Contributions to Zoology, 76 (4) 221-233 (2007)

Littoral Pycnogonida from the Socotra Archipelago

Valerio Bartolino[1], Franz Krapp[2]
[1] *Dipartimento di Biologia Animale e dell'Uomo, Università di Roma La Sapienza, Viale dell'Università, 32, I-00185 Roma, Italy, valerio.bartolino@uniroma1.it*
[2] *Zoologisches Forschungsmuseum A. Koenig, Adenauerallee 160, D-53113 Bonn, Germany, franz.krapp.zfmk@uni-bonn.de*

Keywords: monsoon, taxonomy

Abstract

Nine pycnogonid species from four different families were collected. *Propallene socotrana* n. sp. and *Anoplodactylus erythraeus* n. sp. are described. *Callipallene* cf. *dubiosa* Hedgpeth, 1949 is figured and its systematic position discussed. The Pycnogonida fauna around the Socotra Archipelago (Yemen) supports the hypothesis the Socotra Archipelago represents an important transient zoogeographic region between the Red Sea and the Indian Ocean.

Contents

Introduction

The Socotra Archipelago lies at a unique zoogeographical location in the northwestern Indian Ocean, at the transition between the Arabian and the Red Sea and East African shores at about 12°29'N and 53°51'E. This places it approximately 350 km south of Ras Fartak on the Yemeni mainland, 700 km to the southeast of Aden and 225 km off the 'Horn of Africa' (Cape Guardafui). The archipelago was once part of the supercontinent of Gondwana and detached during the Middle Pliocene, so it is not of volcanic origin. Very little information exists concerning the marine biodiversity of the Socotra Archipelago.

Pycnogonida are among the many unknown taxa from Socotra waters; no specimens have been recorded from Socotra to date and very few in the northwestern and western Indian Ocean. This is also reflected by the few papers that have been published on this wide biogeographic area: Gulf of Suez and Gulf of Aqaba (Stock, 1957, 1958), Oman (Stock, 1992), Ethiopia (Stock, 1964), Somalia (Stock, 1982), Kenya (Arnaud, 1973; Müller, 1990), Tanzania (Stock, 1975a) and farther away by Child (2002).

The marine zoogeographic region along the southern coast of Oman has been identified as a center of marine endemism in the region (Randall and Hoover, 1995; Randall, 1996) that probably extends westwards into Yemen, Socotra and the north coast of Somalia (Kemp, 1998).

The seasonal cold water upwellings associated with the northern Indian Ocean monsoon climate have been considered one of the main mechanisms of enhancing isolation and promoting or mantaining endemisms in many marine taxa along the Arabian coasts (Scheer and Pillai, 1983; Sheppard and Sheppard, 1991; Sheppard *et al.,* 1992; Carbone and Accordi, 2000).

Shallow-water pycnogonids collected in the Socotra Archipelago support the hypothesis that this is a transitional marine zoogeographic region where species from the Red Sea, the Gulf of Aden, the Indian Ocean and endemisms meet.

Materials and methods

Specimens were collected from the northern and western coast of Socotra and from the islands of Abd-el-Kuri, Samha and Darsa during summer 2004 and in spring 2005.

Nine species from four families have been hand-sampled by snorkeling and scuba-diving.

All holotypes and voucher specimens are deposited in the Zoological Museum of Berlin Humboldt University (ZMB repository numbers), while paratypes and other voucher specimens are submitted to the Zoological Museum Amsterdam (ZMA Pa).

Systematic part

Family Ammotheidae Dohrn, 1881
Genus *Achelia* Hodge, 1864
Achelia watamu (Müller, 1990)
Ammothea watamu Müller, 1990: 63-66, figs. 1-6
Achelia watumu (Müller, 1990) – *lapsus calami*: Stock 1992: 81 (in list)
Achelia watamu (Müller, 1990): Stock 1992: 92; figs. 9a+b

Material: Hadibo, 11-19 June 2004, 1-2 m, 2 juv. On macro-algae on rocks and small rock boulders. ZMB 345 1 juv., Hadibo (Socotra), 11 June 2004, 1-2 m, Bartolino leg. ZMB 346 1 juv., Hadibo (Socotra), 19 June 2004, 1-2 m, Bartolino leg.

Our specimens substantially agree with Müller's description. The differences are probably age-related: the trunk segments are fused and the spines on the dorso-distal lateral processes are lacking. Relative proportions resemble the holotype: proboscis is about 1,6 times longer than wide and 3/4 of the trunk length. The abdomen is as long as in adults. Palps are 8-articulated, with the 6th and 7th articles distally enlarged. Ovigers are incompletely developed. Another difference is in the propodus, slender and with auxiliary claws in juveniles too, but the sole has only one large spine in proximal third instead of two, a distinctly juvenile character.

This new record fills the geographic gap between previous records in Kenya (Müller, 1990) and Oman (Stock, 1992).

Genus *Ammothella* Verrill, 1990
Ammothella omanensis Stock, 1992
Stock 1992: 81 (in list), 83-86; figs. 2a-g, 3a-d

Material: Hadibo, 11 June 2004, 1-2 m, 1 male bearing eggs, 2 juv. ZMB 347; 7 July 2004, 1-2 m, 1 juv. ZMB 348; 24 September 2004, 1-3 m, 1 juv. ZMA Pa. 205980; 20 March 2005, 1-3 m, 2 females, 1 juv., ZMB 349; 21 March 2005, 1 m, 2 ovigerous males, 1 female ZMA Pa 205979; 21 March 2005, 1 m, 2 subadults ZMB 350. Dihamri (N 12°40'19''- E 54°11'46''), 9 September 2004, 1-3 m, 1 female ZMB 351. 23 September 2004, 1-3 m, 2 females ZMB 351; Qadamah-Bashorah, 26 September 2004, 1 m, 1 juv. ZMA Pa 205977 ; Qalansiya, 10 October 2004, 1-2 m, 1 male bearing eggs, 2 females with eggs, 3 females ZMB 352; Shassara (12°37'40'' N - 54°16'06'' E), 8 September 2004, 1-2 m, 2 females ZMA Pa 205981. Shassara 31 March 2005, 0-2 m, 1 male bearing eggs, 1 female, 1 juv. ZMA Pa. 205978 + 205979; Shuab, 7 October 2004, 1-2 m, 1 juv.

Among mixed hard coral communities, small encrusting and sub-massive corals. ZMB 352 Bartolino and Tabet leg., all others Bartolino leg.

Ammothella omanensis is the only species collected from most sampling stations, along the north coast of the island, from Shuab to Shassara. Occurs in a variety of environments and on most diverse substrata. Macroalgal assemblages, both on sand-inundated rock platform and rock boulders, dominated by *Padina*, *Dictyota*, *Ulva*, *Codium*, *Caulerpa* and *Udotea*.

