" laboratory, research projects of the Institute of Botany of the Republic of Uzbekistan "Taxonomic revision of polymorphic families of the flora of Uzbekistan" (No. A-FA-2021-427) and international Uzbekistan-Belorussia scientific-technical program "Genetic inventory of rare and endangered species of Belorussia and Uzbekistan by the use of DNA barcoding technology" (No. MRB-AN-2019-30) and "Ecological Management of Saline-Alkali Land in the Aral Sea Region, Central Asia Green Road Project 2 between the Institute of Botany of the Republic of Uzbekistan and Xinjiang Institute of Ecology and Geography of the Chinese Academy of Sciences.

Purposes of the research are practical morphologic and biogeographic studies, molecular-taxonomic assessment of the species based on the plastomes, bioclimatic modelling in the climate change scenarios and development of the National conservation strategy for the species of *Tulipa*.

Tasks of the research:

to investigate morphology of the species of *Tulipa* based on living plant

specimens;

study of comparative morphology and construction of morphology-based phylogenetic tree of *Tulipa* species in the flora of Central Asia;

analyses of species richness in the ecoregional and phytogeographic regions of Central Asia;

development of contemporary synopsis of the species of *Tulipa* in the flora of Uzbekistan;

creation of GIS maps based on grid system of the species, identification of hotspots and implementation of biogeographic analysis;

identification of important bioclimatic variables and analyses of the influence of the environmental factors on the species of *Tulipa*;

bioclimatic modelling the states of populations of rare and endangered *Tulipa* species;

mapping of the plastid genomes and study of genome composition of *Tulipa* species;

construction of the molecular phylogenetic tree and molecular-taxonomic assessment of *Tulipa* species;

development of the National conservation strategy of Uzbekistan for *Tulipa* species.

The object of the research is the species of the genus *Tulipa* (Liliaceae).

The subject of the research. Living plant specimen morphology, biogeographic analyses, modelling methods of populations in various climate scenarios, molecular approaches and development of conservation strategy.

Research methods. Field survey, observation, comparative, cartographic, molecular-genetic, bioinformatic and statistical methods were applied in the dissertation.

The scientific novelty of the research is as follows:

synopsis of the species of *Tulipa* in Uzbekistan was prepared for the forthcoming edition of “Flora of Uzbekistan” based on living plant specimen morphology;

comparative morphology of 48 species in the flora of Central Asia was investigated and morphology-based phylogenetic dendrogram based on 24 morphologic characters was constructed;

hotspot centers of *Tulipa* in Central Asian phytogeographic and ecoregional areas were determined;

grid maps for the sections and species of the genus in the flora of Uzbekistan were developed;

the states of the species distributed in 3 geographic regions in climate change scenarios were modelled;

contribution of three classes of environmental variables as determinants of species distribution was modelled;

structure, genes order and functions of whole plastid genomes of 19 *Tulipa* species were designed and identified;

molecular phylogenetic dendrogram using 29 plastomes of *Tulipa* species was

constructed and taxonomic statuses of the species were assessed;

negative results of the environmental factors on *Tulipa* populations were demonstrated;

national conservation strategy for the species of *Tulipa* in Uzbekistan was developed.

Practical results of the research:

three hundred and eight morphologic features of *Tulipa* in the flora of Uzbekistan were determined and presented for addition to the new issue of “Flora of Uzbekistan”;

species richness of phytogeographic and ecoregions of Central Asia including Uzbekistan were demonstrated to aid in formulating effective conservation measurement. Current and future states of endangered *Tulipa* in climate change scenarios were modelled;

geographic information system maps of 33 species of 5 sections of *Tulipa* in Uzbekistan are developed;

fifty-three species Central Asian including 24 species distributed in Uzbekistan were included the IUCN Red List of Threatened Species and 3 species (*T. borszczowii*, *T. hissarica*, *T. korshinskyi*) recommended for the inclusion in the forthcoming issue of Red Data Book of the Republic of Uzbekistan

Conservation strategy for *Tulipa* in Uzbekistan with 3 approaches and 14 methods was developed.

Reliability of the research results validated by the compliance of obtained results of the dissertation by the use of contemporary methods and scientific approaches to theoretical reviews, publication of results in the scientific journals, discussion of the results in the international and republican conferences, the validity of conclusions, the improvement of practical results of the dissertation by the relevant state organizations on the implementation of the results into practice.

Scientific and practical significance of the research results.

Detailed analysis on the relations of comparative morphology-based phylogeny and molecular-genetic results, the definition of structure and content of 19 plastid genomes of *Tulipa*, reconstruction of molecular phylogenetic dendrogram using 29 species, development of diagnostic keys for the identification of the sections and species of *Tulipa*, annotated checklist of *Tulipa* of Uzbekistan, study of number of occurrence before (1970) and after (2022), investigation of environmental determinants for the suitable distribution, modelling current and future states of *Tulipa* in various climate change scenarios are considered scientific importance of the results of the dissertation.

Investigation of morphology-based on living plant specimens, recommendation of morphologic characters for the inclusion in forthcoming issue of “Flora of Uzbekistan”, recording of 37 new locations of 29 species of *Tulipa* of Uzbekistan, detailed analysis of phytogeographic and ecoregional distribution of *Tulipa* and distribution maps for the effective conservation measures, description of negative results of 13 stress of 3 environmental factors, inclusion of twenty four

Tulipa species of Uzbekistan in the IUCN Red List of Threatened Species, recommendation of three species (*T. borszczowii*, *T. hissarica*, *T. korshinskyi*) for the inclusion in forthcoming issue of the Red Data Book of the Republic of Uzbekistan and development of the national conservation strategy for *Tulipa* with three approaches and 14 methods can be considered practical value of the results of the dissertation.

Implementation of research results. On the basis of the results of the investigation of the genus *Tulipa* of Central Asia and Uzbekistan:

Information of thirty-two species of *Tulipa* distributed in Uzbekistan accessed and implemented in the GBIF (Global Biodiversity Information Facility) database (certificate by GBIF, June 26, 2023). As the result, the information on the type, morphology, distribution patterns, phenology and ecology of the species provided identification of sections and species, assessment of the states of occurrence records of *Tulipa* before and after 1970 and the use of the presented data on the distribution and locations of the species at the international level.

Over 200 herbarium specimens of 26 species were given to National Herbarium of Uzbekistan (TASH) (Reference #. 4/1255-1277, June 9, 2023, of the Academy of Sciences of the Republic of Uzbekistan). As the result, specimen collection of Central Asian section of TASH enriched with rare, endangered and endemic red-listed species of Uzbekistan and provided conduction of detailed studies on morphology and biogeography.

Twenty-four species of *Tulipa* distributed in Uzbekistan are included and implemented in the Red List of Threatened Species of the International Union for Conservation of Nature (IUCN Red List) (IUCN Red List; certified by the International Organization for the Conservation of Nature, June 27, 2023). As the results, conservation of *Tulipa* at the international level, assessment of rarity, the use of implemented data globally and implementation of conservation measures in the practice were provided.

Approval of research results. The results of the research were approved and discussed at 2 international and 4 domestic conferences.

Publication of research results. Twenty-two papers were published on the topic of the dissertation and 16 articles were published (10 domestic and 6 foreign) in scientific journals as recommended for publication by the Supreme Attestation Commission at the Ministry of Higher Education, Science and Innovations of the Republic of Uzbekistan.

Volume and structure of dissertation. The thesis consists of an introduction, seven chapters, conclusions, references and appendices. The volume of the thesis is 198 pages.

