INTRODUCTION

Cockroaches (Blattodea) are an insect order that comprises many highly adaptable species, some of which are feared as peridomestic pest species that were unintentionally introduced in many countries throughout the world. Even though most of these pest species are of tropic origin, some species such as the American cockroach, *Periplaneta americana* (Linnaeus 1758), the German cockroach, *Blattella germanica* (Linnaeus 1758) and the oriental cockroach *Blatta orientalis* (Linnaeus 1758) even established populations in temperate regions (Cochran, 1999).

Sixteen species of cockroaches have been reported for Austria so far (Table 1). Only seven of these species are native to the country and found in the wild and not considered pests. They belong to the family Ectobiidae and are placed in two genera, *Ectobius* (4 species) and *Phylldromica* (3). The remaining nine species, all of which are alien, belong to three families: Ectobiidae (2), Blaberidae (2) and Blattidae (5). Of *Nyctibora* sp. (Ectobiidae) and *Rhyparobia maderae* (Fabricius, 1781) (Blaberidae), only one specimen was ever found in Austria (Ebner, 1946). Most of the alien cockroach species are not (yet) present in the wild, but mainly found in synanthropic indoor habitats such as houses, tropical greenhouses, gardening shops or supermarkets. Several of these species are known to undergo mass reproductions. They can not only destroy and contaminate food reserves, but, because of their potential for transmitting diseases and triggering allergies, might also pose a risk to human health (Baur, Landau Lüscher, Müller, Schmidt, & Coray, 2004; Hubert, Stejskal, Athanassiou, & Throne, 2018; Pospischil, 2010).

Here, we report the first records of the originally tropic Surinam cockroach, *Pycnoscelus surinamensis* (L.), for Austria and thus Central Europe, which were encountered by chance when capturing *P. australasiae*...
TABLE 1  Cockroach species recorded in Austria so far

| Taxon and author                          | Red list | Note      | Published in                      |
|-------------------------------------------|----------|-----------|-----------------------------------|
| Ectobiidae                                |          |           |                                   |
| Ectobius erythronotus Burr, 1898           | VU       | Native    | Ebner (1951) and Derbuch and Berg (1999) |
| Ectobius lapponicus (Linnaeus, 1758)       | Not listed | Native  | Ebner (1951) and Derbuch and Berg (1999) |
| Ectobius supramontes Bohn, 2004            | Not listed | Native  | Bohn (2004)                       |
| Ectobius sylvestris (Poda, 1761)           | Not listed | Native  | Ebner (1951) and Derbuch and Berg (1999) |
| Ectobius vittiventris (A. Costa, 1847)     | Not listed | Introduced | Zimmermann (2014) |
| Nyctibora sp. Burmeister, 1838             | Not listed | Introduced | Ebner (1946) |
| Phyllodromica brevipennis (Fischer, 1853)  | Not listed | Native  | Derbuch and Berg (1999)           |
| Phyllodromica maculata (Schreber, 1781)    | Not listed | Native  | Ebner (1951), Kreissl (1975), Ressl (1983) and Bohn and Chladek (2011) |
| Phyllodromica megerlei (Fieber, 1853)      | VU       | Native    | Ebner (1951), Vidlicka and Majzlan (1997) |
| Blaberidae                                |          |           |                                   |
| Panchlora nivea (Linnaeus, 1758)           | Not listed | Introduced | Ebner (1946) |
| Pycnoscelus surinamensis (Linnaeus, 1758)  | Not listed | Introduced | This study |
| Rhyparobia maderae (Fabricius, 1871)       | Not listed | Introduced | Ebner (1946) |
| Blattidae                                 |          |           |                                   |
| Blatta orientalis Linnaeus, 1758           | Not listed | Introduced | Ebner (1946, 1951) and Ressl (1983) |
| Blattella germanica (Linnaeus, 1767)       | NE       | Introduced | Ebner (1951) and Ressl (1995) |
| Periplaneta americana (Linnaeus, 1758)     | Not listed | Introduced | Ebner (1946, 1951, 1953) and Kanzler (1998) |
| Periplaneta australasiae (Fabricius, 1775) | NE       | Introduced | Ebner (1946, 1951, 1953) and Ressl (1983) |
| Supella longipalpa (Fabricius, 1798)       | Not listed | Introduced | Rabitsch and Essl (2010) |

Note. NE: Neozoa; VU: Vulnerable according to Adlbauer and Kaltenbach (1994). The new record of Pycnoscelus surinamensis is highlighted in bold.

at the botanical garden in Graz for a student’s course and amongst other cockroaches in the Butterfly House in Vienna.

