

A new species of *Scopaeus* Erichson, 1839 (Coleoptera, Staphylinidae, Paederinae) from Socotra Island, with distributional and phylogeographical notes on related species

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Abstract

Scopaeus socotrensis sp. n. is described from Socotra Island, Yemen, and compared to *S. asirensis* Frisch, 2007, *S. pakistanensis* Frisch, 2007, and *S. stramineus* Frisch, 2007. These species constitute the *S. asirensis* lineage of the *S. gracilis* species group in the Middle East judging from their male genital characters, which are illustrated, and their distribution pattern, which is mapped. Additional diagnostic characters are presented for *S. asirensis*, *S. pakistanensis*, and *S. stramineus*. New country records are published for *S. asirensis* (Yemen) and *S. stramineus* (Oman). A recent first record of *S. asirensis* from Socotra is based on *S. socotrensis* sp. n. and thus rejected. The phylogeography of the *S. asirensis* lineage is discussed.

Keywords Scopaeina | Middle East | Arabian Peninsula | Iran | taxonomy

1. Introduction

Scopaeus Erichson, 1839 (Coleoptera, Staphylinidae) constitutes a large, monophyletic clade (Frisch et al. 2002) of predominantly riparian rove beetles, which presently comprises 457 valid species worldwide. While both diversity and phylogeography of Middle Eastern *Scopaeus* are well known owing to my ongoing revisionary studies on the genus, the *Scopaeus* fauna of Socotra Island is still largely unknown. Situated in the Arabian Sea some 250 km north-east-east of the Horn of Africa, Socotra is the main island of the Socotra Archipelago, the ‘Galapagos of the Indian Ocean’, which was designated as a Biosphere Reserve in 2003 and a Natural World Heritage site in 2008 (Batelka 2012: 2) owing to its outstanding biodiversity with a high degree of endemism (e.g. Di Micco De Santo & Zandri 2004: 10; Wranik 2003: 7) caused by geographic isolation since about the Miocene (e.g. Krupp & Zajonz 2009: 49). Unlike our knowledge of the spectacular flora of Socotra,

the previous research on the island’s invertebrates ‘just scratched the surface’ (Wranik 2003: 71).

The first Socotran representatives of *Scopaeus*, the common Palaeotropical *S. filiformis* Wollaston, 1867 and the widespread Afrotropical *S. punctatellus* Fauvel, 1905, were published only recently by Assing (2012: 976) in the first substantial contribution to the Staphylinidae of Socotra based on samples of three expeditions of the National Museum of Natural History, Prague, in 2001, 2003, and 2010, raising the number of staphylinids known from that island to 21 species. The same samples contain a new species of the *S. gracilis* species group, which is described in this contribution.

The *S. gracilis* species group was proposed a monophyletic clade by Frisch et al. (2002: 39) mainly based on the characteristic asymmetry of the aedeagus. While the speciose *S. crassipes* subgroup, which comprises some dozens of described and numerous unnamed Palaeotropical species, still awaits revision, I already revised the smaller *S. gracilis* subgroup, which

is distributed in the West Palaearctic, Middle East, and southern Africa, discussed its phylogenetic relationships, and established a hypothesis on its historical biogeographical origin (Frisch 2007). The discovery of the new Socotran species casts some more light on the phylogeography of the Middle Eastern lineage of the *S. gracilis* subgroup, which is discussed herein.

2. Methods

The habitus photograph (Figure 1) was created with the montage software Helicon Focus based on a stack of digital images taken with a camera attached to a stereoscopic microscope magnified 32 times. Transmitted-light microscopic images (Figures 2–26) were made magnified 200 times using the Zeiss AxioScope imaging system and the montage software Picolay.

The type specimens of *Scopaeus socotrensis* sp. n. were measured magnified 140 times using a stereoscopic microscope with an eye-piece linear micrometer. Total length of specimens = interval from apical spines of labrum to the posterior end of abdomen, depending on intensity of contraction of abdomen; forebody length = interval from apical spines of labrum to posterior margin of elytra at suture; head length = interval from anterior margin of clypeus to posterior margin of head; elytral length = interval from posterior tip of scutellum to posterior end of elytra along suture; eye length = interval from anterior to posterior end of ocular suture; both eye length and temporal length are measured in lateral view; length of antennomeres is measured without the thin basal stalk.