MAIN CONTENT OF THE THESIS

Introduction included the necessity of the dissertation work, connection of the research to priorities for the development of science and technology in the Republic, a review of domestic and foreign scientific research on the subject of the dissertation, degree of awareness of the problem, purpose, tasks, objectives and

subject of the research, implementation of the research results, published contributions and structure of the dissertation issues.

The first chapter of the dissertation “**History of the study of species of the genus *Tulipa* L.**” dedicated to the analyses of studies on the taxonomy, biogeography, bioclimatic investigations of wild *Tulipa* species and conservation issues of biodiversity.

The second chapter of the dissertation, ‘**Materials and research methods**’ describes the nature and geography of the study area, field surveys, research methods and stages and processes of their implementation in detail.

The **study area** was divided into regions: Central Asia (regional), Uzbekistan (administrative) and Ferghana valley (local). Comparative morphology, morphology-based phylogeny, environmental niche modeling, suitable habitat prediction, distribution determinants, phytogeographical and ecoregional analyses, molecular studies were carried out at the regional level, morphology using living plant specimens, grid maps of the species, synopsis of the genus, impact of stress factors and conservation strategies were carried out at the national level and Fergana Valley, the hotspot area with the most species, was studied at the local level.

Central Asia is a particularly vulnerable region due to its geography, which includes deserts and semi-deserts (Lioubimtseva and Henebry 2009). The environment is very sensitive to global climate change and is particularly vulnerable to changing weather patterns (Brooke 2014). Water resources in the area are especially important for the sustainable development of biodiversity. There is a low concentration of water vapor over the area and the distribution of water resources in Central Asia is quite uneven (Wang 2022). Despite of the main centers of plant diversity (Myers et al. 2000; Nowak et al. 2020) and endemism (Tojibaev et al. 2020), the area harbors nearly 10 thousand species of vascular plants (Khasanov 2015). The study area included 75 *Tulipa* species.

In terms of botanical-geographical regionalization, Uzbekistan is divided into the Central Asian Mountain Province (Afghanistan-Turkestan) and the Turan provinces (Tojibaev et al. 2016). The eastern part of the area is surrounded by the western Tian-Shan and Pamir Alay mountain systems, which occupy 12% of the land area. The northwest part of the Republic is covered by the Ustyurt plateau and the central and northern parts are covered by the Kyzylkum deserts. Plant biodiversity decreases from the eastern and central parts of the region to the west. Uzbekistan harbors 33 *Tulipa* species.

The Ferghana valley with the elliptical in shape is situated in the eastern part of the country where the detailed studies were conducted. The valley is surrounded by the Chatkal range in the northwest, the Kurama ranges in the north, the Turkestan and Alay ranges in the south and the Ferghana range in the northeast. The valley is a global hotspot for bulbous geophytes. It harbors more than 60% of the species of *Allium* L. in the mountainous Central Asian province; 50% of the species of *Eremurus* M. Bieb in the flora of Uzbekistan have been recorded (Tojibaev et al. 2018). The area hosts 23 *Tulipa* species.

The third chapter of the dissertation, “**Analysis of morphological features of species of *Tulipa***” discusses morphological features based on living specimens, comparative morphology, morphology-based phylogeny, synopsis of the genus, diagnostic keys for the sections and species, localities, habitats and degree of rarity of the wild species of *Tulipa* in the flora of Uzbekistan.

The study of morphologic characteristics of living specimens was based on over two hundred herbarium specimens of 26 species belonging to the sections *Lanatae*, *Kolpakowskianae*, *Vinistriatae*, *Spiranthera* and *Biflores*. Illustrations of the species for scientific and practical purposes were prepared for the first time. Three hundred and eight morphologic features were recommended for use in the forthcoming edition of ‘the “Flora of Uzbekistan”’.

Comparative morphology of 48 species of sections *Lanatae*, *Kolpakowskianae*, *Vinistriatae*, *Spiranthera*, *Biflores*, *Clusianae*, *Orithyia* and *Multiflorae* in the flora of Central Asia was analyzed and a morphology-based phylogenetic dendrogram using 24 morphologic characters was constructed (fig. 1). According to the results, sect. *Orithyia* and *Biflores* were located at the base and sect. *Lanatae* was on the upper part of the tree. The species located in the basal part are morphologically close to the outgroup of the study. The results agree with the results by Wilson (2023), Christenhusz et al. (2013) and Zonneveld (2009).

Compilation of the synopsis of the species of *Tulipa* for the forthcoming issue of “Flora of Uzbekistan” were based on a taxonomic and nomenclatural revision. Diagnostic dichotomous keys for 33 species of sections *Lanatae*, *Kolpakowskianae*, *Vinistriatae*, *Spiranthera* and *Biflores* were prepared. Reference to protologues, nomenclatural types, phenology, ecology, level of rarity, etymology, distribution in the botanical-geographic regions of Uzbekistan and other important information were presented.

The fourth chapter of the dissertation, “**The main characteristics of the phytogeography of species of *Tulipa* in the study area**” demonstrated the main characteristics of the distribution patterns of *Tulipa* (a) in the phytogeographic regions and ecoregions of Central Asia; (b) and in the territory of Uzbekistan using grid mapping, (c) and in natural protected areas and in the Ferghana Valley (d), as a hotspot area that is characterized by high species diversity and a high rate of endemism.

Ecoregions (Dinerstein et al. 2017) are defined by their distinct ecological characteristics, such as climate, geology, and vegetation, which play a crucial role in plant evolution and diversification (Villarreal et al. 2019; Pandey et al. 2021). Understanding the distribution patterns of the species of *Tulipa* across the regions are important for the effective conservation efforts. According to analysis, the Gissaro-Alay open woodlands were identified as the top hotspot, hosting 41 species. The Tian-Shan foothill arid steppe (19 species), Pamir-Alay and western Tian-Shan mountain systems and the Alay-Western Tian-Shan steppe (18 species each) ecoregions were considered hotspots for *Tulipa* also.

A species richness map of *Tulipa* in the botanical-geographical regions of Central Asia (Kamelin 2021) showed high species diversity of the Ferghana valley

including 25 *Tulipa* species. The Mogoltau-Kurama (13 species), Kukhistan (10 species), Gissar, Darvaz and Kugitang-Baisun (9 species each) regions showed medium species richness.

Biogeographic analyses showed *T. altaica* and *T. turkestanica* (in 6 ecoregions) and *T. korolkowii* and *T. turkestanica* (in 10 phytogeographic regions) to be the most widespread species across ecoregions and phytogeographic regions in Central Asia. The distribution of species (24) in a single ecoregion and phytogeographic region (22 species) revealed a high rate of micro endemism because the majority of the species (66%) in the ecoregion and phytogeographic region (72%) are endemic.

The study of the distribution of *Tulipa* in Uzbekistan (fig. 1) was divided into 100 grid cells with 10 latitudinal (1, 2, 3... and 10) and 10 longitudinal (A, B, C... and J) components. Based on species richness in the grid cells, they were categorized as: poor (16 cells with 1-3 species, mainly located in the western part of the study area), medium (5 grid cells with 4-6 species) in the northwest of the area and abundant (8 grids with 7-13 species; F6, G6, H6, I6, F8, G8, E9, F9) located in the south, northeast and eastern parts of the area.

