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A revision of the genus *Arenopontia* Kunz, 1937 (Copepoda, Harpacticoida, Arenopontiidae), including the description of five new species

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Abstract

A revision of the genus *Arenopontia* Kunz, 1937 (Harpacticoida, Arenopontiidae) is presented based on morphological examination of a wide range of material. The genus, as redefined herein, encompasses *A. subterranea* Kunz, 1937 (type species by monotypy), *A. problematica* Masry, 1970, *A. nesaie* Cottarelli, 1975 and *A. riedli* Lindgren, 1976, in addition to five new species from European waters: *A. adriatica* **sp. nov.**, *A. anatolica* **sp. nov.**, *A. basibuyuki* **sp. nov.**, *A. gunduzi* **sp. nov.** and *A. syltensis* **sp. nov.** *Arenopontia pontica* Apostolov, 1969 is considered unidentifiable and confirmed as a *species inquirenda*. The widely accepted notion that *A. subterranea* represents a cosmopolitan species displaying high intraspecific variability is rejected. Previous illustrated records attributed to the type species are critically reassessed and indicate that future examination of additional material from sandy beaches in the Northern Hemisphere will lead to further splintering of "*A. subterranea*" into a complex of cryptic lineages. *Arenopontia subterranea* and *A. syltensis* **sp. nov.** occur sympatrically on the Isle of Sylt while extensive sampling in the Black Sea revealed a similar overlap in distribution between *A. anatolica* **sp. nov.** and *A. basibuyuki* **sp. nov.** This study provides yet another example of how rigorous morphology-based analysis of pseudocosmopolitan taxa allows resolution of previously unrecognized cryptic status into multiple named species without recourse to molecular sequence data. A key to the nine valid species of *Arenopontia* is presented and distribution data for each species are collated.

Key words: *Arenopontia adriatica* **sp. nov.**, *A. anatolica* **sp. nov.**, *A. basibuyuki* **sp. nov.**, *A. gunduzi* **sp. nov.**, *A. syltensis* **sp. nov.**, identification key, interstitial copepods, pseudocosmopolitanism, sympatry, taxonomic revision

Introduction

Prior to the 1990s, cosmopolitanism was generally, although uncritically, accepted as a regular phenomenon in marine biogeography of harpacticoid copepods (Sewell 1940; Coull & Herman 1970; Wells 1967, 1986a, 1986b). Various dispersal mechanisms have been invoked to explain the long-distance transport and transoceanic distribution patterns of meiofaunal organisms, including harpacticoids (Gerlach 1977) but none seems to provide a plausible explanation for the extensive geographic ranges assumed for some species. Although some literature data appear to support the notion that some interstitial harpacticoids exhibit contemporary cosmopolitanism, we argue that there is currently no positive evidence that supports such a genuine, natural, and prehistorically (*i.e.* prior to the Anthropocene) global or extremely broad distribution ("eucosmopolitanism" *sensu* Darling & Carlton 2018) for this specialized group of copepods. Contemporary cosmopolitanism or transoceanic geographical patterns must be eyed with a healthy dose of skepticism for two reasons. Firstly, some interstitial taxa may have achieved extensive geographic ranges only through historical anthropogenic dispersal, often facilitated over centuries of human maritime traffic; however, there is as yet no demonstrable evidence underpinning such neocosmopolitanism. Secondly, some species for which a broad distribution has been accepted may remain cosmopolitan only so long as taxonomic uncertainty persists and is eventually resolved by detailed morphological scrutiny and/or molecular

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investigation. Such pseudocosmopolitan species typically reflect complexes of multiple geographically restricted or regionally endemic species. Given their small size and limited number of morphological characters, interstitial harpacticoids provide several examples of this category of cosmopolitanism, some of which have already been addressed in the recent literature. Huys (1992) showed that the generally accepted amphi-Atlantic distribution of *Leptastacus macronyx* (Scott, 1892) (Leptastacidae) was an artefact of previous ignorance compounded by excessive overrating of intraspecific variability. The presumed amphi-Atlantic and boreo-Mediterranean distribution patterns of *Leptopontia curvicauda* Scott, 1902 (Leptopontiidae) were tested by Huys & Conroy-Dalton (1996) who found them to be an illusory effect of overconservative taxonomy. Similarly, Huys & Conroy-Dalton's (2006) revision of *Evansula* Scott, 1906 (Cylindropsyllidae) highlighted that the genus consists of a complex of morphologically similar species, which may either occur sympatrically or are in fact geographically restricted provincials. Although Darling & Carlton (2018) advocated an integrated approach, ideally combining morphological and molecular approaches, to resolve pseudocosmopolitanism, the potential of sufficiently rigorous morphological analysis alone as an initial step in revealing previously unrecognized diversity, is often underestimated or totally neglected due to the application and success of increasingly sophisticated molecular genetic tools. Consequently, in most analyses of pseudocosmopolitanism, genetic inference of cryptic lineages unfortunately precedes availability of suggestive morphological data.

Probably one of the best examples illustrative of pseudocosmopolitanism in marine interstitial harpacticoids is *Arenopontia subterranea* Kunz, 1937, the type species of the family Arenopontiidae. Originally described from the Kiel Bay in Germany, the geographical distribution of *A. subterranea* now encompasses records from both seaboards of the North Atlantic, including the Baltic, Mediterranean and Black Sea, and from Madeira, the Indian subcontinent and Andaman archipelago, and Mozambique. Inspired by previous unfounded reports of variability in Biscayan (Noodt 1955a) and Mediterranean (Chappuis 1954b) "populations" of the species, subsequent authors (*e.g.* Lindgren 1976; Rao 1980; Wells 1967, 1986a, 1986b) added to the taxonomic confusion by declaring that *A. subterranea* represents a cosmopolitan species that displays a high level of intraspecific variability. This misconception stems from failure to discriminate between closely related species compounded by previously undetected cases of sympatry in well-studied areas such as the Isle of Sylt and the Black Sea basin.

The latest genus-level revision of the Arenopontiidae (Sak *et al.* 2008: Table 2) reallocated 25 species that had previously been accommodated in *Arenopontia* to the remaining four genera of the family: *i.e. Psammoleptastacus* Pennak, 1942; *Neoleptastacus* Nicholls, 1945; *Mesopontia* Sak, Huys & Karaytuğ, 2008; and *Onychopontia* Sak, Huys & Karaytuğ, 2008. In addition, a few species that had formerly been assigned to the genus *Arenopontia* were removed from the Arenopontiidae to other interstitial families. These include *Arenopontia* sp. *sensu* Griga (1964) (now in *Stenocaropsis* Apostolov, 1982 in the Cylindropsyllidae; *cf.* Marinov 1974; Apostolov 1982), *A. biarticulata* Wells, 1967 (now in *Notopontia* Bodiou, 1977 in the Leptopontiidae; *cf*. Bodiou & Colomines 1986) and *Arenopontia* sp. A *sensu* Willems *et al.* (1982) (now in *Boreopontia* Willems, 1981 in the Cylindropsyllidae; *cf.* Willems 1981). Sak *et al.* (2008) recognized four valid species in the genus *Arenopontia*, however, other as yet undescribed species are known to exist. For example, Giere (1979) and Bodin (1988) had previously reported an unidentified species from sandy beaches near La Coruña (northwestern Spain) and along the northern Finistère coast, Brittany (France), respectively. New *Arenopontia* species have also been recorded from off the Dutch (Smol *et al.* 1989; Huys & De Smet 1991) and Belgian (Herman *et al.* 1986) coasts in the North Sea while Willems *et al.* (2009) cited an as yet undescribed species of *Arenopontia* from subtidal sandy shell gravel in the Koster area near the island of Tjärnö, Sweden. Packmor & George (2018) recorded *Arenopontia* sp. 1 from the littoral zone in Madeira and Porto Santo. Recently, Metin *et al.* (2022) reported an unidentified species from the Gulf of Saros in the Aegean Sea. Indian Ocean records include those by Rao & Ganapati (1966, 1968b) and Rao (1975, 1987) who found an unidentified species in intertidal sand on Palm Beach in Visakhapatnam (formerly Waltair), India and on several islands of the Andaman archipelago, respectively. Vijaya Bhanu *et al.* (2017) and Rao & Misra (1983) listed *Arenopontia* sp. from subtidal sediments in Nizampatnam Bay in the Bay of Bengal and from sandy beaches on the Minicoy Atoll, Lakshadweep (formerly Laccadive Archipelago) but it is not clear whether these Indian records refer to *Arenopontia* or *Neoleptastacus*. Messana *et al.* (1978) recorded *Arenopontia* sp. from coralline sand on Malé Atoll, Maldives. The genus has also been reported in the Southern Hemisphere. An unidentified *Arenopontia* species was recorded as the most abundant harpacticoid in two sandy beaches in Algoa Bay in South Africa by McLachlan & Furstenberg (1977). Rocha *et al.* (2011) discovered three new intertidal species along the northern coast of São Paulo State in Brazil. Except for these two records and a single unconfirmed outlier of *A. subterranea*

from Mozambique (Wells 1967), the genus *Arenopontia* appears to be restricted to the Northern Hemisphere. In this report five new species are added from European waters and previous illustrated records of the type species, *A. subterranea*, are critically reassessed.

Material and methods

Samples in France, Germany, Italy and Türkiye were collected using the Karaman-Chappuis method (Delamare Deboutteville 1953b). Specimens were cleared in lactic acid and dissected in lactophenol. Dissected parts were mounted on slides in lactophenol mounting medium. Broken glass fibres were added to prevent the animal and appendages from being compressed by the coverslip and to facilitate rotation and manipulation, allowing observation from all angles. Preparations were sealed with Entellan® (Merck). All drawings have been prepared using a camera lucida on an Olympus BX-50 or Leica DMR differential interference contrast microscope. Measurements were made with an ocular micrometer. Total body length was measured from the anterior margin of the rostrum to the posterior margin of the caudal rami. Scale bars in illustrations are in µm. The descriptive terminology is adopted from Huys *et al.* (1996). Abbreviations used in the text, figures and table are: *ae*, aesthetasc; *P1–P6*, for swimming legs 1–6; *exp (enp)-1 (-2–3)* to denote the proximal (middle, distal) segment of a ramus; *CR*, for caudal ramus; *An Op*, for anal operculum; *L*, for length. The term 'acrothek' denotes the trifid setal structure typically found on the apical margin of the distal antennulary segment (Huys & Iliffe 1998). Type material was deposited in the Natural History Museum, London (NHM) and the Balıkesir University Zoology Museum (BUZM).

Systematics

Family Arenopontiidae Martínez Arbizu & Moura, 1994

No new species or illustrated records have been added since Sak *et al.* (2008). Readers are advised to consult this publication for a review of the taxonomic history of the family and its current generic composition. A revision of the most species-rich genus, *Neoleptastacus* Nicholls, 1945, will be published elsewhere (Sak *et al.* in prep.).

Although members of the Arenopontiidae are predominantly littoral, inhabiting sandy beaches in both the Northern and Southern Hemispheres, some species have occasionally been reported from subtidal habitats, particularly in northwestern Europe (*e.g.* Van Damme & Heip 1976; Herman *et al.* 1986; Smol *et al.* 1989; Huys *et al.* 1992; Bonne 2003; Willems *et al.* 2009). One extreme example is the discovery of *Psammoleptastacus arenaridus* Pennak, 1942 at a depth of 100 m north of Cape Hatteras off the coast of North Carolina (Coull 1971) but this record requires verification. Except for the Parastenocarididae which inhabit fresh groundwater, harpacticoid families that accommodate exclusively interstitial species are typically restricted to the marine environment. This habitat preference primarily applies also to the Arenopontiidae although some members of *Arenopontia* have occasionally been reported to make incursions into freshwater and oligohaline habitats. Noodt (1962) recorded an unidentified species of *Arenopontia* from a primarily oligohaline lake near La Libertad in El Salvador while Cottarelli *et al.* (1994, 1998) collected *A.* cfr. *subterranea* from a number of localities with freshwater influence in the Latium and Viterbo provinces in Italy.

Genus *Arenopontia* Kunz, 1937

Diagnosis (adapted from Sak *et al.* 2008). Arenopontiidae. Urosomites without conspicuous surface ornamentation. Anal somite without paired dorsolateral spinous processes. Anal operculum not modified. Hyaline frills of abdominal somites with rectangular digitate lappets. Caudal ramus with dorsolateral spur or raised spinular row near medial margin. P1 exopod three-segmented; exp-1 with outer spine; exp-2 without outer element; exp-3 with two spines, one outer distal geniculate seta and one inner distal penicillate seta. P1 endopod prehensile, longer than exopod; enp-1 elongate and distinctly longer than exopod; enp-2 with one outer distal spine and one inner distal geniculate claw. P2–P3 endopods two-segmented. P3 endopod with outer distal element not defined at base or absent. P4 endopod with well developed outer distal element. Armature formula as follows:

	Exopod	Endopod
P2	0.0.021	0.110 or 0.120
P3	0.0.021	0.010 or 0.020
P4	0.0.021	0.020

P3 endopod ♂ not sexually dimorphic, two-segmented. P5 with outer basal seta and three–four discrete elements; innermost one distinctly smaller in ♂. P6 ♂ with one–two seta(e).

Type species. *Arenopontia subterranea* Kunz, 1937 [by monotypy].

Other species. *A. problematica* Masry, 1970; *A. nesaie* Cottarelli, 1975; *A. riedli* Lindgren, 1976; *A. anatolica* **sp. nov.**; *A. adriatica* **sp. nov.**; *A. basibuyuki* **sp. nov.**; *A. gunduzi* **sp. nov.**; *A. syltensis* **sp. nov.**

Species inquirenda. *A. pontica* Apostolov, 1969.

Taxa of doubtful identity. *Arenopontia subterranea* Kunz, 1937 *sensu* Chappuis (1954a); *A. subterranea* Kunz, 1937 *sensu* Chappuis (1954b); *A. subterranea* Kunz, 1937 *sensu* Şerban (1959); *A. subterranea* Kunz, 1937 *sensu* Rao & Ganapati (1969); *A. subterranea* Kunz, 1937 *sensu* Marinov (1971); *A. subterranea* Kunz, 1937 *sensu* Apostolov (1973); *A. subterranea* Kunz, 1937 *sensu* Cottarelli (1975); *A. subterranea* Kunz, 1937 *sensu* Lindgren (1976); *A. subterranea* Kunz, 1937 *sensu* Arlt (1983); *A. subterranea* Kunz, 1937 *sensu* Rao (1991); *A. nesaie* Cottarelli, 1975 *sensu* Mitwally & Montagna (2001).

Nomina nuda. "*Arenopontia subterranea* Kunz, 1937?" *sensu* Şerban & Eitel-Lang (1957); *Arenopontia ciplaki* Sak, 2004; *A. daltonae* Sak, 2004.

Etymology. The generic name is derived from the Latin *arena*, meaning sand, and the Greek *πόντος*, meaning sea. Gender: feminine.

TABLE 1. Morphological characters differentiating species of *Arenopontia*. P1 (enp-1:exp length ratio), P1 enp-1 (length: width ratio), P5 ♀ and P6 ♂ (number of armature elements), CR (ornamentation of caudal rami), An Op (ornamentation of anal operculum). Group I = species with 0–1 spatulate seta(e) on apical segment of antennule, three groups of spinules along outer margin of P1 enp-1, and two elements on ♂ P6; Group II = species with two spatulate setae on apical segment of antennule, single large spinule near outer distal corner of P1 enp-1, and one element on ♂ P6.

	P1	P1 enp-1	P2 enp	P3 enp	P5 ♀	P6 ♂	CR	An Op
Group I								
riedli	1.4	7.0	0.120	0.020	5	2	spur	smooth ?
syltensis	1.8	11.0	0.110	0.010	5	2	spinules	spinulose
anatolica	1.3	5.0	0.110	0.010	4	2	spinules	pinnate
adriatica	1.7	8.5	0.110	0.010	4	?	spinules	pinnate
subterranea	1.5 [a]	6.3 [a]	0.110	0.010	4	2? [b]	spinules	smooth ?
problematica	1.7 [c]	6.9	0.110 [d]	0.010 [d]	4	2? [b]	spinules	smooth ?
Group II								
gunduzi	1.7	8.0	0.110	0.010	4	1	spur	pinnate
nesaie	2.0	9.6	0.110	0.010	4	1	spur	pinnate
basibuyuki	2.2	10.0	0.110	0.010	5	1	spinules	pinnate

[a] Based on Kunz (1937: Abb. 9–Fig. 43).

[b] According to Kunz (1937) and Masry (1970) the P6 is represented by a minute plate bearing three elements but it is conceivable that their claims are based on observational errors.

[c] Based on Sak's (2004) redescription and present account.

[d] Masry (1970) erroneously claimed that there are two distal elements on P2–P3 enp-2.

The nine species recognized here as valid can be assigned to two groups based on the ornamentation of the proximal endopodal segment of P1 (Table 1). In Group I the outer margin of P1 enp-1 shows three sets of (typically two, occasionally three) spinules which are more or less evenly distributed along the length of the segment (*e.g.* Figs 1A; 4A; 12A; 20A). In Group II the ornamentation on P1 enp-1 consists of a single prominent spinule positioned near the outer distal corner of the segment (*e.g.* Figs 10A; 15A). Members of Group I are also characterized by the presence of 0–1 spatulate element(s) on the apical segment of the antennule in both sexes, and two elements on the male P6. In Group II the terminal antennulary segment displays two spatulate setae and the male sixth legs exhibit only one seta. None of the three characters employed to define these groups is known to show variability. Although the phylogenetic significance of this division cannot be tested at present it serves as a useful working model to discuss morphological relationships of taxa of doubtful identity, particularly when only few illustrations (*e.g.* P1) are available.

Arenopontia subterranea Kunz, 1937

Arenopontia (*Arenopontia*) *subterranea* Kunz, 1937: Wells (1967: 324)

Original description. Kunz (1937): 107–110; Abb. 8 (Figures 38–42), 9 (Figures 43–47), 10 (Figures 48–51).
Additional descriptions. Mielke (1975): 109–110; Abb. 73. Martínez Arbizu & Moura (1994): 64; Fig. 3a, c.

Type locality. Germany, Kieler Förde, Schilksee; intertidal coastal groundwater ("Küstengrundwasser").

Body length. 380 µm (♀) [Kunz, 1937]; 300 µm (♀), up to 390 µm (♂) [Noodt, 1952]; 310–430 µm (♀), 280–400 µm (♂) [Mielke, 1975].

Remarks. *Arenopontia subterranea* is morphologically close to *A. problematica* and *A. adriatica* **sp. nov.** All three species can be differentiated from one another by morphometric differences displayed by the P1 endopod (Table 1). According to Mielke (1975: Abb. 73A), the female P5 has a minute dentiform projection at its distal margin, possibly representing a vestige of the fourth seta that is expressed in *A. riedli*, *A. basibuyuki* **sp. nov.** and *A. syltensis* **sp. nov.** Although this feature has not been reported in any other *Arenopontia* species, confirmation of its consistent presence in a larger sample is required before its significance as a diagnostic character can be corroborated.

The type material of *Arenopontia subterranea* no longer exists since Kunz's pre-1940 copepod collections that were deposited at the Institut für Meereskunde in Kiel were destroyed in 1944 during World War II (Schriever 1984). Despite several sampling efforts in German waters, we have been unable to obtain topotype or other material that could be positively attributed to *A. subterranea*. The discovery of a closely related species, *A. syltensis* **sp. nov.**, from the Isle of Sylt also casts further doubt on the validity of certain German records and indeed most northwestern European reports of the species. As pointed out by Sak *et al.* (2008), the problem is exacerbated by Arlt's (1983) discovery of a female specimen from the Baltic which was identified as *A. subterranea*. His illustrations indicate that he was dealing with a different species (see below), raising the suspicion that not all records east of the Skagerrak can be attributed to the type species with confidence. *Arenopontia subterranea* has not only been reported throughout Europe from the Baltic to the Black Sea basin. Additional unverified records from Madeira, the Indian subcontinent, Mozambique and both North and South Carolina have led to the suggestion that this species is potentially cosmopolitan (Lindgren 1972, 1976; Rao 1980; Wells 1967, 1986). Lindgren (1976) claimed that it is conceivable that its geographical range will be extended even further when more sandy intertidal habitats become surveyed in the Pacific. The great majority of the published records of *A. subterranea* are not accompanied by illustrations that could confirm their authenticity. This unfortunate state of affairs stems from the fact that many authors have identified their material with *A. subterranea*, assuming that this species displays extensive intraspecific variability. Faced with this widely adopted misconception we have elected to take a critical stance in accepting records as sufficiently reliable. The true range of the species is as yet unknown but it is likely to be restricted to northwestern Europe where it occurs sympatrically with other congeners such as *A. syltensis* **sp. nov.**

Reliable records

Germany: (1) North Sea coast: Isle of Sylt (Noodt 1952, 1956, 1957; Mielke 1975, 1976), Amrum (Noodt 1956, 1957), Sankt Peter-Ording (Noodt 1956), Helgoland (Martínez Arbizu & Moura 1994); Jade Bay (Rose & Seifried 2006); Wangerooge

Island (Segelken-Voigt *et al.* 2018). (2) Kieler Bucht (Kiel Bay): Schilksee (Kunz 1937; Noodt 1956), Bottsand, Gelting Birk, Weißenhaus and Heiligenhafen (Noodt 1956, 1957).