The morphological structures of the aedeagus are termed following Frisch et al. (2002: 31–34).

3. Taxonomy

Scopaeus (s. str.) *socotrensis* sp. n.
(Figures 1–4, 14, 18, 22, 26, 27)

Type specimens (Yemen, Socotra). Holotype ♂, Dixam Plateau, Wadi Esgego (12°28'09"N 54°00'36"E), 300 m, 02.–03.12.2003, leg. Farkač (National Museum of Natural History, Prague). Paratypes 2 ♂, Noged Plain: Qaareh (waterfall) (12°20'10"N 53°37'56"E), 57 m, 05.–06.12.2003, leg. Farkač (Museum für Naturkunde Berlin; Volker Assing Private Collection, Hannover).

Etymology. The epithet '*socotrensis*' (Latin, adjective: originating from Socotra) refers to the distribution of the new species in Socotra Island.

Description. Total length 3.0–3.1 mm, forebody length 1.6–1.7 mm. Body colour (Figure 1), except for black eyes, light brown with pale yellowish brown antennae, maxillary palpi, and legs; pronotum sometimes somewhat lighter yellowish brown than remaining body. Body surface very finely and densely punctate and without clear microreticulation, relatively mat. Head subquadrate, 1.08–1.11 times as long as wide, with slightly widened tempora, strongly rounded posterior angles and straight posterior margin, across tempora 1.02 – 1.04 times as wide as across eyes only. Species capable of flight; eyes relatively large, 0.7–0.72 times as



Figure 1. Habitus of *Scopaeus socotrensis* sp. n. (holotype; Yemen, Socotra, Dixam Plateau: Wadi Esgego).

long as tempora; elytra with humeral angles, at suture 0.97–0.98 times as long as pronotum; metathoracic wings fully developed; membranous fringe of posterior margin of abdominal tergite VII present. Labrum with lateral teeth as long as median teeth or slightly shorter. Penultimate antennomeres notably elongate; antennomeres 8 and 9 1.3 times and antennomere 10 1.1 times as long as wide. Protarsomeres 2–4 of males strongly dilated, about three times as wide as long. Mesotibia very slender, 6.0–6.3 times as long as wide.

Male: Abdominal sternite VIII (Figure 26) with short, wide emargination occupying approximately posterior eighth of sternite length only. General shape of aedeagus (Figures 2–4) typical of Middle Eastern lineage (Frisch 2007: 213, 214) of *S. longicornis* subgroup (Frisch 2007: 204, 205) of *S. gracilis* species group with reduced, asymmetrical, setiferous lateral lobes, short, asymmetrical, in lateral view very slender distal lobes, distally sclerotized, acute apex of right apical lobe, distally round, membranous apex of left apical lobe, asymmetrical dorsal lobe with very slender distal portion attached to left of broad, transversal basis, and flagellum with horn-shaped, basolateral process and mediolateral extension orientated to left. Distal lobes of aedeagus comparatively long, approximately 0.3 times as long as phallobasis (Figures 2–4); in dorsal view (Figure 22), left apical lobe comparatively short, not projecting from apex of dorsal lobe distally, and distal half of left apical lobe with notably concave lateral margin; flagellum, in lateral view (Figure 14), straight in proximal half, but in distal half evenly curved dorsad, in ventral view (Figure 18) with horn-shaped basolateral process long and thin and lateral extension shallow, not much projecting; central bulb of phallobasis broad, almost reaching lateral margins of aedeagus (Figures 3, 4).

Female: unknown.

Distribution. *Scopaeus socotrensis* sp. n. is hitherto known only from two widely separate localities in southwestern (Noged Plain) and central (Haggeher Mountains) Socotra Island, Yemen (Figure 27). Whether the flying species is endemic to the island or also distributed in the neighbouring Horn of Africa is unknown. The presence in the Arabian Peninsula is unlikely, because the allopatric relatives *S. asirensis* Frisch, 2007 and *S. stramineus* Frisch, 2007 occupy this territory (Figure 27). The biogeographical and phylogenetic relationships of the new species are discussed in chapter *Phylogeography* below.