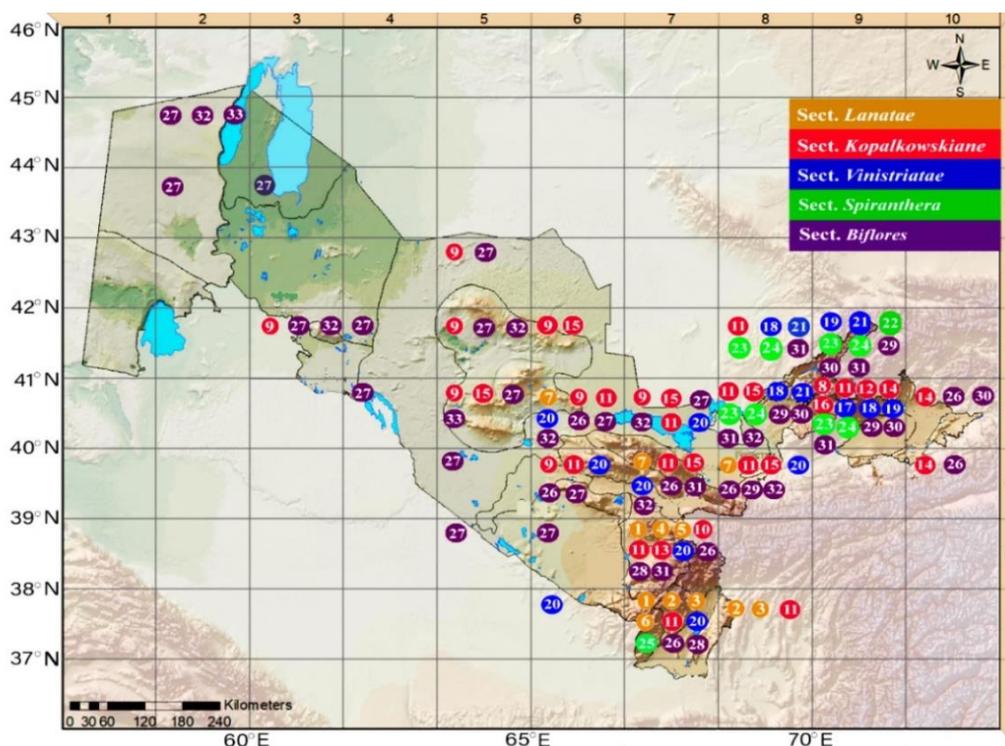


Figure 1. Distribution of *Tulipa* species in Uzbekistan based on grid cells

Studies on the species richness of botanical-geographical regions of Uzbekistan showed the leading position of western Tian-Shan (14 species) and western Hissar (13 species) at the regional level and western Chatkal, Kurama, Baysun and Sangartak-Tupalang at the district level.

Tulipa korolkowii (in 7 regions), *T. sogdiana* and *T. turkestanica* (in 5 regions) are considered to be the most widespread species across botanical-

geographic regions in Uzbekistan and 14 species were recorded from only a single area. Detailed information is presented in the dissertation.

As a result of the analysis, *T. bactriana*, *T. butkovii*, *T. intermedia*, *T. sharipovii* and *T. uzbekistanica* were reconfirmed as the national endemics of Uzbekistan. According to the observations of local researcher, *T. intermedia* (in the Kyrgyz part of the Fergana Valley, G.A. Lazkov) occurs outside of Uzbekistan, but the presence of the species was not published in official sources.

The status of the occurrence numbers of *Tulipa* in Uzbekistan before and after 1970 was analyzed based on herbarium specimens and fieldwork. According to the findings, the numbers of populations decreased after 1970.

The Food and Agriculture Organization of the United Nations (FAO) surveyed soil types worldwide and made miscellaneous maps based on soil units (Fischer et al. 2008). Each soil unit is based on texture, chemical properties, etc. To determine the habitats of *Tulipa* in various soil units, a soil map of Uzbekistan was developed. The distribution of species according to soil units and the relation of the species to edaphic factors showed 25 species to be in lithosols (I), 17 species in calcic xerosols (Xk), 9 species in calcic yermosols (Yk), 8 species in calcareic gleysols (Gc) and 7 species in eutric gleysols (Ge). The richness of lithosols and calcic xerosols are in the western Tian-Shan and Pamir-Alay mountain systems, which are hotspots of *Tulipa* in Uzbekistan.

The establishment of special natural protected areas plays a key role in the conservation of biodiversity (Laguna 2004; Hernandez et al. 2021). Eighty two percent of the species of *Tulipa* in the flora of Uzbekistan are in a network of special natural protection areas. Currently, 27 species of *Tulipa* are protected in 7 state nature and 2 state biosphere reserves and 19 species in national nature parks. Hissar (9 species), Surkhan (8 species) SNR and Ugam-Chatkal NNP (10 species) are in the mountainous regions that are hotspot areas for *Tulipa*. The Lower Amudarya SBR, Aktau-Tamdi and Aralkum NNP, situated in the arid regions of the Republic, are distinguished by having the fewest species of *Tulipa*.

Ferghana Valley, where 23 species in 5 sections have been recorded, is characterized by the high species diversity of *Tulipa* in Central Asia. In the study, contemporary distribution maps based on grids were developed and analyzed. The rate of endemism of the species was assessed and the rarity status based on IUCN (2023) definitions was determined and protection measures for the species were developed. Of the mountain ranges surrounding the valley, the Kurama (12 species), Turkestan and Chatkal (10 species each) were distinguished by the number of species of *Tulipa* they contained. Kyrgyzstan prevailed in the context of administrative territories (6 species). Uzbekistan (5 species) and Tajikistan (4 species) possessed similar indicators. Eight species were considered to be widespread. Protected areas of the Ferghana Valley, such as the Sary-Chelek Reserve (4 species), Pop National Park (3 species) and the Aktash Reserve (3 species), play a crucial role in the conservation of the species of *Tulipa*.

The fifth chapter of the dissertation, “**Plastome structure and phylogeny of species of *Tulipa***” demonstrated the structure of the plastid genomes, gene

categories, names, functions, nucleotide content, nucleotide variability in exons, and molecular phylogeny of the species of *Tulipa*. It also determined their taxonomic status. Plastid genomes of 19 species of *Tulipa* in the flora of Uzbekistan showed a typical quadripartite structure (fig. 2) and consisted of 4 regions (2 IR regions, LSC and SSC), as in other angiosperms. The G+C content of the species in whole genomes (36.6-36.7%) and LSC (34.6%), SSC (30.1-30.2%) and IR regions was higher (42.1%).

The plastid genomes of the species of *Tulipa* contained 134 genes. Of those, 112 were coding genes, including 78 protein-coding, 4 ribosomal RNA (rRNA), and 30 transfer RNA (tRNA) genes. Four genes were pseudogenes. The 134 genes had 18 duplicated genes located in the IR region, including six coding genes (*ndhB*, *rpl2*, *rpl23*, *rps7*, *rps12*, and *ycf2*), four rRNA genes (*rrn4.5*, *rrn5*, *rrn16*, and *rrn23*), and eight tRNA genes (*trnA-UGC*, *trnH-GUG*, *trnI-CAU*, *trnI-GAU*, *trnL-CAA*, *trnN-GUU*, *trnR-ACG*, and *trnV-GAC*) and four pseudogenes (*ycf1*, *rps19*, and two *ycf68*).

