Acta Bot. Croat. 65 (2), 203–209, 2006

CODEN: ABCRA 25
ISSN 0365–0588

Nicotiana glauca Graham (Solanaceae), a new invasive plant in Croatia

SANDRO BOGDANOVIĆ[1*], BOŽENA MITIĆ[1], MIRKO RUŠČIĆ[2], KATIJA DOLINA[3]

[1] University of Zagreb, Faculty of Science, Division of Biology, Department of Botany, Marulićev trg 20/2, 10000 Zagreb, Croatia

[2] University of Split, Faculty of Philosophy, Teslina 12, 21000 Split, Croatia

[3] University of Dubrovnik, Institute for Marine and Coastal Research, PO Box 83, HR-20000 Dubrovnik, Croatia

The South American species *Nicotiana glauca* Graham (Solanaceae) is invasive in the western Mediterranean and has been found for the first time at four localities in Croatia. The first locality was discovered in 1977 on the island of Lokrum, but has previously been neglected, the second in Komiža on the island of Vis, the third in the city of Split and the fourth in the city of Dubrovnik. The newly discovered *N. glauca* is a woody perennial species, while two other *Nicotiana* species occurring in Croatian, *N. tabacum* L. and *N. rustica* L., are annual herbs. An identification key for these three species and their morphological comparison is presented. The further spreading of *N. glauca* in Croatian littoral can be expected, and should be prevented.

Key words: *Nicotiana glauca*, Solanaceae, invasive species, flora, Croatia

Introduction

The genus *Nicotiana* L. is one of the largest within the family Solanaceae, with 76 naturally occurring species. According to KNAPP et al. (2004) the genus is divided into 13 sections. Species of *Nicotiana* occur largely in South and North America and Australia, with one species in Africa.

Previously, in the flora of Croatia the genus *Nicotiana* L. was represented by two cultivated and naturalised annual herb species, *N. rustica* L. and *N. tabacum* L. (LOVAŠEN-EBERHARDT 1997). The species *N. rustica* belongs to the section *Rusticae* G. Don and *N. tabacum* to the section *Nicotiana*. *N. rustica* was formerly widely cultivated for tobacco, but now is largely replaced by *N. tabacum*, which is cultivated throughout most of Europe. Both species have been naturalized and spread worldwide by humans. The newly discovered species, *Nicotiana glauca* Graham, however, belongs to the sect. *Noctiflorae* Goodsp. (MOORE 1972, KNAPP et al. 2004).

* Corresponding author, e-mail: sandro@botanic.hr

During our herbarium researches, we found a single herbarium specimen of the species *N. glauca* in Herbarium Croaticum (ZA) collected in 1977 on the island of Lokrum (Croatian south Adriatic). In spite of this, there were no further herbarium or literature data about the existence of this invasive species in the Croatian flora. Its presence in Croatia is reported here for the first time.

Nicotiana glauca, tree tobacco (Fig. 1), is an evergreen perennial, glabrous soft--wooded shrub or small tree, up to 6 m tall, with stems that are laxly branched. The leaves are stalked, alternate, elliptical to lanceolate or oval, pointed, bluish or greyish-green. The flowers are greenish-yellow, 30–40 mm long, many are borne in a lax panicle. The corolla is tubular with a short-lobed limb. The fruit is an egg-shaped, two-valved capsule, 7–10 mm long and slightly longer than the persistent papery calyx. It produces a large quantity of tiny seeds, which can be dispersed by wind and water. All plant parts are extremely poisonous (GOODSPEED 1954, MOORE 1972, BLAMEY and GREY-WILSON 1998).

Fig. 1. *Nicotiana glauca* Graham, Komiža, May 2002 (photo by S. Bogdanović)

In May and August 2002, during floristic investigations of the island of Vis in the central Adriatic, near the abandoned part of old coal dump for the Neptun cannery in Komiža, we found a *Nicotiana* species, a new alien species for the Croatian flora. We determined it as *N. glauca* Graham. *Nicotiana glauca* is a cosmopolitan bird-pollinated plant native to South America (northwest and central Argentina, Paraguay and Bolivia), distributed in warm temperate, arid and subtropical, dry and moist regions, beside roadsides and along riverbanks, up to altitudes of 3000 m (GOODSPEED 1954, CRONK and FULLER 2001).