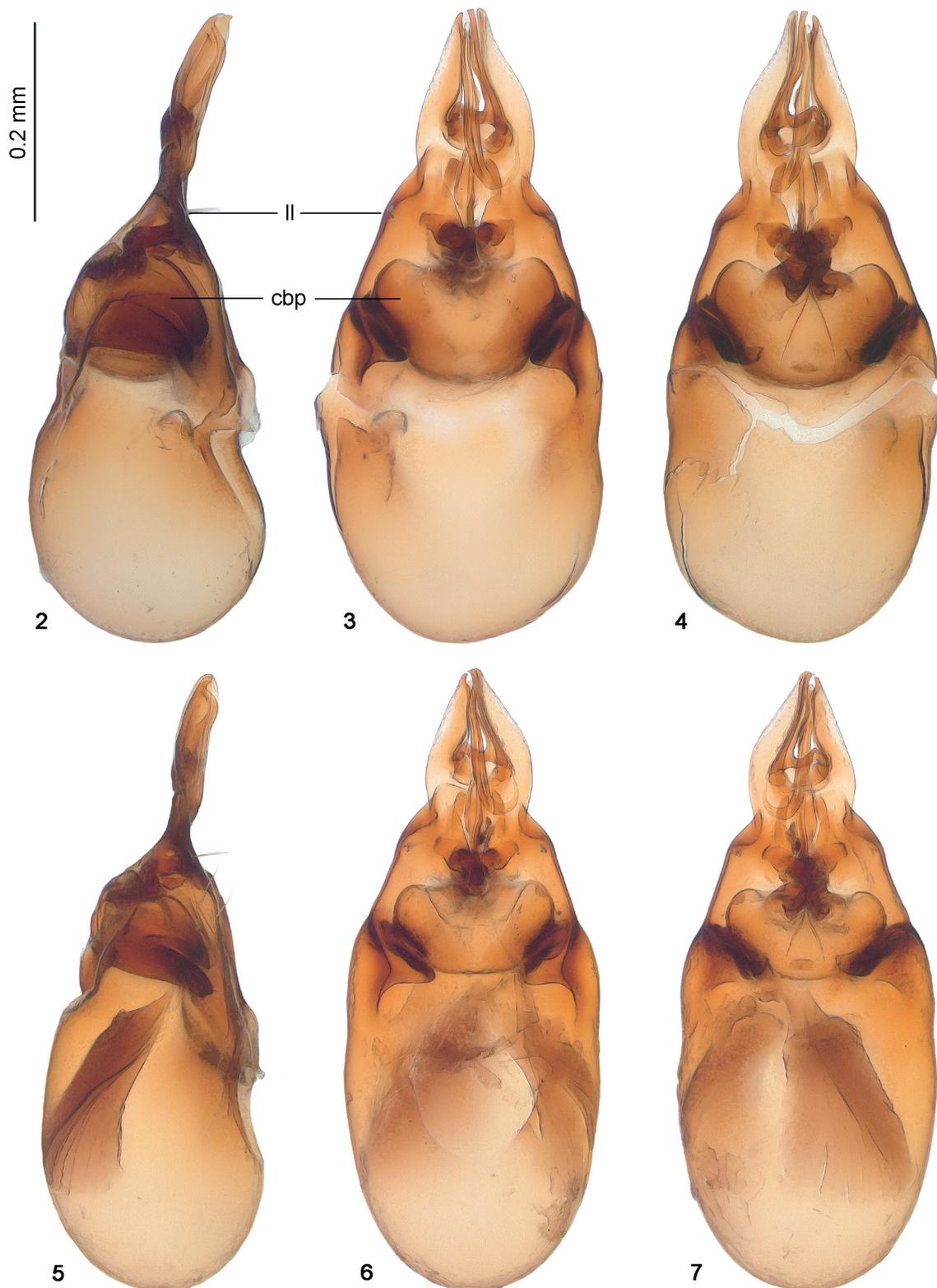
Bionomics. Judging from the label data, *Scopaeus socotrensis* was collected at watercourses, which is in accord with the general habitat preference of *Scopaeus* species (Frisch et al. 2002: 28). The species is expected to be distributed throughout Socotra Island on the banks

of running waters, which are numerous and permanent particularly on the northern slopes of the Haggeher Massif (Batelka 2012: 5; Wranik 2003: 19).