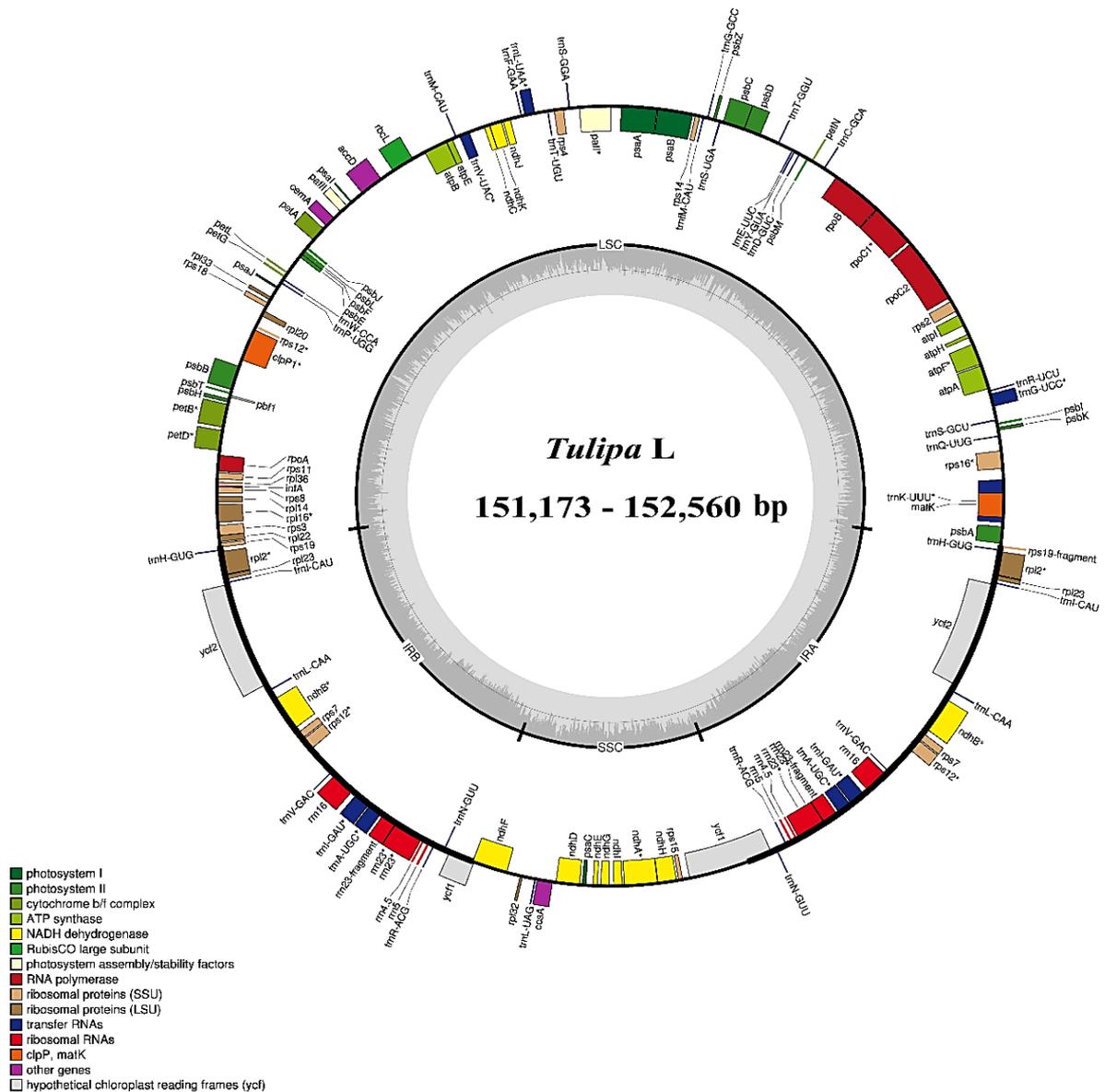


Figure 2. Plastid genome structure of *Tulipa* species

The *rps19* and *ycf1* genes were located in the boundary area of the IR regions. Their protein-coding ability was lost due to partial gene duplication. Two genes *ycf68* and *ycf15* lost their abilities or occurred as pseudogenes. The *infA* gene, which codes for translation initiation factor 1, was lost in all 19 plastid genomes of *Tulipa* because of a missing base. Two genes, *ycf68* and *ycf15* lost their ability or occurred as pseudogenes (Li, Lu et al. 2017, Lu, Li et al. 2017). Our study showed partial loss of coding ability of *ycf68* as pseudogene and *ycf15* genes due to gene redundancy. Similarly, the *infA* gene has totally lost its ability to code translation initiation factor 1 in all 19 plastid genomes as described in Li et al. (2021). This effect may be due to a function taken over by another gene or gene family in *Tulipa* (Li, Lu et al. 2017).

The results of the SSR analysis of *Tulipa* showed the presence of six SSRs categories (mono-, di-, tri-, tetra-, penta-, and hexanucleotide repeats) in the plastid genomes of the species. The mononucleotide repeats were the most frequent. The number of SSRs detected in 19 plastid genomes varied from 61 (*T. scharipovii*) to 89 (*T. sogdiana*).

According to the findings, the *rpoB-trnC*, *petA-psbJ*, *rpl33-rps18*, *rpoA-rps11*, *ndhF-ndhD*, *rps15-ycf1* and *psaJ* sequences showed high levels of polymorphism.

The results of the nucleotide diversity analysis showed high variability in the *psaJ* gene in the plastid genomes of *Tulipa*.

The phylogenetic relationship within the species of *Tulipa* was reconstructed (fig. 3) based on 76 common coding sequences from 29 plastid genomes, including 2 outgroup species (*Erythronium japonicum* and *E. sibiricum*). All, 3 methods (Bayesian inference, maximum parsimony and maximum likelihood) generated almost identical topologies.

The results of other studies (Christenhusz et al. 2013; Wilson 2023) showing the species of sect. *Kolpakowskianae* being replaced in the dendrogram were different. The species of sect. *Kolpakowskianae*, *T. ostrowskiana*, *T. intermedia*, *T. korolkowii*, *T. zenaidae* and *T. thianschanica*, were separated and strongly supported as another clade. Only, *T. schrenkii* (synonym of *T. suaveolens*) from sect. *Tulipa* was placed very close with *T. ostrowskiana* (sect. *Kolpakowskianae*). Based on the molecular and morphologic treatments, we recommend synonymizing *T. schrenkii*, *T. suaveolens* and *T. ostrowskiana* under *T. ostrowskiana*.

In the dendrogram *T. intermedia* closely located with *T. korolkowii*. According to our findings, morphological resemblance and literature reviews (Wilson, 2023), we suggest synonymizing the species under *T. korolkowii*.

Tulipa zenaidae was suspected to be a hybrid with one parent being *T. lehmanniana* based on molecular and morphologic observations (Christenhusz et al. 2013; van Raamsdonk 1995; Everett 2013). In our phylogenetic tree the species was located in different clades. We recommend treating *T. zenaidae* and *T. lehmanniana* as separate species.

Hall (1940) was unable to differentiate *T. thianshanica* and *T. iliensis* based on analysis of herbarium specimens and placed them under *T. altaica*, to which these taxa are certainly allied and deemed them to belong to subgenus *Orithya*. In some contributions (Czerepanov 1995; Nikitina 1951; Zhengyi 2000; Zonneveld 2009) *T. thianshanica* is listed as an independent species (Christenhusz 2013, Everett 2013). Location of *T. altaica* and *T. iliensis* occurred as the result of nucleotide substitution and it should be investigated in further studies.

