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Described from images: The remarkable soldier of *Procryptotermes dioscurae* Harris (Isoptera: Kalotermitidae) from Socotra Island

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Procryptotermes Holmgren is a modestly diverse kalotermitid genus endemic to numerous islands and archipelagos of the world's tropical oceans (Scheffrahn & Křeček 2001). Mainland records from southern India (Bose 1979, Roonwal & Chhotani 1963, Thakur 1975), Queensland Australia (Watson and Abbey 1993), and the Yucatan Peninsula (Scheffrahn and Křeček 2001), also approximate oceanic coastlines. The soldier of *Procryptotermes* is distinguished from most other kalotermitids by long, sickle-shaped mandibles and a rather weak or absent frontal flange or protuberance (Krishna 1961). The winged imago of *Procryptotermes* is similar to that of *Cryptotermes* Banks in which the median vein is unsclerotized and intersects the radial sector near mid-wing. Of the fourteen described species of *Procryptotermes* (Scheffrahn & Křeček 2001), only one species, *P. dioscurae* Harris 1954, lacks a description of the soldier caste. It was described from three winged imagos collected from lights on Socotra Island, Yemen. Unlike soldiers, the imago caste is not present in the colony year round and often lacks species-level diagnostic characters. Therefore, the description of the soldier caste is highly desirable for most termite species.

Beginning in 1999, numerous biotic surveys were conducted on Socotra through an international development program in Yemen by the Czech Republic (Puchart 2012). In 2007, we received a kalotermitid sample collected by cerambycid specialist, Petr Kabátek, in dry wood from Socotra. The sample contained soldiers, a royal pair, and pseudergates. The dealates in Kabátek's sample generally matched Harris' (1954) brief description of the *P. dioscurae* alate. Photographs of one soldier and a few notes on the specimens were taken the same year. The sample was kept in a temporary storage trailer while our laboratory transitioned to a new building. Unfortunately, the sample was lost during the move. We propose to retain Harris's *P. dioscurae* alate as the name bearing type, but in light of its morphologically unique and remarkable soldier, our photographs are far more explicit for comparison with congeners.

Materials and methods

Color images were prepared following the methods of Scheffrahn *et al*. 2006. Scanning electron micrographs were taken with a Hitachi 4700 FESEM microscope at 3-5 kV.

Procryptotermes dioscurae Harris 1954: 493-494: (alate described: Socotra)

Soldier (Figs. 1–2). In dorsal view, frons with all its horns ("horn-like projections", cf. Krishna 1961) very dark glossy chestnut brown; Head capsule grading from orange-brown at vertex to pale yellow at occiput. Mandibles very dark chestnut brown to blackish, excluding chestnut brown basal humps. Anteclypeus whitish; labrum and antennae distally ferruginous; proximal four antennal articles concolorous with mid vertex. Pronotum with light brownish margins and faint midline; remainder concolorous with occiput. Eyespots large and whitish, but indistinct: distant from antennal fossae.

Anterolateral corners of head capsule distinctly embellished with lateral, frontal, and genal horns. Lateral horns, unprecedented among termite soldiers, projecting posteriorly to antennal fossae; termini globular, surface granulated; bases as narrow or narrower than diameters termini; resembling forward turned ears of a hippopotamus. In dorsal view, base of frontal horns rugose, each forming 110° angles; tips glabrous and hemispherical. In lateral view, frontal horns project above antennal fossae above plane of frons. In dorsal view, genal horns forming 80° angles; not eclipsed by the frontal horns. In lateral view termini of genal horns ellipsoid; more removed from antennal fossae than lateral horns.

Head capsule with few longer and scattered shorter setae. Margin of pronotum more pilous than head. Lateral horns covered with a few setae. Mandibles without basal setae. Frontal flange very weakly defined between the lateral horns; frons weakly rugose; with very shallow median concavity from lateral margins of postclypeus to frontal flange. Frons slopes ~30° from plane of vertex. Labrum bluntly linguiform.

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Mandibles long and attenuate; curved evenly ~70° in distal fourths. First marginal tooth of left mandible with clearly defined anterior and posterior margins; second marginal tooth projecting less and with gradually sloping posterior margin. Mandibular base very weakly inflated laterally. Antennae with 11 or more articles; third article clavate, thrice as long as fourth; relative length formula 2<3>4=5. Anterior margin of pronotum weakly crenulate; deeply incised in middle. Anterolateral corners of pronotum forming right angles; lateral margins evenly rounded. Measurements from Fig. 1: maximum span of lateral horns 1.37 mm, maximum head width 1.40 mm, head length with mandibles 2.86 mm, head length to postclypeus 1.84 mm.

Material examined and lost. Yemen, Socotra Island: Wadi Ayhaft; +12.6153, +54.0636; 85m elev; 27NOV2003; Col. Petr Kabátek; 7 soldiers, imago king and queen, pseudergates, larvae.

Comparisons. The soldier of *P. dioscurae* is easily distinguished from all other termite soldiers by a third pair of anterolateral horns which we identify as lateral horns.

