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Distribution of *Crocosmia x crocosmiiflora* (Iridaceae) Outside of Parks and Graveyards in NE Anatolia (Türkiye)

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ABSTRACT
Using plants as ornamentals is one of the most important ways of introduction to the new ecosystems for alien species. *Crorocosmia x crocosmiiflora* seems to be a good example of this situation in Eastern Black Sea Region of Türkiye where it has been planted in many parks and graveyards as an ornamental plant. This hybrid taxon was observed in 37 different locations, outside of parks and graveyards in Artvin (5 records), Rize (17 records), Trabzon (8 records) and Giresun (7 records) cities, mainly on roadsides, fields, thickets, forest margins and waste areas during the field studies on Bur Cucumber. Present observations revealed that Montbretia clearly escaped from cultivation area and continue to increase its distribution range and population density/number in the North East Anatolia. Like other naturalized alien species in Türkiye, Montbretia is rapidly naturalizing in the Eastern Black Sea Region, which is the most important naturalization center of exotic plants in Türkiye, so it will become a part of the wild flora of the this region in the near future.

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ÖZET
Bitkilerin süs bitkisi olarak kullanılması, yabancı türlerin yeni ekosistemlere girişinin en önemli yollarından biridir. *Crorocosmia x crocosmiiflora*, birçok park ve mezarlıkta süs bitkisi olarak yetiştirildiği Türkiye'nin Doğu Karadeniz Bölümü'nde bu duruma iyi bir örnek olarak görünmektedir. Bu hibrit takson, İtdolanbacı türü üzerine yapılan arazi çalışmaları sırasında, mezarlık ve park alanları dışında, Artvin (5 kayıt), Rize (17 kayıt), Trabzon (8 kayıt) ve Giresun (7 kayıt) illerinden toplam 37 lokasyonda, çoğunlukla yol kenarları, tarla kenarları, çalılıklar, orman kenarları ve boş alanlarda gözlenmiştir. Mevcut gözlemler, Afrika Yıldızı'nın kültürden açıkça kaçtığını ve Kuzey Doğu Anadolu'da yayılış alanını ve popülasyon yoğunluğu/sayısını artırmaya devam ettirdiğini ortaya koydu. Türkiye'deki yabancı türlerin öncelikli doğallaşma merkezi olan bu bölgede, diğer birçok yabancı tür gibi Afrika Yıldızı da yakın gelecekte bölgenin doğal florasının bir parçası olma yolundadır.

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INTRODUCTION
Today, 3.9% of the world's plants have naturalized outside their natural habitats as a result of human mobility and activities (van Kleunen et al., 2015). Using plant species for ornamental purposes is one of the most important reasons of naturalization. Due to heavy rainfall throughout the year, North East Anatolia is home to many of ornamentally used alien genera (i.e. Duman & Güner, 1996) and species (i.e. Terzioğlu & Coşkunçelebi, 2017;

Terzioğlu & Coşkunçelebi, 2022; Coşkunçelebi & Terzioğlu, 2022). It is reported that the total number of vascular plant taxa of Türkiye is 12354 (Terzioğlu et al., 2021) of which the 340 alien ones introduced to Türkiye (Uludağ et al., 2017). However, the compilation studies carried out within the scope of the TERIAS project (final report) show that this number is over 400 (Terzioğlu & Coşkunçelebi, 2020).

Crocosmia x crocosmiiflora (Lemoine) N.E.Br. (Montbretia, Iridaceae) called as "Mezarlık çiçeği/Graveyard's flower Turkish/English" by local people is a well-known garden hybrid flower (Nelson, 1993). Although the parent species of this horticultural originated taxon are native to South Africa, *C. x crocosmiiflora* is recorded as an introduced plant in many countries (POWO, 2024; Figure 1). In the world, it has been widely used as an ornamental plants and has become an invasive species in many countries by escaping into nature (CABI, 2024). Montbretia is firstly planted as an ornamental plant in graveyards and parks due to its attractive flowers since an unknown date in North East Anatolia. However, it is listed as an exotic plant by Ergül–Bozkurt (2017) and Terzioğlu (2022) depending on herbarium records and field observations without any further remarks. It is well known that the intentional or unintentional movement of such taxa by humans from one region to another accelerates the naturalization process of ornamental plants (Richardson, et al., 2000). Present observation during the field studies on invasive alien plant species in North East Anatolia revealed that Montbretia have many healthy populations outside of parks and graveyards such as in roadsides, fields, thickets, forest margins and waste areas and gained an invasive feature in this region. However, this hybrid is not listed in the vascular plant check list of Türkiye by Güner et al. (2012), alien flora of Türkiye by Uludağ et al. (2017) or any other relevance literatures, up to now.