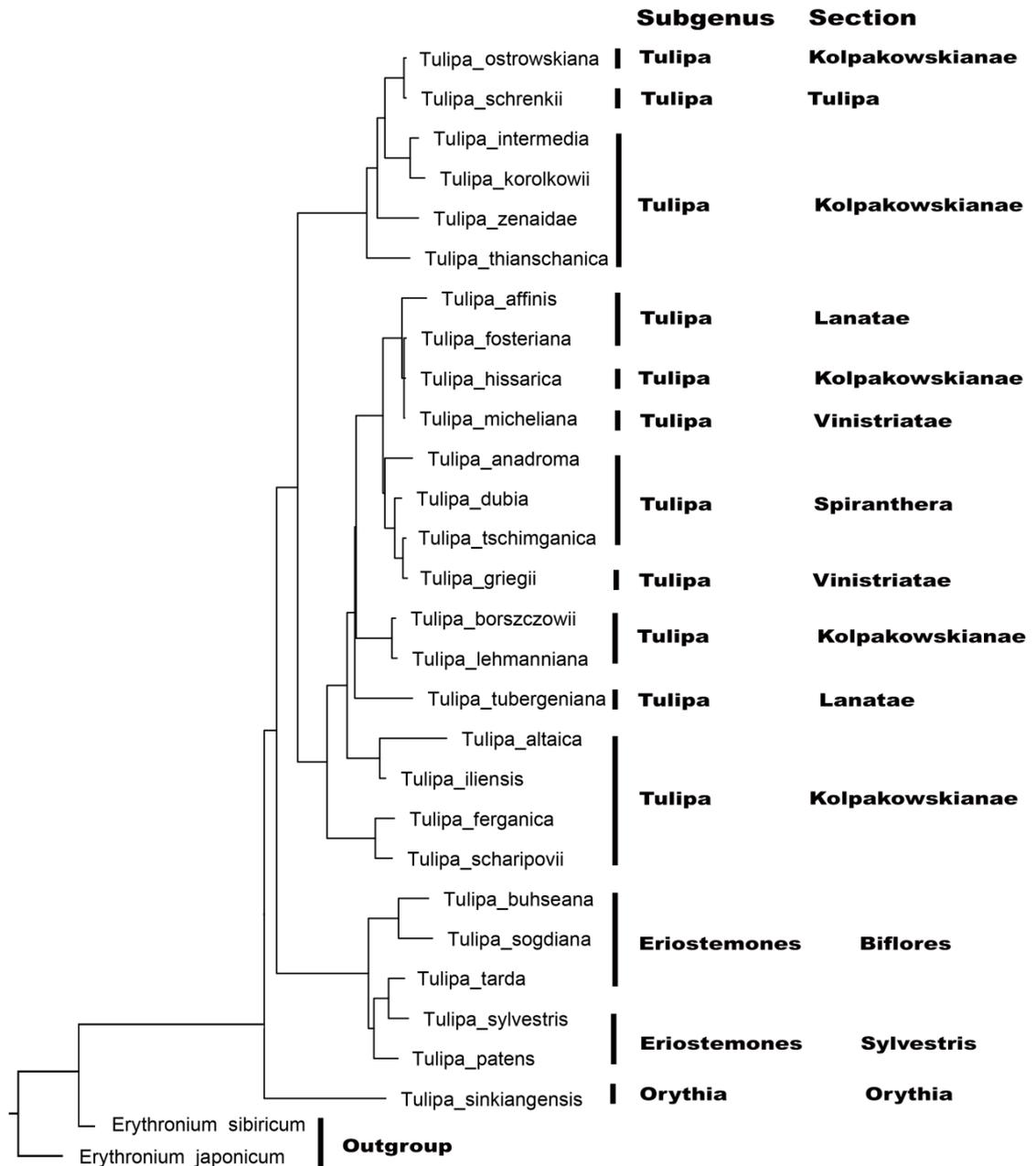


Figure 3. Molecular phylogenetic dendrogram of *Tulipa* species

Christenhusz et al. (2013) synonymized *T. affinis* under *T. fosteriana*. According to distinct morphological characters, we recommend the correct taxonomic assessment in the future.

Tulipa borszczowii and *T. lehmanniana* were located close together, but are recognized as distinct species (Christenhusz et al. 2013). Based on the results of

molecular study, absence of geographical isolation, morphologic resemblance and similar habitats lead us to suggest treating them as *T. lehmanniana*.

Despite the close location of *T. scharipovii* and *T. ferganica* in the tree, the species have some significant, distinct characteristics. First, the habitats of *T. scharipovii* and *T. ferganica* are fully restricted. *T. scharipovii* occurs in saline loess soils in a small, restricted area of the Chap foothills; *T. ferganica* mainly habitats stony slopes of the middle mountain belt of the Kurama, Ferghana, Alay and Turkestan ranges. Second, considering the distinct characteristics of the bulb, pubescence of the vegetative and reproductive parts, structure of the reproductive organs and results of molecular study, we recommend that *T. scharipovii* and *T. ferganica* be treated as separate species.

The habitat and overall view of *T. buhseana* and *T. sogdiana* are very close. Some studies (Christenhusz 2013; Everett 2013; Zhengyi 2000; Zonneveld 2009) presented these species as a synonym of *T. biflora*. Morphologically the species distinct in bulb, location of leaves, number of flowers, pubescence of filament and pubescence of tip of inner and outer tepals. Considering morphologic and molecular results, we suggest *T. buhseana* and *T. sogdiana* as a separate species.

The location of sections *Orithyia*, *Sylvestris* and *Biflores* at the base part of the dendrogram confirms results of our morphology-based and molecular phylogenetic analyses (Christenhusz 2013; Wilson 2023).

The sixth chapter of the work “**Modeling and analysis of environmental issues of *Tulipa* L.**” presents ecological niche, states of red-listed species in different climate change scenarios, species distribution modelling and prediction of suitable habitats for *Tulipa*.

The dissertation demonstrates investigation of important bioclimatic variables of red-listed *Tulipa* species dividing in 3 geographic ranges (western Tian-Shan, Pamir-Alay and widespread across Central Asia). According to the results, ClimaticMoistureIndex, PetWettestQuarter, PetColdestQuarter variables found to be important bioclimatic variables for *Tulipa intermedia*, *T. scharipovii* and *T. ferganica* distributed in **western Tian-Shan** part of Ferghana valley. Predicted suitable areas for the distribution of the species in the climate change scenarios are located very close to their current habitats.

The states of the species distributed in **Pamir-Alay** mountain systems, *Tulipa affinis*, *T. carinata*, *T. ingens*, *T. lanata* and *T. tubergeniana* were investigated. Mean Diurnal Range (BIO2) was significant bioclimatic variables for *T. carinata*, *T. ingens* and *T. lanata* distributed in the mountainous part of the southern Uzbekistan. Various geographical ranges and habitat types of the species showed difference in bioclimatic variables. For example, bioclimatic variables of *T. tubergeniana* distributed in clayey soil of foothills and *T. affinis* in stony slopes of middle mountains of Nurata differed from above-mentioned species. Due to SSPs 5.85 scenarios, the decrease probability of current high suitable area of *T. tubergeniana* and *T. lanata* to 24- and 12.5-times in 2081-2100 were modelled.

Bioclimatic variables of *T. korolkowii* and *T. lehmanniana* which **widespread** in the foothills and middle mountains of study area were similar (Bio06, Bio15,

Bio19 and PET Seasonality). The current high suitable area of *T. korolkowii* and *T. lehmanniana* will decrease 2.7 and 373 times in SSPs 5.85 scenarios respectively. These numbers challenge development of effective and practical conservation measurements.