Biological note. Forbes (1903) reported two termite species on Socotra. Harris (1954) contends that both were collected by G. Popov during 1952-1953. The first, an epigeal mound-builder, was described by Harris (1954) as *Amitermes socotrensis*. The second, *P. dioscurae*, was found to "live in the hollows of dead branches, which they have eaten out" (Forbes 1903). We have observed similar gallery architecture "with colonies often nearly completely and cleanly hollowing-out smaller branches and twigs" in West Indies species of *Procryptotermes* (Scheffrahn and Křeček 2001).

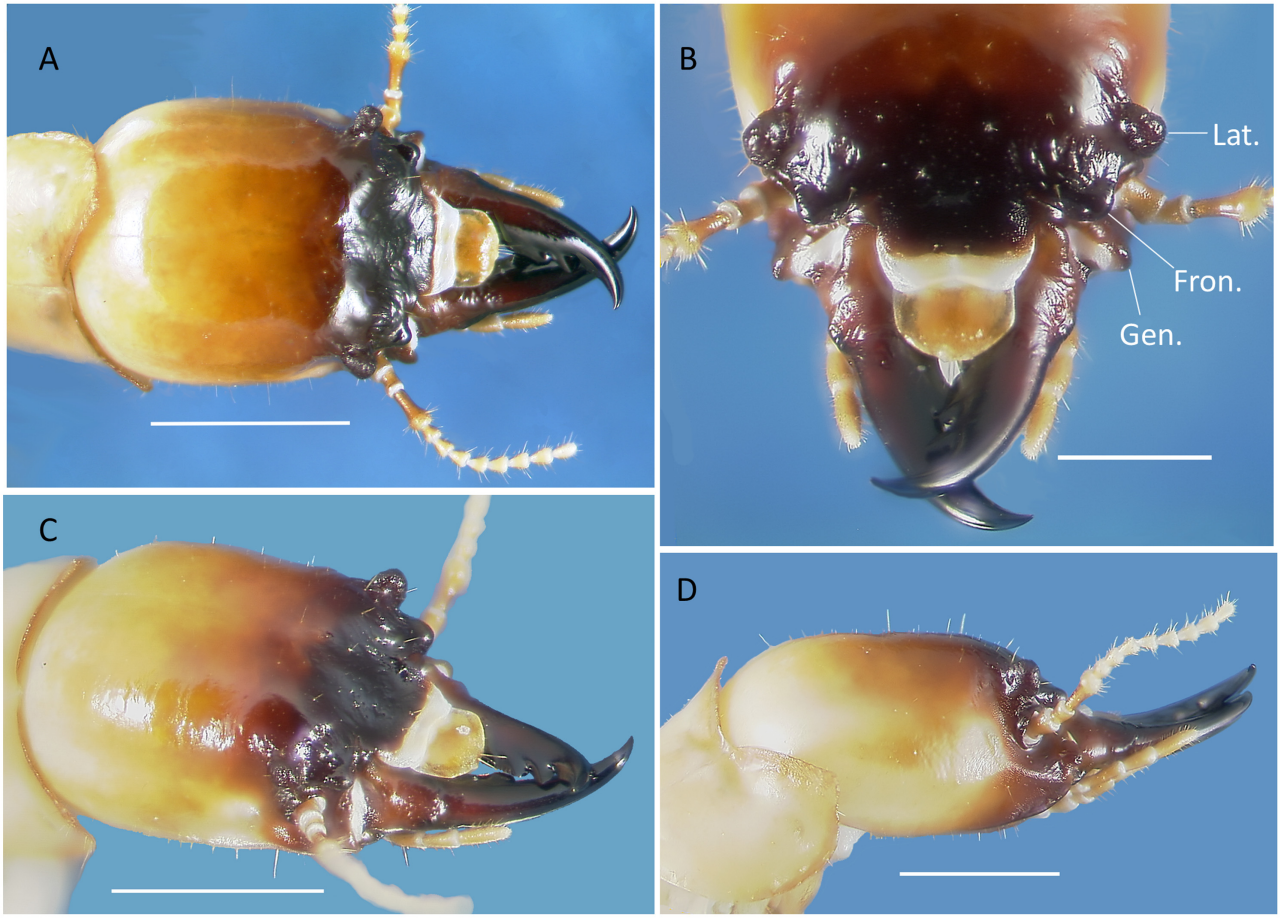

FIGURE 1. Color montage photographs of A) dorsal, B) anterodorsal, C) oblique, and D) lateral view of the head capsule of the lost soldier of *Procryptotermes dioscurae*. Scale bar = 1 mm in A, C, D. Scale bar = 0.5 mm in B. Lat. = lateral horns, Fron. = frontal horns, and Gen. = genal horns.