Furthermore, *N. glauca* is an invasive species that represents a threat to the native flora of the invaded regions. It has invaded Central America (Mexico, California, Channel Islands), Africa (Morocco, South Africa and Namibia), Israel, Australia, Oceanic Islands (St. Helena) (CRONK and FULLER 2001, SCHUELLER 2004). It is also widely naturalised in many parts of the European Mediterranean region – Spain, Portugal, France, Italy, Sicily, Corsica, Sardinia, Greece and Crete (MOORE 1972). For example in Spain, *N. glauca* is quite invasive (Dr. Stephen L. Jury, pers. comm.). As an invader it occupies waste places, dry riverbeds, roadsides and riverbanks of warm temperate arid and moist, and subtropical dry and moist climatic zones. According to CRONK and FULLER (2001), *N. glauca* belongs to the invasive category 3 (invading seminatural or natural habitats which are of some conservation interest).

Materials and methods

Our research comprised field investigations, as well as an analysis of the literature data and the herbarium collections ZA, ZAHO, CNHM, WU and W.

Field research was undertaken from 2002 to 2004 on the area of central and south Croatian Adriatic. Plants of *N. glauca* were determined using GOODSPEED (1954), MOORE (1972) and by comparison with herbaria specimens deposited in WU and ZA.

Morphological features of the species *N. glauca* were described and compared with those of *N. rustica* and *N. tabacum* (Tab. 1), and a determination key for the Croatian species of the genus *Nicotiana* was given.

The positions of the localities of *N. glauca* were determined by GPS Garmin eTrex Vista and a floristic list of the accompanying plants at each locality was made. A distribution map (Fig. 2) of *N. glauca* was produced by combined usage of ArcView 3.1a tool and the *Flora Croatica Database* 2.7 (http://hirc.botanic.hr/fcd).

Collected specimens of *N. glauca* are deposited in the Herbarium Croaticum (ZA).

Results and discussion

It is simply to distinguish *N. glauca* as a shrub, blooming almost all the year, from the herbaceous, summer or earlier autumn blooming species *N. rustica* and *N. tabacum*. The differences are also visible in several other morphological characters (see Tab. 1). For ease of identification, we offer a key to the species of the genus *Nicotiana* present in Croatian flora (modified according to MOORE 1972, BLAMEY and GREY-WILSON 1998):

1	Leaves glabrous, glaucous; shrub	***N. glauca* Graham**
1	Leaves viscid-pubescent, not glaucous; herb	2
2	Petiole not winged	***N. rustica* L.**
2	Petiole winged or absent	***N. tabacum* L.**

Localities of the species *Nicotiana glauca* in Croatia

N. glauca has been found at four localities in Croatia (Fig. 2). In Komiža on the island of Vis near the Neptun cannery (N 43° 2' 23,6", E 16° 5' 46,1"), we found approximately 20 big shrubs of *Nicotiana glauca*. In August 2004 the species *N. glauca* was also found in the

Tab. 1. Morphological differences among *Nicotiana* species in Croatia.

Character	*N. glauca*	*N. tabacum*	*N. rustica*
Habit	Glabrous shrub	Viscid herb	Viscid-pubescent herb
Height (m)	(1–) 2–6 (–10)	1–3	0.5–1.5
Leaves shape	elliptical to lanceolate or ovate, acute, glaucous	ovate to elliptical or lanceolate, acuminate	ovate to elliptical, acute
Leaf length (cm)	5–25	50 and more	10–15 (–30)
Leaf petiole	not winged	absent or short, winged	not winged
Flowering time	January to December	June to August	July to September
Corolla length (mm)	(25–) 30–40 (–45)	(30–) 35–55	12–17
Corolla shape	tubular	infundibuliform	tubular to cupuliform

city of Split (N 43° 30' 46,7", E 16° 26' 48,9"), at an archaeological site in the city centre. In September of 2004 another two localities in south Dalmatia were found, on the island of Lokrum (N 42° 37' 18,7", E 18° 7' 15,6") and in the city of Dubrovnik (N 42° 38' 32,7", E 18° 6' 19,3").