2 | MATERIAL AND METHODS

We first discovered the Surinam cockroach in the Tropic House of the botanical garden in Graz (47°4’53.75”N, 15°27’24.88”E) on May 30, 2015. A single specimen (Figure 1a) was found among several Australian cockroach, Periplaneta australasiae (Fabricius, 1775), individuals. Three years later, on March 11, 2018, only a few Australian cockroaches remained, whereas numerous P. surinamensis were observed. On March 5, 2018, another population of the Surinam cockroach, including both adults and nymphs (Figure 1b,c), was discovered in the Butterfly House in Vienna (48°12’19.26”N, 16°21’59.74”E). The morphologically indistinguishable but bisexually reproducing Indian cockroach (P. indicus) was excluded as only females (and nymphs) were found. Three and four specimens of P. surinamensis were collected in the botanical garden in Graz and the Butterfly House in Vienna, respectively, put in >99% ethanol and deposited in the collection of the Natural History Museum in Vienna (Supporting Information Table S1).
Total genomic DNA was extracted using the DNaseasy® Blood & Tissue Kit (Qiagen) from leg muscle tissue. A 684 bp fragment of the first part of the mitochondrial COI gene, corresponding to the typical DNA barcoding region (Hebert, Cywinska, Ball, & de Waard, 2003), was amplified using the Phusion polymerase (Thermo Fischer Scientific) protocol, following the manufacturer’s instructions using the primers LCO1490 and HCO2198 (Folmer, Black, Lutz, & Vrijenhoek, 1994). PCR products were purified with ExoSAP-IT (Thermo Fisher Scientific). The sequencing reaction followed the protocol in Duftner, Koblmüller, and Sturmbauer (2005), using the same primers as for PCR. Sequencing products were purified with SephadexTM G-50 (Amersham Biosciences) and visualized on an ABI 3130xl capillary sequencer (Applied Biosystems). Sequences were aligned using MUSCLE (Edgar, 2004), as implemented in MEGA6 (Tamura, Stecher, Peterson, Filipski, & Kumar, 2013). Additional sequences of *P. surinamensis* and other *Pycnoscelus* species available from GenBank and BOLD, including our new records from Austria (in bold). Acronyms indicate origin of the specimen (Thailand: T; French Polynesia: FP; Australia: Aus; United States of America: USA; Guyana: G and Austria: Aut; see Supporting Information Table S1). Numbers at nodes indicate bootstrap support values (only values >70 are shown) [Colour figure can be viewed at wileyonlinelibrary.com]
3 | RESULTS

DNA barcodes grouped the Austrian samples with previously published COI sequences of *P. surinamensis*, thus confirming the morphology-based identification. Furthermore, all specimens from Austria shared a single haplotype, which was identical to specimens from the United States of America, Guyana and French Polynesia (Figure 1d). Haplotypes were also shared between *P. surinamensis* and its bisexually reproducing ancestor *P. indicus*. Pairwise K2P distances ranged from 0% to 3.9% within *P. surinamensis*, and from 0% to 11.9% among the *Pycnoscelus* species included in our study.