In the present paper, several new localities outside of parks and graveyards of *Crocosmia x crocosmiiflora* in the Eastern Black Sea Region of Türkiye are recorded for the first time and discussed.

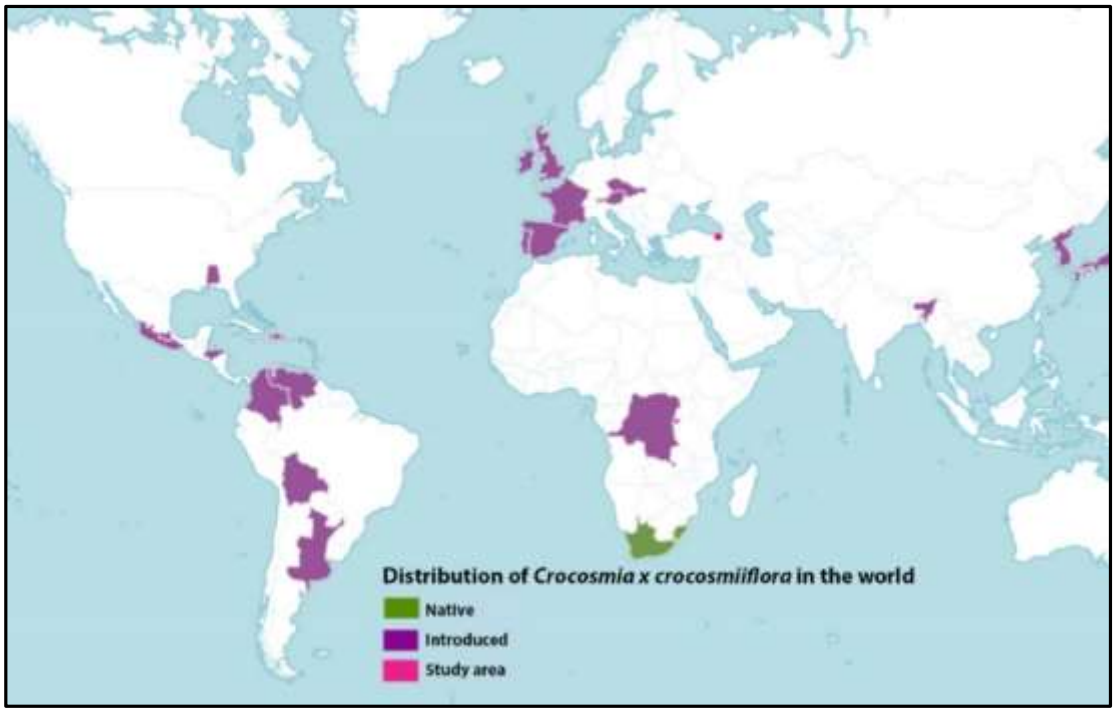

Figure 1. Distribution of *C. x crocosmiiflora* in the world (Modified from POWO, 2024).
Şekil 1. C. x crocosmiiflora'unın dünyadaki yayılışı (POWO, 2024'den uyarlanmıştır).