The first locality is about 20 m^2 in area, with approximately 20 specimens, which are still growing in all vegetation conditions. Taking into consideration the height and condition of the small trees of *N. glauca* on Komiža on the island of Vis, we assume that this species has been present there for quite some time. One of the possible ways of the introduction of *N. glauca* was by ships that transported coal for the cannery. At this locality, *N. glauca* is accompanied by the following species: *Aster squamatus* (Spreng.) Hieron., *Calamintha nepetoides* Jord., *Chenopodium murale* L., *Convolvulus arvensis* L., *Conyza canadensis* (L.) Cronq., *Dactylis glomerata* L., *Desmazeria rigida* (L.) Tutin, *Dittrichia viscosa* (L.) Greuter, *Ecballium elaterium* (L.) A. Rich., *Erodium malacoides* (L.) L' Hér., *Foeniculum vulgare* Mill., *Geranium molle* L., *Lactuca serriola* L., *Matthiola incana* (L.) R. Br., *Pallenis spinosa* (L.) Cass., *Parietaria judaica* L., *Phleum echinatum* Host, *Pinus halepensis* Mill., *Piptatherum miliaceum* (L.) Coss., *Reichardia picroides* (L.) Roth, *Rubus ulmifolius* Schott and *Sonchus oleraceus* L. Since *N. glauca* was discovered, it has been noticed that it is spreading around this locality.

At the second locality, the archaeological site in the centre of Split, an area of about 1000 m^2, we found approximately 30 specimens of *N. glauca,* in the same vegetation conditions as at the first locality. This habitat is ruderal and abandoned, and *N. glauca* grows here with the following species: *Ailanthus altissima* (Miller) Swingle, *Alopecurus myosuroides* Hudson, *Amaranthus retroflexus* L., *Antirrhinum majus* L., *Aster squamatus* (Sprengel) Hieron, *Avena barbata* Pott et Link, *Ballota nigra* L., *Calamintha nepethoides* Jord., *Campanula pyramidalis* L., *Carduus pycnocephalus* L., *Carex halerana* Asso, *Centaurea solstialis* L., *Chenopodium album* L., *Chondrila juncea* L., *Cichorium intybus* L., *Cirsium vulgare* (Savi) Ten., *Convolvulus arvensis* L., *Conyza bonariensis* (L.) Cronq., *Conyza canadensis* (L.) Cronq., *Crepis foetida* L., *Dasypyrum villosum* (L.) P. Candargy, *Ecbalium elaterium* (L.) Rich., *Desmazeria rigida* (L.) Tutin, *Erigeron annus* (L.) Pers. subsp. *septentrionalis* (Fern. et Wieg.) Wag., *Diplotaxis tenuifolia* (L.) DC., *Dittrichia viscosa* (L.) Greuter, *Euphorbia chamaesyce* L., *Ficus carica* L., *Geranium rotundifolium* L., *Helichry-*

sum italicum (Roth.) G.Don f., *Hordeum murinum* L. subsp. *leporinum* (Link.) Arcangeli, *Lactuca serriola* L., *Lepidium graminifolium* L., *Malva sylvestris* L., *Melilotus albus* Med., *Melilotus italicus* (L.) Lam., *Parietaria judaica* L., *Picris hieracioides* L., *Piptatherum miliaceum* (L.) Coss., *Platanus orientalis* L., *Polygonum aviculare* L., *Prunus cerasifera* Ehrh., *Prunus dulcis* (Miller) D.A.Webb., *Reseda alba* L., *Reseda lutea* L., *Robinia pseudoacacia* L., *Sonchus oleraceus* L., *Trifolium campestre* Schreb., *Ulmus minor* Mill., *Urospermum picroides* (L.) Scop. and *Verbascum sinuatum* L. At this locality, *N. glauca* shows evidence of further spreading and probably could be expected in the wider urban area by means of the enormous number of small seeds produced.