Unconfirmed records

Scotland: River Ythan, Aberdeenshire (Goodman 1980; Hockin 1981, 1982a–d, 1983; Hockin & Ollason 1981), Irvine Bay in Firth of Clyde (McIntyre 1977), Loch Ewe (McIntyre *et al.* 1970; McIntyre & Murison 1973), Firth of Forth (Read *et al.* 1983).
England: Isle of Man (Moore 1979), Whitsand Bay, Cornwall (Harris 1972), River Exe estuary (Wells 1963; Joint *et al.* 1982; Gee 1987), St. Martin's, Isles of Scilly (Wells 1961, 1970).
Southern Bight of North Sea (Van Damme & Heip 1976).
The Netherlands: Oosterschelde (Smol 1986).
France: Wissant, Manche (Renaud-Debyser & Salvat 1963), Kersaint, Finistère (Bodin 1988; Le Guellec 1988), Bassin d'Arcachon, Gironde (Renaud-Debyser 1963a–b, 1964; Renaud-Debyser & Salvat 1963), Mimizan-Plage and Lacanau-Océan, Landes (Noodt 1955a–b; Delamare Deboutteville 1960a; Delamare Deboutteville *et al.* 1955).
Spain: Tarragona (Chappuis 1954b; Delamare Deboutteville 1954).
Portugal: Praia do Norte, Praia de Banhos and Fuseta, Peniche (Wells & Clark 1965), Francelos, south of Porto (Galhano 1970).

False records

Madeira: Cap São Lourenço (Delamare Deboutteville 1960b).
France: Canet-Plage, Roussillon (Chappuis 1954a; Delamare Deboutteville 1955, 1960a), La Rochelle (Bodin 1968a), Cannes (Kunz 1975).
Italy: Fregene (Latium), Sestri Levante (Gulf of Genoa) (Chappuis 1954b; Delamare Deboutteville 1960a), near Porto S. Stefano (Tuscany) (Cottarelli 1973), Sardinia (Cottarelli 1975), Isola Budelli (Arcipelago de La Maddalena), Isola Tavolara and Isola di San Pietro (Cottarelli & Venanzetti 1989).
Algeria: Annaba (= Bône), Bou Zadjar, El Kala (= La Calle), Skikda (= Philippeville) (Chappuis 1954b; Delamare Deboutteville 1953c, 1960a).
Tunisia: Sousse and Reyville (Chappuis 1954b; Delamare Deboutteville 1953a, 1960a).
Türkiye: Sea of Marmara (Noodt 1955c), Datça-Bozburun Peninsula, Muğla (Alper 2009; Alper *et al.* 2010).
Greece: Crete, Elafonisi Beach and Pahia Ammos (Sevastou 2005; Sevastou *et al.* 2011).
Bulgaria: Varna (Apostolov 1970, 1971), locality not specified (Marinov 1971; Apostolov 1973), Arkutino (Michailova & Voinova-Stavreva 1971).
Rumania: Agigea (Şerban 1959; Georgescu *et al.* 1962), unknown locality (Samargiu 2010).
Ukraine: Odessa Bay (Vorobjeva 1984).
Mozambique: Inhaca Island (Wells 1967).
India: Visakhapatnam (formerly Waltair) coast, Andhra Pradesh (Rao 1967, 1968; Rao & Ganapati 1966, 1968a–b, 1969), Puri and Konarak, Odisha (formerly Orissa) (Rao 1970, 1989; Nagabhushanam 1972), Andaman Islands (Rao 1975, 1980), Agatti and Kavaratti, Lakshadweep (Laccadive Archipelago) (Rao & Misra 1983; Rao 1991), Chennai coast (Mantha *et al.* 2012), Manamelkudi in Palk Bay (Sugumaran & Padmasai 2019).
U.S.A.: North Carolina (Lindgren 1972, 1976), South Carolina (Coull & Dudley 1985).

Mielke (1975) provided a brief redescription, confirming the armature pattern of the swimming legs and providing illustrations of the P1, fifth leg of both sexes and the caudal ramus in dorsal aspect. His population from the Isle of Sylt displayed variability in the caudal ramus (shape), P5 (sometimes with 5 elements instead of 4) and anal operculum (sometimes with large spinules). These observations suggest that he was probably dealing with an amalgam of two or more species (most likely including *A. syltensis* **sp. nov.**—see below) since we did not observe such variability in any of the species we examined. Mielke (1975) also reported variability in egg-sac arrangement (uni- or multiseriate) but according to Noodt (1952), who found the species in four localities on the Isle of Sylt, the oval egg-sac contains seven eggs, suggesting they were not arranged in a uniseriate way. We had no ovigerous females at our disposal to confirm the condition in *A. syltensis* **sp. nov.** Mielke (1976) provided data on the length of the reproductive phase, horizontal zonation and vertical distribution but these data might have been pooled from populations of sympatric *Arenopontia* species. Goodman (1980) estimated the individual dry weight for males and non-gravid females (0.76 + 0.02 μg) and ovigerous females (1.00 + 0.03 μg) but the authenticity of his

Scottish material from the River Ythan remains to be confirmed. Lindgren (1976) cited Bodin's (1968b) paper on deep-sea harpacticoids from the Golfe of Gascogne as the source of a record of *A. subterranea*, but this must be an error. Bodin (1968a) refers to an unconfirmed record from La Rochelle which was probably Lindgren's intended citation.

Arenopontia problematica Masry, 1970
(Fig. 1)

Arenopontia (*Arenopontia*) *problematica* Masry, 1970: Bodin (1979: 124)

Original description. Masry (1970): 249–251; Fig. 12.

Type locality. Israel, Levantine coast. Masry (1970) did not explicitly designate a type locality but mentioned that he collected material in five different sites: Nitzanim, Mikhmoret, Palmahim, Yel Yavne and south of Tel-Shiqmona. The latter site was labelled on the holotype slide and is consequently designated as the type locality (ICZN Art. 76.1).

Material examined. Hebrew University, Jerusalem: damaged holotype ♀ mounted *in toto* on slide.

Partial redescription of female. Total body length from tip of rostrum to posterior margin of caudal rami 277 μm [290–320 μm according to Masry (1970)]. Hyaline frills unconfirmed but probably like in other species of the genus (thoracic ones weakly developed and crenulated, abdominal ones consisting of rectangular digitate lappets).

Caudal ramus (Fig. 1F) short, 1.7 times longer than wide (measured in lateral view from anterior margin to apex of spinous process), tapering posteriorly; with a pore laterally; outer distal corner produced into posteriorly directed recurved spinous process, accompanied at base by outer spinular row; dorsal surface without spur-like process but with row of strong spinules near inner margin. Armature consisting of seven setae; seta I small; setae II and III long and naked; seta IV short, located between seta V and spinous process; seta V long and with fracture plane; seta VI small, naked and located at inner distal corner; seta VII distinctly foliaceous and tri-articulate at base.

Antennule (Fig. 1E) short, six-segmented. Segment 1 with a short seta near anterodistal margin. Segment 2 longest, about twice longer than maximum width. Segment 4 with long aesthetasc (L: 25 μm) fused at base with seta. Distal segment with seven naked setae (none of which clearly spatulate) and apical acrothek consisting of short aesthetasc (L: 15 μm) and two slender setae. Armature formula: 1-[1], 2-[7 + 1 plumose], 3-[4], 4-[(1 + ae)], 5-[1], 6-[7 + acrothek].

Antenna (Fig. 1G). Coxa (not figured) small, without ornamentation. Allobasis about 2.6 times as long as maximum width; original basis-endopod boundary marked by partial transverse spinule row; with fine spinules along exopodal margin as figured. Exopod one-segmented, elongate, with short naked apical seta (about 1.5 times longer than exopod). Free endopod with two spinular rows on anterior surface and finer spinules at outer distal corner; medial armature consisting of two short spines; apical armature consisting of two spines and three geniculate setae, strongest of which with spinules around geniculation and fused basally to tiny accessory seta.

The detailed morphology of the mouthparts and maxillipeds could not be discerned in the mounted specimen.

P1 (Fig. 1A). Basis with spinular row near bases of endopod and exopod; anterior surface with a small inner seta. Exopod three-segmented; exp-1 and -2 with spinules around outer margin; exp-1 longest, with long bare outer spine; exp-2 without outer element; exp-3 with short unipinnate outer spine, a long curved unipinnate spine and one geniculate seta distally, and one inner, apically penicillate seta subdistally. Endopod two-segmented, prehensile; enp-1 6.9 times longer than wide, and about 1.68 times longer than exopod; with a serrate inner seta in proximal third, and three pairs of spinules along outer margin; enp-2 slightly longer than wide, with a short unipinnate spine, a geniculate claw and a small inner spinule.

P2–P4 (Fig. 1B–D). Bases with a spinular row near base of endopod (P3–P4; not figured for P3) and outer distal corner (P2, P4); outer basal seta absent (P2), plumose (P3) or naked (P4). Exopods three-segmented; segments with spinular ornamentation as figured; inner distal seta of exp-3 sparsely bipinnate, all other elements unipinnate; hyaline frills of exp-1 and -2 well developed; exp-2 with lateral pore halfway down inner margin length; P3–P4 exp-3 with anterior surface pore. Endopods two-segmented; P2–P4 enp-1 about 1.7, 1.9 and 3.3 times longer than their respective distal endopodal segments, with few spinules as figured. P2 enp-2 with a long, apically serrate, posteriorly oriented seta near inner margin and a long, sparsely pinnate distal seta. P3 enp-2 with a long bipinnate

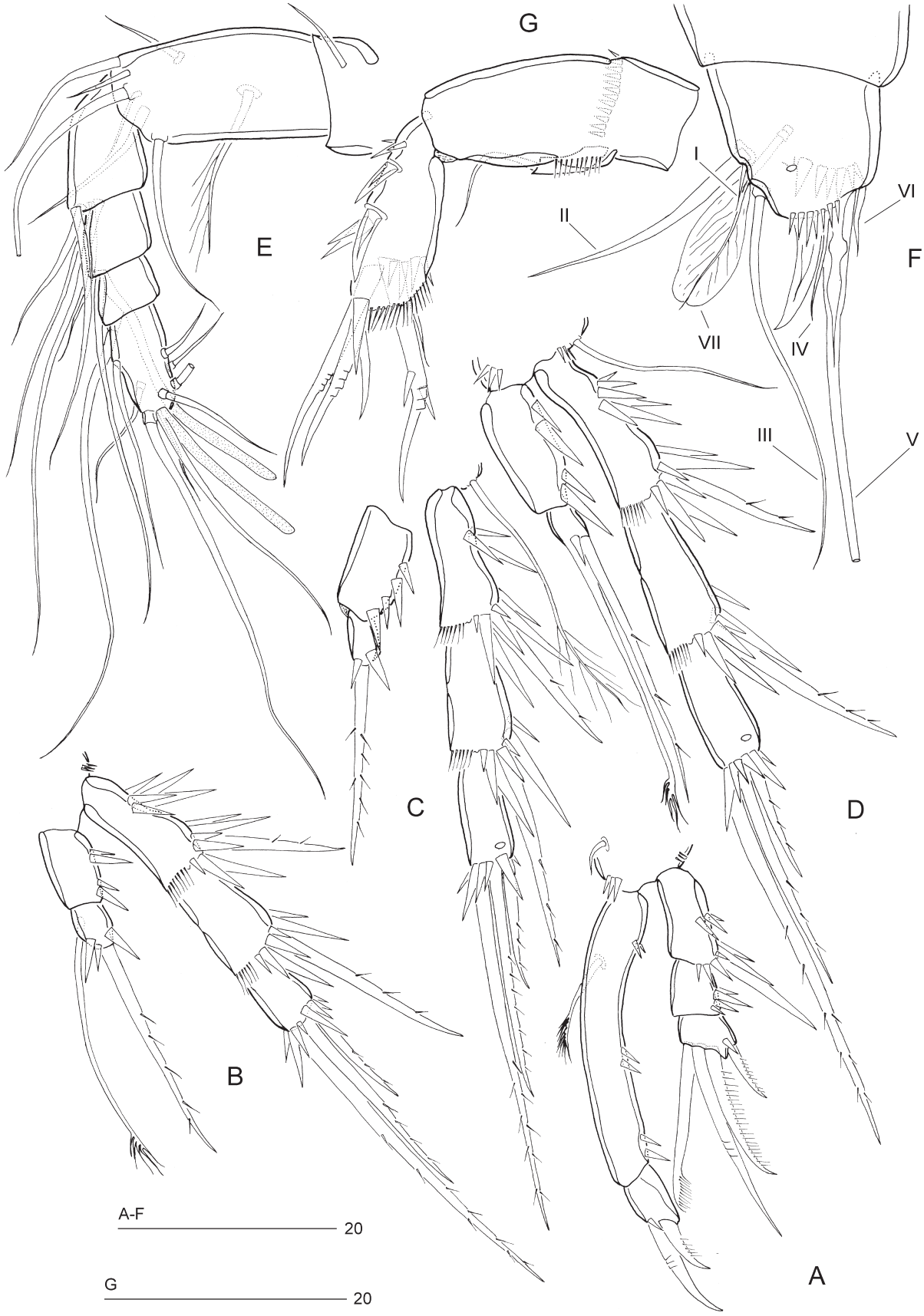

FIGURE 1. *Arenopontia problematica* Masry, 1970 (♀): (A) P1, anterior [coxa omitted]; (B) P2, anterior [protopod omitted]; (C) P3, anterior [protopod omitted]; (D) P4, anterior [protopod largely omitted]; (E) antennule, dorsal; (F) right caudal ramus, lateral; (G) antenna [coxa omitted].

seta distally. P4 enp-2 minute, with a basally fused, apically serrate seta, and long unipinnate seta at outer distal corner. Spine and seta formula as follows:

	Exopod	Endopod
P2	0.0.021	0.110
P3	0.0.021	0.010
P4	0.0.021	0.020

The structure of the P5 and genital field could not be observed in the badly preserved holotype.

Remarks. Our re-examination of the holotype showed that Masry's (1970) illustrations and text contain several significant errors, invalidating most of his criteria proposed to separate *A. problematica* and *A. subterranea*: (1) the author claimed that the female antennule is only five-segmented with a single, very long aesthetasc arising from the annulated apical segment; in reality, the antennule in *A. problematica* displays the typical arenopontiid pattern, being six-segmented with aesthetacs on segments 4 and 6 and no subdivisions of the apical segment (Fig. 1E); (2) the antennary exopod, claimed to be absent, was overlooked (Fig. 1G); (3) the innermost seta on P1 exp-3 is distally penicillate and not pinnate (Fig. 1A); (4) the inner serrate seta on P1 enp-1 was overlooked (Fig. 1A); (5) contrary to Masry's Figure 62, the P2 basis does not have an outer seta (Fig. 1B); (6) P2 enp-2 has one apical seta instead of two (the short outer one illustrated in his Figure 62 is a spinule (Fig. 1B)); (7) P3 enp-2 has one apical seta instead of two, the short outer one figured by Masry being a spinule (and in reality much shorter; Fig. 1C); (8) P4 exp-3 has only one outer spine instead of two (Fig. 1D); Masry (1970) lists two elements in the armature formula and illustrates two in his Figure 64; for this reason *A. problematica* keys out to the wrong codon in Wells' (2007: 188) key; and (9) caudal seta VII is clearly foliaceous. In addition, his claim that the male P6 bears three spines is almost certainly wrong since the maximum number of armature elements observed in any arenopontiid is two. The female P5 displays a deep incision along its free distal margin; this unique morphology could not be confirmed due to the bad condition of the holotype. Masry (1970) also states that the posterior margins of all body somites are smooth but this is highly unlikely given that the hyaline frills of the abdominal somites have rectangular digitate or nondigitate lappets in all other members of the family.

Arenopontia problematica is extremely close to *A. subterranea*, differing only in body size (the former being smaller), the morphology of the female P5 (unknown in the male) and the relatively shorter P2–P4 enp-1 and caudal ramus. A proper redescription of the fifth legs and the male are required before potential conspecificity with *A. subterranea* can be ruled out. The species is known only from the Israeli coast and has not been recorded again since its original description. According to Masry (1970), females (95%) greatly outnumbered males.

Arenopontia nesaie Cottarelli, 1975

Arenopontia (*Arenopontia*) *nesaie* Cottarelli, 1975: Bodin (1979: 124)
Arenopontia nesiae Cottarelli, 1975: Martínez Arbizu & Moura (1994: 57), Wells (2007: 55, 192) [*lapsus calami*]
Arenopontia nessiae Cottarelli, 1975: Martínez Arbizu & Moura (1994: 63) [*lapsus calami*]
Arenopontia ciplaki: *nomen nudum* in Sak (2004: 117)

Original description. Cottarelli (1975): 65–70; Figs 1–11, 13–16, 18–19, 21–23.

Additional description. Sak *et al.* (2008: 414–420; Figs 1–5).

Type locality. Italy, Sardinia, near Cagliari, Bay of Quartu S. Elena, Poetto beach.

Remarks. Wells (2007) pointed out that many of the arguments used by Cottarelli (1975) to distinguish *A. nesiae* from *A. subterranea* were based on a comparison with very inadequately described aspects of *A. subterranea*. Both sexes of this species were recently redescribed in detail by Sak *et al.* (2008), based on material from Dutlimanı beach (Sea of Marmara, Türkiye). They noted minute differences with Cottarelli's (1975) type material from Sardinia, Italy, and considered Mitwally & Montagna's (2001) Egyptian population, identified as *A. nesaie*, a taxon of doubtful identity (see below). The species is widespread in the Mediterranean from the Spanish east coast to at least Crete and the Turkish west coast (Cottarelli 1975; Martínez Arbizu & Moura 1994; Bruno *et al.* 1998; Sak 2004; Lampadariou *et al.* 2005; Sevastou 2005; Sak *et al.* 2008; Sevastou *et al.* 2011; Alper *et al.* 2015; Metin *et al.* 2022).

Arenopontia nesaie is most closely related to *A. gunduzi* **sp. nov.** (known only from the Pas-de-Calais region, France) with which it shares the dorsal spur on the caudal ramus and the armature formula of P2–P6. It differs from this species in the longer P1 endopod, the shorter P4 enp-1 (being distinctly shorter than P4 exp-1 instead of equally long), the innermost element on the fifth legs of both sexes being longer and more slender, and the relatively longer posterior spinous process on the caudal ramus. *Arenopontia subterranea* lacks the dorsal spur on the caudal ramus and has a distinctly shorter P1 endopod (enp-1:exp = 1.5 *vs* 2.0 in *A. nesaie* and 1.7 in *A. gunduzi* **sp. nov.**). It is conceivable that Bonne's (2003) record of *A. nesaie* from the Kwinte Bank off the Belgian coast refers to *A. gunduzi* **sp. nov.**

Arenopontia riedli Lindgren, 1976

Arenopontia (*Arenopontia*) *riedli* Lindgren, 1976: Bodin (1979: 124)

Original description. Lindgren (1976): 233–238; Figs 3–5.

Type locality. U.S.A., North Carolina, near Morehead City, west of Ocean Steamer Pier on the oceanic side of Bogue Bank (76°50'00" W, 34°41'30" N); fully exposed high-energy sandy beach.

Material examined. None. According to Lindgren (1976) the type material of *A. riedli* was deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C. but subsequent attempts to trace it failed (T. C. Walter, pers. comm.).

Remarks. This species [body length: 390 µm (♀), 350 µm (♂)] can readily be distinguished from its congeners by the most primitive armature on P2–P3 enp-2 (Table 1). Lindgren (1976) stated that P1 exp-3 has "... three geniculate setae and one spine" but his illustration shows the typical armature for the genus, except that the innermost element is not penicillate (probably an oversight due to imperfect orientation). He also claimed that P1–P2 had an outer basal seta but his drawings prove otherwise, showing only the spinules typically found in this position. Lindgren (1976) found that there was little overlap in distribution within the beach between *A. riedli* and a closely related population, which he attributed to *A. subterranea*. The species is so far known only from its type locality in North Carolina where it is common in the coastal groundwater between mean sea level and mean low water mark.

Arenopontia anatolica sp. nov.

https://zoobank.org/7F0E3C20-D032-4342-BAB9-33EDDC81FFC3
(Figs 2–6)

Type locality. Türkiye, Sakarya Province (Black Sea coast), Caferiye (41°04.365' N, 30°56.329' E); sandy beach.

Material examined. Holotype ♀ (dissected on six slides) (NHMUK reg. no 2024.1000). Paratypes are 1 ♂ dissected on six slides (NHMUK reg. no 2024.1001), 1 ♂ dissected on four slides (BUZM), 5 ♀♀ and 2 ♂♂ in ethanol (NHMUK reg. nos 2024.1002–1008), and 30 ♀♀ and 8 ♂♂ in ethanol (BUZM); all collected at type locality; leg. S. Sak and S. Karaytuğ, 06 July 2001.