MATERIAL and METHODS

Crocossmia x crocosmiiflora was identified by using relevant literature (Goldblatt & Brown, 2002; Goldblatt & Manning, 2020; Żurawik et al, 2015; NRA, 2010) and samples of both KATO (21808!, 21952!, 24454!, 24455!, 24456!) and KTUB (Coşkunçelebi 1470!, 1471!) which stored in the herbarium of Forest Botany (KATO) and Biology (KTUB) at Karadeniz Technical University. As well, field observations and remarks of the present authors during the excursions on invasive plant species distributed in North East Anatolia were also used in identification. List of records belong to the Montbretia is ordered alphabetically by the names of the cities including the name of administrative area, the name of localities with GPS coordinates, altitudes and the date of collection/observation. The distribution map was prepared with the help of ArcGIS 10.5 program (Esri, 2014) based on the records mentioned in Ergül–Bozkurt (2017), Terzioğlu (2022) and observations in the current study. The hybrid taxon was named in Turkish according to guidelines of Menemen et al. (2016).

RESULTS and DISCUSSION

Crocosmia x crocosmiiflora (Lemoine) N. E. Brown, Trans. Roy. Soc. South Africa. 20: 264, 1932 (Figure 2).
Syn.: *Montbretia x crocosmiiflora* Lemoine, The Garden 18: 188 (21 August 1881) [as *M. crocosmiaeflora*]. *Tritonia x crocosmiiflora* (Lemoine) Nicholson, Illustrated Dictionary of Gardening 4: 94 (1888) [as *T. crocosmiflora*].
Type: Illustration in Morren, La Belgique Horticole 31: t. 14 (1881), neo., designated by Goldblatt et al. (2004).
The description of present alien hybrid was prepared based on fresh materials and herbarium specimens together with Goldblatt & Brown (2002) and Goldblatt & Manning (2020).
Stiff, leafy, clump–forming geophyte with underground rhizome, 35–100 cm. Rootstock a depressed-globose corm, 1.5–2.5 cm in diam., rooting from below. Stem laxly, 2–4-branched. Leaves 5–8, mostly basal, plane, narrowly lanceolate, ± 2⁄3 as long as stem, 8–20 mm wide, cauline narrower than basal. Spike lightly flexuose, mostly 6–10 flowered; bracts reddish with dry brown tips, 6–10 mm. Flowers distichous, bright orange, paler in throat, unscented; perianth tube funnel–shaped, slightly curved forward, 12 mm, tepal spreading, subequal, 15–22 mm. Filaments 15–22 mm, anthers 6–8 mm long, yellow. Style arching over stamens, dividing, branches ± 4 mm, apically bifid. Fruit an inflated globose, 3–lobed capsule, ca. 8 mm. Seeds blackish, ca. 2.5 mm diam., often aborted or ± globose, reddish brown.
Flowering period: July-September.
Habitat: Parks, graveyards, near sea coast, roadsides, thickets, wood margins and waste grounds.
Altitude: 4–577 m.
Vernacular (Turkish) name: Afrika yıldızı according to guidelines of Menemen et al. (2016).