The juvenile stage is in this species quite long and large specimens still with juvenile characters, as chelate chelifore and lack of ovigers, have been found. No significant differences have been noticed between our material and the topotypes from Oman.

This is the second record for this species, before it was known from the type locality in Oman only (Stock, 1992).

Genus *Tanystylum* Miers, 1879
Tanystylum bredini Child, 1970
Child 1970: 296-299; figs. 3a-i
Child 1977: 441
Child 1988b: 52
Müller 1989a: 125; figs. 11-21
Müller 1990: 67; figs. 7-15
Müller 1992a: 156, 159; figs. 6-11
Stock 1992: 92-93
Stock 1994: 36-37
Child 1996: 546

Material: Hadibo, 20 July 2004, 1-2 m, 1 male, from macro-algae and sparse hard coral community on small rock boulders. ZMB 355 1 male. Hadibo (Socotra), 20 July 2004, 1-2 m, Davis and Bartolino leg.

Müller (1989a, 1990) examined the variability of *T. bredini* by comparing specimens from Kenya, Sri Lanka, Malaysia and Polynesia. The male we collected in Socotra doesn't have the particularly long tubercles on the first coxae as the specimen reported from Kenya by Müller (1990). The shape of these spiny tubercles is in good agreement with the material from French Polynesia.

Tanystylum bredini is a widely distributed species throughout the tropical Indo-Pacific. It has been recorded from Sri Lanka (Müller, 1990), Malaysia (Müller, 1992), French Polynesia (Child, 1970, 1977; Müller, 1989a), Seychelles (Child, 1988b), Kenya (Müller,1990) and Oman (Stock, 1992).

Family Nymphonidae Wilson, 1878
Genus *Nymphon* Fabricius, 1784
Nymphon adenense Müller, 1989
Müller 1989b: 283-284; figs. 21-27

Material: Shassara (12°32'11"N - 54°15'43"E), 31 March 2005, 0-2 m, 1 female with ripe ova. Found on mixed hard coral communities on a relict reef separated by sand channels. ZMB 356 1 female-ovigerous, Shassara (Socotra), 31 March 2005, 0-2 m, Bartolino leg.

Nymphon adenense was known previously from the type locality only, the Gulf of Aden. Both holotype and paratypes were collected by the research-ship 'Meteor' at 76 m depth (Müller, 1989b) and this new record suggests a bathymetric distribution that reaches very shallow water.

Nymphon setimanus Barnard, 1946
Barnard 1946: 61
Barnard 1954: 103-105; fig. 8
Stock 1962: 278
Stock 1965: 18-19; figs. 13-17
Müller 1989b: 287-288; figs. 35-41

Material: Abd-el-Kuri, Ras Anjro (12°09'6"N - 52°22'09"E), 24 March 2005, 2-3 m, 1 subadult taken on macro-algae and sparse hard coral communities on small rock boulders and outcrops. ZMB 357 1 subadult, Ras Anjero (Abd-Al-Kuri Is.), 24 March 2005, 2-3 m, Bartolino leg.

The distinctive pigment pattern represented by a narrow mid-dorsal band on the trunk between ocular tubercle and abdomen distinguishes *N. setimanus* from most of the other species of the genus.

This species has previously been reported from South Africa, Madagascar and the Gulf of Aden; Müller (1989b) thinks that also two specimens from the Andaman Islands identified by Calman as *N. andamanense* could belong to *N. setimanus*.

Family Callipallenidae Hilton, 1942
Genus *Callipallene* Flynn, 1929
Callipallene aff. *dubiosa* Hedgpeth, 1949: Figure 1
Hedgpeth 1949: 275-277; fig. 35
Stock 1954: 41; fig. 17
Stock 1957: 88
Utinomi 1965: 335
Utinomi 1971: 322
Nakamura and Child 1983: 58
Kim 1984: 535
Kim and Hong 1986: 38
Hong and Kim 1987: 153
Müller 1990: 71
Nakamura and Child 1991: 38
Müller 1992: 159

Material: Hadibo, 17 June 2004, 1-2 m, 1 juv., ZMA Pa 205988; 25 June 2004, 1-2 m, 1 female with ripe ova ZMA Pa 205986; 2 females, 1 male, 2 juv., Hadibo (Socotra), 27 June 2004, 1-3 m, ZMB 360. 2 July 2004, 1-4 m, 3 males bearing eggs and larvae, 2 males, 1 female with ripe ova ZMB 359; 19 July 2004, 2-3 m, 1 male and 1 juv., ZMB 362; 20 July 2004, 1-2 m, 8 males bearing eggs and larvae, 2 females with eggs, 4 juv., ZMB 358; 22 July 2004, 1-3 m, 1 male bearing eggs and larvae ZMA Pa 205985; 9 August 2004, 1-2 m, 2 females with eggs, 1 female, 2 males, 1 juv., ZMA Pa 205984; 6 September 2004, 1-2 m, 2 females with eggs and 1 juv., ZMA Pa 205983; Hadibo-Qadheb, 24 September 2004, 1-2 m, 1 male bearing eggs ZMA Pa 205983; Qadamah-Bashorah, 26 September 2004, 1 m, 1 female with eggs and 2 juv., ZMB 361; Abd-el-Kuri, Ras Anjra, 24 March 2005, 2-3 m, 1 female ZMB 363; Darsa, 27 March 2005, 5-7 m, 1 female with eggs ZMB 364.

Material was collected both on macro-algae and coral dominated substrata. Macro-algae and sparse massive hard corals on rock outcrops parallel to shore, but also on small and large rock boulders (ZMB 358 Davis and Bartolino leg., all the rest Bartolino leg.).

Measurements of one male specimen: total length

0.67, length of body segments 2-4: 0.12, 0.11, 0.07; length of proboscis 0.22, width of proboscis 0.16; lengths of articles in leg 3: coxa 1 = 0.11, coxa 2 = 0.36, coxa 3 = 0.19; femur 0.67, tibia 1 = 0.65, tibia 2 = 0.74, tarsus 0.06, propodus 0.34; lengths of oviger articles: 0.05, 0.10, 0.11, 0.18, 0.30, 0.09, 0.08, 0.10, 0.10, 0.07, diameter of 2nd trunk segment 0.16.

Although several differences have been observed between our specimens from Socotra and *C. dubiosa* Hedgpeth, 1949, they appeared to be too small to dare the description of a new species within the still confuse taxonomy of the genus *Callipallene*. Thus, we prefer to stress the strong relation with *C. dubiosa*, assigning the provisional status of affinis *dubiosa* and postponing the discussion of the value to assign to the differences found.