Suitable elevation for the habitat of the *Tulipa* species in Central Asia including Uzbekistan is 700-2200 m. than sea level. Considering species-richness of the elevation interval, *Tulipa* species may have survived during the past climatic oscillations, for example, in glacial period, during past historical geological periods. From here, the speciation of *Tulipa* in Central Asia apparently proceeded towards the dry (desert) and cold (alpine) environments. The elevation range spanned by the species distribution was found to be positively correlated with a number of populations ($r = 0.50$, $p < 0.05$) and AOO ($r = 0.57$, $p < 0.05$) which means adaptation of the species to different climatic conditions increases the survival ability and leads to increase in populations number and, subsequently, to the expansion of the AOO.

Topography is a key environmental factor influencing species distributions and it provides the plants with sunlight, heat, and the spatial redistribution of water and nutrients, leading to the formation of specific micro environment (Costa et al. 2005; Lassueur et al. 2006; Macek et al. 2019; Svenning et al. 2009). Topography was the primary determinant of 11 red-listed species distributed in the foothills and plains. Conservation of *T. hissarica*, *T. vvedenskyi*, *T. carinata*, *T. ingens*, *T. affinis*, *T. micheliana*, *T. korolkowii* in *ex-situ* conditions requires to take account into the topography factors. Soil was the primary determinant for the distribution of *T. uzbekistanica*, *T. butkovii* and *T. lanata* while climate was the primary determinant of all the species subjected to species distribution modelling.

The seventh chapter “**Development of conservation strategy the species of *Tulipa* in the flora of Uzbekistan**” presents results of the impact of stress factors causing decrease of the populations and development of the conservation strategy for *Tulipa* species.

The effect of abiotic factors can be observed in Ustyurt plateau and Kyzylkum desert with *T. biflora*, *T. buhseana*, and *T. sogdiana*. In some cases, low precipitation and elevated temperature in dry years lead to early desiccation of plants, without blooming and sometimes seedlings. Absence of the record of *T. bactriana* from the type locality, sharply decrease of areas of *T. uzbekistanica* and *T. borszczowii* as the results of low rainfall and natural disaster respectively. In total, edaphic factors, elevated temperature, precipitation and natural disaster lead to decrease of population numbers and areas of 7 species.

Parasitism, grazing by animals and interspecific competition were demonstrated as the biotic stress factors. The impact of predation by insects and microbial invasion were observed with 7 species (*T. lehmanniana*, *T. tubergeniana*, *T. ingens*, *T. affinis*, *T. greigii*, *T. albertii* and *T. kolpakowskiana*). Grazing of the bulbs by wild animals identified with *T. vvedenskyi*, *T. dubia* in Tashkent region and *T. ingens* in Surkhondaryo region. Interspecific competition of 9 *Tulipa* species mainly occurs in the habitats with forensic elements.

The interspecific competition can be observed in the blooming period of *Tulipa* when the vegetation of others plants is in exponential stage. The competition occurs for sunlight and micro- and macro-elements in the soil.

Anthropogenic factors have a huge impact on biodiversity. The results of anthropogenic factors to *Tulipa* species presented below.

Urbanization. The growth of population and urbanization have been a strong negative impact in the foothills and middle mountains. The birth rate increased by 17% in 2022 than 2021 (Statistical edition of the state Committee on Statistics 2022). Ferghana valley and Tashkent region with a high density of population are considered hotspots of *Tulipa*. According to georeferenced data, 44% and 38% of habitats of *T. greigii* in Bustanlik district of Tashkent region and *T. tubergeniana* in Sherobod district in Surkhondaryo region were urbanized between 2013-2017 respectively. Urbanization had a negative impact on 11 red-listed species.

Agriculture. Intensive land use in *Tulipa* growing habitat for agricultural aims can be observed in Fergana Valley, Tashkent and Surkhondaryo regions which are special with a high density of population and advanced agricultural techniques. Currently, habitats of *T. scharipovii*, *T. intermedia*, and *T. bifloriformis* in the foot of Kurama range of Chap badlands, *T. ferganica*, and *T. turkestanica* in the foothills of Arbagish in Namangan region have been used intensively for agricultural aims. A similar situation can be observed in Kashkadaryo and Surkhondaryo part of the Pamir-Alay mountains ranges with the species of sect. *Lanatae* and in Kyzylkum desert with some representatives of the sect. *Kopalkowskianae* and *Biflores* also. This factor negatively impacts 11 red-listed *Tulipa* species in total.

The intensity and scale of the **fragmentation** depends on the development of socio-economic reforms directly. There are 570,100 enterprises and organizations in Uzbekistan and this number is growing to 15,000 per month (Doclade of the state Committee on Statistics 2021). Due to the georeferenced data, as an example, 10 populations of *T. lanata*, 25 and 21 populations of *T. greigii*, and *T. turkestanica* have been fragmented respectively.

Overexploitation of *T. vvedenskyi* and *T. kaufmanniana* can be observed in Kamchik pass in Kurama range, *T. tschimganica*, *T. greigii*, and *T. kaufmanniana* in Chimgan range, *T. fosteriana* in Takhtakaracha pass in Zarafshan range, and some species of sect. *Lanatae* in Surkhondaryo region.

Overgrazing. Due to statistics in January 2022 (Statistics Agency under the President of the Republic of Uzbekistan 2023), there are 23,623,700 sheep, 13,857,600 cows, and 269,100 horses recorded in Uzbekistan. Livestock as a main source of income in rural areas, all *Tulipa* species suffer from uncontrolled and unregulated grazing in areas ranging from foothills to alpine zones.

Habitat loss. Development of construction materials production and mining industry in the central part of Uzbekistan lead to a considerable decrease of populations and their habitats. For example, the use of stony part of Nurata relic mountains for the construction aims caused the decrease of *T. affinis*, *T. micheliana* and *T. lehmanniana* and limestone usage in the vicinities of Varzik and Gova in

Namangan region have been causing sharply decrease of the population of *T. intermedia* and *T. bifloriformis*.

in situ conservation strategy with 6 methods was considered broad spectrum and effective approach for *Tulipa* species. The “**Phenology based pasture**” demonstrates prohibition of husbandry activity in the botanical and geographical regions of Uzbekistan during the flowering and fruiting period of *Tulipa* and rotation of areas with high species rich areas of rare or endangered species.

Considering the membership of Uzbekistan to some international nature conservation organizations and providing of conservation of biodiversity in the Republic, **inclusion** of *Tulipa* species **in Red Data Book** plays a crucial role. The last issue of Red Data book of Uzbekistan includes 19 *Tulipa* species (Khasanov 2019) and 24 species in the flora of Uzbekistan included IUCN red-list of threatened species (2022). According to our results, we recommend the inclusion of 3 species (*T. borszczowii*, *T. hissarica*, and *T. korshinskyi*) in the forthcoming issue of RDB of Uzbekistan.

The experience on the **privatization of hotspot zones** is absent in Uzbekistan. Hence, privatization of hotspot zones of rare and endangered species is recommended and the sequence of the implementation is developed. Such privatized zones should be established in Chingan mountains in Tashkent region, Chaknak and Baxcha villages in Surkhondaryo region, Imam-Ata Mountains and hills of Bogishamol recreation areas in Andijan region.