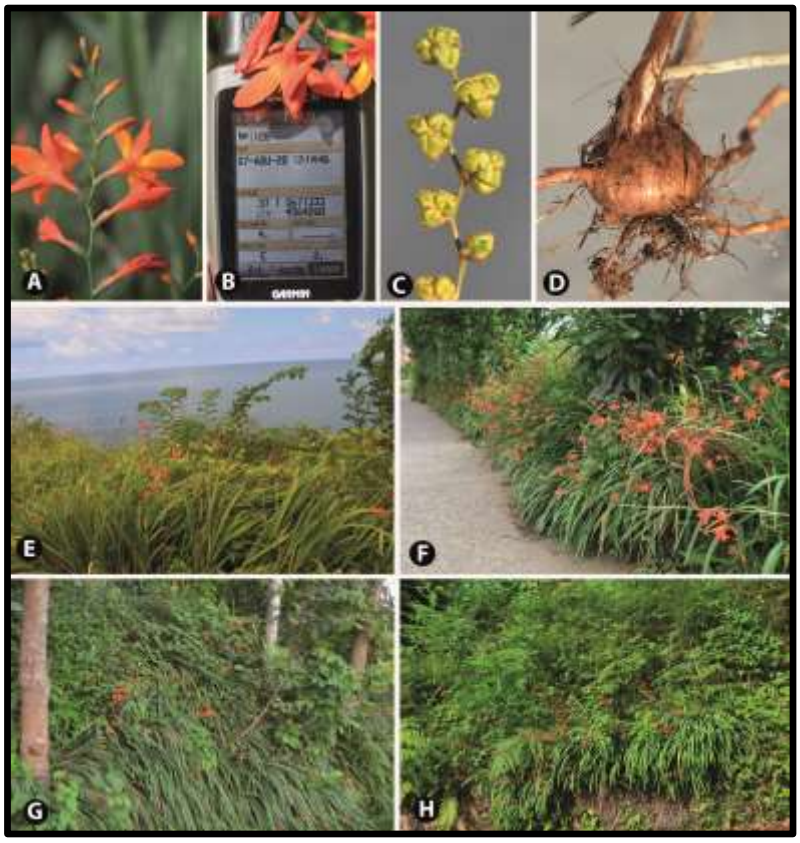

Figure 2. Some distinctive parts and habitat types of *C. x crocosmiifolia*; **A**–Inflorescence (Lightly flexuose spike), **B**–Coordinate information of the 13th record (Rize: Ardeşen, Işıklı), **C**–Fruit (Globose capsules), **D**–Rootstock (Rooted corm), **E**–**H**–Habitats (Sea coast, roadside, wood margin and waste ground, respectively).

Şekil 2. *C. x crocosmiifolia'nın bazı ayırt edici kısımları ve habitat tipleri;* ***A*** *- Çiçek kurulu (Gevşek–zigzag başak),* ***B****–13. Noktaya (Rize: Ardeşen, Işıklı) ait koordinat bilgisi,* ***C***–Meyve (*Yuvarlağımsı kapsüller),* ***D***–*Toprakaltı gövdesi (Köklenmiş kormus),* ***E***– ***H***–*Habitatlar (Sırasıyla; deniz kenarı, yol boyu, orman kenarı ve boş alan).*

The genus *Crocosmia* Planch. includes 8 species and one hybrid taxa, *C. x crocosmiifolia*, native to Sudan to S. Africa and Madagascar (POWO, 2024). It has been widely cultivated as an ornamental and has escaped from cultivation area (parks, graveyards, etc.) to field sides, disturbed sites, wasteland, along roadsides, and shrub lands

in many countries (Ensbey et al., 2014). A total of 39 locations were coordinated by GPS during the field study in Black Sea Region of Türkiye (Table 1, Figure 3). These findings confirmed that this hybrid taxon escaped from parks and graveyards to roadsides, thickets, sea coast, wood margins, field sides and waste grounds and going on to widen its distribution in Black Sea Region of Türkiye (Table 1, Figure 3). So, every new habitat it reaches is a potential expansion point for this taxon.

Table 1. Records of *Crocosmia x crocosmiiflora* in Eastern Black Sea Region of Türkiye
Çizelge 1. Türkiye'nin Doğu Karadeniz Bölümü'nde Crocosmia x crocosmiiflora kayıtları

