

First record of the Turkestan cockroach (*Shelfordella lateralis*) from Cyprus and Turkey (Dictyoptera: Blattidae)

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ABSTRACT

The Turkestan cockroach *Shelfordella lateralis* is a peridomestic species originally from the Middle East and Central Asia, which has recently become an invasive species in the USA, Mexico, Japan and Sardinia, where it is considered as a pest. We provide the first records of this species from Cyprus and Turkey, making these the second records of established populations of the Turkestan cockroach in Europe. We also provide biological information regarding its reproduction in semi-natural conditions in Cyprus, as well as a detailed description and images of the male genitalia.

KEYWORDS: New record, pest, peridomestic, synanthropic, invasive, anthropogenic.

ΠΕΡΙΛΗΨΗ

Η κατσαρίδα του Τουρκιστάν *Shelfordella lateralis* είναι ένα περιοριστικό είδος θηαγενές στη Μέση Ανατολή και την Κεντρική Ασία, το οποίο πρόσφατα έχει επεκτείνει την εξάπλωσή του ως εισβάλλον είδος στις ΗΠΑ, το Μεξικό, την Ιαπωνία και την Σαρδηνία, όπου θεωρείται ζιζάνιο. Σε αυτήν την έρευνα, καταγράψαμε το είδος αυτό για πρώτη φορά από την Κύπρο και την Τουρκία, καθιστώντας την αναφορά μας ως την δεύτερη καταγραφή εγκατεστημένου πληθυσμού της κατσαρίδας του Τουρκιστάν στην Ευρώπη. Επίσης, παρέχουμε βιολογικές πληροφορίες για την αναπαραγωγή της κατσαρίδας του Τουρκιστάν σε ημιφυσικές συνθήκες στην Κύπρο, καθώς και λεπτομερή περιγραφή και φωτογραφίες των αρσενικών γεννητικών μορίων.

ΛΕΞΕΙΣ-ΚΛΕΙΔΙΑ: Νέα αναφορά, ζιζάνιο, περιοριστικό είδος, συνανθρώπινο είδος, εισβάλλον είδος, ανθρωπογενές.

ÖZET

Türkistan hamam böceği *Shelfordella lateralis* Orta Doğu ve Orta Asya asilli insanlar arasında yaşayan bir cinstir ve yakın geçmişte Amerika, Meksika, Japon ve Sardinya adasında istilacı ve haşere olarak değerlendirilmiştir. Kıbrısta ve Türkiyede bu cins tespit edilmesinden sonra Türkistan hamam böceği Avrupada ikinci belirlenmiş nüfus dağılımıdır. Kıbrısta yarı doğal koşullarda reproduksiyon için biyolojik bilgiler sağlandirilmiştir, ayrıca erkek cinsi için ayrıntılı tasvir ve görüntüler sunuldu.

ANAHTAR SÖZCÜKLER: Yeni rapor, haşere, yerleşim cinsi, insanoğlu cinsi, istilacı cins.

INTRODUCTION

The Turkestan cockroach (*Shelfordella lateralis* (Walker, 1868)) is one of the lesser-known species of synanthropic cockroaches, compared to notorious pests such as the American [*Periplaneta americana* (Linnaeus, 1758)] and the Oriental (*Blatta orientalis* Linnaeus, 1758) cockroach. Thought to be native to the Middle East, North-eastern Africa, India and Central Asia (Al-Houty 2011; Alesho 1997; Grandcolas 1994b; Sandhu & Sohi 1981), *Sh. lateralis* has now expanded outside its original range to the USA (Kim & Rust 2013), Japan (Kimura *et al.* 2003) and Mexico (Cueto-Medina 2015) by anthropogenic means. In Europe, it has so far only been recorded from Sardinia (Cillo *et al.* 2009), but further data from its presence on this continent are lacking.

The habits of *Shelfordella lateralis* are classified as peridomestic, as it frequents man-made environments such as gardens, sewers, manure heaps and landfills (Abassi *et al.* 2018; Artyukhina & Sukhova 1972; Memona *et al.* 2017), but enters human habitations only infrequently (Roth & Willis 1960). However, when it does so, it is considered a household pest, and given that it may maintain and transmit dysentery (Zmeev 1940), the distribution of this species should be monitored, especially in areas of its range where this disease is prevalent. In terms of its interactions with other pest cockroaches, it has been suggested that at least in the USA and Pakistan, *Sh. lateralis* competes with *B. orientalis* for shelter and it may be replacing the latter species (Kim & Rust 2013; Memona *et al.* 2017).