As Stock himself suggested (1954) *C. dubiosa* is not well distinguished from *C. brevirostris* and *C. emaciata*. Referring to Stock's drawings (1952), it has a cephalon with a shorter neck and a more curved and larger propodus than *C. brevirostris*. Its similarities are still stronger with *C. emaciata*. The proboscis of *C. dubiosa* that resembles 'somewhat ... the small end of an egg' (Hedgpeth, 1949) doesn't seem a stable character considering Stock's specimens from Indo-Pacific (1954) and our samples from Socotra. Furthermore our material differed by a more variable number of leaflike spines on strigilis articles and no suture line between third and fourth body segment (see Table 1).

Our specimens can be well distinguished from *C. kenyensis* Müller, 1990 by the presence of 7 and 11 teeth respectively on the movable and immovable chelifore fingers and by strigilis articles with leaflike spines in the formula: 6-8 spines on the seventh articles, 5-7 on the eighth, 5-7 on the ninth and 7-8 on the tenth. Propodus is sligthly curved in both *C. dubiosa* and *C. kenyensis* without a distinct heel, but *C. kenyensis* has the sole armed with 3 strong spines in the proximal third organized in a single row, 4 smaller spines in the two distal thirds and no row of setae, while specimens from Socotra have respectively 6-7 strong spines arranged in two rows, 6-7 small spines and several setae (see Table 1).

Most of the bibliography around *C. dubiosa* and *C. kenyensis* refers to their resemblance to *C. emaciata* and different authors look for small characters to distinguish several *Callipallene* specimens found in the Indo-Pacific. We don't want to discuss here the taxonomic value of these characters, as we are conscious of the urgence of a revision of this genus.

Together with *Ammothella omanensis*, this is the most abundant species in our samplings, found also in the islands of Abd-el-Kuri and Darsa. Specimens at any developmental stage have been collected, also males and females with eggs and larvigerous males, too. Some male specimens bore simultaneously eggs and larvae. As typical for Callipallenidae, rather advanced larvae (with three pairs of legs) have been found still attached to ovigers (fig. 1).

Although the sampling effort has not been the same during our two visits on the archipelago, all 13 ovigerous males found have been collected during the monsoon season and no one during spring time.

Callipallene dubiosa is a shallow-water species distributed in the Indo-West Pacific found by Müller (1990) along the Kenya coasts.

Genus *Propallene* Schimkewitsch, 1909

Propallene socotrana n. sp.

Material: Hadibo, Socotra, 12°38'50''N - 53°59'40''E, 21 March 2005 - 19 July 2004. Distributed to Berlin and Amsterdam museums as follows: 21 March 2005, 1 m, 1 male (holotype) ZMB 341. 17 June 2004, 1-2 m, 1 female (paratype) ZMB 342, 3 juv. ZMB 343; 19 July 2004, 2-3 m, 3 females (paratypes), 1 juv. ZMA Pa 205982.

Table 1. Some important characters distinguishing *C. dubiosa* from *C. kenyensis*, and the same characters found in specimens from Socotra.

characters	***C. kenyensis*** Müller, 1990	***C. dubiosa*** Hedgpeth, 1949	***C.*** aff. ***dubiosa***
chela fingers	gaping	parallel	parallel
teeth number	6+8	8+10	7+11
sole spines	3+4 (single row), no setae	4(6)+?, several setae	6(7)+6(7) (double row), several setae
suture line between 3rd-4th segment	absent	present	absent
oviger spines formula	4:3:3:5	7(8):7(8):7(8):7(8)	6(8):5(7):5(7):7(8)
tibiae lengths	tibia1= tibia2	tibia1< tibia2	tibia1< tibia2