Home garden conservation. This approach can be implemented under both *in-situ* and *ex-situ* conditions. Due to results, *in-situ* home gardens exist for *T. fosteriana* in Kitab district, Kashakadaryo region, *T. tubergeniana* (Pashxurt village, Surkhondaryo region), *T. intermedia* and *T. bifloriformis* (Gova village, Namangan region), *T. lehmaniana* (Navoi region, Kyzylkum, vicinities of experimental field of Institute of Botany). *ex-situ* home gardens exist for *T. fosteriana* in Kitab district, Kashakadaryo region and *T. ingens* in Omonkuton, Samarkand region.

Considering the absence of the experience on the **establishment of micro-reserves**, organization of the areas in 6 hotspots is recommended.

Effective management included the establishment of the special fixed boundaries near the protected areas and organization of workshops on plant morphology, distribution patterns and conservation issues for conservationists. For example, white and yellow forms with red blotch of *T. kaufmanniana* can be found in Kurama range, where yellow form of the species undergoes high impact of overexploitation as the result of nescience on the morphological issues of the plants. Because Red Data Book of Uzbekistan (Khasanov 2019) presents only the white form of *T. kaufmanniana*.

An effective method of *ex-situ* conservation is **Botanic gardens**. Currently, 2.394 plant species including 33 species of *Tulipa* are conserved in Tashkent Botanical Garden. Also, the preservation of 68 species of 62 genera in Kokand botanical garden challenges the establishment of sister botanical gardens in different regions of the Republic due to soil-climate conditions.

Seed storage and DNA storage conservation. The Institute of Botany Academy Sciences of the Republic of Uzbekistan is providing seeds preservation for 1.232 plant species including 23 species of *Tulipa* (Pechenitsyn 2020) of the study area. Additionally, DNA material of 19 tulips species were obtained and barcoded in Barcode of Life Data System (2022).

in vitro conservation. Micropropagation provides not only recover of population of endangered species but also a good chance for the creation of new populations of target species. Currently, *in vitro* technique wild relatives of decorative tulips (*T. fosteriana* and *T. ingens*) distributed in Samarkand region was developed recently (Shukrullozoda R et al. 2022).

The actuality of the **civic awareness** and the upbringing of youth in the spirit of nature conservation were described by Nelson Mandela, who considered the education process as the most powerful weapon for the change of the world (Mandela et al. 2012). Considering dependence of effectiveness and scope of all conservation actions on human willing, civic awareness was included as a separate strategic component.

Legal-regulatory framework of the Republic can be divided into 2 parts: discussion and inclusion of suggestions to the projects of normative documents (Portal for the discussion of the projects of normative legal acts 2022) and database of normative documents (National Database of Legislation of the Republic of Uzbekistan 2023), where all approved documents can be found for the use. The legal-regulatory system is an effective measure in fighting against illegal usage of plants and damage of habitats. For example, a relevant role of illegal collection (59.6%) and damage of habitats (22.8%) was identified during 2010-2018 (Environmental Performance Review, 2020). These situations are controlled by the Resolution of Cabinet of Ministers (2014) of Uzbekistan.

Environmental pedagogy includes the preparation of cadres in the sphere of environmental protection, biodiversity conservation and the upbringing of youth from an early age in the spirit of nature conservation. The reforms carried out in the continuous education system of Uzbekistan and their significance for the conservation of biodiversity are presented in the dissertation in detail.

Environmental awareness. Implementation of the “*Tulip Fields for Conservation*” program in 4 hotspot regions of the Republic and the “*Conservation Month for Tulips*” activities and the experience of Israel (Volis 2016) and Germany (2022) in integrated *ex-situ* and *in-situ* conditions were recommended.

Summarizing the results, the model of conservation strategy for *Tulipa* species in the flora of Uzbekistan was developed (fig. 4). The strategy recommended for the conservation of rare and endangered species of the flora of Central Asia also.

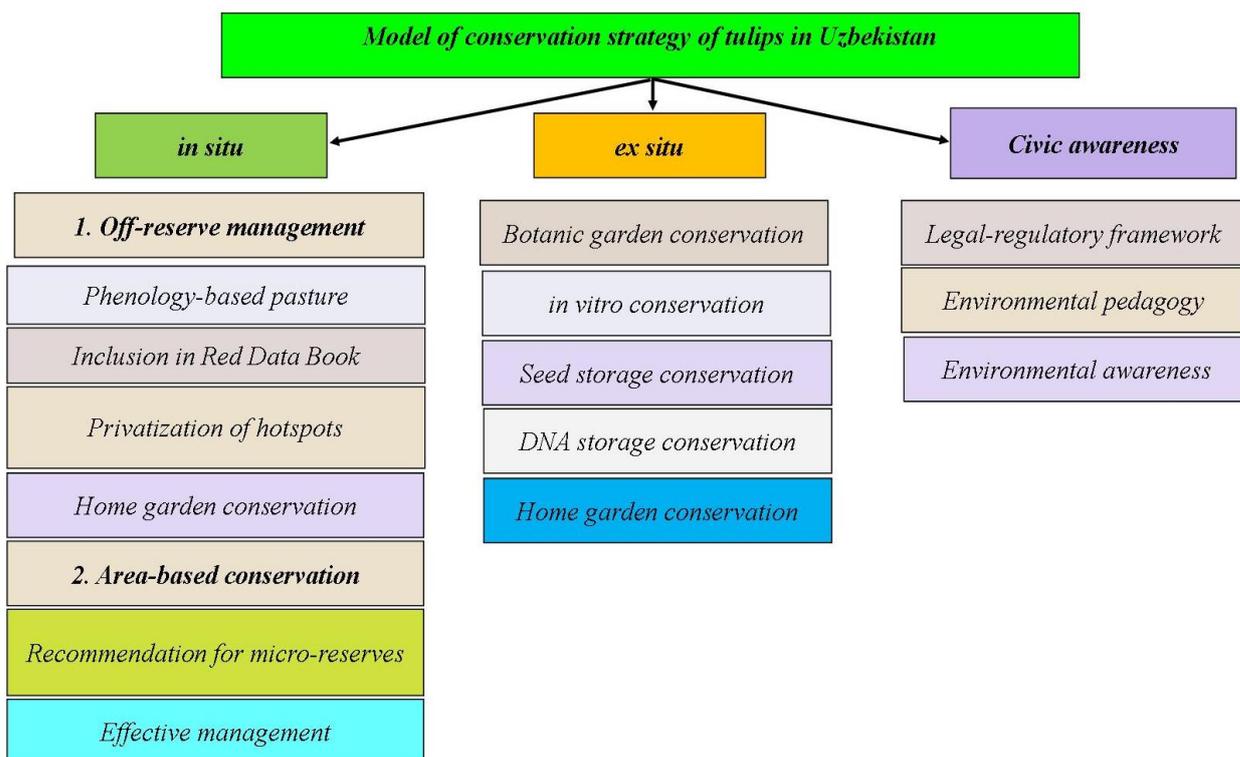


Figure 4. Model of conservation strategy of *Tulipa* in Uzbekistan

CONCLUSION

As a result of the doctoral dissertation (DSc) "New insights into the species of *Tulipa* L.: morphology, distribution, molecular and conservation issues", the following conclusions were presented:

1. Three hundred eight morphologic features of the species recommended for the inclusion in the forthcoming issue of "Flora of Uzbekistan".
2. Comparative morphology of 48 Central Asian species by the use of 24 morphologic characters was analyzed. Distinct characters of the species within sections positively correlate to the diversity of the habitat of occurrence. *Orithyia* and *Biflores* are considered archaic and early divergence sections.
3. New synopsis of the genus was compiled and new dichotomous diagnostic keys for the identification of the species have been developed.
4. Analysis on the distribution of *Tulipa* in phytogeographic regions and ecoregions of Central Asia revealed top hotspot status of Gissaro-Alay open woodlands (41 species) and species richness of Ferghana valley (25 species) respectively.
5. Distribution maps of *Tulipa* in Uzbekistan based on grid system were developed. Five species are considered as endemic species of Uzbekistan.
6. Leading position of lithosols (25 species) and calcic xerosols (17 species) soil units on the distribution patterns of the species was presented for the first time.
7. Decrease of recorded occurrence of all *Tulipa* after 1970 is revealed. Conservation of 27 *Tulipa* species (82%) in 19 protected areas is determined.