The earliest known locality on the island of Lokrum in south Dalmatia was obtained by analysing the herbarium ZA. We found a single herbarium sheet with one specimen collected by S. Hećimović on May 17th in 1977. On the herbarium label he noted: »the island of Lokrum, near playground below the wall near the sea«. Although Hećimović found *N. glauca* on the island, he did not include it in his floristic work (HEĆIMOVIĆ 1982). Probably, he thought that *N. glauca* had escaped from the Botanical garden on Lokrum. Today, this species still exists on two sites on the island of Lokrum, but outside the Botanical garden borders. *Nicotiana glauca* was found on the southern part of the island near Lake Mrtvo

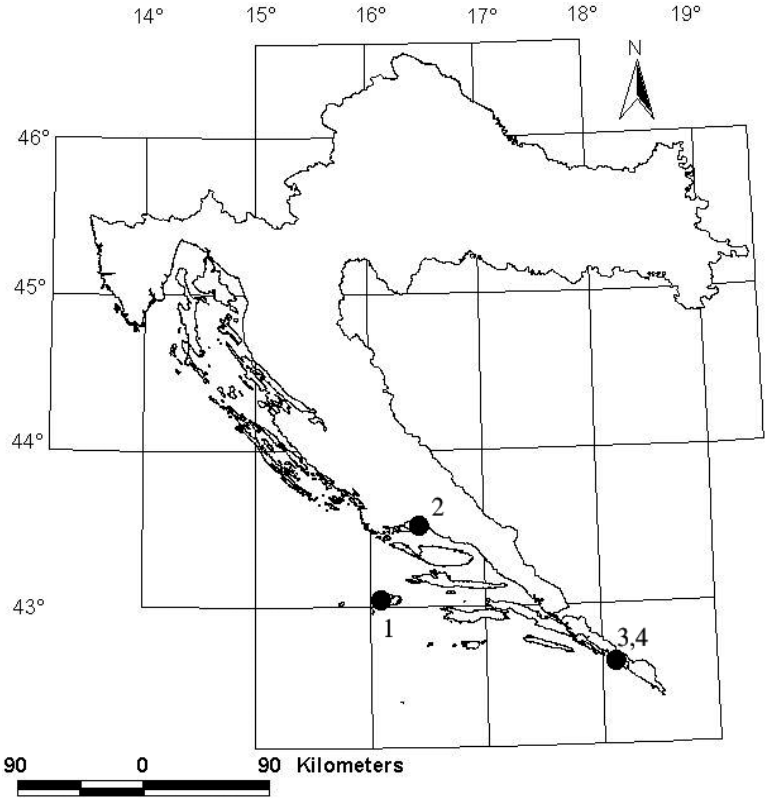

Fig. 2. Distribution map of *Nicotiana glauca* Graham in Croatia. 1 – Vis; 2 – Split; 3,4 – Dubrovnik, Lokrum

more, in an area of 300 m^2 where it is represented by 15–20 specimens. It grows with: *Anagallis arvensis* L., *Asparagus acutifolius* L., *Chenopodium album* L., *Cichorium intybus* L., *Conyza bonariensis* (L.) Cronq., *Conyza canadensis* (L.) Cronq., *Crithmum maritimum* L., *Cynodon dactylon* (L.) Pers., *Cyperus rotundus* L., *Dichanthium ischaemum* (L.) Roberty, *Dittrichia viscosa* (L.) Greuter, *Elymus pycnanthus* (Godr.) Melderis, *Eragrostis cilianensis* (All.) F.T.Hubb., *Helichrysum italicum* (Roth) G. Don, *Heliotropium europaeum* L., *Hyoscyamus albus* L., *Limonium anfractum* (C. E. Salomon) C. E. Salomon, *Lotus cytisoides* L., *Medicago orbicularis* (L.) Bartal., *Parietaria judaica* L., *Piptatherum miliaceum* (L.) Coss., *Pistacia lentiscus* L., *Portulaca oleacea* L., *Schoenus nigricans* L., *Silene vulgaris* (Moench.) Garcke subsp. *angustifolia* Hayek and *Xanthium strumarium* L. subsp. *italicum* (Moretti) D.Löve. The other find on the island of Lokrum is around the ruins of church near the monastery (N 42° 37' 29,1", E 18° 7' 17,3"). Only six specimens of *N. glauca* grow there in an area 100 m^2 together with: *Asplenium ceterach* L., *Calamintha nepetoides* Jord., *Conyza bonariensis* (L.) Cronq., *Conyza canadensis* (L.) Cronq., *Cupressus sempervirens* L. f. *pyramidalis* (Targ. Tozz.) Nym., *Cynodon dactylon* (L.) Pers., *Desmazeria rigida* (L.) Tutin, *Dichanthium ischaemum* (L.) Roberty, *Euphorbia peplus* L., *Hedera helix* L., *Hypericum perforatum* L., *Lagurus ovatus* L., *Laurus nobilis* L., *Malva sylvestris* L., *Parietaria judaica* L., *Piptatherum miliaceum* (L.) Coss., *Umbilicus horizontalis* (Guss.) DC., *Verbascum sinuatum* L. and *Vinca major* L. At this site, during the summer of 2005, archaeological excavations of graves were undertaken and the majority of the plants were pulled up. However, young plants have been noticed sprouting around the locality.