No	Square (Davis, 1974) and Locality Information	Altitude (m)	Latitude	Longitude	Remarks
1	A8 Artvin, Hopa, Çamlı, Hopa-Sarp road, 07 August, 2020	6	41.372.486.439	41.342.479.343	NR*
2	A8 Artvin, Kemalpaşa, Sarp, 04 August, 2020	42	41.518.013.981	41.548.646.122	NR
3	A8 Artvin, Kemalpaşa, Kayaköy, 04 August, 2020	79	41.525.029.928	41.624.675.336	NR
4	A8 Artvin, Hopa, 15 June 2013	200	-	-	Ergül–Bozkurt (2017)
5	A8 Artvin, Kemalpaşa, Kayaköy, 04 August, 2020	305	41.504.271.178	41.563.190.466	NR
6	A8 Rize, Çamlıhemşin, Kavak, 18 August, 2020	344	41.052.362.452	41.037.985.002	NR
7	A8 Rize, Çamlıhemşin, Behice, Hincipici, 18 August, 2020	274	41.086.406.697	41.037.155.908	NR
8	A8 Rize, Kalkandere, Ünalan, 19 August, 2020	577	40.928.060.077	40.494.783.202	NR
9	A8 Rize, Merkez, Tekke, 19 August, 2020	201	40.954.852.400	40.532.291.834	NR
10	A8 Rize, İyidere,Hazar, 08 August, 2020	147	40.992.175.141	40.347.411.440	NR
11	A8 Rize, Çayeli, Yeşilköy, 05 August, 2020	14	41.023.629.628	40.691.158.492	NR
12	A8 Rize, Çayeli, Yaka, Hopa-Sarp road, 04 August, 2020	24	41.080.475.637	40.702.828.844	NR
13	A8 Rize, Ardeşen, Işıklı, 07 August, 2020	4	41.209.954.608	41.043.465.768	NR
14	A8 Rize, Ardeşen, Fırtına, 07 August, 2020	16	41.180.190.026	40.969.852.283	NR
15	A8 Rize, Ardeşen, Bayırcık, 07 August, 2020	322	41.125.113.012	41.087.334.392	NR
16	A8 Rize, Çayeli, Yenitepe, 07 August, 2020	186	41.046.717.364	40.726.301.393	NR
17	A8 Rize, Çayeli, Haremtepe, 07 August, 2020	231	41.043.065.475	40.728.359.355	NR
18	A8 Rize, Çayeli, Haremtepe, 07 August, 2020	235	41.041.184.589	40.730.047.097	NR
19	A8 Rize, Çayeli, Haremtepe, 07 August, 2020	247	41.040.908.754	40.730.420.575	NR
20	A8 Rize, Çayeli, Haremtepe, 07 August, 2020	269	4.103.682.587	40.736.571.024	NR
21	A8 Rize, Çayeli, Haremtepe, 07 August, 2020	371	41.035.278.658	40.732.842.619	NR
22	A8 Rize, Çayeli, Haremtepe, 07 August, 2020	413	41.032.022.422	40.732.543.101	NR
23	A8 Trabzon, Of, Sefaköy, 26 August, 2020	365	40.901.691.045	40.295.484.226	NR
24	A8 Trabzon, Sürmene, Çamburnu, Kuleli, 07 August, 2020	18	40.916.928.213	40.194.083.880	NR
25	A8 Trabzon, Sürmene, Çamburnu, Kutlular, 07 August 2020	52	40.908.066.915	40.203.363.869	NR
26	A8 Trabzon, Sürmene, Çamburnu, Kutlular, 07 August 2020	194	40.902.198.732	40.205.465.768	NR
27	A8 Trabzon, Sürmene, Çamburnu, Kutlular, 07 August 2020	189	40.902.132.803	40.204.016.136	NR
28	A8 Trabzon, Çaykara,2022	250	-	-	Terzioğlu (2022)

29	A8 Trabzon, Sürmene,16.07.2013	150	-	-	Ergül–Bozkurt (2017)
30	A8 Trabzon, Sürmene, Yeniay, Kumru, 07 August, 2020	124	40.911.733.175	40.192.090.544	NR
31	A7 Giresun, Eynesil, Ören, Camidüzü Mahallesi,11 August, 2020	289	41.032.518.202	39.148.425.712	NR
32	A7 Giresun, Eynesil, Çorapçılar, Derebaşı, 11 August, 2020	58	41.062.773.267	39.150.897.784	NR
33	A7 Giresun, Eynesil,Çorapçılar, 11 August, 2020	254	41.055.030.022	39.173.847.553	NR
34	A7 Giresun, Merkez, Yukarıalınlı, 12 August, 2020	550	40.858.664.334	38.366.928.912	NR
35	A7 Giresun, Merkez, Samanlıkkıranı, 12 August, 2020	90	40.890.750.513	38.419.732.441	NR
36	A7 Giresun, Keşap, Geçit, 12 August, 2020	731	32.289.255.469	82.097.187.668	NR
37	A7 Giresun, Tirebolu, Arageriş, Mınak, 12 August, 2020	155	40.951.717.075	38.766.344.261	NR