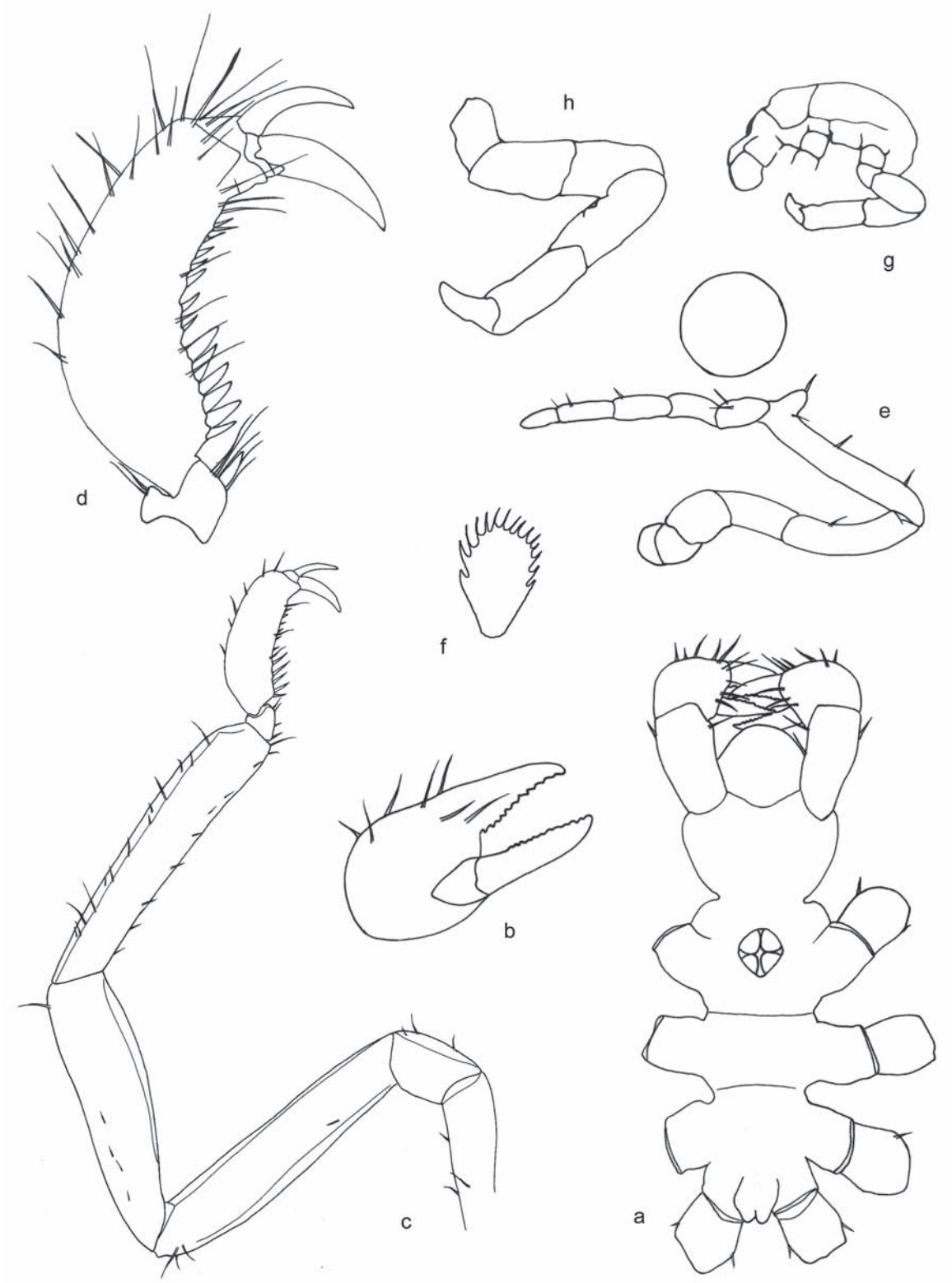

Fig.1. Callipallene aff. *dubiosa* Hedgpeth, 1949. Male a) trunk (dorsal view); b) chela; c) leg 2; d) distal articles leg 2; e) oviger with egg; f) spine of oviger article 10; g) larva; h) leg 3 of larva.

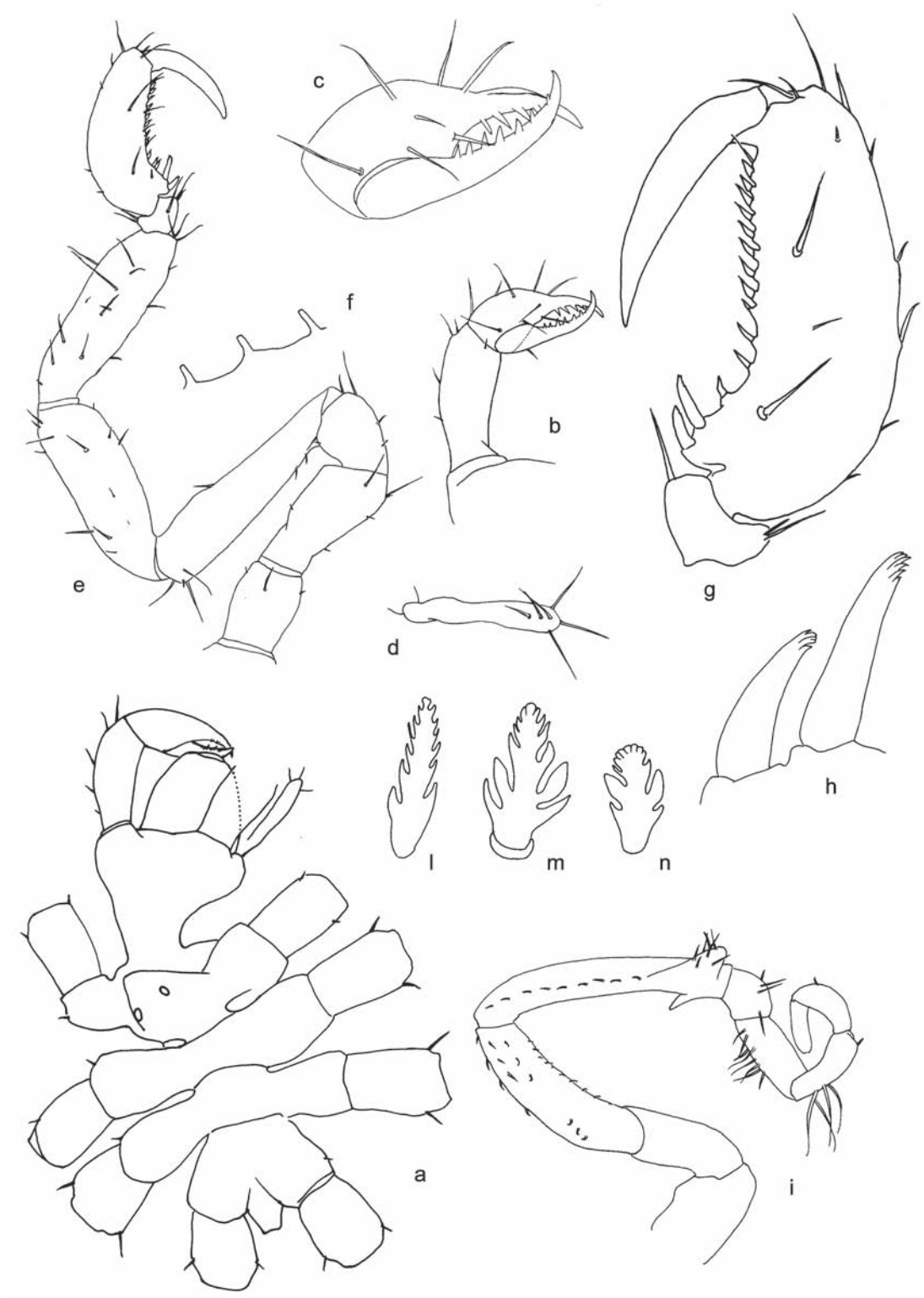

Fig. 2. *Propallene socotrana* n. sp. Male (holotype) a) trunk (dorsal view); b) chelifore; c) chela; d) palp; e) leg 3; f) cement gland ducts of leg 1; g) distal articles leg 2; h) spines on the propodus heel; i) oviger; l) spine 8 of oviger article 8; m) spine 9 of oviger article 9; n) spine 8 of oviger article 10.