Discussion

Recently, heated debate has erupted in support of (Minteer *et al*. 2014, Marshall and Evenhuis 2015) and condemnation of (Rocha *et al*. 2014, Rogers *et al*. 2017) images as substitutes for type specimens. Krell and Marshall (2017) review this issue and note that ICZN (2017) now specifically allows images or genetic sequences to be used in place of preserved name-bearing specimens. We support the use of images when specimens are lost or cannot be retained. For example, protist taxonomy benefits from ICZN (2017) when a novel cell is photographed and then must be destroyed to

obtain genomic sequences (Jasso-Selles *et al*. 2017). Because termites have three morphologically distinct caste groups (soldier, imago, worker) the type is selected from the available caste that most distinguishes it from congeners. Had Harris (1954) obtained soldiers of *P. dioscurae*, he would have most certainly selected the soldier as the name-bearing type. Furthermore, travel to Socotra to collect may be untenable. The U.S. Department of State has recently issued (May 2017) a warning for American citizens to depart from Yemen. Yemen is currently in a civil war (Munteanu 2016) and Socotra is suffering from habitat loss caused by human expansion and overgrazing (Damme & Banfield 2011).

We reiterate our contention that, in this case, an image of the *P. dioscurae* soldier (e.g., Fig. 1B), designated as a neotype, would far better diagnose this species than Harris' 1954 drawings of the type alate or the actual specimen in the British Museum.

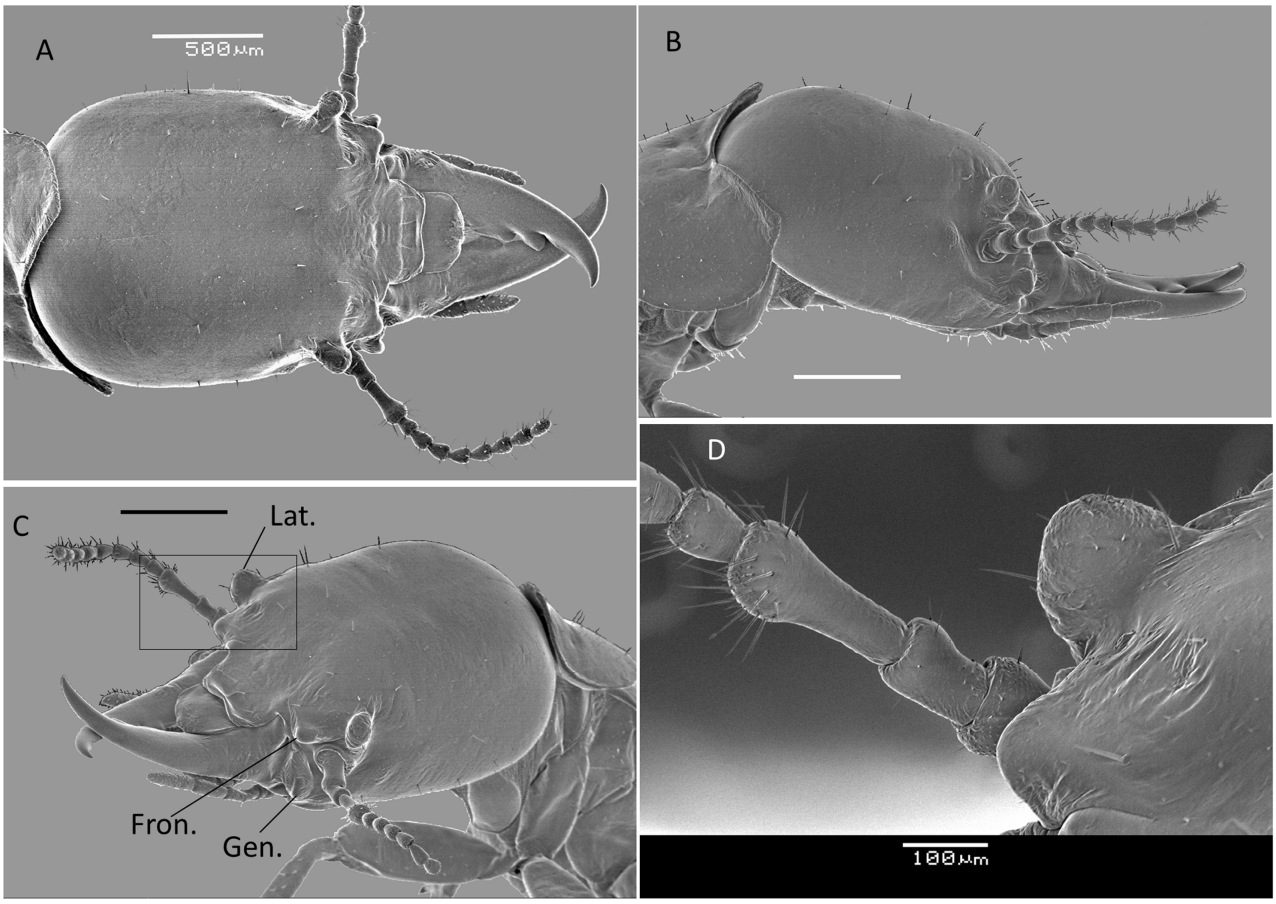

FIGURE 2. Scanning electron micrographs of A) dorsal, B) lateral, C) oblique, and D) lateral lateral and frontal horn enlarged from inset in C of the head capsule of the lost soldier of *Procryptotermes dioscurae*. See Fig. 1 for abbreviations.

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