Comparative notes. *Scopaeus socotrensis* sp. n. can easily be confused with its Socotran congener *S. filiformis* Wollaston, 1867 according to body shape, coloration, and the dense, fine punctuation of the body surface. However, it can easily be distinguished by the broad protarsomeres, which are notably less than twice as wide as long in *S. filiformis*. In the male, *S. filiformis* differs by the very narrow emargination of abdominal sternite VIII (Frisch 1999: Figures 20, 21) and the aedeagus with shorter, symmetrical, ventrad curved apical lobes and a hook-shaped ventral endophallic process (Frisch 1999: Figures 4–9).

The light coloured form of *S. punctatellus* Fauvel, 1905, which is distributed in the southwestern Arabian Peninsula, is also present in Socotra Island. It is readily distinguished by the coarsely punctured, stronger convex body surface, remarkably thickened mesotibiae, and the coloration of the elytra with a light brown or light reddish brown transverse band and a light yellowish brown posterior margin. Males of *S. punctatellus* differ from *S. socotrensis* by the long, dorsad curved, median process projecting from the posterior margin of the deep, triangular emargination of abdominal sternite VIII and the completely different shape of the aedeagus with two long, slender, setiferous lateral lobes (see Coiffait 1984: 155, Figure 46D–G).

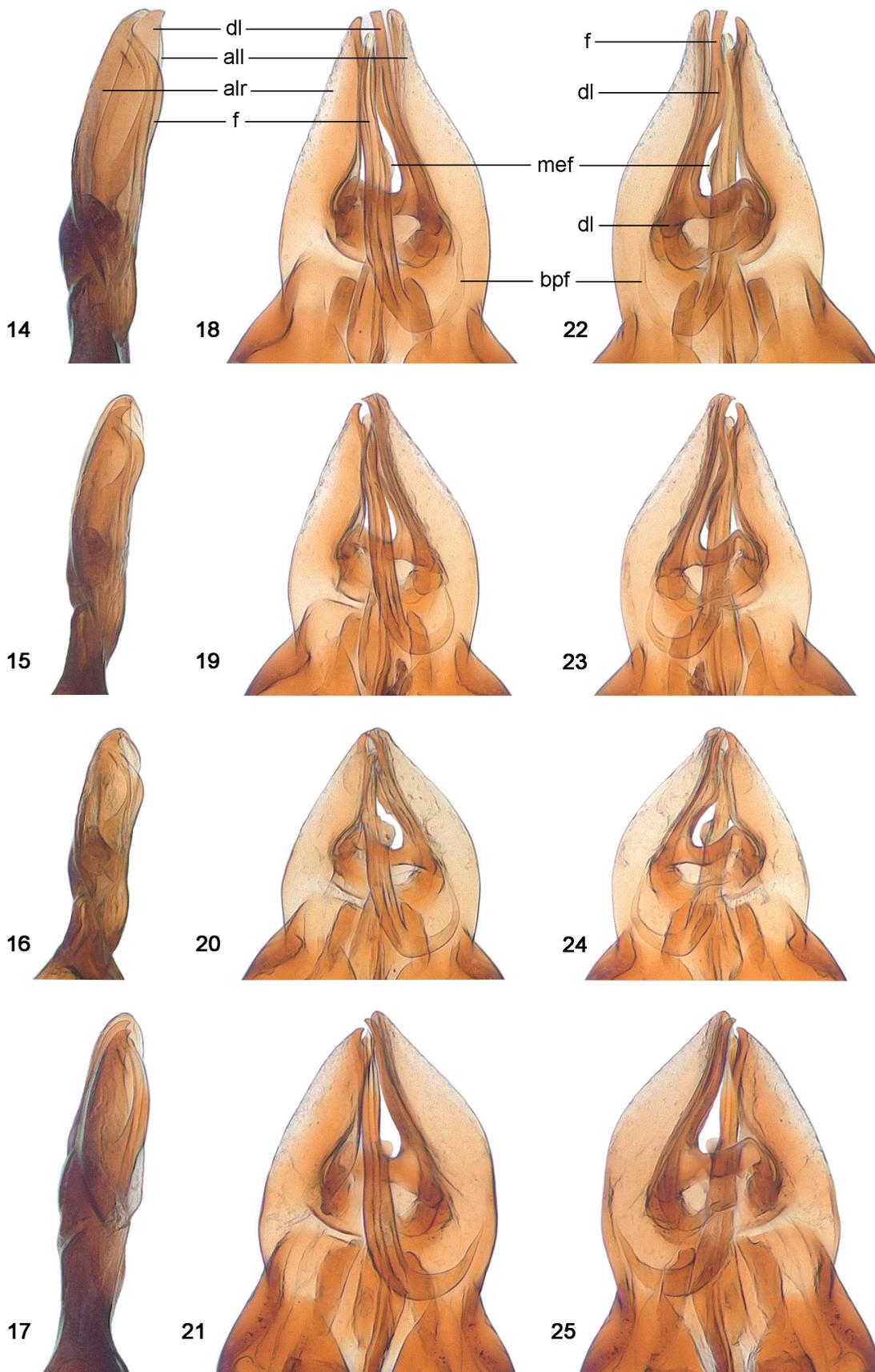
Scopaeus socotrensis sp. n. cannot be distinguished from its close Middle Eastern relatives of the *S. gracilis* species group according to characters of the ectoskeleton, but it differs by the notably shorter, stout phallobasis (Figures 2–4). As far as known presently, however, these allopatric species, *S. asirensis* Frisch, 2007, *S. stramineus* Frisch, 2007, and *S. pakistanensis* Frisch, 2007, are absent from Socotra Island (Figure 27). *Scopaeus asirensis* from the Asir Mountains in the southwestern Arabian Peninsula differs from the new species by notably shorter distal lobes of the aedeagus, which are only about 0.25 times as long as the phallobasis (Figures 5–7), the straight lateral margin of the left apical lobe (Figure 13, 19), and the stouter, almost semicircularly dorsad curved flagellum (Figure 15). Both *S. stramineus* from southern Iran and *S. pakistanensis* from Pakistan and the very southeast of Iran can be readily distinguished from *S. socotrensis* by the considerably smaller, slender central bulb of the phallobasis (Figures 9, 10, 12, 13), which covers about the median third of the width of the phallobasis only, the straight lateral margin of the left apical lobe (Figures 24, 25), and the more strongly projecting mediolateral extension of the flagellum (Figures 20, 21, 24, 25). *Scopaeus stramineus* differs moreover by the distinctly