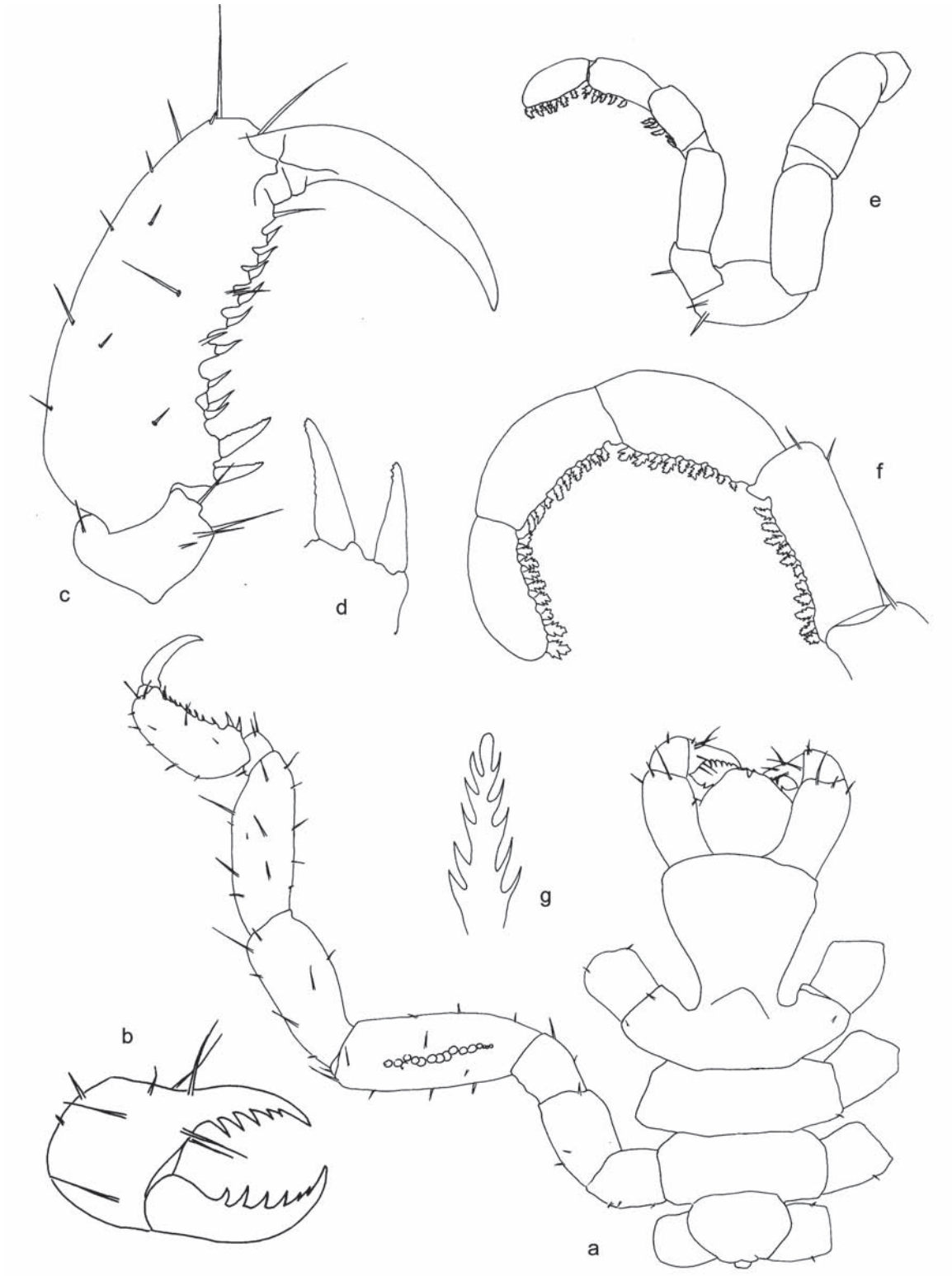

Fig. 3. *Propallene socotrana* n. sp. Female (paratype) a) trunk and leg 3 with eggs (dorsal view); b) chela; c) distal segments leg 2; d) spines on the propodal heel; e) oviger; f) distal articles of oviger; g) spine of oviger article 8.

From macro-algae (i.e. *Padina* and *Dictyota*) and sparse hard coral community on small rock boulders. Bartolino leg.

The holotype is the only male among five mature specimens identified as this new taxon from Socotra island. *Propallene* is a well defined Callipallenidae genus characterised by the presence of 2-articulated palps in the male sex only. At the moment twelve species are ascribed to *Propallene,* all from the Indo-Pacific region, with the exception of *P. stocki* Fage, 1956 found in Sierra Leone. The species identification is rather difficult as mentioned by Stock (1975b), several taxa sharing a similar habitus. Diagnostic characters refer to morphology of palps and chelae, to the structure of male ovigers and shape and number of cement gland apertures, mainly.

Description: This species is discriminated from most other *Propallene* species by a fully segmented concentrated body, further characterised by lateral processes separated by less than half their diameter (figs. 2-3). Neck short, ventrally bent, proboscis very short.

It is distinguished by *P. ardua* Stock, 1975 by:

1. wider and more compact propodus;
2. second spine on the propodus heel longer than the first;
3. more numerous teeth on the movable chela finger;
4. more compact tibiae, with a length-width ratio of 2.8-3.2
5. less numerous cement gland openings;
6. cone-shape ocular tubercle much less rounded.

It differs from *P. crassimanus* Stock, 1959 by the following characters:

1. neck progressively enlarging to the origin of chelae;
2. 10th article of oviger sligthly shorter than 9th;
3. propodus more slender without evident sexual dimorphism;
4. cheliphore scape not longer than chela.

Eye cone moderately high, four feebly pigmented eyes sitting near base of eye cone, slightly enlarging towards its midlength, from there tapering to a bluntly rounded tip. Cheliphore scape longer than proboscis, chelae overhanging the mouth. Chela with single setae on all aspects, both fingers slightly longer than palm, bearing five denticulate teeth on immobile and 7 on the movable finger.

Palps bi-articulate, basal article short, terminal one long, of a flattened rod-like shape, terminally bearing 3+3-4 setae.

Oviger origin barely discernible from above, on anterior margin of first cruriger. Oviger 10-articulated, the 5th article the longest, the thickened 4th and the short 6th form the 'knee'; they bear 2 and 1 longer setae, respectively. Strigilis with leaf-shaped special spines in the formula 13:12:10:9 (in male holotype); spines slender and with 5 serrations on both flanks; no terminal claw (see genus definition).

Abdomen a tiny knob, curved ventrally, its extremity almost level with 4th lateral process.

Legs rather short, coxae 1 and 3 subequal, barely longer than wide, coxa 2 longer (see measurements), femur the longest article, tibiae of subequal length, tarsus very short, propodus about 1/4 shorter than tibia 2, heel not distinctly set off, bearing two short spines, sole with about 8-10 setae. Terminal claw long, moderately curved, no auxiliaries.

All leg articles sparsely beset with setae, the longest of them on dorsal face of both tibiae.

Measurements im mm: total length 1.05; lengths of body segments: 2nd 0.13; 3rd 0.15; 4th 0.16, length of proboscis 0.4, width of proboscis 0.36; lengths of all articles of 3rd leg: coxa1 0.26; coxa2 0.41; coxa3 0.26; femur 0.78; tibia1 0.62; tibia2 0.66; propodus 0.08; tarsus 0.58. Lengths of palp articles: 1st 0.04; 2nd 0.33. Lengths of oviger articles: 0.23 - 0.24 - 0.46 - 0.60 - 0.10 - 0.19 - 0.21 - 0.15 - 0.13.