Description of female. Total body length from tip of rostrum to posterior margin of caudal rami 257–349 µm (mean = 303 µm; n = 35; holotype = 347 µm). Maximum width 43 µm measured near posterior margin of cephalothorax. Body slender and cylindrical, without clear distinction between prosome and urosome (Fig. 2A, B). Hyaline frills of thoracic somites weakly developed and crenulated, those of genital double-somite and free abdominal somites strongly developed and consisting of narrow rectangular non-digitate lappets (Figs 2A, B; 6C). Genital double-somite (Figs 2A, B; 6C) 1.2 times longer than wide (measured in dorsal aspect); without chitinous ribs marking original segmentation; with two middorsal, two lateral and two ventral pores. Anal somite (Figs 2A, B; 5A) with two dorsal and two lateral pores. Anal operculum pinnate; with minute spinules along free distal margin (Fig. 5A). Anus positioned subterminally between caudal rami. Rostrum (Fig. 2B) small, broadly subtriangular, tapering distally, with two delicate sensilla.

Caudal rami 2.5 times longer than wide (measured in dorsal view from anterior margin to apex of spinous process), tapering posteriorly; with a pore dorsally (Fig. 5A), near ventral proximal margin (Fig. 6C) and laterally near insertion site of seta III (Fig. 5B, E); outer distal corner produced into posteriorly directed, recurved spinous process, accompanied at base by outer spinular row (Fig. 5B, E); dorsal surface without spur-like process but with

few spinules posterior to insertion of seta VII (Fig. 5A). Armature consisting of seven setae; seta I small; setae II and III long and naked; seta IV short, sparsely pinnate, located between seta V and posterior spinous process; seta V long, with proximal fracture plane and few long setules in middle third (Fig. 5E); seta VI small, naked and located at inner distal corner; seta VII distinctly foliaceous and tri-articulate at base.

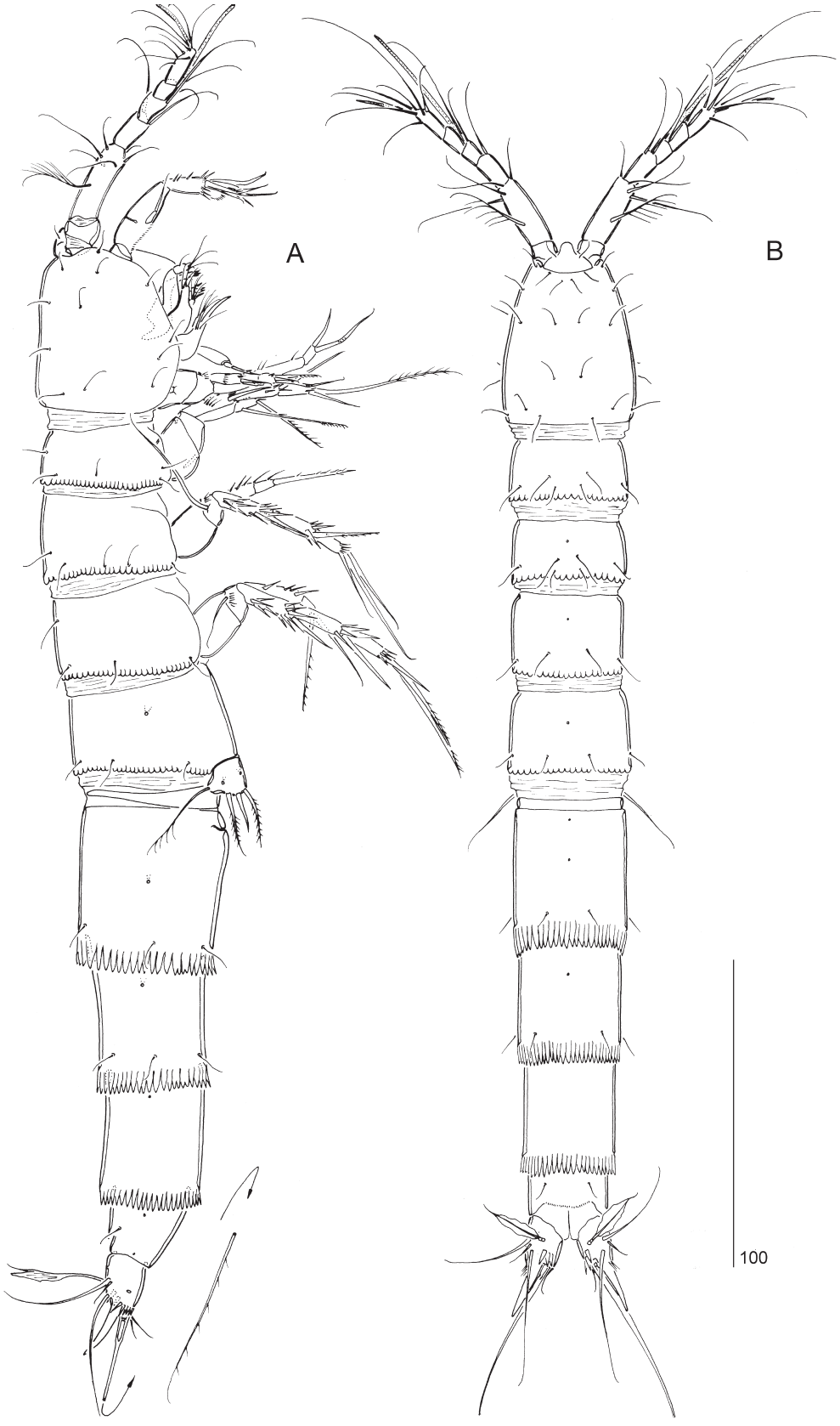

FIGURE 2. ***Arenopontia anatolica*** **sp. nov.** (♀): (A) habitus, lateral; (B) habitus, dorsal.

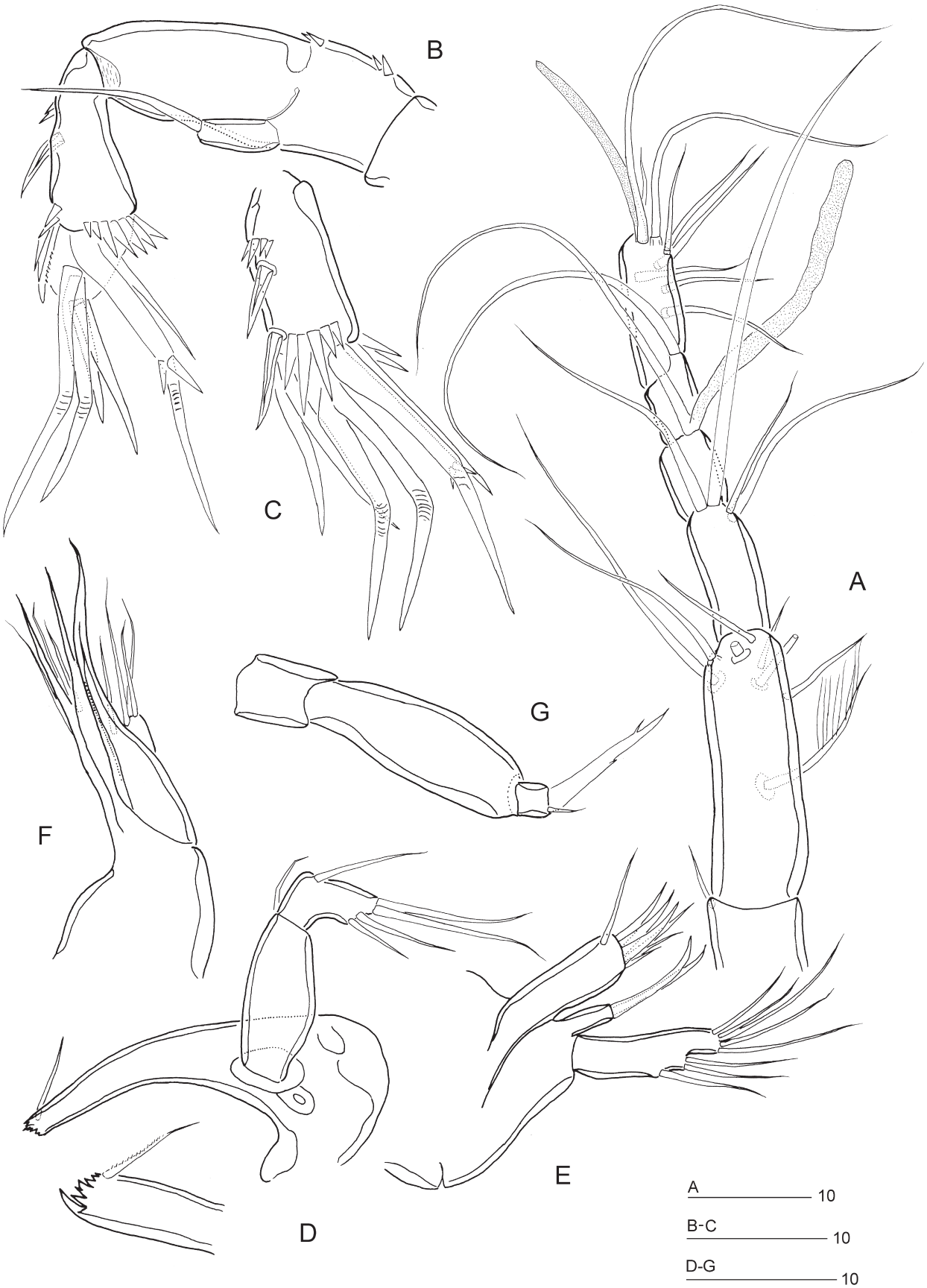

FIGURE 3. ***Arenopontia anatolica*** **sp. nov.** (♀): (A) antennule, dorsal [two setae on segment 2 incomplete); (B) antenna; (C) free endopod of antenna; (D) mandible [inset: gnathobase viewed from different angle]; (E) maxillule; (F) maxilla; (G) maxilliped.

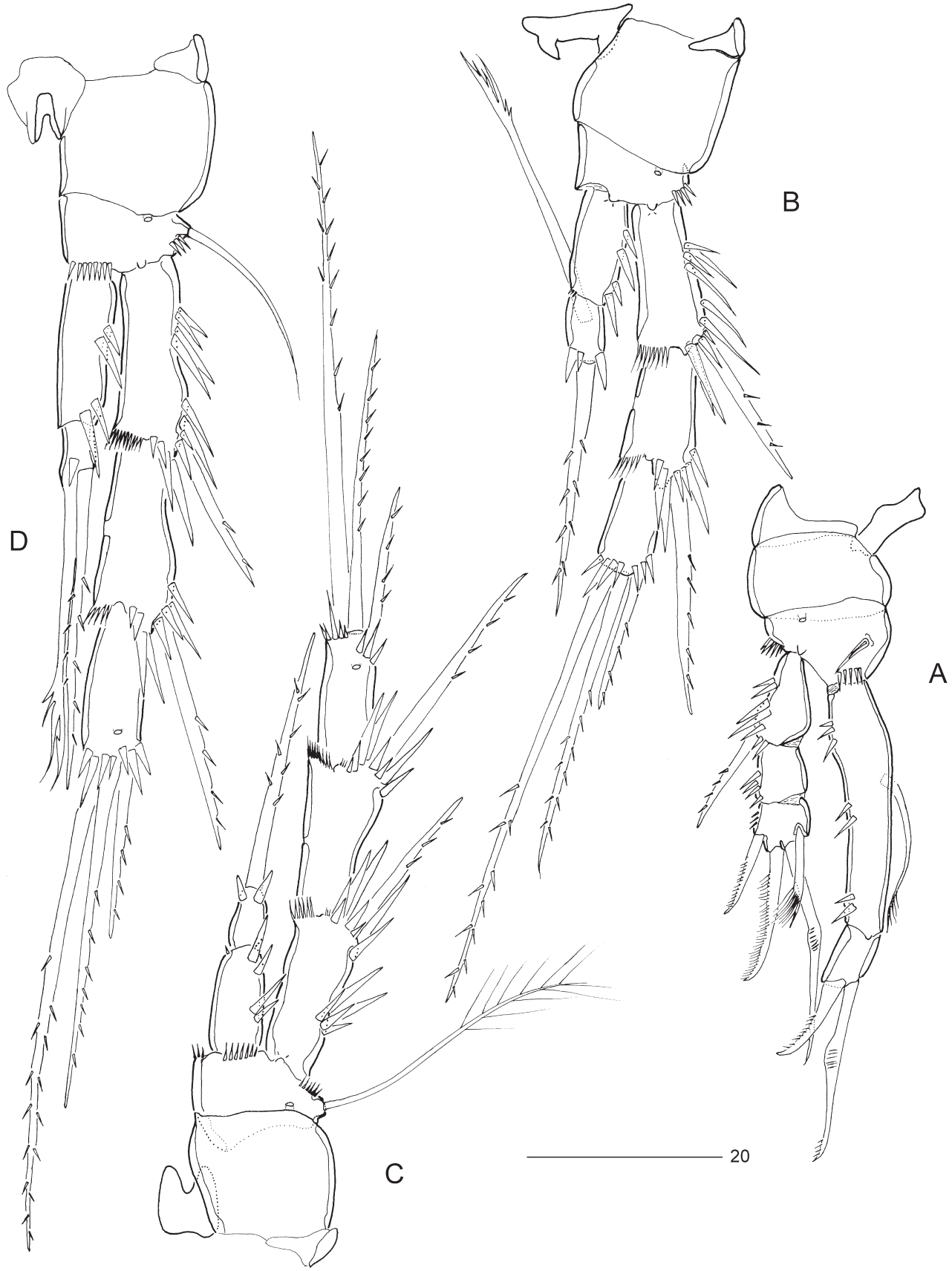

FIGURE 4. ***Arenopontia anatolica*** **sp. nov.** (♀): (A) P1, anterior; (B) P2, anterior; (C) P3, anterior; (D) P4, anterior.

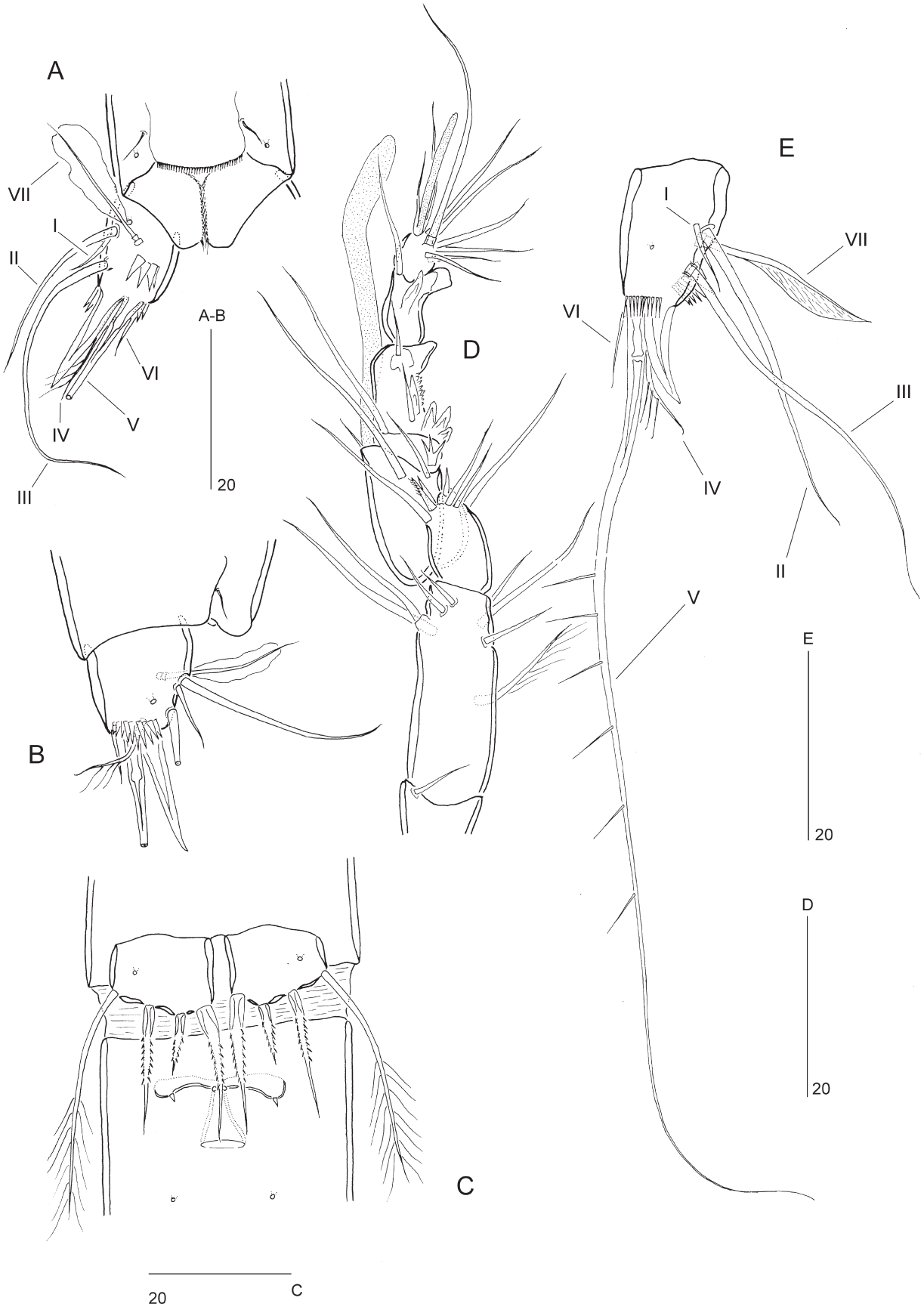

FIGURE 5. ***Arenopontia anatolica*** **sp. nov.**: (A) anal somite and left caudal ramus ♀, dorsal; (B) posterior part of anal somite and left caudal ramus ♀, lateral; (C) P5 and genital field ♀, ventral; (D) antennule ♂, anterior; (E) left caudal ramus ♀, lateral.

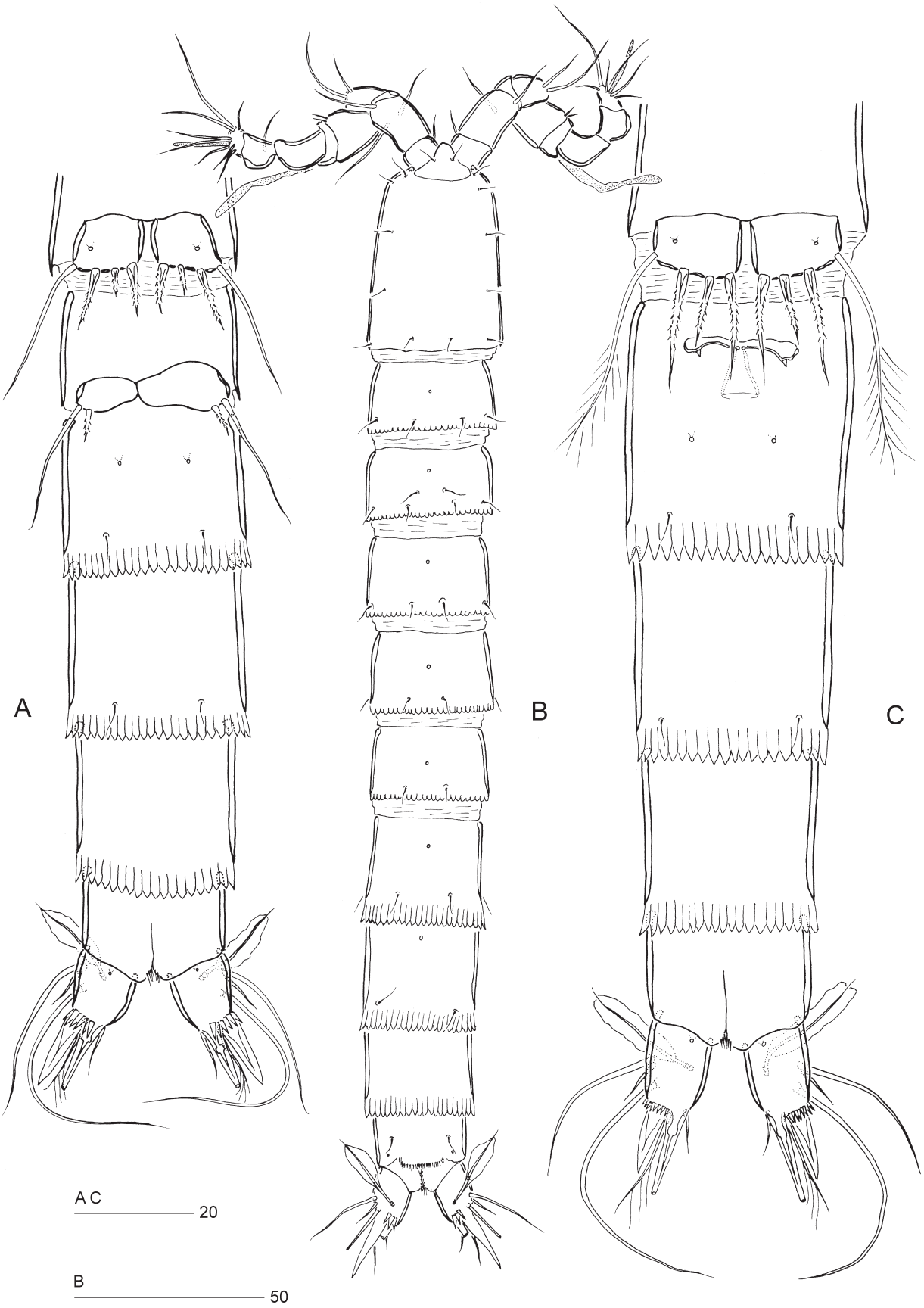

FIGURE 6. ***Arenopontia anatolica*** **sp. nov.**: (A) urosome ♂, ventral; (B) habitus ♂, dorsal; (C) urosome ♀, ventral.