Figures 2–7. *Scopaeus socotrensis* sp. n.: Aedeagus in (2) lateral, (3) ventral, (4) dorsal view (holotype; Yemen, Socotra, Dixam Plateau: Wadi Esgego). *Scopaeus asirensis*: Aedeagus in (5) lateral, (6) ventral, (7) dorsal view (Yemen, Al Hudaydah: Jabal Bura National Park). **Abbreviations:** ll – lateral lobes, cbp – central bulb of phallobasis.



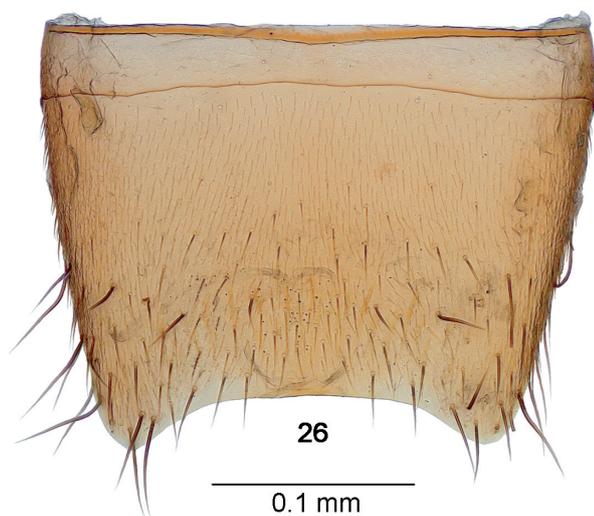
Figures 8–13. *Scopaeus stramineus*: Aedeagus in (8) lateral, (9) ventral, (10) dorsal view (holotype; Iran, Hormozgan, Bakhun Mts: Tall-e Gerdu). *Scopaeus pakistanensis*: Aedeagus in (11) lateral, (12) ventral, (13) dorsal view (paratype; Iran, Sistan va Baluchistan, 100 km NE Chabahar, env. Bahu Kalat: Dorgos).



shorter distal lobes of the aedeagus, which are only about 0.2 times as long as the phallobasis (Figures 8–10), and the stouter, more strongly dorsad curved flagellum (Figure 16). *Scopaeus pakistanensis* is also distinguished by the notably broader apical lobes of the aedeagus (Figures 21, 25) and the weakly, evenly curved flagellum (Figure 17).