Propallene socotrana n. sp. enriches the zoogeographical scenario depicted by this genus along the

Table 2. Main characters distinguishing *Propallene socotrana* n. sp. from *P. crassimanus* and *P. ardua*:

characters	***P. crassimanus*** Stock, 1959	***P. ardua*** Stock, 1975	***P. socotrana*** n. sp.
oviger spine formula	14:12:12:?	10:10:8:9	11:9:9:8
cement gland openings	8-14	9	4-7
number of chela teeth	8 + 4-6	3-6 + 3-6	6-7 + 4-5
sexual dimorphism propodus	yes	?	no
lateral processes (LP) distance	<1/2 LP diameter	3/4-1 LP diameter	~3/4 LP diameter
lateral processes (LP) length	<1/2 trunk diameter	slightly < trunk diameter	sligthly > trunk diameter
known distribtion	S-E Africa, Oman	Tanzania	Socotra

African coasts, filling the gap between *P. ardua* Stock, 1975 found in Tanzania (Stock, 1975a) and *P. crassimanus* Stock, 1959 recorded from South Africa (Stock, 1959) and Oman (Stock, 1992) (see Table 2).

Etymology: The species is named after its type locality, Socotra Island, Yemen.

Family Phoxichilidiidae Sars, 1891
Genus *Anoplodactylus* Wilson, 1878
Anoplodactylus erythraeus n. sp.

Material: Shassara, Socotra (12°38'11"N - 54°15'43"E), 31 March 2005, 0-2 m, 1 male (holotype) ZMB 344 comes from macro-algae (i.e. *Padina* and *Dictyota*) and sparse hard coral community on small rock boulders. Bartolino leg.

Remarks: This newly found species belongs to a group of closely related *Anoplodactylus*-species of an extremely attenuated habitus. A fourth species in this complex was described after the submission of the present paper based on the specimens referred by Arango (2003) to *A. tenuicorpus*. A review of that *tenuicorpus*-complex is given in Arango and Krapp (2007). *Anoplodactylus typhloides* is a blind species - from deeper waters - of a roughly similar body shape but otherwise very different from these shallow water species belonging to the *tenuicorpus* group from coral habitats.

Description: Body extremely slender, segments of about the same diameter as crurigers 2 and 3, separated by nearly 5 times their width. Only few short setae on body surface. Eye cone lowly rounded, placed close to the anterior margin of cephalon, with 4 distinct eyes. Cephalon shortest segment, its crurigers anteriorly bent at an angle of about 60°. Body segments 2 and 3 of subequal length, extremely attenuated, elongated towards their anterior sutures. 4th segment shorter, bent backwards at an angle of about 135°. Abdomen tiny, reaching to about half length of 4th crurigers.

Proboscis long (shorter than either body segments 2 or 3), narrowing at base, with a slight expansion at midlength and after little narrower stretch follows a subterminal swelling, mouth opening with three distinct lips = the antimere tips.

Chelifore scape extremely slender, longer than proboscis, movable finger distinctly longer than hand. Chela gaping, both finger tips crossing at their extremities, on their 'cutting' edge fitted with about 5 needle-like teeth.

Ovigera originating on a swelling ventrally at midlength of first crurigers, 6-articulated, slightly spinose, 3rd article the longest, its articulation with 4th article forming the most apparent 'knee', less so between articles 5 and 6; this terminal article bearing about 7 strong endal setae, which are bent backwards.

Legs extremely slender, coxae 1 and 3 short, coxa 2 around 3 times longer than 3rd one; femur the longest article, tibia 2 almost as long, tibia 1 somewhat shorter (see measurements). All leg articles bearing a few short setae. Cement gland opening slit-like, on the dorsal face of femur of male holotype, slit length almost one sixth of femur length. Tarsus shorter than broad, ventrally bearing one subterminal spine and 3-4 setae. Propodus slender, heel region almost imperceptibly merging into sole, but in this basal region three heavy spines, the third one the longest and with 9 serrations on distal side. Propodal sole bearing about 8 spines which are flanked on both sides by setae, no cutting lamina. Main claw very long, moderately curved, reaching almost to base of serrated spine. Auxiliary claw absent.

Anoplodactylus erythraeus is distinguished from *tenuicorpus* Child, 1991 by the following characters:
1. lack of tiny cutting lamina distally on propodal sole;
2. greater number (about 9 instead of about 5) of spines on sole of propodus;
3. only one slit-like expanded cement gland opening on dorsal aspect of femur instead of two tiny ones (this seems the most important among those characters);
4. tibia 2 instead of femur is the longest leg article.

From *exaggeratus* Stock, 1994 it is distinguished by:
1. a different palm shape (approaching more the condition in *tenuicorpus*);
2. more sole spines (see Table 3);
3. less crenulations on long sole spine (fig. 4);
4. the configuration of the very distinct cement gland opening.

From *perissoporus* Arango et Krapp, 2007 it is distinguished by:
1. The presence of distinct needle-like teeth on both chela fingers (against none),
2. the absence of a cutting lamina on the propodal sole,
3. 9 instead of around 13 crenulations on 3rd propodal heel spine,