The fourth locality, in the city of Dubrovnik, Pile region, is the smallest, with only a single individual of *N. glauca* growing in an area of 5 m^2 with the following species: *Amaranthus deflexus* L., *Chenopodium album* L., *Conyza canadensis* (L.) Cronq., *Cynodon dactylon* (L.) Pers., *Cymbalaria muralis* P.Gaertn., B.Mey. et Scherb., *Oxalis corniculata* L. and *Parietaria judaica* L. Evidently, this locality shows the further spread of *N. glauca* along the Croatian coast.

The reason for such good adaptation of the species *N. glauca* in new habitats might be its known capacity of self-pollination with probably successful self-fertilisation (cf. SCHUELLER 2004). Moreover, it is known that *N. glauca* produces a large quantity of seeds dispersed mostly by wind, has early reproductive maturity, a rapid rate of growth, is grazing- and drought-resistant and tolerant to a wide range of environmental conditions (CRONK and FULLER 2001). We expect that the locality in Split could be the most affected by *N. glauca*, due to its central position on the Adriatic coast, and density of population. We consider it necessary to remove the plants in all the localities, to prevent serious invasions of *N. glauca* and any negative influence on the natural plant communities in Croatia.

Acknowledgements

We would like to thank Dr. Stephen L. Jury for helpful talk and comments on *Nicotiana glauca* as a global invader. We also wish to thank our colleagues Dr. Nenad Jasprica and Igor Boršić B.Sc. for their useful comments.

References

BLAMEY, M., GREY-WILSON, C., 1998: Mediterranean wild flowers. Harper Collins Publisher, London.

CRONK, Q. C. B., FULLER, J. L., 2001: Plant Invaders – the Threat to natural Ecosystems. Earthscan Publications Ltd., London and Sterling.

GOODSPEED, T.H., 1954: The genus *Nicotiana*. Chron. Bot. 16, 1–536.

HEĆIMOVIĆ, S., 1982: Flora otoka Lokruma, Bobare i Mrkana. Acta Bot. Croat. 41, 155–170.

KNAPP, S., CHASE, M. W., CLARKSON, J. J., 2004: Nomenclatural changes and a new sectional classification in *Nicotiana* (Solanaceae). Taxon 53, 73–82.

LOVAŠEN-EBERHARDT, Ž., 1997: *Nicotiana* L. In: Nikolić, T. (ed.), Flora Croatica. Index Florae Croaticae 2. Nat. Croat. 6 (Suppl. 1), 123.

MOORE, D. M., 1972: *Nicotiana* L. In: Tutin, T.G., Heywood, V.H., Burges, N.A., Moore, D.M., Valentine, D.H., Walters S.M., Webb, D.A. (eds.), Flora Europaea 3, 201. Cambridge University Press, Cambridge.

SCHUELLER, S. K., 2004: Self-pollination in island and mainland populations of the introduced Hummingbird-pollinated plant, *Nicotiana glauca* (Solanaceae). Am. J. Bot. 91, 672–681.