NR: New Record.*

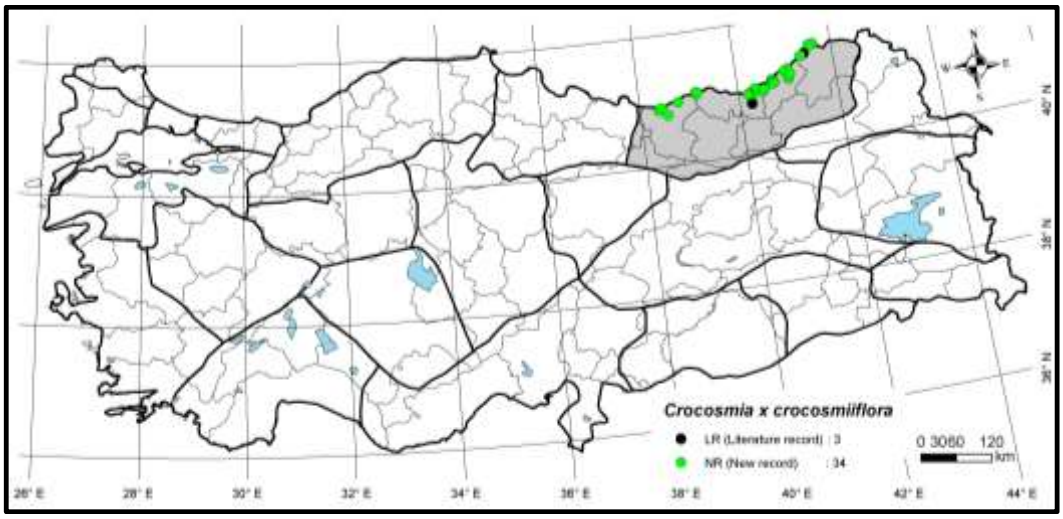

Figure 3. Distribution map of *Crocosmia x crocosmiiflora* in Eastern Black Sea Region of Türkiye.
Şekil 3. Crocosmia x crocosmiiflora'nın Türkiye'nin Doğu Karadeniz Bölümü'ndeki yayılış haritası.

Spread of alien species, especially invasive ones, considered the second most significant threat to biodiversity after habitat loss (Wilcove et al., 1998). Depending on the adaptation capacity, alien taxa spends decades in their newly introduced ecosystems, before becoming invasive according to their abilities. Thanks to their ecological adaptation capacities, they begin to change the species composition and some ecological conditions in these ecosystems (Reaser et al., 2020). *C. x crocosmiiflora* is a hybrid taxon that it is disease resistant, remarkably vigorous and easily propagated (Kumar et al., 2019). So, it remains widely cultivated today because it is so easy to grow, is undemanding of care and soil, and thrives in a wide range of habitats and climate zones (Goldblatt & Brown, 2020). Its rapid vegetative reproduction capacity, it persists in abandoned gardens and slowly spreads into meadows, roadsides and eventually into undisturbed vegetation, and it in order to escape from the parks and graveyards in Türkiye. This rapid spreading is estimated that this taxon will be a serious weed in Türkiye starting from Black Sea Region. Although Montbretia could be confused with equitant leaved *Iris* taxa distributed in this region before blooming, it is easy to distinguish from other taxa by the distinct shape and attractive orange scarlet flowers in flowering stage.

Although this hybrid taxon was carried to Türkiye as an ornamental plant, this study underlined that it has started to spread out of control outside parks and graveyards in NE Anatolia. It has also been observed that this hybrid formed dense populations over the years in this region. This is because it should be monitored regularly and if necessary physical/mechanical control should be conducted. It is reported that the most practical way of preventing and managing invasions is to provide detailed information about introduction routes and vectors. This information also is necessary both to prevent the escape of alien species to natural habitats and to prevent their further spread.

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Statement Contribution of the Authors

The authors declare the contribution of the authors is equal.

Statement of Conflict of Interest

The authors have declared no conflict of interest

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