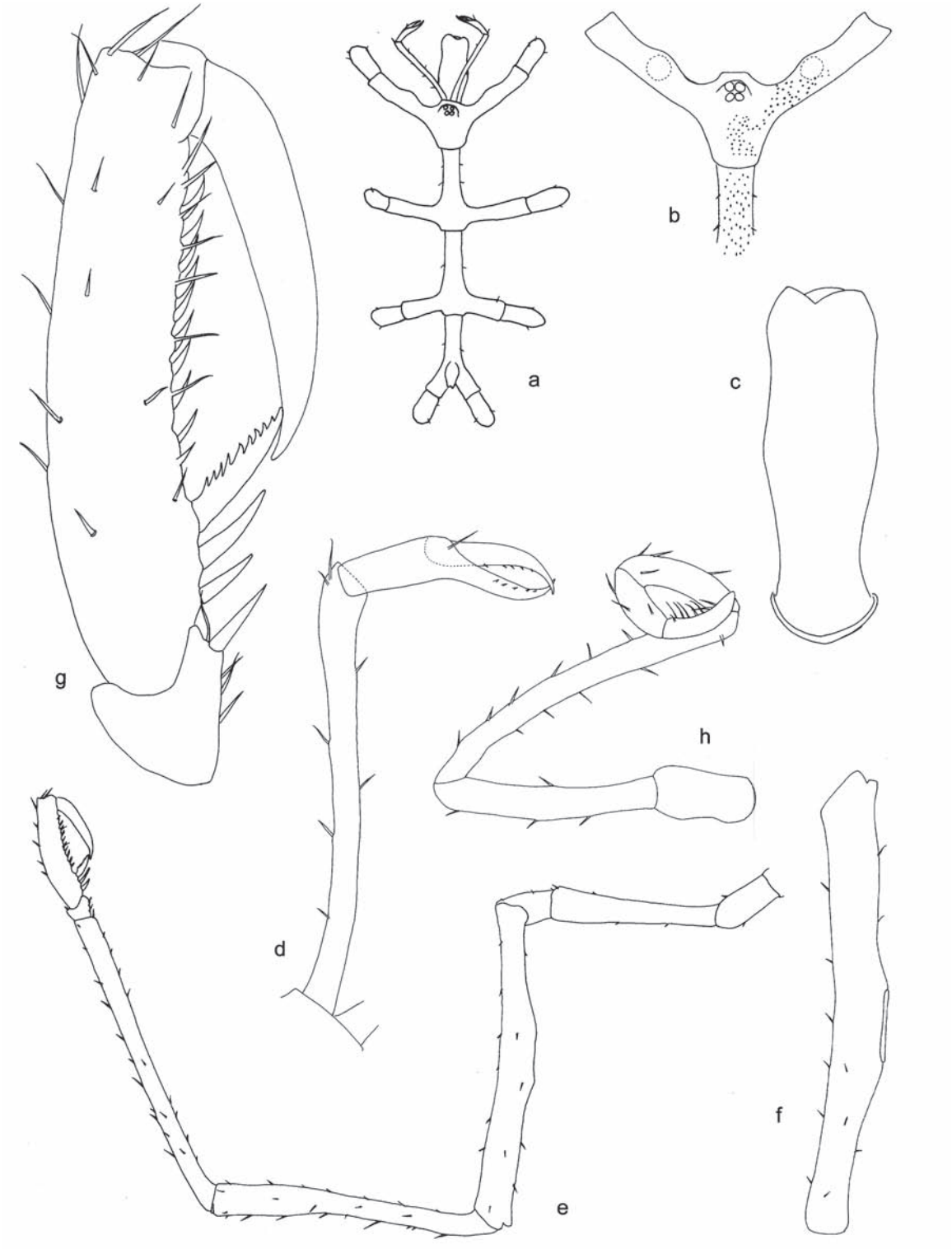

Fig. 4. *Anoplodactylus erythraeus* n. sp. Male (holotype) a) trunk (dorsal view); b) body segment 1; c) proboscis (ventral view); d) chelifore; e) leg 3; f) femur of leg 4; g) distal articles leg 3; h) oviger.

4. one prolonged slit-like cement gland opening against 5-9 mounds,
5. 3 distinct (against obliterated) body segment lines.

(See also Table 1 in Arango and Krapp 2007).

Measurements in mm: total length 2.17, length of body segments 1 - 4: 0.36, 0.63, 0.65, 0.53; length of proboscis 0.64, width of proboscis 0.22; lengths of articles of leg 3: coxa 1 = 0.31, coxa 2 = 0.77, coxa 3 = 0.25; femur 1.51, tibia 1 = 1.27, tibia 2 = 1.49; tarsus 0.06, propodus 0.53, lengths of the palp articles: basal 0.04, distal 0.33; lengths of the oviger articles 0.21, 0.47, 0.73, 0.25, 0.14, 0.18; width across 2nd lateral processes 1.13; distance between lateral processes 2 and 3: 0.45.

Members of this species group were recorded also from Aldabra Atoll and the Seychelles Islands by Child (1988b) and Arango (2003) from the Australian Great Barrier Reef. Child (1988b) identified some females as *A. attenuatus* based on habitus alone, this species was originally described by Child under that preoccupied name in his 1988a paper from the Philippines. In 1991 he had to change it to *tenuicorpus*. Arango (2003) applied this name also to her Great Barriere Reef material even if depicting clearly deviating characters. Evidently both authors relied mostly on the slender build and were not aware of Stock's (1994) paper in which he described *A. exaggeratus* as another related species.

Etymology: The species epithet is derived from the classical Greek erythros = red, and refers to the nearness of Socotra to the Red Sea, but mainly to the fact that the old Greeks called the sea region off the actual Eritrea the 'Red Sea'; only afterwards this denomination was extended to cover the entire present-day Red Sea. Needless to add that the country Eritrea derives its name from the same Greek word.

Anoplodactylus turbidus Stock, 1975

Stock 1974: 16 (nomen nudum, without description)
Stock 1975a: 1079-1080; figs. 56b-g
(Red Sea specimens only, fide Child 2002: 1816)
Stock 1975b: 133 (cf. det.)
Child 2002: 1816 (lit.)

Material: Shassara (12°37'40''N - 54°16'06"E), 8 September 2004, 1-2 m, 1 female with eggs ZMB 366 Bartolino and Mohammed Kaed leg.; Hadibo-Qadheb, 24 September 2004, 1-3 m, 1 female ZMB 365 Bartolino leg. Both from macro-algae and sparse massive hard corals and on rocks, relict reefs and large boulders.

Many small *Anoplodactylus*-species are ascribed to the *Anoplodactylus pygmaeus*-complex. It clusters closely similar species whose taxonomic identity is still uncertain. Among all these taxa we can roughly identify two groups on the presence or absence of auxiliary claws. The main species with auxiliaries are: *A. minutissimus* Stock, 1954, *A. micros* Bourdillon, 1955, *A. trispinosus* Stock, 1951 and *A. turbidus* Stock, 1975. The differences between these species are minute and easier to identify in males than females because their ovigers and the length and position of the cement gland are important identification characters. The toothed finger of chela and the presence of two spines in front of a long lamina on the propodal sole have brought us to the present identification. A certain degree of variability of several diagnostic characters has been previously observed for some species of the *A. pygmaeus* complex (Stock, 1951; Stock, 1964; Stock, 1975c). The presence of two strong spines on the propodal heel, sometimes reduced to only a single (unpaired) one, is for the first

Table 3. Some important characters distinguishing three attenuated *Anoplodactylus*-species in this complex (for the fourth one see Arango and Krapp, 2007).

characters	***A. tenuicorpus*** Child, 1991	***A. exaggeratus*** Stock, 1994	***A. erythraeus*** n. sp.
chela length	1/3 of scape	1/2 of scape	1/2 of scape
teeth number	3+3	5+3	4-5 + 5
teeth shape on chela	triangles	needles	needles
palm	2 × largest ø	3 × largest ø	2 × largest ø
cutting lamina	tiny, distal	absent	absent
sole spines	~ 5	~ 7	~ 9
crenulations (on sole spine)	7-8	12	9
oviger articles	6	7 (pseudoarticulation)	6
relative lengths	femur>tibia 2>tibia1	tibia 2 > tibia 1 > femur	tibia 2 > femur > tibia1
cement gland(s)	2 mounds	one mound	one slit

time mentioned for this species, as it was also recorded by Stock (1964) for *A. trispinosus*.

Several specimens from the Dahlak Archipelago (South Red Sea), previously identified as *A. trispinosus,* have been assigned to this species together with Ethiopian material after its description by Stock (1975). The same author reported 3 specimens from Madagascar in 1974.