4 | DISCUSSION

With the detection of the originally Indo-Malaysian Surinam cockroach *Pycnoscelus surinamensis* in Austria, the number of cockroach species reported for Austria increases to seventeen (Table 1), ten of which are alien. These Austrian *P. surinamensis* are also the first records of this species for Central Europe. Previously, the species has been reported from mainly tropical and subtropical regions, such as Florida, Louisiana, Texas and Hawaii in the United States, Cuba, Puerto Rico, the Bahamas, the Dominican Republic, Trinidad, Barbados, Martinique, Grenada, St. Vincent, Jamaica, Mexico, Costa Rica, Guiana, Brazil, Bermuda, Mauritius, the Central African Republic, Cameroon, Senegal, China, Taiwan, Australia, the Loyalty Islands, Japan, but also Spain and Sweden (Bell, Roth, & Nalepa, 2007; Garanto, 2015; Grandcolas, Dejean, & Deleporte, 1996; Schwabe, 1949). It is considered a peridomestic species that invades households and causes considerable damage to commercial rose, orchid and lily plantations, but also feeds on roots of pineapples, potato tubers, cucumbers, palm, tomatoes, papayas, figs, sweet potatoes and other plants (de Carvalho Moretti, Quirán, Solis, Rossi, & Thyssen, 2011; Schwabe, 1949). Outside its native range, it relies on human-mediated activities, especially transportation of soil, mulch, vegetable mould or plants from one human settlement to the next, to colonize new areas (Bell et al., 2007). Due to its synanthropic or peridomestic lifestyle (Grandcolas et al., 1996), it often finds itself in suitable climatic conditions right away, even when transported to subtropical or temperate regions, as *P. surinamensis* has been repeatedly reported from greenhouses (Schwabe, 1949; Pellens & Grandcolas, 2002; Yamauchi & Kato, 2009; Komatsu, Kawakami, Banzai, Ooi, & Uchida, 2015; Garanto, 2015; this study).

*Pycnoscelus surinamensis* is the thelytokous descendant of its bisexually reproducing progenitor *P. indicus* (Linnaeus 1758) (Bourguignon et al., 2018; Roth, 1967). Its parthenogenetic mode of reproduction facilitates a rapid establishment of new populations, with only a single female being sufficient to found a new population. It is noteworthy that many invasive species are parthenogenetic (e.g., Lombardo & Elkinton, 2017; Gutekunst et al., 2018) and that many taxa for which sexual reproduction is common in the native range, tend to switch to obligate or facultative parthenogenesis in introduced populations (e.g., Dybdahl & Kane, 2005; Caron, Ede, & Sunnucks, 2014). *Pycnoscelus surinamensis* is no exception as its almost global distribution contrasts the restricted distribution of *P. indicus* in the Indo-Malayan region (plus some introduced populations in Hawaii and Australia; Roth and Willis, 1960).

Numerous clonal lineages have been reported for *P. surinamensis*. This high clonal diversity and the establishment of general purpose genotypes are believed to underlie the species’ adaptability and considered one of the main reasons for the species’ colonization success (Parker, Selander, Hudson, & Lester, 1977; Niklasson & Parker, 1994). For Austria, we thus far identified only a single mitochondrial haplotype—likely corresponding to one clone—that is shared with samples from the USA, Guyana and French Polynesia. Overall, genetic distances among *P. surinamensis* haplotypes published so far are similar to levels of intraspecific divergence in other (sexually reproducing) cockroach taxa (Cho, Suh, & Bae, 2013; Che, Gui, Lo, Ritchie, & Wang, 2017).

Although the prevailing opinion is that this species’ dispersal ability is very limited without human intervention (de Carvalho Moretti et al., 2011; Pellens & Grandcolas, 2002), it may be considered as a potential pest species in Central Europe in the light of the current climate change. Global warming increasingly provides suitable conditions even outside of conditioned greenhouses, likely enhancing winter survival as well as redefining/broadening current species’ distributions (Dukes & Mooney, 1999; Robinet & Roques, 2010). Thus, to prevent an unintended spread of alien species, monitoring of all introduced cockroach species as well as careful handling of plants, soil and food to prevent further accidental dispersal of *P. surinamensis* and other exotic species is advised.

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AUTHOR CONTRIBUTION

LZ, GK and SK designed the study. GK and CB collected samples. LZ conducted the laboratory work. LZ and SK analysed the data. LZ, GK and SK wrote the manuscript. All authors read and approved the manuscript.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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