In the present study, we document the presence of *Shelfordella lateralis* from Cyprus and Turkey, where, to our knowledge, this species has not been previously recorded. We also provide information on the habitats it occupies and its biology, and describe the male genitalia in detail.

MATERIALS AND METHODS

Depositories

The studied material is housed in the Davranoglou Personal Collection (DPC) and the Oxford University Museum of Natural History (OUMNH).

Material examined

Cyprus: 1♀, Lakatamia, Nicosia, 35°05'48.5"N 33°18'26.1"E, 248 m, 21.vii.2016, collected while wandering in a house garden at night, together with *P. americana*, M. Hadjiconstantis [the specimen deposited an ootheca, of which 9 larvae emerged and were reared to adulthood (3♀ 6♂)]; 1♂, Geri (unknown precise location), Nicosia, garden, 19.vii.2006, G. Constantinou [photographic record]; 1♂, 8 3rd instar larvae, Alaminos, Larnaka, 34°46'25.5"N 33°28'12.3"E, 0 m, 5.x.2016, found in a fishing harbour at night, together with *P. americana*, M. Hadjikonstantis [the adult male was feeding on freshly-deposited cat faeces; the larvae were reared to adulthood (2♀ 6♂)]; the adults were allowed to reproduce for several months, some of which were subsequently euthanized in 70 % ethanol; all ethanol-preserved specimens are deposited at the OUMNH.].

Turkey: 2♀, 9 5th instar, 2 2nd instar larvae, Beldibi, 36°41'48"N 30°34'11"E, 7 m, 12.v.2001, under debris, peridomestic habitat, D. Mann & M. Barclay (OUMNH-2002-015).

USA: 3♀, California, Riverside, 20.vii.2014, in gardens, together with *P. americana* and *B. orientalis*, L.-R. Davranoglou (DPC).

Dissection and imaging

For genitalic dissection, the abdomen of the wild-caught adult male from Lakatamia was removed, immersed in 10 % KOH for 15 min and then cleared in ethanol. All dissections were made using Dumont#5 forceps. Following dissection, the specimen was dry pinned, with the genitalia preserved in a microvial with glycerol, along with the specimen, now deposited at the Life Collections, OUMNH. Habitus, pronotum and genitalic images of the male and female from Lakatamia were taken using a Leica M165c binocular microscope equipped with a Leica DFC490 camera, and the resulting stacked images were combined using Helicon Focus. Live specimens were photographed using a Canon 600D camera with a Canon EF 100mm f/2.8L Macro IS USM lens.

Rearing

We attempted to breed *Sh. lateralis* based on 30 descendants of the specimens collected from Alaminos, Larnaka, and two females from the descendants of the female from Lakatamia, Nicosia. We raised the larvae in a transparent 80 L box (46×36×71 cm) under standard conditions. To rear the species in semi-natural conditions, the box was placed in an outdoor warehouse (width: length: height 5×3×3 m) in Lakatamia, which lacked any heating device and was always 1–3 °C warmer than the external temperature.

Terminology

We used the works of Grandcolas (1994b) and Tanaka (2003) for species identification. We follow Klass (1997) for genitalic terminology, with the terms of Grandcolas (1994a) provided in parentheses, in order to facilitate recognition of the relevant phallomeres between the two works.

RESULTS

Identification

Both sexes of *Sh. lateralis* are easily distinguished from all other native or invasive cockroaches of Cyprus and Turkey, based on the following characters: in males, the lateral margins of the pronotum and tegmina are distinctly translucent (Fig. 1A, C, D; black arrows), the ventral surface of the body is pale white (Fig. 1E), and the shape of the phallomeres as in Fig. 2A, B. In females, the tegmina (tg) are always brachypterous and possess a characteristic yellowish stripe (Fig. 1B, F), whereas tergum 1 is provided with a pair of orange spots on its lateral margin (Fig. 1B, F; white arrows); the ventral surface of the fore coxae is almost entirely pale, while the mid and hind coxae are bicolourous, being black and pale on their anterior and