Antennule (Fig. 3A) long, six-segmented. Segment 1 with a small seta near anterodistal margin. Segment 2 longest, about three times longer than wide. Segment 4 with long aesthetasc (L: 26 μm) fused at base with seta. Distal segment with seven setae (none distinctly spatulate) and apical acrothek consisting of short aesthetasc (L: 17 μm) and two setae. All setal elements naked except for plumose seta on dorsal surface of segment 2. Armature formula: 1-[1], 2-[7 + 1 plumose], 3-[4], 4-[(1 + ae)], 5-[1], 6-[7 + acrothek].

Antenna (Fig. 3B, C). Coxa small, without ornamentation. Allobasis about 2.8 times as long as maximum width; original basis-endopod boundary marked by partial transverse surface suture at base of exopod; basal part with two groups of small spinules along abexopodal margin. Exopod one-segmented, elongate, with a naked apical seta (about 2.25 times longer than exopod). Free endopodal segment with two spinular rows on medial surface and larger spinules at outer distal corner; medial armature consisting of two short spines; apical armature consisting of two spines and three geniculate setae, longest of which with spinules around geniculation and fused basally to naked accessory seta.

Mandibular palp two-segmented (Fig. 3D); basis elongate with one lateral seta; endopod forming right angle with basis, with one inner, two subapical and two apical setae; all armature elements naked. Gnathobase with fine teeth distally and one minutely pinnate seta at dorsal corner.

Maxillule (Fig. 3E) with praecoxal arthrite bearing seven elements around distal margin. Coxal endite with two naked spines. Basis with rami entirely incorporated, forming one-segmented elongate palp with eight naked setae.

Maxilla (Fig. 3F). Syncoxa with two slender coxal endites; proximal and distal endites each with basally fused spine and two and one additional setae, respectively. Allobasis drawn out into long slender claw with one accessory seta. Endopod one-segmented; with three setae. All elements naked.

Maxilliped (Fig. 3G). Syncoxa small and unarmed. Basis elongate and unarmed. Endopod with minute accessory seta and slightly curved claw, bearing subterminal spinule along medial margin and minute spiniform process halfway along outer margin.

P1 (Fig. 4A). Intercoxal sclerite wide and subrectangular. Praecoxa triangular and naked. Coxa without ornamentation. Basis with spinular row near base of endopod and along outer margin; anterior surface with a pore and a small spine near medial margin. Exopod three-segmented; all segments with spinules around outer margin, those of exp-3 shortest; exp-1 longest, with long unipinnate outer spine; exp-2 without outer element; exp-3 with short unipinnate outer spine, a long curved unipinnate spine and one geniculate seta distally, and one inner, apically penicillate seta subdistally. Endopod two-segmented, prehensile; enp-1 about 5 times longer than wide, and 1.3 times longer than exopod; with a serrate inner seta in proximal half, and three groups of sparse spinules along outer margin; enp-2 slightly longer than wide, distal margin with a short unipinnate outer spine and a long geniculate inner claw.

P2–P4 (Fig. 4B–D) intercoxal sclerites naked, with concave distal margin. Praecoxae small and naked, represented by triangular sclerite. Coxae squarish and without ornamentation. Bases smaller than coxae, with a spinular row near base of endopod (P3–P4) and at outer distal corner (P2–P4); anterior surface with a pore near articulation with coxa; outer basal seta absent (P2), plumose (P3) or naked (P4). Exopods three-segmented; segments with spinular ornamentation as figured; all elements uni- or bipinnate; hyaline frills of exp-1 and -2 well developed; exp-2 with lateral pore halfway down inner margin length. Endopods two-segmented, with enp-1 distinctly longer than enp-2; P2–P4 enp-1 about 1.9, 1.9 and 3.3 times longer than their respective distal segments, with few coarse spinules as figured. P2 enp-2 with a long, apically serrate, posteriorly directed seta near proximal inner margin. P2–P3 enp-2 with a long bipinnate seta terminally. P4 enp-2 minute, with a basally fused, apically serrate seta, and a long bipinnate seta at outer distal corner. Spine and seta formula as follows:

	Exopod	Endopod
P2	0.0.021	0.110
P3	0.0.021	0.010
P4	0.0.021	0.020

Fifth legs (Figs 5C; 6C) closely set together but not touching medially. Baseoendopod and exopod fused, forming a rectangular plate with anterior surface pore; distal margin with three pinnate elements, middle one half the length of outer one, inner one spiniform; outer basal seta long and plumose.

Genital field (Figs 5C; 6C) positioned near anterior margin of genital double-somite. Genital apertures fused forming median slit; closed off by fused P6 forming common operculum with one minute dentiform process on either side; copulatory pore located midventrally; seminal receptacles difficult to discern.

Description of male. Total body length from tip of rostrum to posterior margin of caudal rami 240–280 μm (mean = 255 μm; n = 10). Maximum width 35 μm measured at cephalothorax. Body ornamentation (Fig. 6B) essentially as in female. Sexual dimorphism in antennule, urosomal segmentation, P5 and P6.

Antennule (Fig. 5D) nine-segmented, haplocer; geniculation between segments 7 and 8. Segment 2 longest and about 2.5 times longer than wide; segment 4 an incomplete sclerite with 1 modified (fused at base) and 1 tiny element; segment 5 with three setae plus long aesthetasc (L: 37 μm) fused basally to a small slender seta; segment 6 with a spinulose spine and long distal seta; segment 7 with four modified spines and two setae; segment 8 with three basally fused, modified spines; distal segment with seven naked setae (two of which spatulate) and apical acrothek. Setal formula: 1-[1], 2-[7 + 1 plumose], 3-[4 + 2 spines], 4-[1 + 1 modified], 5-[2 + (1 + ae)], 6-[1 + 1 modified], 7-[2 + 4 modified], 8-[1 + 3 modified], 9-[7 + acrothek]. Acrothek consisting of short aesthetasc (L: 14 μm) fused basally to two slender setae.

P5 (Fig. 6A) with anterior surface pore with armature as in female but all elements distinctly shorter and more spiniform; inner element also shorter than outer one (instead of equally long as in the ♀). Outer basal seta naked.

Sixth legs (Fig. 6A) asymmetrical, with smallest P6 closing off functional gonopore; each with a long naked outer seta and a short bipinnate inner spine.

Etymology. The specific epithet (a noun in the genitive case) is derived from the geographical name Anatolia (Asia Minor) which represents the Asian part of Türkiye, the region where the specimens were collected.

Remarks. *Arenopontia anatolica* **sp. nov.** belongs to a complex of closely related species, including *A. subterranea*, *A. problematica* and *A. adriatica* **sp. nov.** (see Remarks under the latter species). It can be differentiated from the congeners of this group by the short P1 endopod, enp-1 being only five times as long as wide and 1.3 times the length of the exopod (Table 1).

According to Sak (2004) the species assumes an almost continuous distribution along the Turkish Black Sea coast from the Bulgarian border to Georgia with confirmed records from Iğneada and Kastro (Kırklareli Province), Karasu and Ağva (Kocaeli Province), Caferiye (Sakarya Province), Terme and Omtel (Samsun Province), and Kuzguncuk (Trabzon Province). The species was also recorded from Ören along the Aegean Sea coast (Balıkesir Province) (Sak 2004). Noodt's (1955c) record of *A. subterranea* from a sandy beach near the Bosporus (Black Sea coast) almost certainly refers to *A. anatolica* **sp. nov.** According to Sak (2004), the Black Sea material identified by Marinov (1971) as *A. subterranea* is very similar to *A. anatolica* **sp. nov.**, however, obstacles remain to confirm conspecificity (see below).

Arenopontia basibuyuki sp. nov.

https://zoobank.org/18347A20-27B8-4BD9-9782-0C84486E04E2
(Figs 7–10)

Type locality. Türkiye, Sinop Province, Sarıkum (42°01.129' N, 34°54.032' E); sandy beach.

Material examined. Holotype ♀ (dissected on eight slides) (NHMUK reg. no 2024.1009). Paratypes are 2 ♂♂ dissected on seven slides each (NHMUK reg. nos 2024.1010–1011), 1 ♀ and 1 ♂ dissected on eight and three slides, respectively (BUZM), 10 ♀♀ and 10 ♂♂ in ethanol (NHMUK reg. nos 2024.1012–1031), 23 ♀♀ and 20 ♂♂ in ethanol (BUZM); all collected at type locality with Karaman-Chappuis method; leg. S. Karaytuğ and S. Sak, 13 September 2002.

Description of female. Total body length from tip of rostrum to posterior margin of caudal rami 254–334 μm (mean = 310 μm; n = 28; holotype = 304 μm). Maximum width 45 μm measured at posterior margin of P4-bearing somite. Body slender and cylindrical, without clear distinction between prosome and urosome (Fig. 7A, B). Hyaline frills of thoracic somites weakly developed and crenulated, those of genital double-somite and free abdominal somites strongly developed and consisting of rectangular digitate or weakly incised lappets (Figs 7A, B; 8A, C). Genital double-somite (Figs 7A, B; 8A) 1.15 times longer than wide (measured in dorsal aspect); without chitinous ribs marking original segmentation; with two middorsal, two lateral and two ventral pores. Anal somite (Fig. 8A, C, D) with two dorsal, two lateral and two ventral pores. Anal operculum pinnate; with minute spinules along free

distal margin (Fig. 8D). Anus positioned subterminally between caudal rami. Rostrum (Fig. 7B) small, broadly subtriangular, tapering distally, with two delicate sensilla.

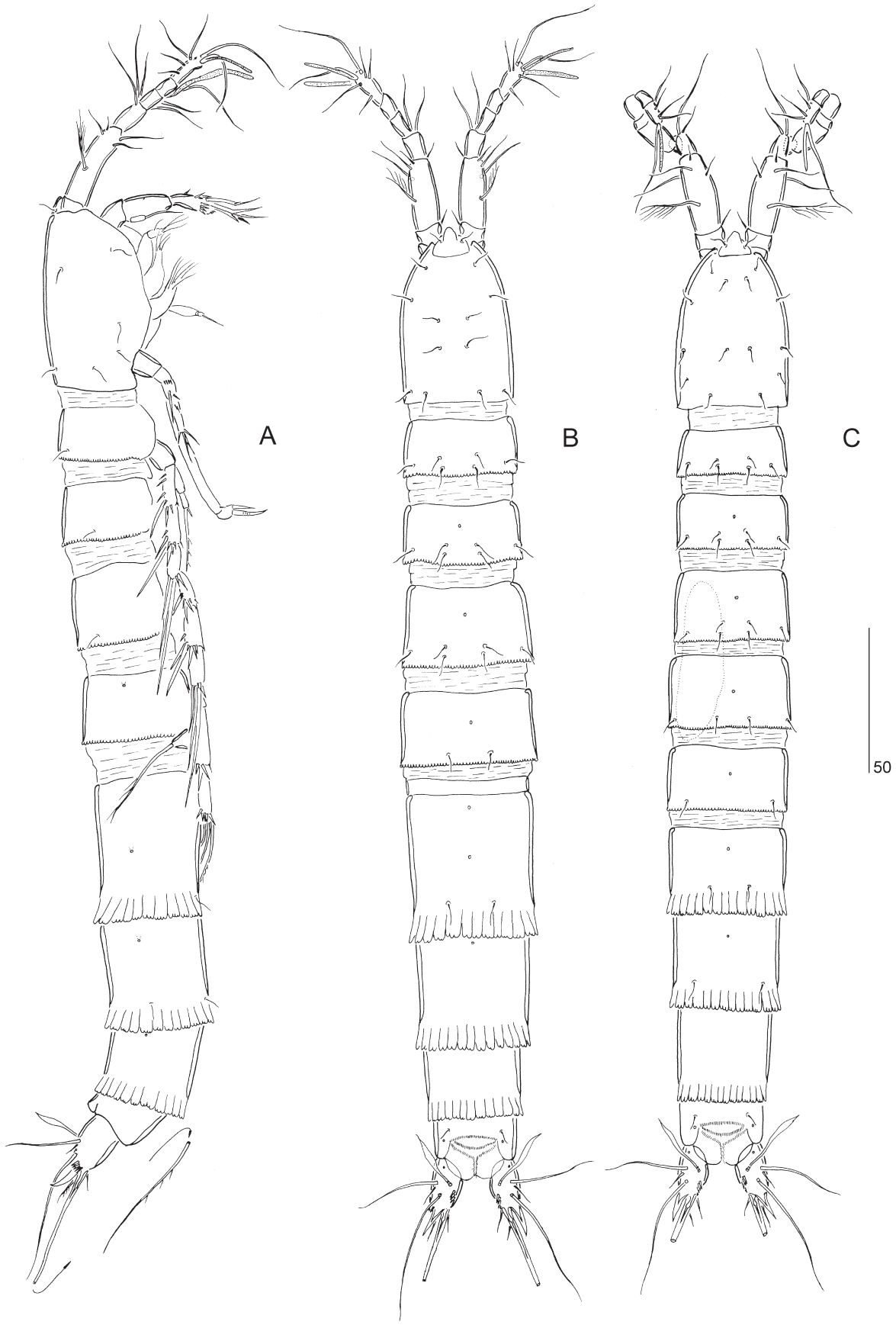

FIGURE 7. ***Arenopontia basibuyuki*** **sp. nov.**: (A) habitus ♀, lateral; (B) habitus ♀, dorsal; (C) habitus ♂, dorsal.

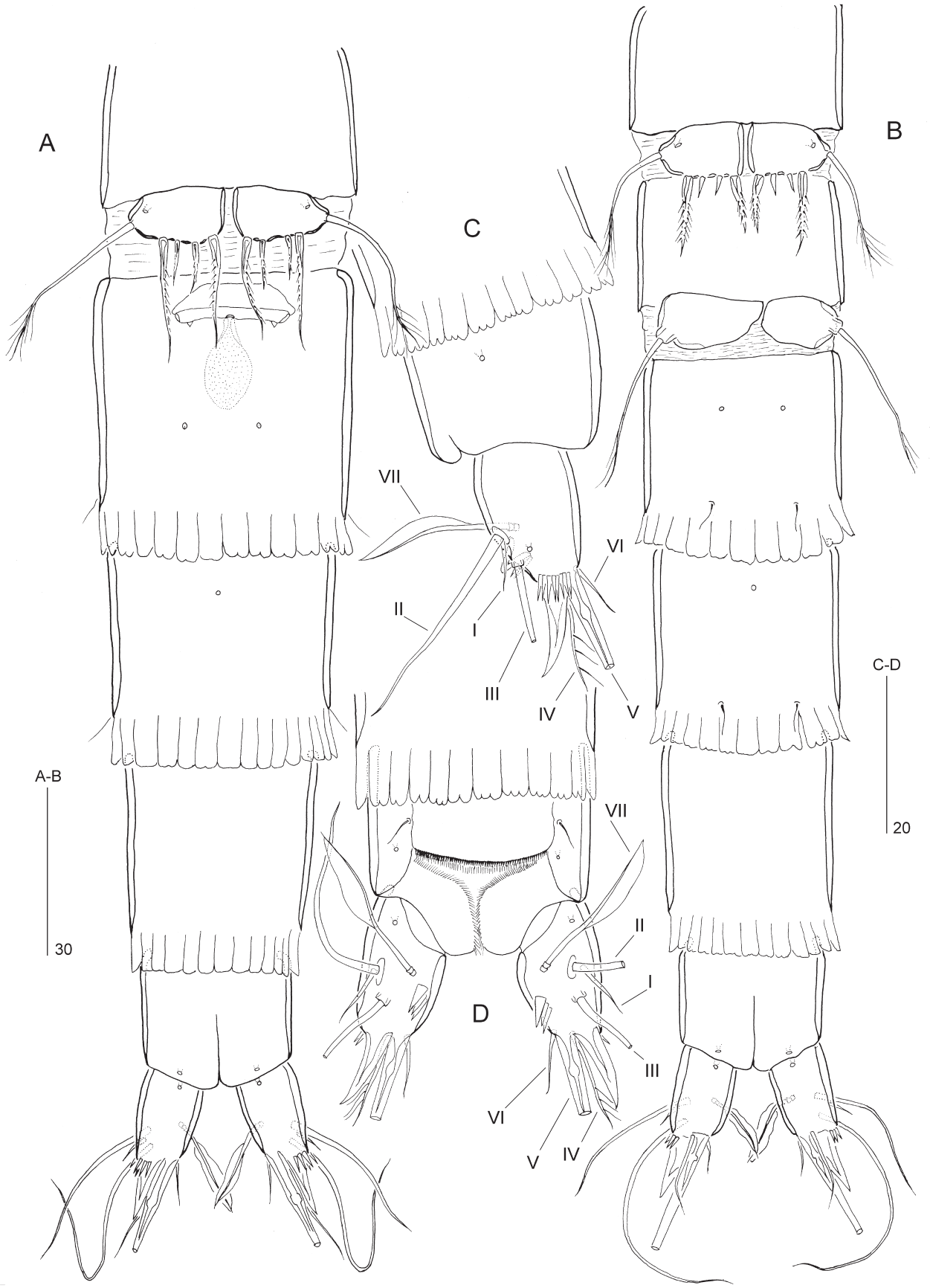

FIGURE 8. ***Arenopontia basibuyuki*** **sp. nov.**: (A) urosome ♀, ventral; (B) urosome ♂, ventral; (C) anal somite and right caudal ramus ♀, lateral; (D) anal somite and caudal rami ♀, dorsal.

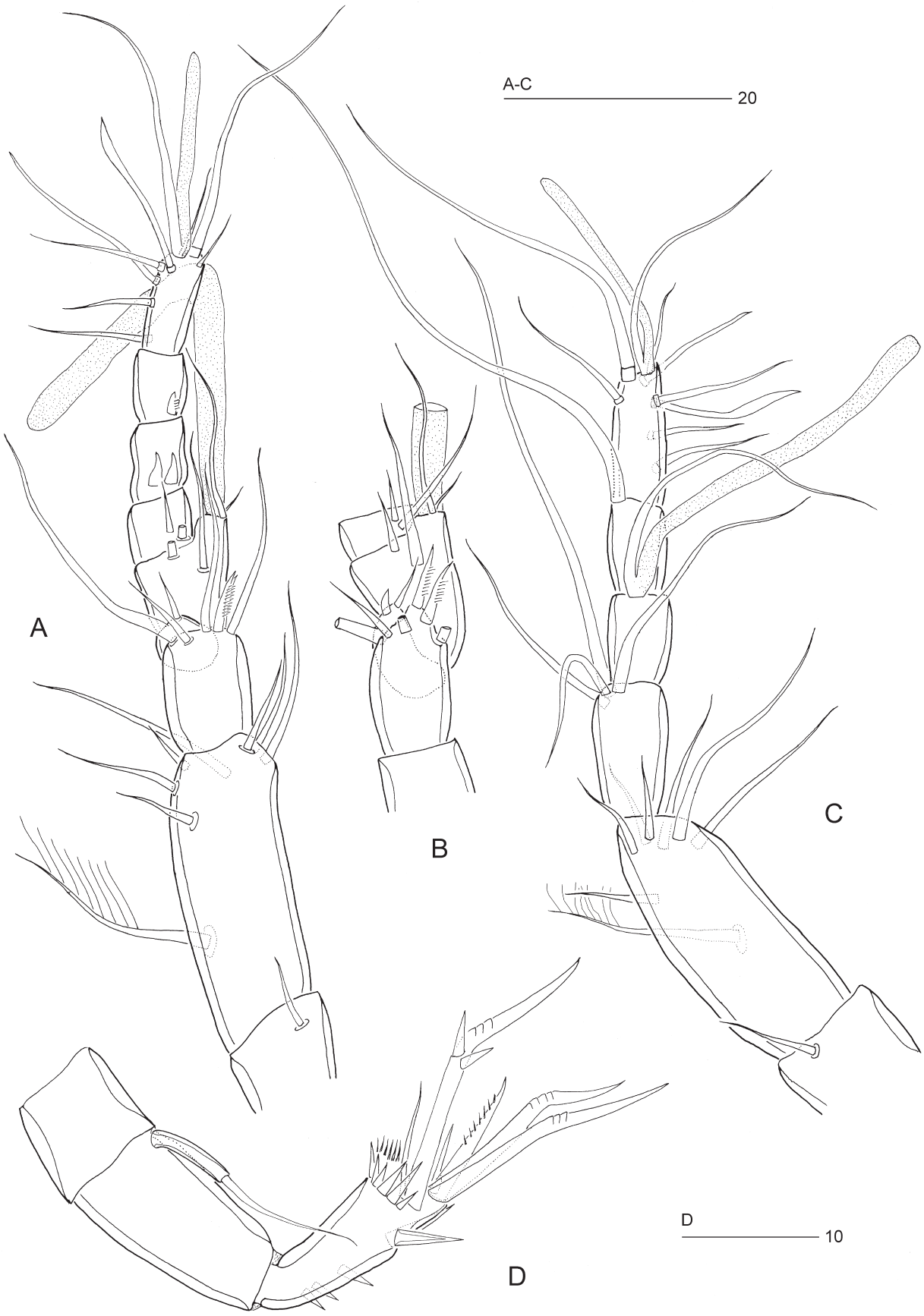

FIGURE 9. ***Arenopontia basibuyuki*** **sp. nov.**: (A) antennule ♂, anterior [armature of segments 3–6 partly omitted; see (B)]; (B) antennulary segments 3–6 ♂, anterior; (C) antennule ♀, anterior; (D) antenna ♀, lateral.

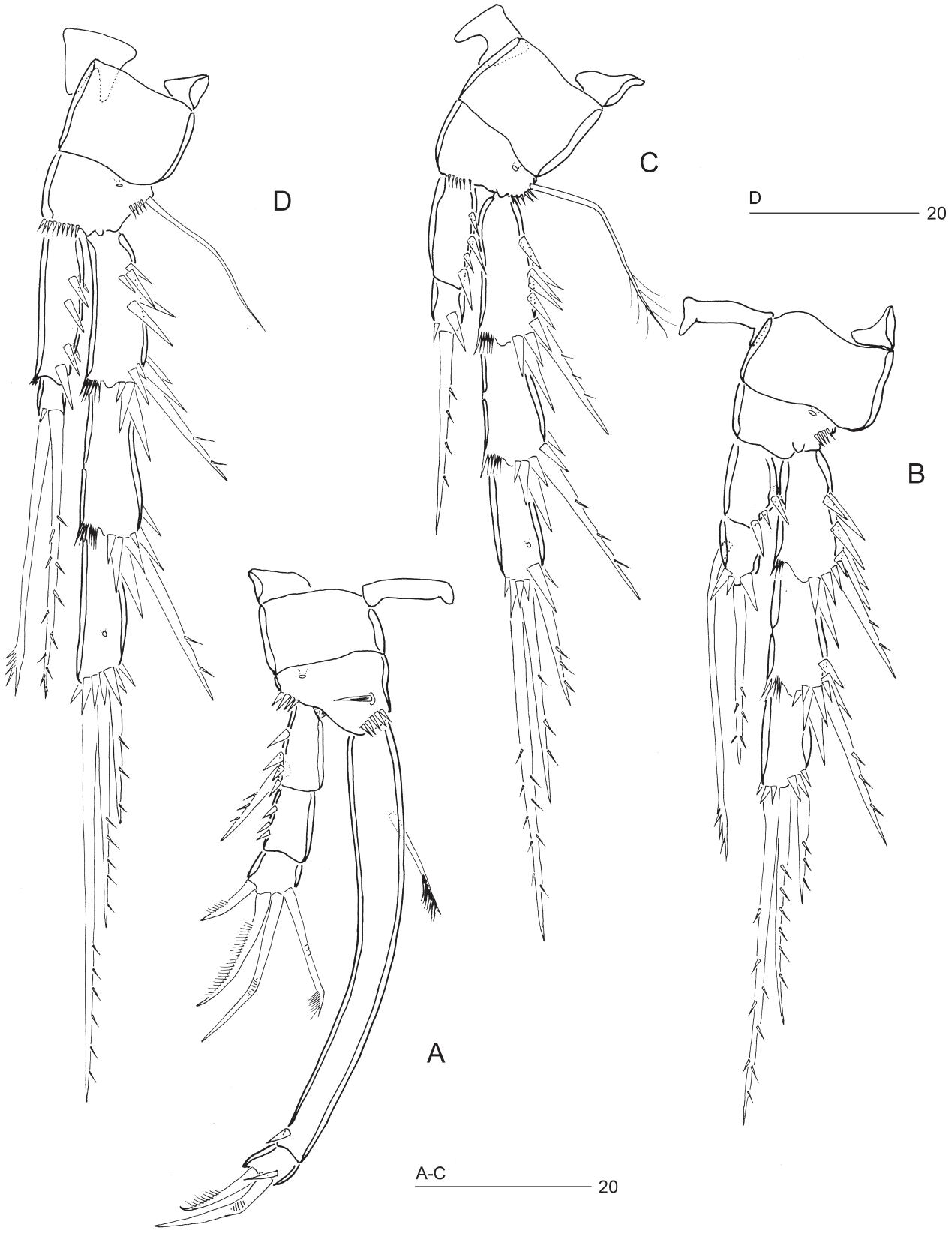

FIGURE 10. ***Arenopontia basibuyuki*** **sp. nov.** (♀): (A) P1, anterior; (B) P2, anterior; (C) P3, anterior; (D) P4, anterior.

Caudal rami approximately 2.9 times longer than maximum width (measured in dorsal view), tapering posteriorly; with single pores dorsally and ventrally near anterior border (Fig. 8A, D) and laterally near insertion site of seta III (Fig. 8C); outer distal corner produced into posteriorly directed, recurved spinous process, accompanied

at base by outer spinular row (Fig. 8C); dorsal surface without spur-like process but with spinules near inner margin (Fig. 8D). Armature consisting of seven setae; seta I small; setae II and III long and naked; seta IV short, sparsely pinnate, located between seta V and posterior spinous process; seta V long and with fracture plane; seta VI small, naked and located at inner distal corner; seta VII foliaceous and tri-articulate at base.

Antennule (Fig. 9C) slender, six-segmented. Segment 1 with a short seta near anterodistal margin. Segment 2 longest, about 2.6 times longer than wide. Segment 4 with long aesthetasc (L: 35 μm) fused at base with seta. Distal segment with seven naked setae (one of which spatulate) and apical acrothek consisting of short aesthetasc (L: 21 μm) and two slender setae. All setae naked except for plumose seta on dorsal surface of segment 2. Armature formula: 1-[1], 2-[7 + 1 plumose], 3-[4], 4-[(1 + ae)], 5-[1], 6-[7 + acrothek].

Antenna (Fig. 9D). Coxa small (not figured), without ornamentation. Basis and proximal endopodal segment discrete and without ornamentation. Exopod one-segmented, elongate, with a naked apical seta (about 1.9 times longer than exopod). Distal endopodal segment with spinules on medial surface and at outer distal corner; medial armature consisting of two short spines; apical armature consisting of two spines and three geniculate setae, longest of which with spinules around geniculation and fused basally to naked accessory seta.

Mandible, maxillule, maxilla and maxilliped as in *A. anatolica* **sp. nov.**

P1 (Fig. 10A). Intercoxal sclerite wide and subrectangular. Praecoxa represented by triangular naked sclerite. Coxa without ornamentation. Basis with spinular row near base of endopod and around outer margin; anterior surface with a pore and a small spine near medial margin. Exopod three-segmented; exp-1 and -2 with spinules around outer margin; exp-1 slightly longer than exp-2, with unipinnate outer spine; exp-2 without outer element; exp-3 with short unipinnate outer spine, a longer curved unipinnate spine and one geniculate seta distally, and one inner, apically penicillate seta subdistally. Endopod two-segmented, prehensile; enp-1 about 10 times longer than wide, and 2.2 times longer than exopod; with a serrate inner seta in proximal third, and one spinule near outer distal corner; enp-2 about as long as wide, with a short unipinnate outer spine and a slightly longer geniculate inner claw, in addition to one large spinule.

P2–P4 (Fig. 10B–D) intercoxal sclerites naked, with concave distal margin. Praecoxae small and naked. Coxae wider than long and without ornamentation. Bases smaller than coxae, with a spinular row near base of endopod (P3–P4) and at outer distal corner (P2–P4); anterior surface with a pore near coxa-basis boundary; outer basal seta absent (P2), plumose (P3) or naked (P4). Exopods three-segmented; segments with spinular ornamentation as figured; inner distal spine of exp-3 bipinnate (except P4), all other exopodal elements unipinnate; hyaline frills of exp-1 and -2 well developed; exp-2 with lateral pore halfway down inner margin length; P3–P4 exp-3 with anterior surface pore. Endopods two-segmented, with enp-1 distinctly longer than enp-2 in P3–P4; P2–P4 enp-1 about 1.1, 2.1 and 5.2 times longer than their respective distal segments, with few coarse spinules along outer margin as figured. P2 enp-2 with a long, apically serrate, posteriorly directed seta near proximal inner margin. P2–P3 enp-2 with a long bipinnate seta terminally. P4 enp-2 minute, with a basally fused, apically serrate seta, and a long bipinnate seta at outer distal corner. Spine and seta formula as follows:

	Exopod	Endopod
P2	0.0.021	0.110
P3	0.0.021	0.010
P4	0.0.021	0.020

Fifth legs (Fig. 8A) closely set together but not touching medially. Baseoendopod and exopod fused forming a rectangular plate with anterior surface pore; distal margin with four pinnate setae, middle two less than half the length of inner and outer ones; outer basal seta long and plumose.

Genital field positioned near anterior margin of genital double-somite (Fig. 8A). Genital apertures (Fig. 8A) fused forming median common slit; closed off by fused P6 forming operculum with one minute dentiform processes on either side; copulatory pore located midventrally, close to genital slit; seminal receptacles difficult to discern.

Description of male. Total body length from tip of rostrum to posterior margin of caudal rami 250–317 μm (mean = 285 μm; n = 22). Body ornamentation (Figs 7C, 8B) essentially as in female. Sexual dimorphism in antennule, urosomal segmentation, P5 and P6. Spermatophore length approximately 55 μm.

Antennule (Fig. 9A, B) nine-segmented, haplocer; geniculation between segments 7 and 8. Segment 2 longest and about 2.6 times longer than wide; segment 4 an incomplete sclerite with two small elements (one spiniform, one

setiform) (Fig. 9B); segment 5 with three setae plus long aesthetasc (L: 42 μm) fused basally to a small slender seta; segment 6 with two setae; segment 7 with two modified spines and a seta; segment 8 with a short unipinnate spine; distal segment with seven naked setae (two of which spatulate) and apical acrothek. Setal formula: 1-[1], 2-[7 + 1 plumose], 3-[4 + 2 unipinnate spines], 4-[2], 5-[3 + (1 + ae)], 6-[2], 7-[2 modified], 8-[1 modified], 9-[7 + acrothek]. Acrothek consisting of short aesthetasc (L: 18 μm) fused basally to two slender setae.

P5 (Fig. 8B) with anterior surface pore and with armature as in female but all elements on distal margin comparatively shorter; inner and outer marginal elements spiniform (instead of setiform as in the ♀), middle elements minute and naked (instead of bipinnate as in the ♀). Outer basal seta plumose.

Sixth legs (Fig. 8B) asymmetrical, with smallest P6 closing off functional gonopore; each with a long sparsely plumose seta.

Etymology. The species name (a noun in the genitive case) is named after Prof. Hasan Hüseyin Başıbüyük (Akdeniz University, Antalya), in recognition of his contributions to zoology in Türkiye.

Remarks. *Arenopontia basibuyuki* **sp. nov.**, *A. gunduzi* **sp. nov.** and *A. nesaie* belong to the same species group, characterized by the presence of a single coarse spinule near the outer distal corner of P1 enp-1 and male sixth legs displaying a reduced armature represented by an outer plumose seta. The latter two species differ from *A. basibuyuki* **sp. nov.** in the presence of a dorsal spur (instead of a raised spinular row; Fig. 8D) on the caudal ramus and only four elements (instead of five; Fig. 8A, B) on the fifth leg in both sexes. The relatively longer P1 enp-1 (2.2 times as long as exopod) also serves to distinguish *A. basibuyuki* **sp. nov.** from *A. nesaie* (2.0) and *A. gunduzi* **sp. nov.** (1.7).

The known records from the type locality, Karasu (Sakarya Province) and Yoroz Feneri (Trabzon Province) (Sak 2004) suggest that the species is distributed along the entire Turkish Black Sea coast and may overlap in distribution with *A. anatolica* **sp. nov.**

***Arenopontia adriatica* sp. nov.**

Arenopontia daltonae: *nomen nudum* in Sak (2004: 135)

https://zoobank.org/B4CFEAD7-7582-403E-AC1D-EA4B0BA741EC

(Figs 11–12)

Type locality. Croatia, Dalmatian coast, Isle of Mljet, Soline; coarse sandy beach.

Material examined. Holotype ♀ (in ethanol) (NHMUK reg. no 2024.1032). Paratypes are 3 ♀♀ in alcohol (NHM reg. nos 2024.1033–1035); leg. H. Kunz, 04 May 1986.

Description of female. Total body length from tip of rostrum to posterior margin of caudal rami 180–245 μm (mean = 212 μm; n = 4; holotype = 245 μm). Body slender and cylindrical, without clear distinction between prosome and urosome. Hyaline frills of thoracic somites weakly developed and crenulated, those of genital double-somite and free abdominal somites strongly developed and typically consisting of rectangular digitate lappets (Fig. 11A, B). Genital double-somite (Fig. 11A) 1.2 times longer than wide; without chitinous ribs marking original segmentation; with two middorsal, two lateral and two ventral pores. Anal somite (Fig. 11B) with two dorsal and two ventral pores. Anal operculum pinnate, with minute spinules along free distal margin (Fig. 11B). Anus positioned subterminally between caudal rami. Rostrum (Fig. 11F) small, broadly subtriangular, tapering distally, with two delicate sensilla and an apical pore.

Caudal rami (Fig. 11A, B) approximately 2.25 times longer than wide (measured in dorsal view), tapering posteriorly; outer distal corner produced into posteriorly directed, recurved spinous process, accompanied at base by outer spinular row; dorsal surface without spur-like process but with spinules near inner margin. Armature consisting of seven setae; seta I small; setae II and III long and naked; seta IV short, naked, located between seta V and posterior spinous process; seta V long and with fracture plane; seta VI small, naked and located at inner distal corner; seta VII foliaceous and tri-articulate at base.

Antennule (Fig. 11C) slender, six-segmented. Segment 1 with a short seta near anterodistal margin. Segment 2 longest, about three times longer than wide. Segment 4 with long aesthetasc (L: 20 μm) fused at base with seta. Distal segment with seven naked setae (one of which spatulate) and apical acrothek consisting of short aesthetasc (L: 15 μm) and two slender setae, one of which minute. All setae naked except for plumose seta on dorsal surface of segment 2. Armature formula: 1-[1], 2-[7 + 1 plumose], 3-[4], 4-[(1 + ae)], 5-[1], 6-[7 + acrothek].

FIGURE 11. ***Arenopontia adriatica*** **sp. nov.** (♀): (A) urosome, ventral [genital field not figured]; (B) anal somite and caudal rami, dorsal; (C) antennule, dorsal; (D) antenna, lateral; (E) free antennary endopod, medial; (F) rostrum and first antennulary segment, dorsal.

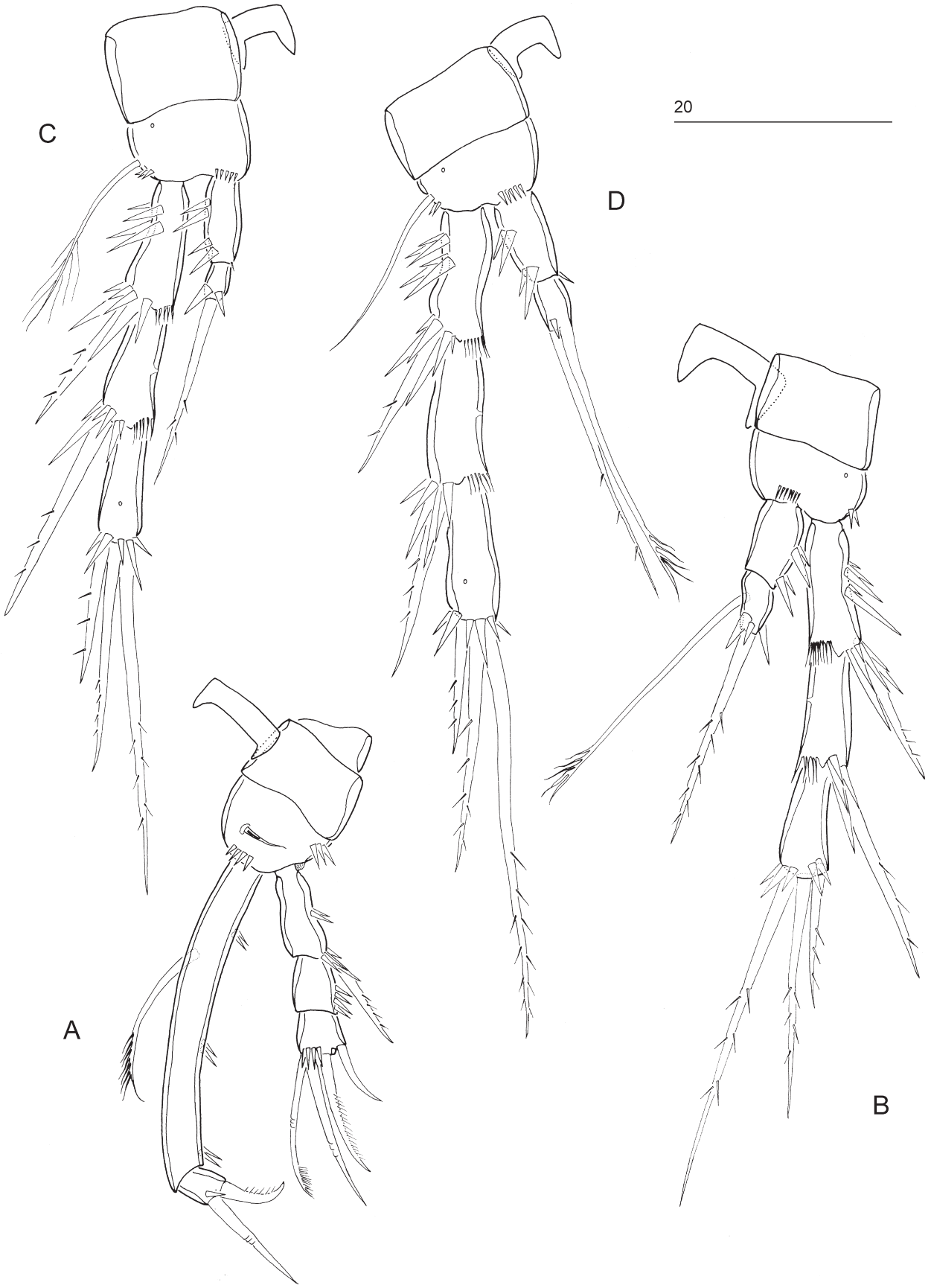

FIGURE 12. ***Arenopontia adriatica*** **sp. nov.** (♀): (A) P1, anterior; (B) P2, anterior; (C) P3, anterior; (D) P4, anterior.

Antenna (Fig. 11D, E). Coxa small (not figured), without ornamentation. Basis and proximal endopodal segment fused, forming elongate allobasis; original segmentation marked by incomplete transverse spinular row. Exopod one-segmented, elongate, with a naked apical seta (about 2.1 times longer than exopod). Distal endopodal segment with spinules on medial surface and at outer distal corner; medial armature consisting of two short spines; apical armature consisting of two spines and three geniculate setae, longest of which with spinules around geniculation and fused basally to naked accessory seta.

Mandible, maxillule, maxilla and maxilliped as in *A. anatolica* **sp. nov.**

P1 (Fig. 12A). Intercoxal sclerite wide and subrectangular. Praecoxa represented by triangular naked sclerite. Coxa without ornamentation. Basis with spinular row near base of endopod and around outer margin; anterior surface with a small, setiform, naked spine near medial margin, pore not discernible. Exopod three-segmented; exp-1 and -2 with spinules around outer margin; exp-1 1.6 times longer than exp-2, with unipinnate outer spine; exp-2 without outer element; exp-3 with short naked outer spine, a longer curved unipinnate spine and one geniculate seta distally, and one inner, apically penicillate seta subdistally. Endopod two-segmented, prehensile; enp-1 about 8.5 times longer than wide, and 1.7 times longer than exopod; with a serrate inner seta in proximal third, and three groups of two spinules along outer margin; enp-2 slightly longer than wide, with a short unipinnate, curved outer spine and a longer geniculate inner claw, in addition to one spinule.

P2–P4 (Fig. 12B–D) intercoxal sclerites naked, with concave distal margin. Praecoxae small and naked, represented by triangular sclerite. Coxae rectangular and without ornamentation. Bases slightly smaller than coxae, with a spinular row near base of endopod and at outer distal corner; anterior surface with a pore near articulation with coxa; outer basal seta absent (P2), plumose (P3) or naked (P4). Exopods three-segmented; segments with spinular ornamentation as figured; all elements uni- or bipinnate (inner apical spine of exp-3); hyaline frills of exp-1 and -2 well developed; exp-2 with lateral pore halfway down inner margin length; P3–P4 exp-3 with anterior surface pore. Endopods two-segmented, with enp-1 longer than enp-2; P2–P4 enp-1 about 1.5, 2.4 and 1.8 times longer than their respective distal segments, with few coarse spinules as figured. P2 enp-2 with a long, apically serrate, posteriorly directed inner seta. P2–P3 enp-2 with a long bipinnate seta terminally. P4 enp-2 minute, with a basally fused, apically serrate seta, and a long unipinnate seta at outer distal corner. Spine and seta formula as follows:

	Exopod	Endopod
P2	0.0.021	0.110
P3	0.0.021	0.010
P4	0.0.021	0.020

Fifth legs (Fig. 11A) closely set together but not touching medially. Baseoendopod and exopod fused forming a rectangular plate with anterior surface pore near outer margin; distal margin with three pinnate setae, middle one markedly shorter than others, outer marginal seta longest; outer basal seta long and plumose.

Genital field as in *A. anatolica* **sp. nov.**

Male. Unknown.

Etymology. The species name (a noun in the genitive case) is named after the Adriatic Sea where the Croatian type locality is situated.

Remarks. *Arenopontia adriatica* **sp. nov.** belongs to a close-knit species group defined by the absence of a dorsal spur on the caudal ramus, presence of only four elements on the female P5, ornamentation of P1 enp-1 (with three groups of spinules along outer margin) and an anal operculum that is either pinnate (with fine spinules) or smooth. Other members of this group include *A. subterranea*, *A. problematica* and *A. anatolica* **sp. nov.**, all of which display a P1 endopod (Fig. 12A) that is less slender than in *A. adriatica* **sp. nov.** In the latter species and *A. problematica*, enp-1 is about 1.7 times the length of the exopod, compared to 1.5 and 1.3 times in *A. subterranea* and *A. anatolica* **sp. nov.**, respectively. However, in *A. adriatica* **sp. nov.** enp-1 is 8.5 times as long as its maximum width *vs* 6.9 times in *A. problematica*. Additional differences can be found in the relative proportions of some of the segments of P2–P4 (*e.g.* compare Figs 1B and 12B, and Figs 1D and 12D, respectively). Masry's (1970: Fig. 65) illustration of the female P5 shows differences in proportional lengths of the marginal elements compared to those of *A. adriatica* **sp. nov.** However, given the deficiencies observed in other aspects of his morphological description (see above), additional material of *A. problematica* needs to be re-examined before these discrepancies can be corroborated.

***Arenopontia gunduzi* sp. nov.**
https://zoobank.org/9196D0ED-D217-45E3-BD72-DB8CE1E0
(Figs 13–16)

Type locality. France, Pas-de-Calais, Ambleteuse; fine sandy beach, near low-water mark.

Material examined. Holotype ♀ (dissected on eight slides) (NHMUK reg. no 2024.1036). Paratypes are 1 ♀ dissected on nine slides (NHMUK reg. no 2024.1037), 2 ♂♂ dissected on six and seven slides, respectively (NHMUK reg. nos 2024.1038–1039), and 3 ♀♀ and 1 ♂ in ethanol (NHMUK reg. nos 2024.1040–1043); all collected at type locality with Karaman-Chappuis method; leg. R. Huys & S. Conroy-Dalton, 19 May 1997.

Description of female. Total body length from tip of rostrum to posterior margin of caudal rami 340 μm (only holotype measured before dissection). Body slender and cylindrical, without clear distinction between prosome and urosome (Fig. 13A, B). Maximum width 25 μm measured at posterior margin of cephalothorax; width more or less uniform throughout remainder of body. Hyaline frills of thoracic somites weakly developed and crenulated, those of genital double-somite and free abdominal somites strongly developed and consisting of rectangular digitate or weakly incised lappets (Figs 13A, B, D; 14A). Genital double-somite (Figs 13A, B; 14A) 2.27 times longer than wide (measured in ventral aspect); without chitinous ribs marking original segmentation; with two middorsal, two lateral and two ventral pores. Anal somite (Figs 13B, D, 14A) with two dorsal and two lateral pores. Anal operculum pinnate; with minute spinules along free distal margin (Fig. 13D). Anus positioned subterminally between caudal rami. Rostrum (Fig. 13A) small, broadly subtriangular, tapering distally, with two delicate sensilla.

Caudal rami (Fig. 13C, D) approximately 2.65 times longer than maximum width (measured in dorsal view), tapering posteriorly; with single pores dorsally in anterior quarter (Fig. 13D) and laterally in posterior half near insertion of seta III (Fig. 13C); outer distal corner produced into posteriorly directed, recurved spinous process, accompanied at base by outer spinular row (Fig. 13C); dorsal surface with spur-like process, inner margin with few spinules (Fig. 13C). Armature consisting of seven setae; seta I small; setae II and III long and naked; seta IV short, sparsely pinnate, located between seta V and posterior spinous process; seta V long and with fracture plane; seta VI small, naked and located at inner distal corner; seta VII foliaceous and tri-articulate at base.

Antennule (Fig. 14C) slender, six-segmented. Segment 1 with a short seta near anterodistal margin. Segment 2 longest, about 3.7 times longer than wide. Segment 4 with long aesthetasc (L: 30 μm) fused at base with seta. Distal segment with seven naked setae (two of which spatulate) and apical acrothek consisting of short aesthetasc (L: 15 μm) and two slender setae. All setae naked except for plumose seta on dorsal surface of segment 2. Armature formula: 1-[1], 2-[7 + 1 plumose], 3-[4], 4-[(1 + ae)], 5-[1], 6-[7 + acrothek].

Antenna (Fig. 16B, C). Coxa small (not figured), without ornamentation. Basis and proximal endopodal segment fused, forming elongate allobasis; with fine spinules along exopodal margin as figured; original basis-endopod boundary marked by incomplete transverse spinule row. Exopod one-segmented, elongate, with a naked apical seta (about 1.35 times longer than exopod). Distal endopodal segment with spinules on medial surface and at outer distal corner; medial armature consisting of two short spines; apical armature consisting of two spines and three geniculate setae, longest of which with spinules around geniculation and fused basally to naked accessory seta.

Mandible, maxillule, maxilla and maxilliped as in *A. anatolica* **sp. nov.**

P1 (Fig. 15A). Intercoxal sclerite wide and subrectangular. Praecoxa represented by triangular naked sclerite. Coxa without ornamentation. Basis with few coarse spinules near base of endopod and fine spinules around outer margin; anterior surface with a pore and a small, setiform, naked spine near medial margin. Exopod three-segmented; exp-1 and -2 with spinules around outer margin; exp-1 1.55 times longer than exp-2, with unipinnate outer spine; exp-2 without outer element; exp-3 with short unipinnate outer spine, a longer curved unipinnate spine and one geniculate seta distally, and one inner, apically penicillate seta subdistally. Endopod two-segmented, prehensile; enp-1 about eight times longer than wide, and 1.73 times longer than exopod; with a serrate inner seta in proximal third, and one spinule near outer distal corner; enp-2 about as long as wide, with a short unipinnate outer spine and a slightly longer geniculate inner claw, in addition to one large spinule.

P2–P4 (Fig. 15B–D) intercoxal sclerites naked, with concave distal margin. Praecoxae triangular, small and naked. Coxae wider than long and without ornamentation. Bases smaller than coxae, with a spinular row near base of endopod and at outer distal corner; anterior surface with a pore near coxa-basis boundary; outer basal seta absent (P2), plumose (P3) or naked (P4). Exopods three-segmented; segments with spinular ornamentation as figured; inner distal spine of exp-3 bipinnate, all other exopodal elements unipinnate; hyaline frills of exp-1 and -2 well developed; exp-2 with lateral pore halfway down inner margin length; P3–P4 exp-3 with anterior surface

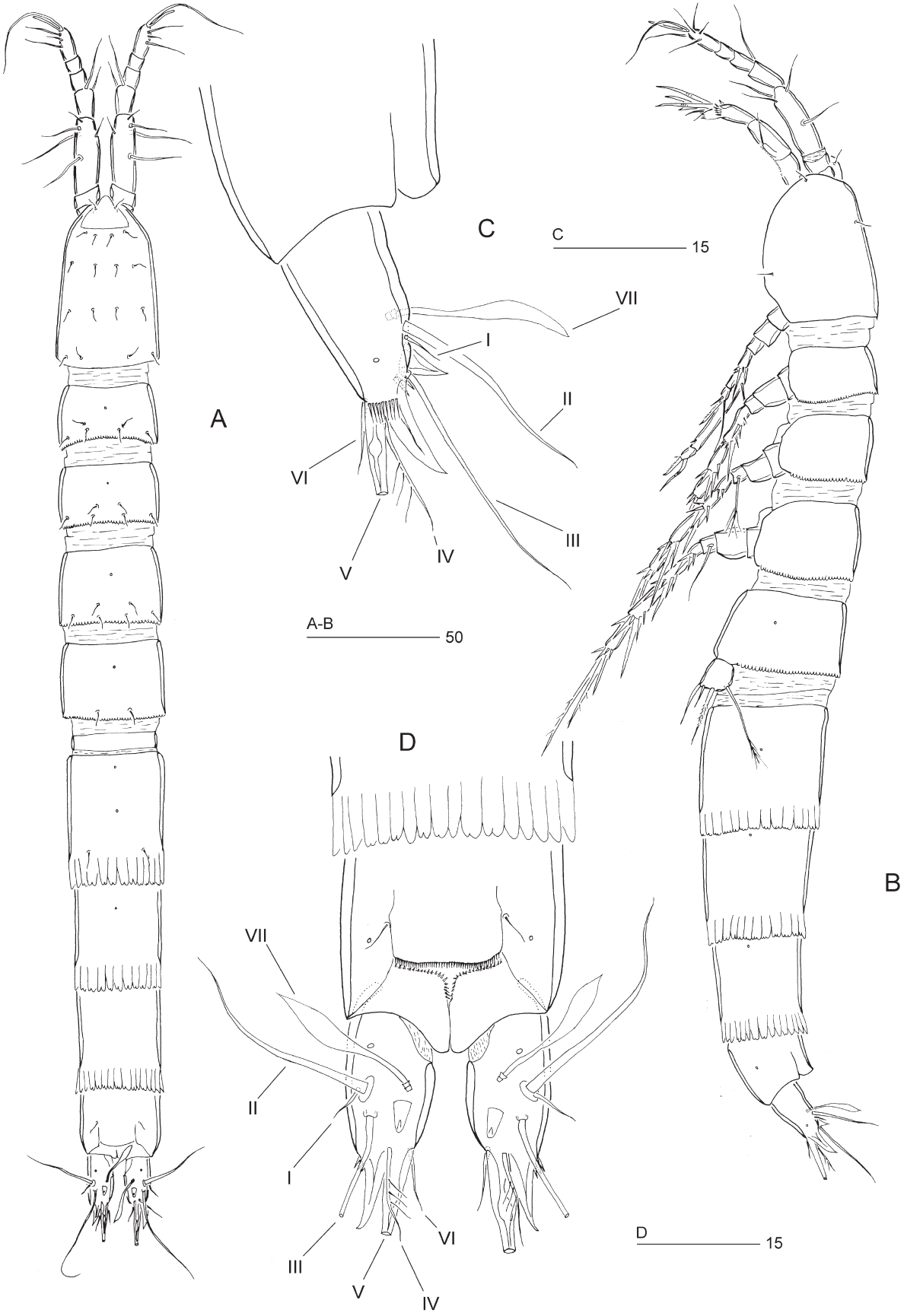

FIGURE 13. ***Arenopontia gunduzi*** **sp. nov.** (♀): (A) habitus, dorsal; (B) habitus, lateral; (C) anal somite and left caudal ramus, lateral; (D) anal somite and caudal rami, dorsal.

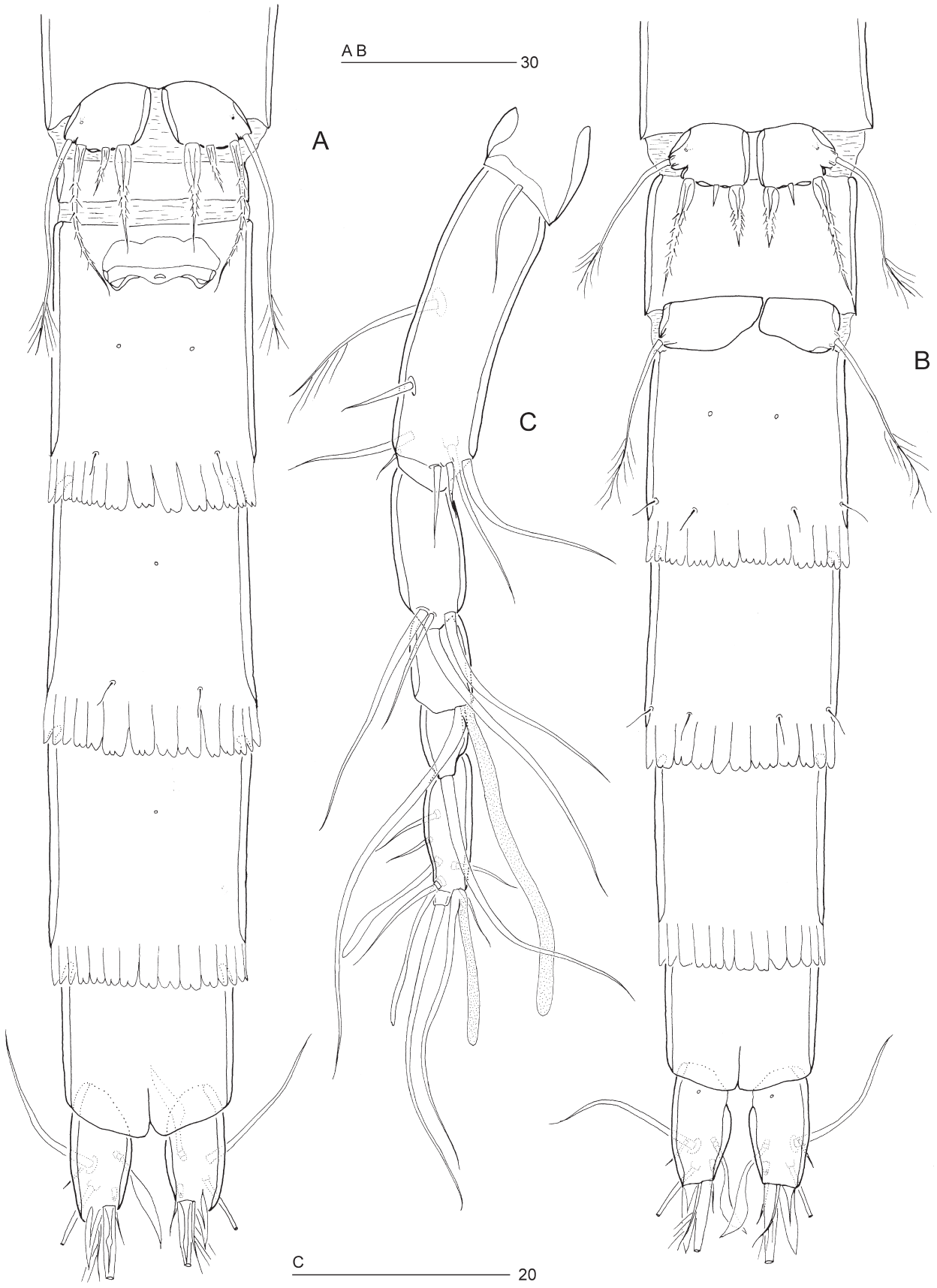

FIGURE 14. ***Arenopontia gunduzi*** **sp. nov.**: (A) urosome ♀, ventral; (B) urosome ♂, ventral; (C) antennule ♀, ventral.

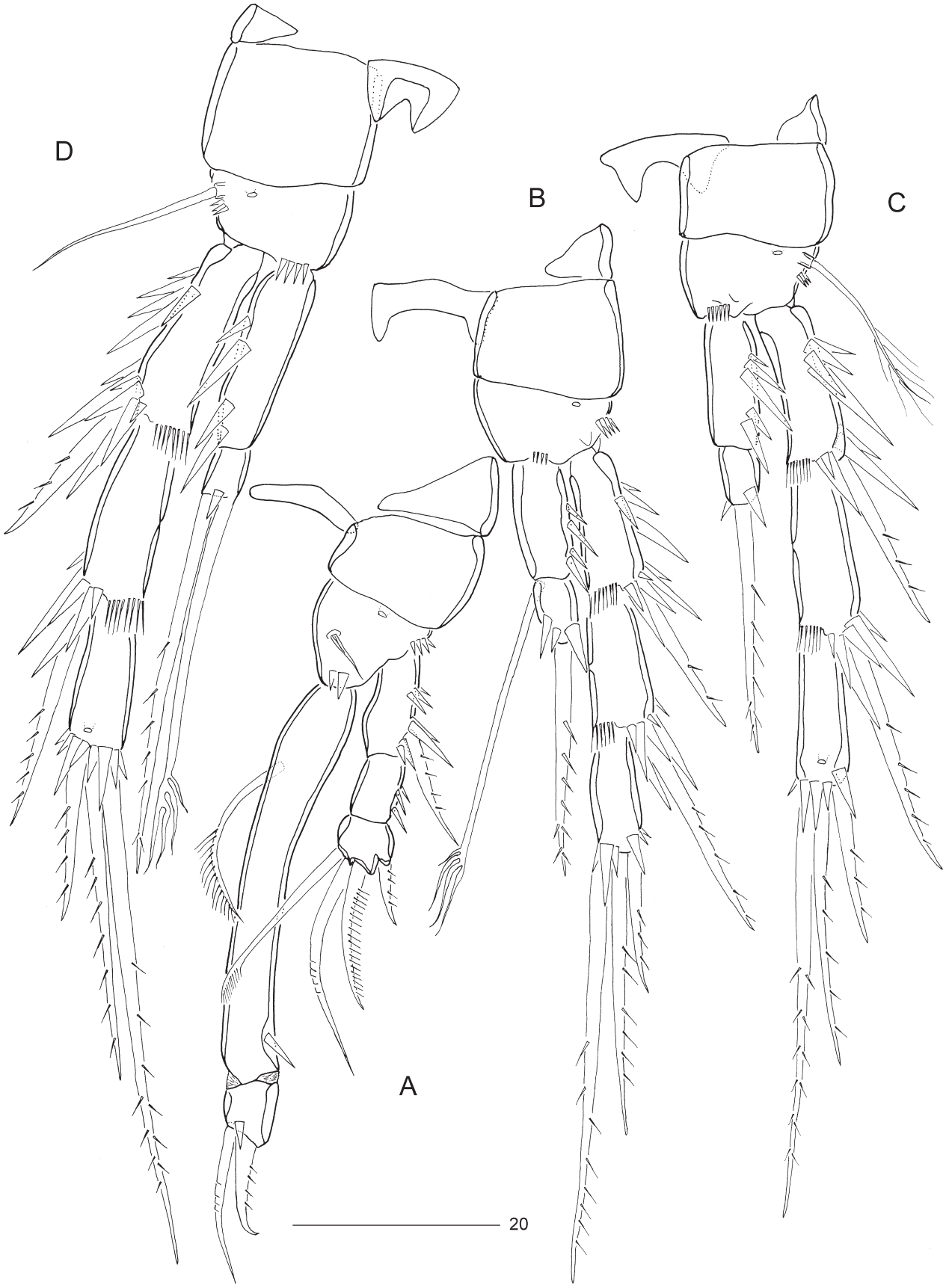

FIGURE 15. ***Arenopontia gunduzi*** **sp. nov.** (♀): (A) P1, anterior; (B) P2, anterior; (C) P3, anterior; (D) P4, anterior.

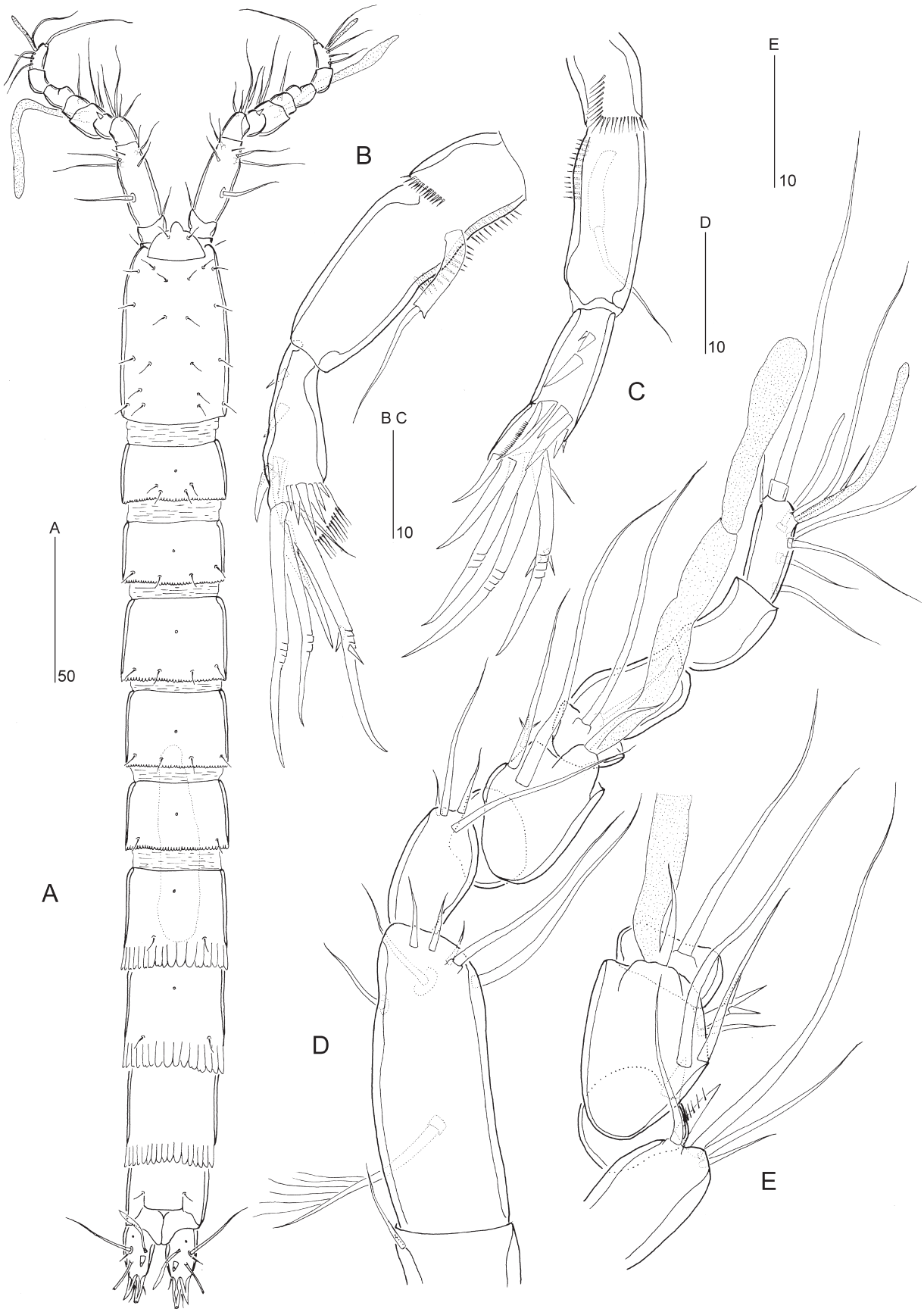

FIGURE 16. ***Arenopontia gunduzi*** **sp. nov.**: (A) habitus ♂, dorsal; (B) antenna ♀, lateral; (C) antenna ♀, medial; (D) antennule ♂, ventral [armature of segments 3–6 partly omitted; see (E)]; (E) antennulary segments 3–6, anterior ♂ [modified elements on segments 7–8 omitted].

pore. Endopods two-segmented, with enp-1 distinctly longer than enp-2 in P3–P4; P2–P4 enp-1 about 1.8, 2.4 and 3.8 times longer than their respective distal segments, with few coarse spinules along outer margin as figured. P2 enp-2 with a long, apically serrate, posteriorly directed seta near proximal inner margin. P2–P3 enp-2 with a long bipinnate seta terminally. P4 enp-2 small, with a basally fused, apically serrate seta, and a long bipinnate seta at outer distal corner. Spine and seta formula as follows:

	Exopod	Endopod
P2	0.0.021	0.110
P3	0.0.021	0.010
P4	0.0.021	0.020

Fifth legs (Fig. 14A) closely set together but not touching medially. Baseoendopod and exopod fused forming a trapezoid plate with anterior surface pore near outer margin; distal margin with three pinnate setae, outer one longest, middle one shortest an inner one spiniform and swollen in proximal half; outer basal seta long and plumose.

Genital field positioned near anterior margin of genital double-somite (Fig. 14A). Genital apertures (Fig. 14A) fused, forming median common slit; closed off by fused P6 forming operculum, rudimentary armature elements not discernible; copulatory pore small, located midventrally, close to genital slit; seminal receptacles difficult to discern.

Description of male. Total body length from tip of rostrum to posterior margin of caudal rami 336 μm. Body ornamentation (Figs 14B, 16B) essentially as in female. Sexual dimorphism in antennule, urosomal segmentation, P5 and P6. Spermatophore length approximately 68 μm.

Antennule (Fig. 16D, E) nine-segmented, haplocer; geniculation between segments 7 and 8. Segment 2 longest and about 2.7 times longer than wide; segment 4 an incomplete sclerite with two small spiniform elements (one pinnate) (Fig. 16E); segment 5 with three naked setae and one spinulose element plus long aesthetasc (L: 57 μm) fused basally to a small slender seta; segment 6 with two setae; segment 7 with two modified spines and a seta; segment 8 with a short unipinnate spine; distal segment with seven naked setae (two of which spatulate) and apical acrothek. Setal formula: 1-[1], 2-[7 + 1 plumose], 3-[6], 4-[1 + 1 pinnate], 5-[3 + 1 spinulose + (1 + ae)], 6-[2], 7-[1 + 2 modified], 8-[1 modified], 9-[7 + acrothek]. Acrothek consisting of short aesthetasc (L: 28 μm) fused basally to two slender setae.

P5 (Fig. 14B) with anterior surface pore and with armature as in female but all elements on distal margin comparatively shorter and more spiniform; outer element longest and bipinnate, middle one minute and naked, inner one bipinnate but without flagellate distal part observed in ♀. Outer basal seta plumose.

Sixth legs (Fig. 14B) asymmetrical, with smallest P6 closing off functional gonopore; each with a long sparsely plumose seta.

Etymology. The species name (a noun in the genitive case) is named after Prof. İslam Gündüz (Ondokuz Mayıs University, Samsun), in recognition of his contributions to zoology in Türkiye.

Remarks. *Arenopontia gunduzi* **sp. nov.** shares the presence of a dorsal spur on the caudal ramus with *A. riedli* and *A. nesaie*. While *A. riedli* can readily be distinguished by the much shorter P1 endopod, the presence of two distal elements on P2–P3 enp-2, five elements on the female P5 and two elements on the male P6, *A. gunduzi* **sp. nov.** and *A. nesaie* are morphologically very similar. Differences between both species include (1) relative length of P1 enp-1 (1.7 times length of exopod *vs* 2.0); (2) proportional lengths of endopodal segments of P2 (enp-1:enp-2 1.75 *vs* 1.5); (3) P4 endopod (distinctly longer than exp-1 and setae of enp-2 extending beyond exp-3 *vs* about as long as exp-1 and setae of enp-2 not extending beyond exp-3); (4) length of ♀ P5 middle marginal element (0.3 times length of outer marginal seta *vs* 0.45–0.50); (5) length of outer and inner marginal elements of ♀ P5 distinctly different (inner one shorter) *vs* equally long); (6) ♂ P5 inner marginal element shorter in *A. gunduzi* **sp. nov.** (0.5 *vs* 0.75 times length of outer marginal seta); (7) ♂ P5 middle marginal element naked and reduced (15% length of outer marginal element) *vs* bipinnate and longer (one-third length of outer marginal element); and (8) female genital operculum (fused sixth legs) without armature *vs* with three minute processes (vestigial setae).

The only confirmed record of *A. gunduzi* **sp. nov.** is from the type locality. Bonne's (2003) record of *A. nesaie* from the Kwinte Bank, a sand bank off the Belgian coast, may in reality refer to *A. gunduzi* **sp. nov.** The same conspecificity may apply to the records of *A. subterranea* from southern England (Harris 1972; Gee 1987; Joint *et al.* 1982; Wells 1961, 1963, 1970) and northern France (Bodin 1988; Le Guellec 1988; Renaud-Debyser & Salvat 1963).

***Arenopontia syltensis* sp. nov.**
https://zoobank.org/4B7EBE47-018E-471B-8451-22B86E4CB9B0
(Figs 17–20)

Type locality. Germany, Isle of Sylt, List; sandy beach.

Material examined. Holotype ♀ (dissected on six slides) (NHMUK reg. no 2024.1044). Paratypes are 1 ♀ dissected on three slides (NHMUK reg. no 2024.1045), 1 ♂ dissected on eight slides (NHMUK reg. no 2024.1046), and 7 ♀♀ and 3 ♂♂ in ethanol (NHMUK reg. nos 2024.1047–1049); all collected at type locality; leg. R. Huys & S. Conroy-Dalton, 25 August 1996.

Description of female. Total body length from tip of rostrum to posterior margin of caudal rami 341–391 μm (mean = 368 μm; n = 7; holotype = 375 μm). Maximum width 44 μm measured at posterior margin of cephalothorax. Body slender and cylindrical, without clear distinction between prosome and urosome (Fig. 17A, B). Hyaline frills of thoracic somites weakly developed and crenulated, those of genital double-somite and free abdominal somites strongly developed and consisting of rectangular digitate lappets (Figs 17A, B; 18A; 19A). Genital double-somite (Figs 17A, B; 18A) 1.15 times longer than wide (measured in ventral aspect); without chitinous ribs marking original segmentation; with two middorsal, two lateral and two ventral pores. Anal somite (Figs 17C, D; 19A) with two dorsal, two lateral and two ventral pores. Anal operculum spinulose; with coarse spinules along free distal margin (Fig. 19A). Anus positioned subterminally between caudal rami. Rostrum (Fig. 19B) small, broadly subtriangular, tapering distally, with two delicate sensilla.

Caudal rami (Figs 17D; 19A) approximately 2.9 times longer than maximum width (measured in dorsal view), tapering posteriorly; with single pores dorsally in anterior quarter (Fig. 19A) and laterally at level of insertion of seta III (Fig. 17D); outer distal corner produced into posteriorly directed, recurved spinous process, accompanied at base by outer spinular row (Fig. 17D); dorsal surface without spur-like process, inner margin with few spinules (Fig. 19A). Armature consisting of seven setae; seta I small; setae II and III long and naked; seta IV short, sparsely pinnate, located between seta V and posterior spinous process; seta V long and with fracture plane; seta VI small, naked and located at inner distal corner; seta VII foliaceous and tri-articulate at base.

Antennule (Fig. 19B) slender, six-segmented. Segment 1 with a short seta near anterodistal margin. Segment 2 longest, about 2.6 times longer than wide. Segment 4 with long aesthetasc (L: 32 μm) fused at base with seta. Distal segment with seven naked setae (one of which spatulate) and apical acrothek consisting of short aesthetasc (L: 17 μm) and two slender setae. All setae naked except for plumose seta on dorsal surface of segment 2. Armature formula: 1-[1], 2-[7 + 1 plumose], 3-[5], 4-[1 + (1 + ae)], 5-[1], 6-[7 + acrothek].

Antenna (Fig. 19D, E). Coxa small (not figured), without ornamentation. Basis and proximal endopodal segment discrete, each with spinule row along exopodal margin. Exopod one-segmented, elongate, with a naked apical seta (about 1.4 times longer than exopod). Distal endopodal segment with spinules on medial surface and at outer distal corner; medial armature consisting of two short spines; apical armature consisting of two spines and three geniculate setae, longest of which with spinules around geniculation and fused basally to naked accessory seta.

Mandible, maxillule, maxilla and maxilliped as in *A. anatolica* **sp. nov.**

P1 (Fig. 20A). Intercoxal sclerite wide and subrectangular. Praecoxa represented by triangular naked sclerite. Coxa without ornamentation. Basis with few coarse spinules near base of endopod and around outer margin; anterior surface with a pore and a small, setiform, naked spine near medial margin. Exopod three-segmented; all segments with spinules around outer margin (smaller and fewer on exp-3); exp-1 1.3 times longer than exp-2, with unipinnate outer spine; exp-2 without outer element; exp-3 with short unipinnate outer spine, a longer curved unipinnate spine and one geniculate seta distally, and one inner, apically penicillate seta subdistally. Endopod two-segmented, prehensile; enp-1 about 11 times longer than wide, and 1.85 times longer than exopod; with a serrate inner seta in proximal third, and three groups of two spinules along outer margin; enp-2 about as long as wide, with a short unipinnate outer spine and a slightly longer geniculate inner claw, in addition to one small spinule.

P2–P4 (Fig. 20B–D) intercoxal sclerites naked, with concave distal margin. Praecoxae small and naked. Coxae wider than long and without ornamentation. Bases smaller than coxae, with a spinular row near base of endopod and at outer distal corner; anterior surface with a pore near coxa-basis boundary; outer basal seta absent (P2), plumose (P3) or naked (P4). Exopods three-segmented; segments with spinular ornamentation as figured; inner distal spine of exp-3 bipinnate, all other exopodal elements unipinnate; hyaline frills of exp-1 and -2 well developed; exp-2 with lateral pore halfway down inner margin length; P3–P4 exp-3 with anterior surface pore. Endopods two-segmented,

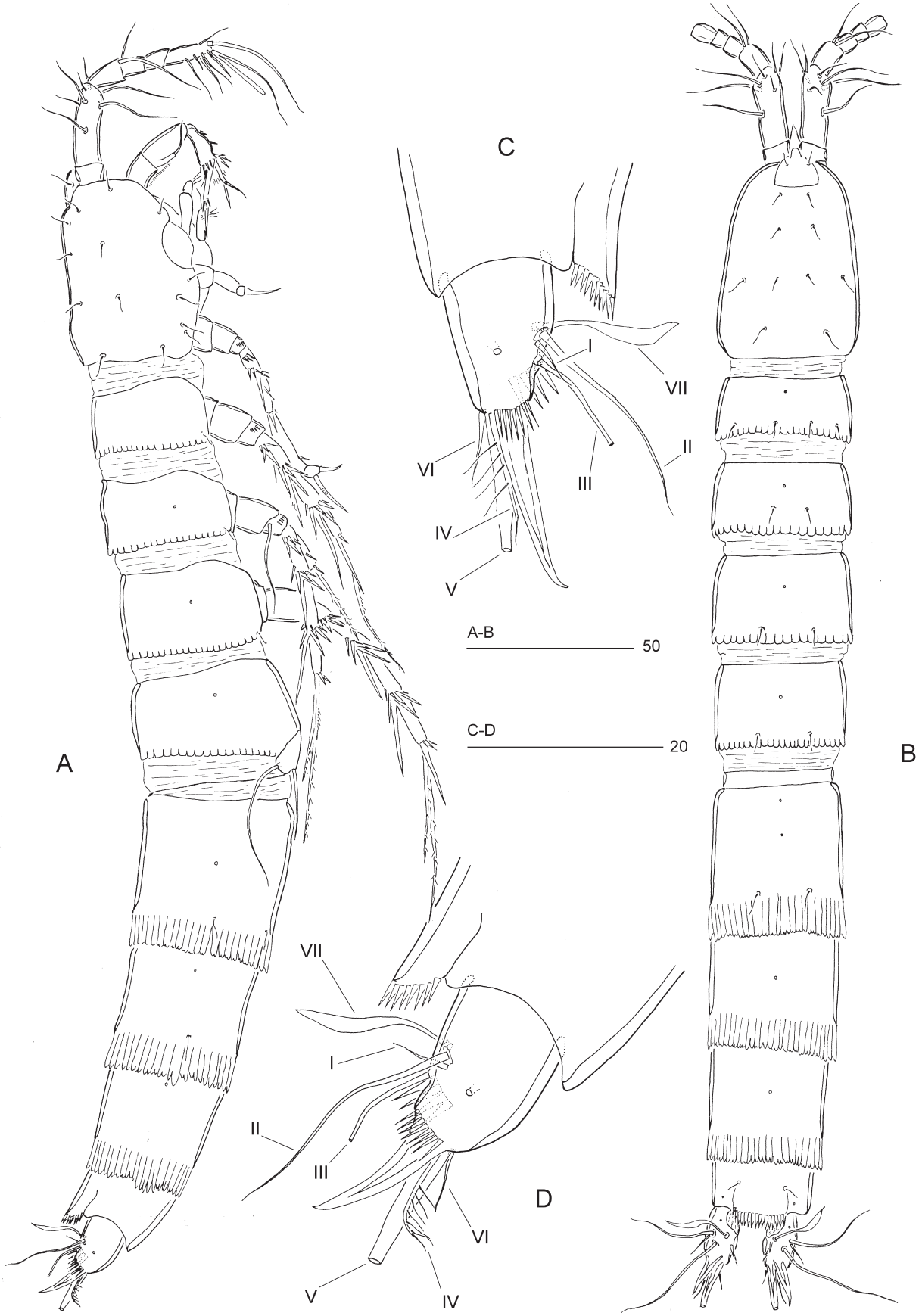

FIGURE 17. ***Arenopontia syltensis*** **sp. nov.**: (A) habitus ♀, lateral; (B) habitus ♀, dorsal; (C) posterior part of anal somite and left caudal ramus ♂, lateral; (D) posterior part of anal somite and right caudal ramus ♀, lateral

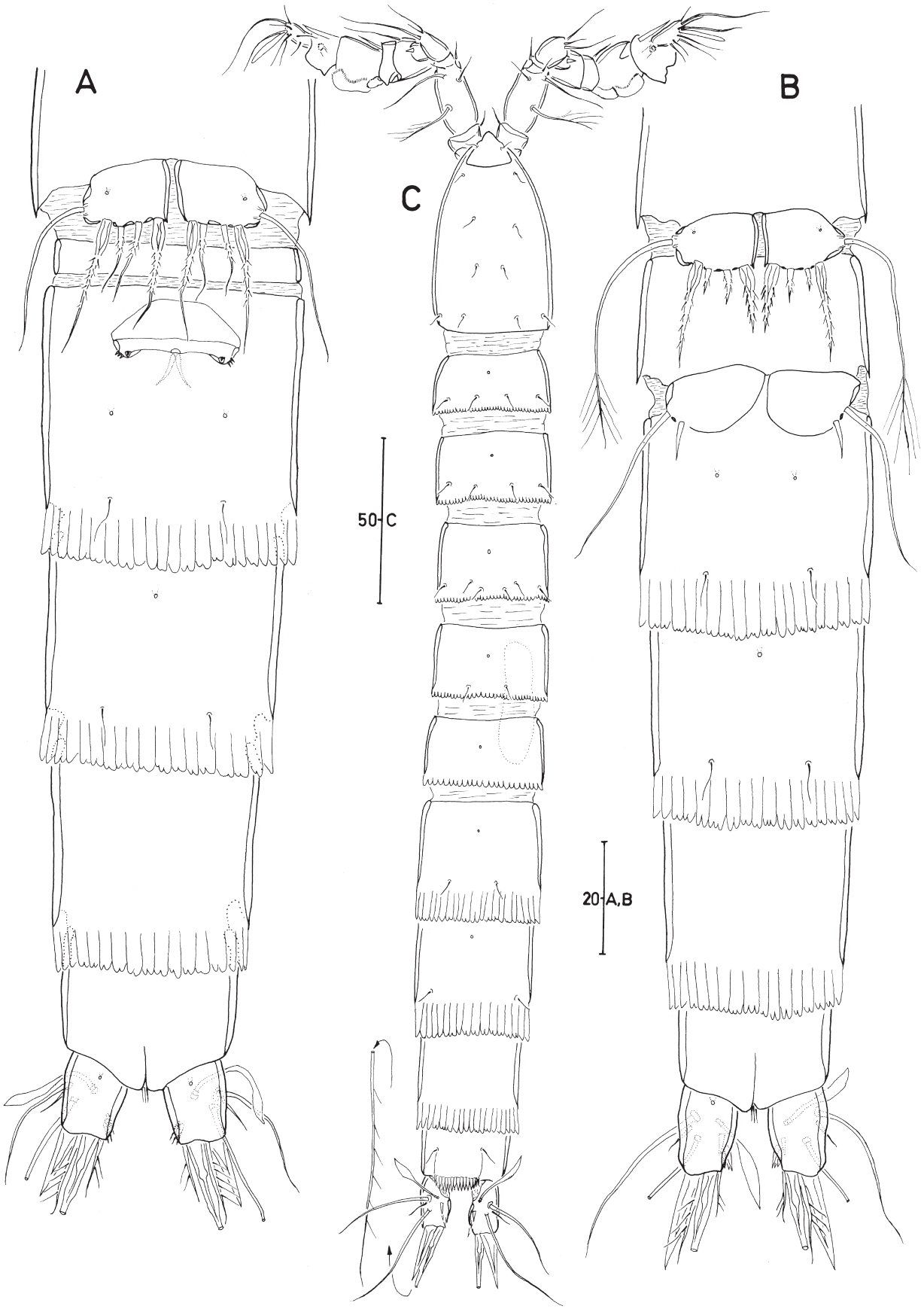

FIGURE 18. ***Arenopontia syltensis*** **sp. nov.**: (A) urosome ♀, ventral; (B) urosome ♂, ventral; (C) habitus ♂, dorsal.

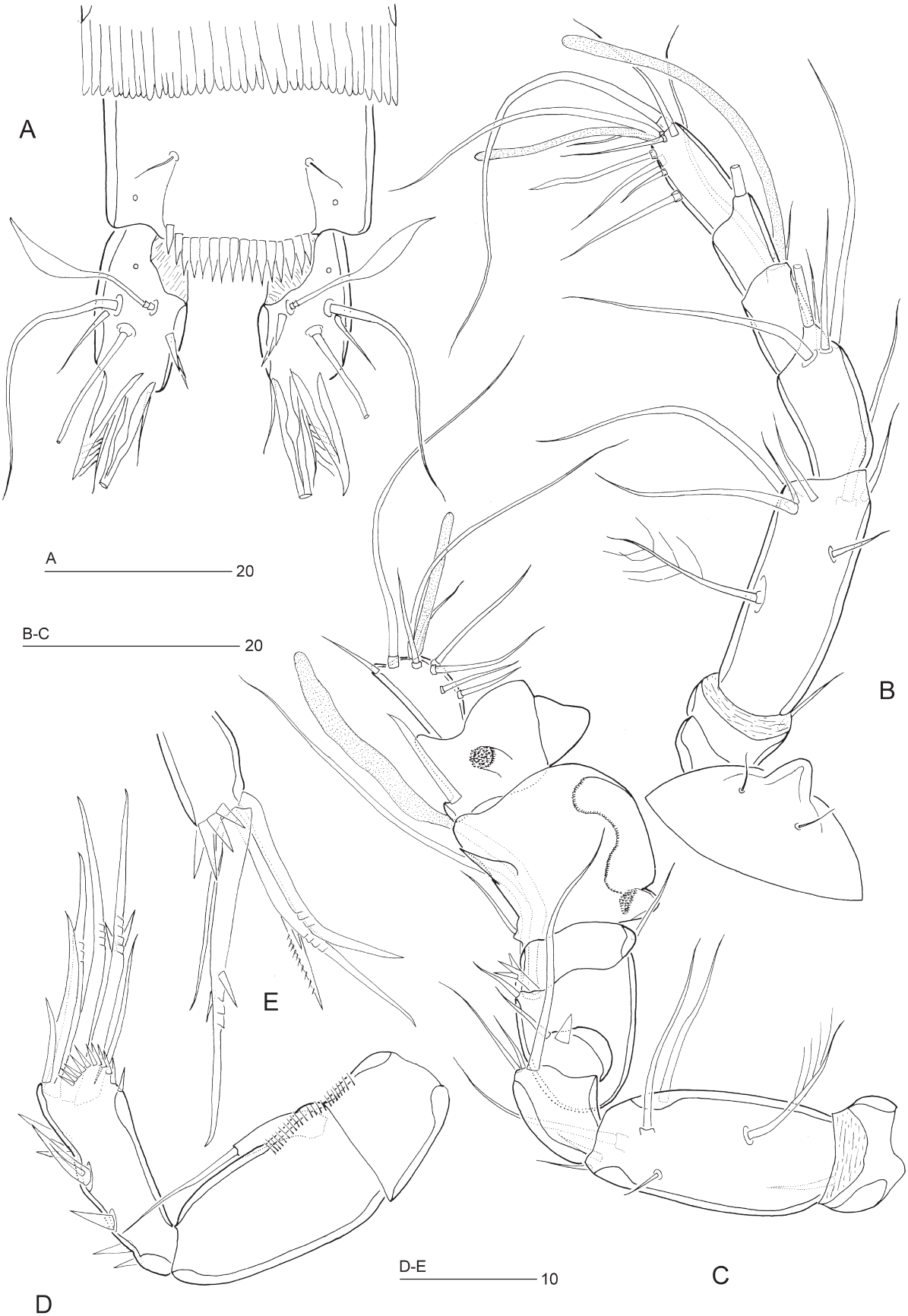

FIGURE 19. ***Arenopontia syltensis*** **sp. nov.**: (A) anal somite and caudal rami ♀, dorsal; (B) rostrum and left antennule ♀, dorsal; (C) antennule ♂, dorsal; (D) antenna ♀; (E) distal part of antennary endopod ♀, viewed from different angle.

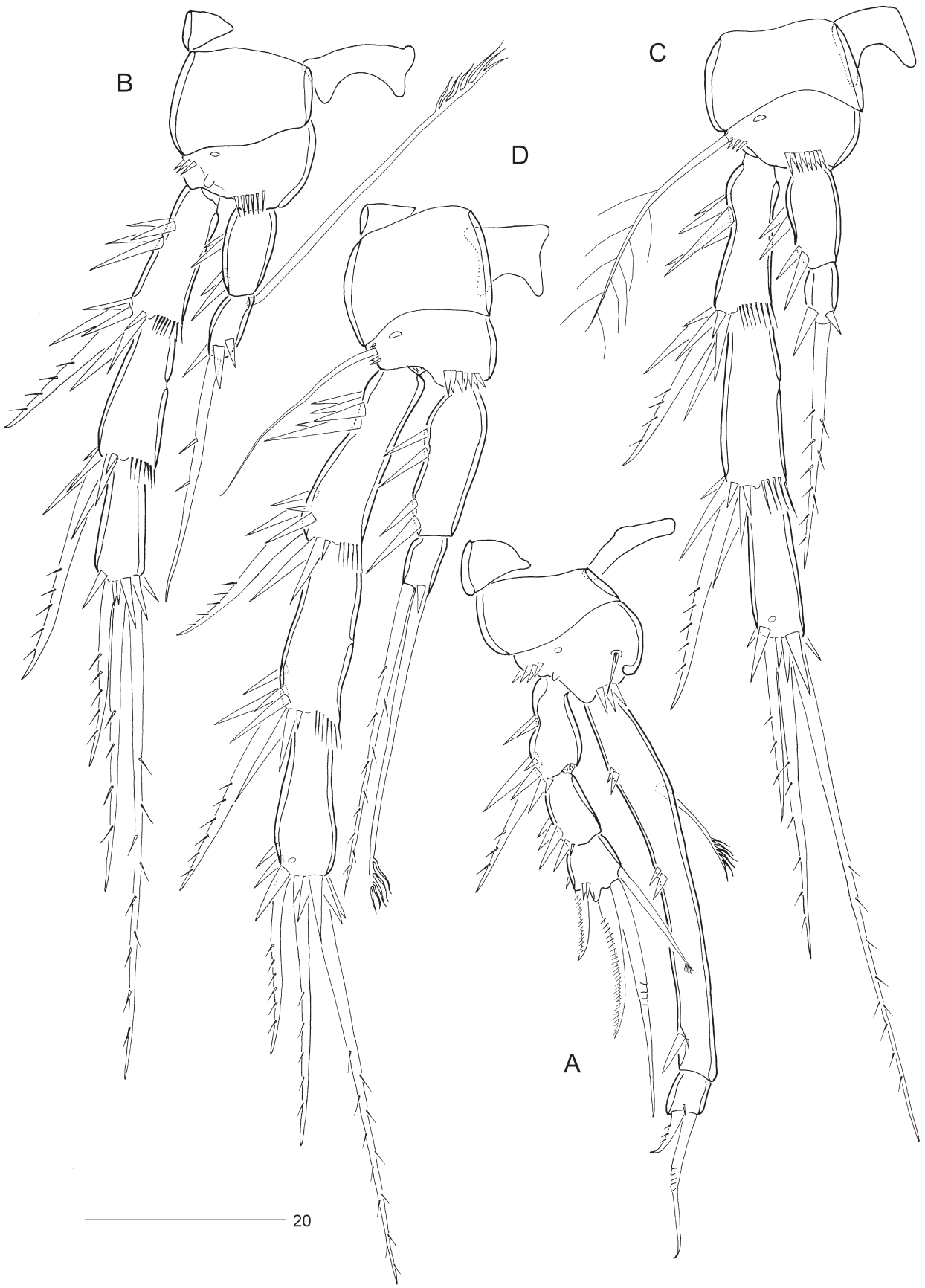

FIGURE 20. ***Arenopontia syltensis*** **sp. nov.** (♀): (A) P1, anterior; (B) P2, anterior; (C) P3, anterior; (D) P4, anterior.

with enp-1 distinctly longer than enp-2 in P4; P2–P4 enp-1 about 1.4, 1.7 and 3 times longer than their respective distal segments, with few coarse spinules along outer margin as figured. P2 enp-2 with a long, apically serrate, posteriorly directed seta near proximal inner margin. Enp-2 with a long sparsely unipinnate (P2) or bipinnate (P3) seta terminally. P4 enp-2, with a basally fused, apically serrate seta, and a long bipinnate seta at outer distal corner. Spine and seta formula as follows:

	Exopod	Endopod
P2	0.0.021	0.110
P3	0.0.021	0.010
P4	0.0.021	0.020

Fifth legs (Fig. 18A) closely set together but not touching medially. Baseoendopod and exopod fused forming a subrectangular plate with anterior surface pore; distal margin with four pinnate setae, middle ones shortest and about equally long, inner and outer ones swollen in proximal third; outer basal seta long and plumose.

Genital field positioned near anterior margin of genital double-somite (Fig. 18A). Genital apertures (Fig. 18A) fused, forming median common slit; closed off by fused P6 forming operculum, each with three rudimentary armature elements; copulatory pore small, located midventrally, close to genital slit; seminal receptacles difficult to discern.

Description of male. Total body length from tip of rostrum to posterior margin of caudal rami 328–343 µm (mean = 336 µm; n = 4). Body ornamentation (Figs 18B, C) essentially as in female. Sexual dimorphism in antennule, urosomal segmentation, P5, P6 and caudal ramus. Spermatophore length approximately 37 µm.

Antennule (Fig. 19C) nine-segmented, haplocer; geniculation between segments 7 and 8. Segments 7 and 8 swollen, expanded along posterior margin, each with spinulose process. Segment 2 longest and about twice longer than wide; segment 4 an incomplete sclerite with one small spiniform element and one small naked seta; segment 5 with one naked seta and one spinulose element plus long aesthetasc (L: 38 µm) fused basally to a long slender seta; segment 6 with one seta; segment 7 with one modified spine and a seta; segment 8 with a strong naked spine; distal segment with seven naked setae (none of which noticeably spatulate) and apical acrothek. Setal formula: 1-[1], 2-[6 + 1 plumose], 3-[3], 4-[2], 5-[1 + 1 spinulose + (1 + ae)], 6-[1], 7-[1 + 1 modified], 8-[1], 9-[7 + acrothek]. Acrothek consisting of short aesthetasc (L: 17 µm) fused basally to two slender setae.

P5 (Fig. 18B) with anterior surface pore and with armature as in female but all elements on distal margin comparatively shorter and more spiniform; outer element longest and bipinnate, middle ones short and bipinnate, inner one bipinnate but without flagellate distal part observed in ♀. Outer basal seta plumose.

Sixth legs (Fig. 18B) asymmetrical, with smallest P6 closing off functional gonopore; each with short inner and long outer seta; both elements naked.

Caudal ramus (Fig. 17C) as in ♀ except for posterior spinous process being comparatively longer.

Etymology. The specific epithet (a noun in the genitive case) is derived from the name of the island where the type locality is located, the Isle of Sylt.

Remarks. *Arenopontia syltensis* **sp. nov.** differs from its congeners by the distinctive spinulose ornamentation of the anal operculum (Fig. 19A) and the modified male antennules (Fig. 19C) which are characterized by the enlarged segments either side of the geniculation (segments 7–8), each one of which displaying an expansion along the posterior margin and a spinulose process on the dorsal surface. The species shares with *A. riedli* and *A. basibuyuki* **sp. nov.** the presence of five elements on the fifth legs of both sexes (four in all other species) but differs from the former in the presence of only one apical element on P2–P3 enp-2 (instead of two) and the absence of a dorsal spur on the caudal ramus, and from the latter in the ornamentation of P1 enp-1 and the presence of two elements on the male P6 (instead of one).

It is conceivable that *A. syltensis* **sp. nov.** occurs sympatrically with *A. subterranea* in sandy beaches on the Isle of Sylt and possibly in other localities along the German North Sea coast. This is clearly indicated by Mielke's (1975: 109) statement that his material of *A. subterranea* showed variability in the armature of the fifth legs (sometimes with five elements) and the ornamentation of the anal operculum (sometimes with coarse spinules), suggesting that it included *A. syltensis* **sp. nov.** His illustration of P1 (Abb. 73D), particularly the relative length of enp-1, also indicates that it was based on *A. syltensis* **sp. nov.** rather than *A. subterranea* which displays a shorter endopod (Kunz 1937: Abb. 9–Fig. 43).

Discussion

Valid species versus *species inquirendae* and taxa of doubtful identity

For the great majority of records of the allegedly cosmopolitan *A. subterranea* the authenticity can no longer be confirmed due to the lack of voucher specimens or other representative material. However, in some instances where illustrations were provided an objective statement can be made as to whether the populations examined are conspecific with the type species. The repeated failure to recognize the true diversity of the genus in European waters has certainly contributed to the erroneous identification of the species elsewhere, and suggests a similar, as yet undisclosed, diversity in other parts of at least the Northern Hemisphere. Below we present a critical appraisal of the records for which morphological evidence has been documented.

Arenopontia subterranea Kunz, 1937 *sensu* Chappuis (1954a)

Chappuis (1954a: 43; Fig. III-4, 5) provides illustrations of the endopods of P2 and P4 of specimens collected from a sandy beach in Canet-Plage, Roussillon (France) which he had identified as *A. subterranea*. Slight differences were encountered between his Mediterranean specimens and the type material from Kiel Bay, however, as Chappuis (1954a) pointed out himself, some of them could be attributed to deficiencies in Kunz's (1937) original description. He noted that the penicillate inner seta on P1 exp-3 and the foliaceous seta VII on the caudal ramus were not as distinctly developed as in the German material but that their modification was nevertheless discernible under higher magnification. More importantly, Chappuis (1954a) claimed and illustrated that his specimens carried three apical setae instead of two on P4 enp-2 (formula 0.030) and that the posteriorly directed inner seta on P2 enp-2 was lacking (formula 0.010). This is extremely unlikely since no other arenopontiids carry three setae on the distal endopod segment of P4 [020 as a rule; 010 in *Neoleptastacus africanus* (Chappuis & Rouch, 1961)] and the inner seta is always present on P2 enp-2 with the exception of *Onychopontia intermedia* (Rouch, 1962) and *O. peteraxi* (Mielke, 1982). Chappuis (1954a) rightly pointed out that these differences are insufficient to warrant the proposal of a distinct subspecies since it is obvious that all of them are based on observational errors. In the absence of important information on the P1, P5 of both sexes and caudal ramus it is impossible to make any positive statement on the real identity of Chappuis's (1954a) material other than that it is not conspecific with *A. subterranea*.
Noodt (1955a, c) confirmed that his *A. subterranea* material from the French Biscayan coast (♀: 350 μm; ♂: 320 μm) and the Sea of Marmara agreed in all aspects with Kunz's (1937) original description, except for the dorsal seta VII which is not foliaceous. In two female specimens from France the P1 endopod appeared to be more similar to the slender type illustrated by Chappuis (1954b).

Arenopontia subterranea Kunz, 1937 *sensu* Chappuis (1954b)

Chappuis (1954b) collected *Arenopontia* specimens in Algeria, Tunisia, the Gulf of Genoa and Catalonia, all of which were attributed to *A. subterranea*. His brief description (Chappuis 1954b: 267–268; Figs 40–45) provides illustrations of P1, P2–P4 endopods and the P5 of both sexes. The presence of a strong spinule near the outer distal corner as the only spinular ornamentation of P1 enp-1 rules out conspecificity with any of the species listed in Group I (Table 1), including *A. subterranea*. This is corroborated by the extraordinary length of the segment, being 11 times as long as wide and 2.5 times the length of the exopod. The number of armature elements (four) on the fifth leg relates Chappuis's (1954b) material to either *A. gunduzi* **sp. nov.** or *A. nesaie*, the latter being closest in terms of enp-1/exp length ratio (2.0). Although there is a general resemblance in P5 morphology (both sexes), other characters such as the longer P2–P3 enp-2 and the unequal terminal elements (outer one half the length of inner one) on P4 enp-2 suggest that Chappuis's (1954b) specimens are not *A. nesaie* but possibly belong to another, as yet unidentified, species or an amalgam of species. The presence/absence of the dorsal caudal ramus spur and the condition of the male P6 remain unconfirmed.

Arenopontia subterranea Kunz, 1937 *sensu* Şerban (1959)

Şerban's (1959) report from a fine sandy beach in front of the sanatorium in Agigea (Romania) is the first record from the Black Sea basin that was attributed to *A. subterranea*. His description is totally lacking in illustrations and no data were provided for the body length of both sexes. In the absence of information about the ornamentation of P1 enp-1 it is impossible to refer the Pontic material to either of the two groups recognized herein. Although Şerban (1959) announced a detailed description by himself & Eitel-Lang, this never happened (C. Pleşa, pers. comm. to RH; see also Sak *et al.* 2008: 413). Şerban (1959) pointed out that the Romanian material deviated from Kunz's (1937) original description in several aspects, including (1) the P1 endopod being distinctly longer, (2) the inner distal seta of P1 exp-3 not being modified, (3) the dorsal seta of the caudal ramus being slender and not foliaceous, and (4) the male P5 possessing five elements instead of four. Although Şerban (1959) admitted that such differences would normally justify establishing a distinct species for the Pontic material, he refrained from doing so because of previous reports of morphologically divergent populations of *A. subterranea* in the Mediterranean (Chappuis 1954a-b). He also suggested that detailed study of more material from a wider range of localities would be required before a strong recommendation for proposing a separate Black Sea subspecies could be made. More specifically, Şerban (1959) called for confirmation of the non-modified dorsal caudal setae in the Pontic material since in all other populations they appeared to be foliaceous.

The long P1 endopod rules out conspecificity with *A. anatolica* **sp. nov.** but not with *A. basibuyuki* **sp. nov.**, which also has a total of five elements on P5. Şerban (1959) referred only to the marginal elements (thus not the outer basal seta) in his comparison with Kunz' (1937) and Chappuis' (1954b) descriptions of the male P5, indicating his observation of four elements excluded the outer basal seta. Unfortunately, no information was given about the female condition.

Arenopontia subterranea Kunz, 1937 *sensu* Rao & Ganapati (1969)

Sak *et al.* (2008) remarked that Rao & Ganapati's (1969) material of *A. subterranea* from Visakhapatnam (Andhra Pradesh, India) cannot possibly belong to the genus *Arenopontia* due to the different morphology of the P1, showing a non-prehensile endopod, the absence of the penicillate seta on exp-3, and the presence of two geniculate setae on enp-2. They suggested that this material, and possibly previous records of *A. subterranea* from Palm Beach in Visakhapatnam (Rao 1967, 1968; Rao & Ganapati 1966, 1968a, 1968b), represent an as yet undescribed species of the genus *Psammoleptastacus*.

Arenopontia pontica Apostolov, 1969

Original description. Apostolov (1969): 125–127, Abb. 36–45.

Type locality. Bulgaria, south of Lozenetz, Düni Beach; 5 m from low-tide mark.

Body length. 420 µm (♀), 500 µm (♂).

Remarks. Sak *et al.* (2008) discussed the numerous inconsistencies in Apostolov's (1969) description of *A. pontica*. If correct, several features that were illustrated (*e.g.* bisetose antennary exopod; P1 exp-2 with outer spine; P2–P3 exp-2 with inner seta) would exclude the species from the Arenopontiidae. Apostolov (1969) recognized a close relationship with *A. subterranea*, *A. indica* and *A.* sp. *sensu* Griga (1964) but according to Sak *et al.* (2008) it is impossible to make any positive statement on the identity and possible relationships of *A. pontica* other than that it can be assigned to the genus *Arenopontia*. Pending redescription, they considered it a *species inquirenda* which is confirmed here. There is no evidence to substantiate conspecificity with *A. subterranea* as claimed by Marinov (1971) and Apostolov (1973) or to regard it as a subspecies of the latter (Apostolov, 1973). It should also be noted that Apostolov's (1969) specimens are remarkably large for the genus.

Arenopontia subterranea Kunz, 1937 *sensu* Marinov (1971)

Marinov (1971) fiercely criticized Apostolov's (1969) description of *A. pontica*, stating that it contained numerous observational errors in addition to contradictions between the text and illustrations. Despite these inadequacies,

Marinov (1971: 69–70; Figs 23(3), 26) claimed that *A. pontica* looked very similar to *A. subterranea* from the Black Sea and provided illustrations of the female P1–P5 and caudal ramus based on specimens collected from the Bulgarian coast (no exact localities specified). No text description was provided and information about the body length and the male is lacking. The spinular ornamentation on P1 enp-1 is continuous along the entire outer margin—a questionable condition not found in any other member of the genus—and may suggest that it belongs to Group I. Although his material bears some resemblance to *A. anatolica* **sp. nov.** (as pointed out by Sak 2004), we have elected not to treat it as conspecific for now because of small differences in the length of the P1 endopod and setal elements on the female P5. Such morphological discrepancies may be suggestive of the presence of an as yet undescribed species occurring along the Bulgarian Black Sea coast or merely reflect inaccuracies in Marinov's figures. Pending re-examination of material *A. subterranea sensu* