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Johnston's whistling frog in Prague: report of populations of *Eleutherodactylus johnstonei* (Anura: Eleutherodactylidae) in the Czech Republic

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Abstract. Populations of Johnstone's whistling frog *Eleutherodactylus johnstonei* Barbour, 1914 are reported in greenhouses in Prague for the first time. Currently, this non-native species is accidentally being transferred on plants between botanical and zoological greenhouses. Exceptionally, *E. johnstonei* can temporarily occupy habitats outside greenhouses and even interact with the native Czech herpetofauna.

Key words. Non-native species, greenhouse exhibits, Amphibia, Europe.

INTRODUCTION

Johnstone's whistling frog *Eleutherodactylus johnstonei* Barbour, 1914 (Eleutherodactylidae) is an invasive anuran species originating from northern Lesser Antilles (likely St. Lucia or Antigua and Barkuda; Leonhart et al. 2019, Frost 2020). This species was accidentally or intentionally introduced to many Caribbean and Central and South American localities where it established naturalized populations (e.g. on other Antillean islands, Aruba, Barbados, Bermuda, Bonaire, Brazil, Colombia, Costa Rica, Curaçao, Dominica, French Guiana, Grenada, Grenadines, Guadeloupe, Guyana, Jamaica, Marie Galante, Trinidad, Panama, and Venezuela; for a historical overview see Kaiser & Hardy 1994, Lever 2003, Leonhardt et al. 2019). *Eleutherodactylus johnstonei* and less frequently also other species of *Eleutherodactylus* Duméril et Bibron, 1841, e.g. *E. coqui* Thomas, 1966 or *E. planirostris* (Cope, 1862), are able to establish thriving populations in non-natural environments in the temperate zone of North America and Europe. Most of these populations are reported in greenhouses with tropical plants or animals, where they become established as a result of unintentional dispersal via the ornamental plant trade or a purposeful human introduction (see e.g. Anonymous 2006, 2017, Leonhardt et al. 2019).

In Europe, the first population of *E. johnstonei* (determined originally as *Hylodes martinicensis* (Tschudi, 1838) was recorded in a greenhouse in Kew gardens (London) in 1885 (Günther 1895). According to Kaiser (1997), this greenhouse population persisted for at least 13 years. Later, the species was recorded in the botanical garden of the University of Basel (where it came with a shipment of plants from Guadeloupe in 1993 and today, at least 10 different greenhouse populations exist in zoological and botanical institutions in Germany and the Netherlands (Leonhardt et al. 2019).

In this paper we report thriving populations of *E. johnstonei* in Prague's botanical and zoological greenhouse exhibits and summarize the data available on their history.

MATERIAL AND METHODS

During June and August 2020 we surveyed greenhouses in four of Prague's institutions: (i) Prague Zoological Garden (U Trojského zámku 3/120, Praha 7, 50.11680°N, 14.40744°E), (ii) Botanical Garden of the Faculty of Science, Charles University (Na Slupi, 16, Praha 2, 50.07083°N, 14.42072°E), (iii) Prague Botanical Garden, Fata Morgana greenhouse (Trojská 800/196, Praha 7, 50.12221°N, 14.41381°E), and (iv) Club of Natural Scientists of the city of Prague (Drtinova 1a, Praha 5, 50.07522°N, 14.40016°E).

We visited tropical plant exhibits at night and searched for "greenhouse" frogs. If the frogs were present, we recorded the mating call of the males and collected voucher specimens for the herpetological collections of the National Museum Prague (NMP-P6V). In addition, we examined museum material of the "greenhouse" frogs (NMP-P6V 75898/1–2) caught by pitfall traps during an arachnological research conducted in tropical houses in the Prague Zoological Garden in 2018 (Pešan 2018). Possible origin and history of the "greenhouse" frog populations were discussed with the curators of the plant and animal exhibits.

RESULTS

Eleutherodactylus johnstonei Barbour, 1914
(Figs. 1–6)

Voucher specimens. NMP-6V 76039–76041, Botanical Garden of the Science Faculty of the Charles University, tropical greenhouse, collected by K. Kodejš & V. Miller on 21 July 2020; NMP-6V 76042–76043, 76058–76059, Prague Zoological Garden, Rákos' Bird house, collected by P. Velenský & J. Thuma on 30 July 2020; NMP-6V 76057, Club of Natural Scientists of the city of Prague, tropical greenhouse, collected by K. Kodejš on 26 August 2020.

Voucher photographs. NMP-P6F 31, Prague Botanical Garden (Fata Morgana greenhouse), provided by R. Černý on 31 August 2016; NMP-P6F 32–33, Prague Zoological Garden (a garden pathway), taken by J. Šimek on 27 July 2019.

This species was recorded in the greenhouses of all four of the institutions visited.

Fig. 1. Adult male of *Eleutherodactylus johnstonei* Barbour, 1914, Prague Zoological Garden, 30 July 2020.

Fig. 2. Adult female of *Eleutherodactylus johnstonei* Barbour, 1914, Botanical Garden of the Faculty of Science, Charles University, Prague, 21 July 2020.

Eleutherodactylus sp.

Voucher specimens. NMP-6V 75898/1–2, Prague Zoological Garden, Zoological exhibit "Indonesian Jungle", collected by V. Pešan in 2018.

A small population of *Eleutherodactylus* sp. morphologically resembling *Eleutherodactylus planirostis* was reported as being present for some time in the greenhouse of the Club of Natural Scientists in 2020 (Hříbal ad verb., 2020). According to the observations of the curators of the individual greenhouse exhibits this species was present also in greenhouses of the other Prague's institutions, but gradually disappeared. The last record in the Prague Zoological Garden was documented in 2018 (Pešan 2018). The available voucher specimens (NMP-6V 75898/1–2) are poorly preserved and do not allow for an accurate determination.

History of the Prague's *Eleutherodactylus* populations

Eleutherodactylus johnstonei. The supposedly first established "Czech" population of *E. johnstonei* was recorded in a greenhouse of a private farm producing ornamental aquatic and aquarium plants in Kostelní Lhota (ca. 50 km east of Prague). The frogs were introduced to the greenhouse by its owner Mr. Pavel Gabriel in the early nineties of the last century. The frogs (informally called "Caracas frogs") were imported from Germany and were most likely of the Venezuelan origin.

Fig. 3. Calling male of *Eleutherodactylus johnstonei* Barbour, 1914 with partly inflated vocal sack, Botanical Garden of the Faculty of Science, Charles University, Prague, 21 July 2020.

A thriving greenhouse population of *E. johnstonei* existed in Kostelní Lhota for several years until its extinction due to local population of the Grass snakes, *Natrix natrix*. Individual snakes frequently entered the greenhouse and preyed on *Eleutherodactylus* (Hořánková ad verb., 2020).

In Prague, *E. johnstonei* appeared for the first time in a greenhouse exhibit of the Club of Natural Scientists in the late nineties of the last century. It appears, that the frogs were introduced into the greenhouse from the Kostelní Lhota population, both accidentally with ornamental water plants (Hříbal ad verb., 2020) and intentionally by frog keepers (Dvořák in litt., 2020). The frogs established viable population, which prospered for more than 20 years (Hříbal ad verb., 2020).

The population of the frogs inhabiting the Fata Morgana greenhouse (Prague Botanical Garden) is a result of willful introduction, which also occurred in the late nineties of the last century but later than the case of accidental spreading with borrowed plants (Černý in litt. 2016) and the intentional introduction to the Club of Natural Scientists (Dvořák in litt., 2020) were reported. The Fata Morgana greenhouse was constructed in 1996–2003 and opened to the public in 2004.

According to the data, populations of *E. johnstonei* living in the Prague Zoological Garden and Botanical Garden of the Faculty of Science, Charles University, originated from unintentional introductions. In both cases the frogs entered the greenhouses via plant imports from the Fata Morgana (Dvořák in litt., 2020, Thuma ad verb., 2020). The population in the Zoological Garden became established during 2004–2008 (Velenský pers. data, 2020). Originally, the largest population was associated with the greenhouse zoological exhibit called "Indonesian Jungle". Later the frogs were also detected in other suitable zoological greenhouses. The most important continuing factor in their spread is the stable population living in the so-called plant recovery greenhouse.

This place is used for temporary deposition and revitalization of plants from different zoological exhibits. The repeated plant transfers distribute the frogs from this recovery greenhouse to other parts of the garden. Moreover, the frogs are also able to invade spontaneously open habitats within the garden. For example, the hearing of a strong chorus of numerous *E. johnstonei* males was reported ca. 75 m from the nearest tropical greenhouse on 23 July 2019. The calling males occupied different decorative herbaceous plants along a garden pathway, e.g., wide leaves of *Hosta* sp. (Šimek in litt., Velenský pers. data; voucher photographs NMP-P6F 32–33).

Each of the populations of *E. johnstonei* in Prague consists of tens of adult individuals.

***Eleutherodactylus* sp**.

The populations of this species seem to be of Cuban origin. The frogs were introduced purposefully by Czech frog fanciers to the Fata Morgana greenhouse (Prague Botanical Garden) and the greenhouse of the Club of Natural Scientists in the last decade (Dvořák in litt., 2020, Hříbal ad verb., 2020). Consequently, this species was accidentally transferred on plants to the zoological exhibit "Indonesian Jungle" (Prague Zoological Garden). It appears, that this species is competitively weaker than *E. johnstonei* as the latter species is much more abundant in both places where the two species occur together. In addition, our observations indicate, that populations of *E. johnstonei* and *Eleutherodactylus* sp. were in the last two years completely outcompeted in the zoological exhibit "Indonesian Jungle" by the Java whipping frog *Polypedates leucomystax* (Gravenhorst, 1829). *Polypedates leucomystax* is an attractive large anuran species, which together with several other small vertebrates were kept in barrier-free conditions in the exhibit (Velenský pers. data, 2020).

Fig. 4. Calling male of *Eleutherodactylus johnstonei* Barbour, 1914 with fully inflated vocal sack, Botanical Garden of the Science Faculty of the Charles University, Prague, 21 July 2020.

DISCUSSION

Eleutherodactylus johnstonei is a very successful colonizer and one of the most widely distributed frogs (Kaiser 1997, Melo et al. 2014, Leonhart et al. 2019). In disturbed habitat in climatically suitable areas this species can compete with native anuran species (see Kaiser et Henderson 1994, Kaiser 1997). In addition, it is possible that *Eleutherodactylus* may transmit diseases (Rödder 2009). Therefore, the spread of this species has attracted the attention of biologists (Kaiser et al. 2002, Melo et al. 2014, Leonhardt et al. 2019).

According to our data, *E. johnstonei* has successfully colonized tropical greenhouses in the Czech Republic for at least 25 years mainly via intentional human-mediated introductions, but also accidentally via plant transfers. In addition, it can temporarily occupy habitats outside greenhouses and even interact with members of the native Czech herpetofauna.

Taking the above into account, it is likely that the populations of *E. johnstonei* in Prague will contribute to the spread of this species to other non-natural environments in the Czech Republic

Fig. 5. Clutch of 27 developing eggs of *Eleutherodactylus johnstonei* Barbour, 1914, Botanical Garden of the Faculty of Science, Charles University, Prague, 21 July 2020.

Fig. 6. Eggs and a fresh hatchling of *Eleutherodactylus johnstonei* Barbour, 1914, Botanical Garden of the Faculty of Science, Charles University, Prague, 1 August 2020.

or surrounding countries. In this respect, a wider screening for the presence of *E. johnstonei* in Central Europe is desirable.

Eleutherodactylus sp. was introduced into Czech greenhouses relatively recently and its populations are much less abundant than those of *E. johnstonei*. The information that the introduced animals are descendants of individuals imported directly from Cuba seems to be reliable as Cuba is a traditional destination of Czech tourists and animal lovers. It appears, that *Eleutherodactylus* sp. is a less successful competitor of already established *E. johnstonei* and it tends to disappear.

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