Diagnostic remark on *Scopaeus asirensis*, *S. pakistanensis*, and *S. stramineus*

When I wrote the original descriptions (Frisch 2007), I was not aware of an important character for the distinction of *Scopaeus asirensis*, *S. pakistanensis*, and *S. stramineus*, the size and shape of the central bulb of the phallobasis. This diagnostic character is relevant particularly to distinguish *S. asirensis* and *S. stramineus*, which agree in relatively short distal lobes of the aedeagus and the stout, strongly dorsad curved flagellum (Figures 15, 16, 19, 20). These similar species can, however, be identified safely according to the central bulb of the phallobasis, which is almost as broad as the aedeagus in *S. asirensis* (Figures 6, 7), but very narrow in *S. stramineus*, occupying about the median third of the width of the aedeagus only (Figures 9, 10). *Scopaeus pakistanensis* also shows that narrow central bulb of the phallobasis (Figures 12–13) and can safely be distinguished accordingly from both *S. asirensis* and *S. socotrensis* sp. n. (Figures 2–7).



▲ **Figure 26.** Abdominal sternite VIII of male of *Scopaeus socotrensis* sp. n. (holotype; Yemen, Socotra, Dixam Plateau: Wadi Esgego).

4. Biogeography

***Scopaeus* (s. str.) *asirensis* Frisch, 2007**
(Figure 27)

New localities. Saudi Arabia: Makkah Province: Baha – Ta'if road: Al Atawla (Wadi Bawah) (20°45'N 41°15'E), 1310 m, 08.11.2012, leg. Sharaf (Volker Assing Private Collection, Hannover). **Yemen:** Al Hudaydah: Jabal Bura National Park (14°52'N 43°24.6–25.2'E), 240–350 m, 04.11.2010, leg. Bezděk (Museum für Naturkunde Berlin; National Museum of Natural History, Prague).

Discussion. *Scopaeus asirensis* was described from Wadi Horash (21°07'N 40°31'E) in the Asir Mountains, Makkah Province, Saudi Arabia (Frisch 2007: 209). Judging from the find in the Jabal Bura National Park in Yemen, the species is probably distributed throughout the Asir Mountain Range, which delimits the Arabian Peninsula to the southwest and the western slopes of which are a well-known refuge for the arboreal fauna including the riparian element.

The record of *S. asirensis* from Socotra (Assing 2012: 976) is based on the type specimens of *S. socotrensis* sp. n. Considering the allopatric distribution of the members of the *S. asirensis* lineage (Figure 27), the presence of *S. asirensis* in Socotra is unlikely. The species is here for the first time recorded for Yemen.

***Scopaeus* (s. str.) *stramineus* Frisch, 2007**
(Figure 27)

New locality. Oman: Al-Batinah: SE Rustaq, W Awabi: Wadi Bani Awf (Al-Akhdar Mts) (23°20'13''N 57°29'23''E), 430 m, 29.–30.12.2009, light trap, leg. Lehmann, Bittner & Stadie (Andreas Pütz Private Collection, Eisenhüttenstadt; Museum für Naturkunde Berlin).

Discussion. Described from the south Iranian provinces of Hormozgan (Bakhun Mountains) and Fars (20 km NW Darab) (Frisch 2007: 208) and later recorded from the Jebal Barez in the province of Kerman (Frisch 2010: 189), *Scopaeus stramineus* is here for the first time recorded from the Arabian Peninsula, where it was collected in the Al-Akhdar Mountains in the north of Oman. Thus, the riparian species is distributed in the mountains both north and south of the Persian Gulf.

◀ **Figures 14–25.** Distal lobes of aedeagus of *Scopaeus asirensis* lineage in (14–17) lateral, (18–21) ventral, (22–25) dorsal view: *Scopaeus socotrensis* sp. n. (14, 18, 22), *S. asirensis* (15, 19, 23), *S. stramineus* (16, 20, 24), *S. pakistanensis* (17, 21, 25). Localities of illustrated specimens as in Figures 2–13. Abbreviations: **all** – left apical lobe, **alr** – right apical lobe, **dl** – dorsal lobe, **f** – flagellum, **bpf** – basolateral process of flagellum, **mef** – mediolateral extension of flagellum.