8. Twenty-three *Tulipa* species were recorded in the natural geographic area of Ferghana Valley as a hotspot center of the genus and distribution maps based on a grid system was developed.
9. Structure of plastid genome of *Tulipa* species distributed in Central Asia was investigated and molecular phylogenetic tree was constructed. Taxonomic assessment for the species based on morphologic, biogeographic and molecular analyses is recommended.
10. Global climate change and bioclimatic variables of the rare species of Central Asia were investigated. Predicted suitable areas of the species distributed in the western Tian-Shan mountain systems in the climate change scenarios are located very close to their current habitats. The response of the species distributed in Pamir-Alay mountain systems in climate change scenarios depends on type of the habitat. The decrease of the current areas of some red-listed species is modelled.
11. Significance of the species-rich elevation (700-2200 m a.s.l.) in the natural-historical formation and dispersion of *Tulipa* species in Central Asia is demonstrated. Currently this elevation with high concentration of species is considered optimal growth habitat for the species. Topography and climate change were found as the primary determinant in the species distribution model.
12. The results of environmental factors on *Tulipa* was demonstrated. Anthropogenic factors have a negative influence on all species in Uzbekistan, and the results occurs in the foothills and middle mountain regions mainly.
13. By the use of the results on the negative influence of environmental factors, a model of National conservation strategy for *Tulipa* L. was developed and recommended for the conservation of rare and endangered species in the flora of Central Asia.

**НАУЧНЫЙ СОВЕТ DSc.02/30.12.2019.В.39.01 ПО
ПРИСУЖДЕНИЮ УЧЕНЫХ СТЕПЕНЕЙ ПРИ ИНСТИТУТЕ
БОТАНИКИ**

ИНСТИТУТ БОТАНИКИ

ДЕХКОНОВ ДАВРОН БУРХОНОВИЧ

**НОВЫЕ ВЗГЛЯДЫ НА ВИДЫ *TULIPA* L.: МОРФОЛОГИЯ,
РАСПРОСТРАНЕНИЕ, МОЛЕКУЛЯРНЫЕ ДАННЫЕ И
ПРОБЛЕМЫ СОХРАНЕНИЯ**

03.00.05 – Ботаника

**АВТОРЕФЕРАТ ДИССЕРТАЦИИ ДОКТОРА НАУКА (DSc)
ПО БИОЛОГИЧЕСКИМ НАУКАМ**

Ташкент – 2023

Тема диссертации доктора наук (DSc) по биологическим наукам зарегистрирована в Высшей аттестационной комиссии при Министерстве высшего образования, науки и инноваций Республики Узбекистан за номером B2023.2.DSc/B 189.

Диссертация выполнена в Институте ботаники.

Автореферат диссертации на трех языках (узбекский, английский и русский (резюме)) размещён на веб-странице Научного совета по адресу www.botany.uz и в Информационно-образовательном портале «ZiyoNet» по адресу www.ziyo.net.

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Защита диссертации состоится «8» 09 2023 года в 15 часов на заседании Научного совета DSc 02/30.12.2019.B.39.01 при Институте ботаники (Адрес: 100125, г. Ташкент, ул. Дурмон йули, дом 32. Актовый зал Института ботаники. Тел.: (+99871) 262-37-95, факс (+99871) 262-79-38, E-mail: botany@academy.uz).

С диссертацией можно ознакомиться в Информационно-ресурсном центре Института ботаники (зарегистрировано за номером №59. Адрес: 100125, г. Ташкент, ул. Дурмон йули, дом 32. Тел.: (+99871) 262-37-95).

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ВВЕДЕНИЕ (аннотация диссертации доктора наук (DSc))

Целями исследования являются морфологические и биогеографические исследования, молекулярно-таксономическая оценка видов на основе пластомов, биоклиматическое моделирование в сценариях изменения климата и разработка Национальной стратегии сохранения видов *Tulipa*.

Объектами исследования являются виды *Tulipa* (Liliaceae).

Научная новизна исследования заключается в следующем:

подготовлен краткий обзор видов тюльпанов Узбекистана на основе морфологии образцов живых растений к предстоящему изданию «Флоры Узбекистана»;

исследована сравнительная морфология 48 видов *Tulipa* флоры Средней Азии, и построена филогенетическая дендрограмма по 24 морфологическим признакам;

определены очаги распространения тюльпанов в фитогеографических и экорегиональных районах Средней Азии;

разработаны сеточные карты по секциям и видам рода во флоре Узбекистана;

смоделированы состояния видов, распределенных в 3 географических регионах, в сценариях изменения климата;

был смоделирован вклад трех классов переменных окружающей среды в качестве детерминантов распространения видов;

сконструированы и идентифицированы структура, порядок генов и функции цельного пластидного генома 19 видов *Tulipa*;

построена молекулярно-филогенетическая дендрограмма с использованием пластомов 29 видов *Tulipa* и оценен таксономический статус видов;

было продемонстрировано отрицательное влияние факторов окружающей среды на популяции тюльпанов;

разработана национальная стратегия сохранения видов *Tulipa* в Узбекистане.

Внедрение результатов исследований. По результатам изучения видов рода *Tulipa* во флоре Средней Азии и Узбекистана:

Для целей исследования и сохранения информация о 32 видах *Tulipa* включена в базу данных GBIF (Global Biodiversity Information Facility) (сертификат GBIF от 26 июня 2023 г.). В результате, информация о типах, морфологии, закономерностях распространения, фенологии и экологии видов позволила выделить секции и виды, оценить состояние местонахождений тюльпанов до и после 1970 г. и использовать представленные данные по распространению и местонахождению вида на международном уровне.

Более 200 гербарных образцов были переданы в Национальный гербарий Ташкента (TASH) (справка Академии наук Республики Узбекистан, № 4/1255-1277, 9 июня 2023 г.) В результате коллекция образцов Центрально-

Азиатского отдела TASH пополнилась редкими, исчезающими и эндемичными краснокнижными видами Узбекистана и обеспечила проведение детальных морфологических и биогеографических исследований.

24 вида тюльпанов, распространенных в Узбекистане, включены в Красный список исчезающих видов Международного союза охраны природы (Красный список МСОП) (сертификат МСОП, 27 июня 2023 г.). В результате сохранения *Tulipa* на международном уровне, оценка редкости, использование реализованных данных в глобальном масштабе и внедрение мер сохранения в практику были обеспечены.

Объем и структура диссертации. Диссертация состоит из введения, семи глав, выводов, списка использованной литературы и приложения. Объем диссертации составляет 198 страниц.

ЭЪЛОН ҚИЛИНГАН ИШЛАР РЎЙХАТИ
СПИСОК ОПУБЛИКОВАННЫХ РАБОТ
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