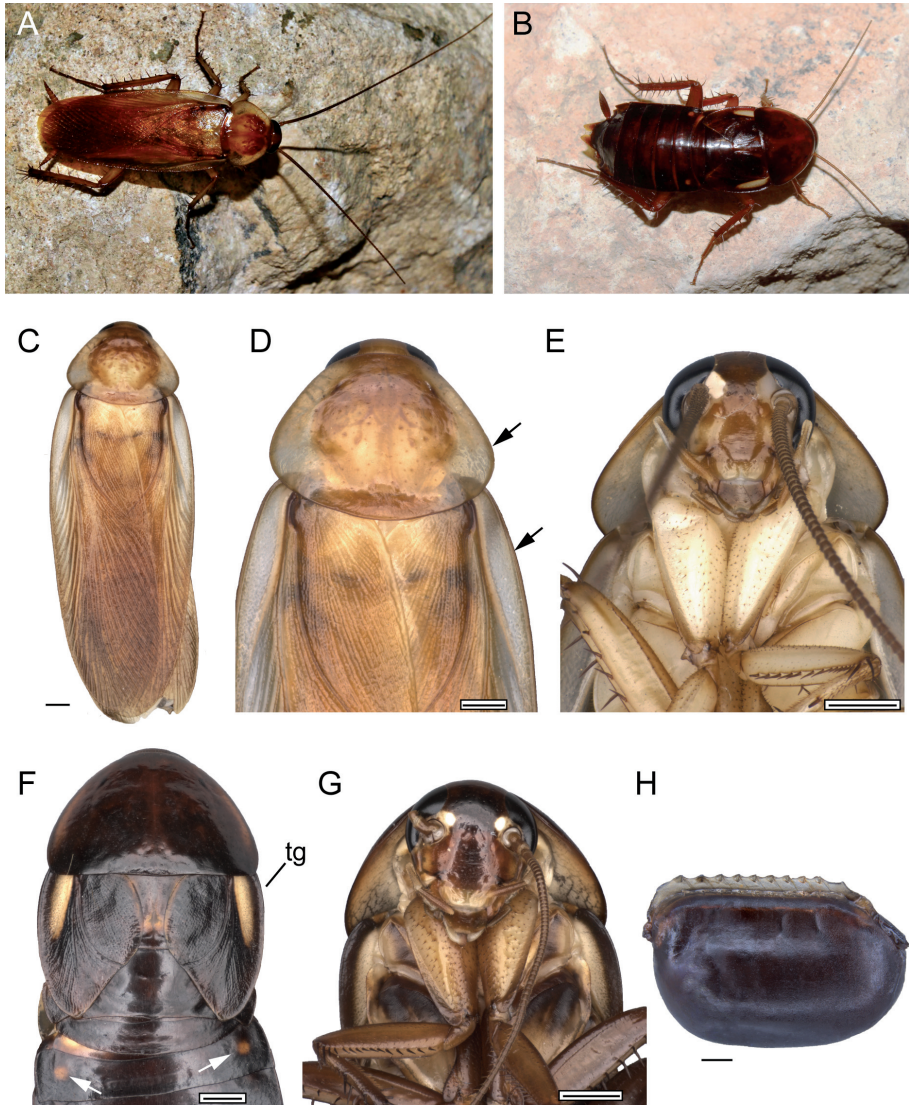


Fig. 1: Habitus of *Shelfordella lateralis* from Cyprus: (A) live male specimen from Alaminos, Lamaka, dorsal view; (B) live female specimen from Lakatamia, Nicosia, dorsal view; (C) male, dorsal view; (D) male, dorsal view, black arrows indicating translucent areas of pronotum and tegmina; (E) male, ventral view, showing the pale colouration of the coxae; (F) female, dorsal view, showing the yellowish stripe on the brachypterous tegmina (tg) and the paired orange spots on tergum I (white arrows); (G) female, ventral view, showing the pale fore coxae and the bicolorous mid and hind coxae; (H) ootheca. All scale bars 1 mm.

posterior halves respectively (Fig. 1G). The external female genitalia (Fig. 2C, D) and ootheca (Fig. 1H) are also characteristic for this species, and identical to those of the Turkish and USA specimens examined in this study. Since all our specimens possess the characters diagnostic for this species (Grandcolas 1994b; Tanaka 2003), we believe that our identification is justified.

Morphology of male genitalia

The paraprocts (papt) are strongly asymmetrical (Fig. 2A, B; black dashed line); L3 (L3d) bears three distinct processes: a small, semi-transparent spine (1), a large, hooklike process (2), and a medium sized spine with a tapered apex (3)

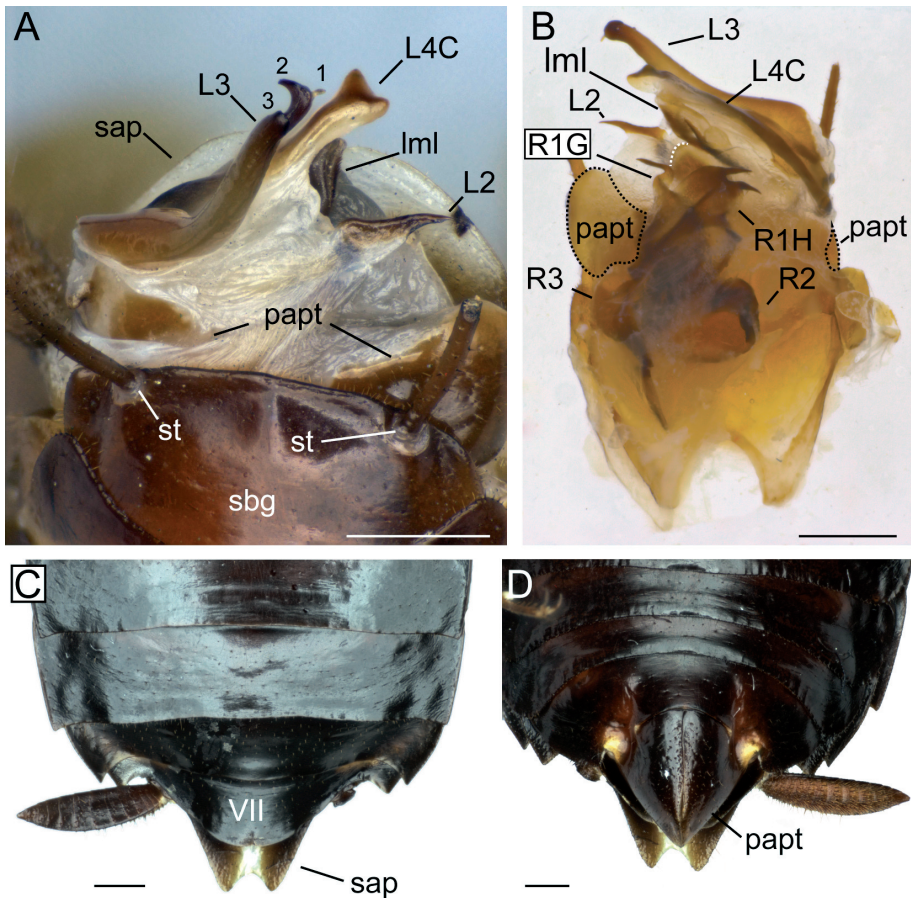


Fig. 2: Male and female genitalia of *Shelfordella lateralis* from Cyprus: (A) phallomeres and subgenital plate (sbg), ventral view, lml – large membranous lobe of phallomere L2, papt – paraprocts, sap – supra-anal plate, st – stylus; (B) phallomeres and subgenital plate, dorsal view, white dashed line indicating the anterior outline of phallomere L4F; (C) external female genitalia, dorsal view; (D) external female genitalia, ventral view. All scale bars 1 mm.

(Fig. 2A); L4C (L2d) is in the shape of a sclerotized line, its apex is distinctly bilobed due to the presence of a membranous lobe (Fig. 2A, B); ventral to L4C, there is a large membranous lobe [lml (L2v); part of phallomere L2 according to Anisyutkin (2014)], whose sclerotised portion bears a field of setae (Fig. 2A, B); the caudal process of L2 is in the form of an acute spine (Fig. 2A, B); L4F is small and rounded (outline indicated by white dashed line on Fig. 2B); phallomeres L1 and L4D are not observed.

We note that there is an incongruence between the two studies of Grandcolas (1994a, b) regarding the identity of certain phallomeres: using his terminology, what he illustrated as L2d and L2v of *Periplaneta* are mentioned as L3v and L2d respectively in *Shelfordella*.

Rearing

The first generation (F1) offspring matured after one year, with the majority being males (10 females and 20 males). The adults reproduced continuously throughout the year until dying approximately one year later. The reproductive output of this species was considerable, even when kept in seminatural conditions with cold periods during winter, as by the time F1 died out, the subsequent two generations (adults F2 and larvae F3) in the the captive population numbered more than 4,000 individuals. By rearing this species in the local climate for more than two years, as well as collecting gravid females and larvae from the wild, we provide evidence that the species can reproduce successfully in Cyprus.

DISCUSSION — INVASIVE OR NATIVE?

Most authors consistently list the Middle-Eastern, Central Asian and North African distribution of this species as part of its native range (e.g. Alesho 1997), without providing any justification for doing so. Two lines of evidence may support this notion. First, its two other congeners, *Shelfordella arabica* Bey-Bienko, 1938 and *Sh. monochroma* (Walker, 1871) are known from the Arabian Peninsula and Central Asia respectively (Grandcolas 1994b), indicating that these may be the ancestral areas of diversification of this genus. Indeed, the similarity between the male genitalia of *Sh. arabica* and *Sh. lateralis* may suggest that both originate from the Middle East. Second, the oldest records of *Sh. lateralis* in the 19th and 20th centuries were also from Central and Western Asia (e.g. Zmeev 1940), although we cannot exclude that these represent earlier anthropogenically mediated expansions of this species.

In spite of the geographical proximity and biogeographical similarity of Cyprus and Turkey to the native range of *Sh. lateralis*, we tentatively suggest that this species is invasive in both countries. This species seems to be rare in both Cyprus and Turkey, and has so far only been found in peridomestic habitats such as ports and gardens. Furthermore, the intense collecting efforts of M. Hadjiconstantis in Cyprus have failed to find this species in semi-disturbed or natural habitats adjacent to the human settlements where it was collected, indicating a dependence on man-made habitats. Although the cockroach fauna of this part of the world is certainly poorly

studied, it is surprising that such a large blattid would have evaded the attention of entomologists for so long. We should also note that M. Hadjiconstantis has located a pet shop selling this species as food for exotic reptiles, but we cannot confirm whether it has contributed to the possible distributional expansion of *Sh. lateralis* in Cyprus, as it may have happened in the USA (Kim & Rust 2013).

We consider these populations of *Sh. lateralis* to be established in both Cyprus and Turkey, as we collected adult specimens of both sexes, including gravid females (in Cyprus), and larvae of several instars (in both Cyprus and Turkey). Especially in Cyprus, the species has been present for at least 13 years and reproduces successfully in both captivity and the wild, at a rate far exceeding that of other pest cockroaches (Kim & Rust 2013). However, the species remains rare, having been collected from only three locations on the island, and at fairly low numbers (compared to other sympatric pest cockroaches). This observation is consistent with the findings of previous studies (Memona *et al.* 2017; Sandhu & Sohi 1981), which list *Sh. lateralis* as a species with a low abundance compared to other synanthropic cockroaches. This suggests that certain factors may be limiting the population growth and perhaps dispersal of this species, such as competition with *B. orientalis* and *P. americana*, in spite of the opposite trend taking place in the USA and Pakistan (Kim & Rust 2013; Memona *et al.* 2017).

Several countries of the Mediterranean with warm, arid climates are likely to be invaded by this species, especially ports and their environs. Given the peridomestic nature of this species and its ability to carry pathogenic microorganisms, we suggest that close monitoring of the invasion and possible future expansion of *Sh. lateralis* is necessary.

ACKNOWLEDGEMENTS

M. Hadjiconstantis would like to thank Juliet Michael, Ioannis & Sophia Hadjiconstantis for their assistance with the collecting and captive-breeding of this species in Cyprus, and George Constantinou for providing the 2006 photographic record of the specimen from Nicosia. L.-R. Davranoglou would like to thank the Alexander S. Onassis Public Benefit Foundation, Scholarships for Hellenes, for funding his research. We would like to thank Heidi Hopkins and Leonid Anisyutkin for reviewing this manuscript, and Konstantin Davranoglou for translating the abstract into Turkish.

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