5. Phylogeography

Scopaeus asirensis Frisch, 2007, *S. pakistanensis* Frisch, 2007, *S. socotrensis* sp. n., and *S. stramineus* Frisch, 2007 constitute a distinct phylogenetic lineage within the Old World *S. gracilis* species group, which is here named the *S. asirensis* lineage and substantiated a monophyletic clade below. The *S. gracilis* species group was proposed monophyletic by Frisch et al. (2002: 39) due to a combination of primary and secondary sexual characters, the most relevant of which is the asymmetry of the aedeagus with asymmetrical lateral lobes and apical lobes, an asymmetrical dorsal lobe, and the also asymmetrical, strongly lengthened flagellum, which is as long as the apical lobes at least.

Within the *S. gracilis* species group, the *S. asirensis* lineage is to be assigned to the *S. gracilis* subgroup, which is monophyletic according to distinct characters of the aedeagus such as the absence of projecting lateral lobes and the presence of a peculiar lateral process at the basal fourth of the flagellum [Frisch et al. 2002: 33 (Figures 13–15), 39], which in dorsal view projects to the left.

I already distinguished two sister clades of the *S. gracilis* subgroup (Frisch 2007: 213), the West

Palearctic *S. gracilis* complex, which comprises four species with an apomorphic shape of the aedeagus with long, narrow distal lobes of the aedeagus and a short basolateral process of the flagellum (Frisch 2007: Figures 1–15), and the *S. longicornis* complex in the Middle East, southern Africa, and Madagascar, which I consider to be monophyletic judging from the stout apical lobes of the aedeagus and the remarkable, horn-shaped, apicad curved basolateral process of the flagellum (Figures 2–25).

Judging from the appearance of the aedeagus and their distribution pattern [Frisch 2007: Figure 54 (distribution map)], the *S. longicornis* complex shows two distinct phylogenetic lineages, probably sister groups, for which I use the terms *S. longicornis* and *S. asirensis* lineages. While *S. longicornis* Fauvel, 1905 and *S. meridiaofricanus* Frisch, 2007 represent the southern *S. longicornis* lineage in southern Africa and Madagascar, the *S. asirensis* lineage comprises, as far as known presently, *S. socotrensis* sp. n. and its three Middle Eastern relatives treated in this contribution.

The discovery of *S. socotrensis* sp. n. makes it possible to establish a preliminary hypothesis on sistergroup relationships within the *S. asirensis* lineage, which experienced allopatric radiation in Pleistocene refuges of the Middle East (Frisch 2007: 215). Judging from