Acknowledgements

The authors would like to thank the Environmental Protection Authority of Yemen for releasing the authorizations for the collection of samples. We are grateful to the Socotra Conservation and Development Programme for logistics and to Miles Davis and Mohammed Kaed Hassan Ali for their valuable help in the fieldwork. We thank the reviewers for their very helpful comments.

References

Arango CP. 2003. Sea spiders (Pycnogonida, Arthropoda) from the Great Barrier Reef, Australia: new species, new records and ecological annotations. *Journal of Natural History* 37: 2723-2772.

Arango CP, Krapp F. 2007. A new species of *Anoplodactylus* (Arthropoda: Pycnogonida) from the Great Barrier Reef and discussion on the *A. tenuicorpus*-complex. *Zootaxa* 1435: 19–24.

Arnaud F. 1973. Pycnogonides des rècifs coralliens de Madagascar. *Téthys* 4: 953-960.

Carbone F, Accordi G. 2000. The Indian Ocean Coast of Somalia. *Marine Pollution Bulletin* 41: 141-159.

Cheung C, DeVantier L. 2007. Socotra - A Natural History of the Islands and their People. Odyssey Books and Guides.

Child CA. 1970. Pycnogonida of the Smithsonian-Bredin Pacific Expedition, 1957. *Proceedings of the biological Society Washington* 83: 287-308.

Child CA. 1977. On some Pycnogonida of French Oceania. *Proceedings of the biological Society Washington* 90: 440-446.

Child CA. 1988a. Pycnogonida of the western Pacific Islands, III: Recent Smithsonian-Philippine expeditions. *Smithsonian Contributions to Zoology* 468: I-IV, 1-32.

Child CA. 1988b. Pycnogonida from Aldabra Atoll. *Bulletin of the biological Society Washington* 8: 45-78.

Child CA. 1996. Pycnogonida of the western Pacific Islands, XIII. Collections from Indonesia, Melanesia, and Micronesia. *Proceedings of the biological Society of Washington* 109: 540-559.

Child CA. 2002. Some Pycnogonida from the Eastern (Hasa) District of Saudi Arabia. *Journal of Natural History* 36: 1805-1821.

Hedgpeth JW. 1949. Report on the Pycnogonida collected by the Albatross in Japanese waters in 1900 and 1906. *Proceedings of the United States national Museum* 98 (3231): 233-321.

Kemp JM. 1998. Zoogeography of coral reef fishes of the Socotra Archipelago. *Journal of Biogeography* 25: 919-933.

Müller H-G. 1989a. Shallow-water Pycnogonida from coral reefs at Moorea, Society Islands, with description of *Rhynchothorax tiahurensis* n. sp. *Bonner zoologische Beiträge* 40: 123-139.

Müller H-G. 1989b. Pycnogonida from the Gulf of Aden, Northern Indian Ocean. *Senckenbergiana maritima* 20: 277-290.

Müller H-G. 1990. Shallow-water Pycnogonida from Kenya and Sri Lanka, with descriptions of three new species. *Bonner zoologische Beiträge* 41: 63-79.

Müller H-G. 1992. Pycnogonida from Malaysian coral reefs, including descriptions of three new species. *Bonner zoologische Beiträge* 43: 155-178.

Randall JE. 1996. *Coastal fishes of Oman*, pp. 439. Crawford House, Australia.

Randall JE and Hoover JP. 1995. *Scarus zhufar*, a new species of parrotfish from southern Oman, with comments on endemism of the area. *Copeia* 1995: 683-688.

Scheer G and Pillai CSG. 1983. Report on the stony corals of the Red Sea. *Zoologica Stuttgart* 133: 1-198.

Sheppard CRC, Price A, Roberts C. 1992. *Marine ecology of the Arabian region. Patterns and processes in extreme tropical environments*, pp. 359. Academic Press, London.

Sheppard CRC and Sheppard ALS. 1991. Corals and coral communities of Arabia. *Fauna Saudi Arabia* 12: 1-170.

Stock JH. 1951. 5. Pantopoda. Résultats Scientifiques des Croisiéres de la Navire-E'cole Belge Mercator. *Mémoires de l'Institut Royal des Sciences naturelles de Belgique* 43: 1-2.

Stock JH. 1952. Revision of the European representatives of the genus *Callipallene* Flynn. *Beaufortia* 1 (13): 1-15.

Stock JH. 1954. Pycnogonida from Indo-West Pacific, Australian and New Zealand Waters. *Videnskabelige Meddelelser fra Dansk naturhistorisk Foreningen* 116: 1-168.

Stock JH. 1957. Pycnogonida from the Gulf of Aqaba. *Bulletin Sea Fisheries Research Station, Haifa* 13: 13-14.

Stock JH. 1958. The Pycnogonida of the erythrean and of the Mediterranean coasts of Israel. Contributions to the knowledge of the Red Sea, 5. *Bulletin Sea Fisheries Research Station, Haifa* 16: 3-5.

Stock JH. 1959. On some south African Pycnogonida of the university of Cape Town ecological surveys. *Transactions of the Royal Society of South Africa* 35: 549-567.

Stock JH. 1964. Report on the Pycnogonida of the Israel South Red Sea Expedition. *Bulletin Sea Fisheries Research Station, Haifa* 35: 27-34.

Stock JH. 1974. Medio- and infralittoral Pycnogonida collected during the I.I.O.E. near the landbase of Nossi-Bé, Madagascar. *Bulletin Zoölogisch Museum, Universiteit van Amsterdam* 4 (3): 11-22.

Stock JH. 1975a. Infralittoral Pycnogonida from Tanzania. *Travaux du Muséum d'Histoire Naturelle "Grigore Antipa"* 16: 127-134.

Stock JH. 1975b. The pycnogonid genus *Propallene* Schimkewitsch, 1909. *Bulletin Zoölogisch Museum, Universiteit van Amsterdam* 4(11): 89-97.

Stock JH. 1975c. Pycnogonida from the continental shelf, slope and deep sea of the tropical Atlantic and East Pacific - Bio-

logical results of the University of Miami deep-sea expeditions, 108. *Bulletin of Marine Science* 24: 957-1092.
Stock JH. 1982. Researches on the coast of Somalia. Shallow-water pycnogonida. *Monitore Zoologico italiano* (N.S.) Suppl. 17: 183-190.
Stock JH. 1992. Littoral Pycnogonida from Oman. *Bijdragen tot de Dierkunde* 62: 81-98.
Stock JH. 1994. Indo-West Pacific Pycnogonida collected by some major oceanographic expeditions. *Beaufortia* 44: 17-77.

Received: 18 January 2007.
Accepted: 5 September 2007.