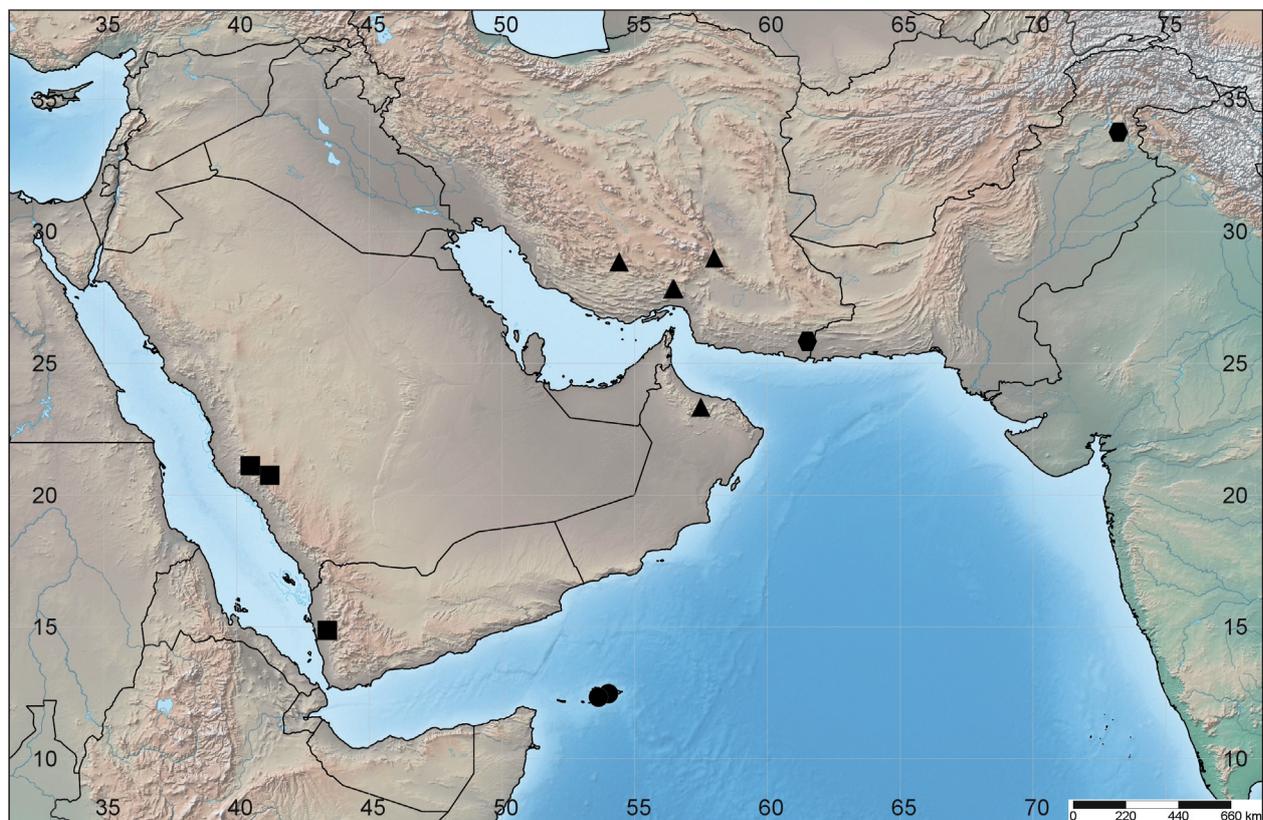


Figure 27. Distribution of the *Scopaeus asirensis* lineage in the Middle East: ● *Scopaeus socotrensis* sp. n., ■ *S. asirensis*, ▲ *S. stramineus*, ◆ *S. pakistanensis*.

the broad central bulb of the phallobasis (Figures 3, 4, 6, 7), the slenderer apical lobes of the aedeagus, and the shallow mediolateral extension of the flagellum (Figures 18, 19, 22, 23), *S. asirensis* from the Asir Mountains in the southwestern Arabian Peninsula and *S. socotrensis* sp. n. from Socotra Island are closely related, perhaps sister species. Their close phylogenetic relationship is supported by palaeogeographic arguments. Batelka (2012: 5, 6) briefly summarized various hypotheses on the insularisation of Socotra, according to which the island was connected with the Arabian Peninsula until it split off between 35 and 15 Mya ago in the course of the spreading of the Gulf of Aden. *Scopaeus socotrensis* sp. n. and *S. asirensis* constitute the southern sister clade of *S. pakistanensis* from Pakistan and Southeast Iran (Baluchistan) and *S. stramineus* from the mountains adjacent to the Persian Gulf in southern Iran and the north of Oman, which are linked by the derived, strongly reduced, narrow central bulb of the phallobasis (Figures 9, 10, 12, 13), the stouter, broader apical lobes, and the longer, semicircular or oblong mediolateral extension of the flagellum (Figures 20, 21, 24, 25).

The distribution of the *S. asirensis* lineage is more or less confined to water-bearing, mountainous areas within the Middle Eastern desert belt, a part of the Saharo-Sindian desert belt (Figure 27). The allopatric areas of distribution of the species included can easily be put down to long accepted Pleistocene refuges of the arboreal fauna. The distribution of *S. pakistanensis* concurs with the Sindian refuge according to de Lattin (1957: 389) in Punjab and the Indus Valley, the known area of *S. stramineus* is located within the Iranian refuge (de Lattin 1951: 211, 1957: 388), and the distribution of *S. asirensis* matches the Southwest-Arabian refuge in the Southwest Arabian mountain ranges surrounded by the Saharo-Sindian desert belt (e.g. Schneider 1987: 119). The allopatric speciation of *S. socotrensis* sp. n. most probably took place in Socotra Island, because that archipelago of Gondwanan origin, which was separated from the African continent in the early Tertiary at the same time as Arabia, India, and Madagascar, is an isolated geographical unit since about the late Miocene (e.g. Krupp & Zajonz 2009: 49).

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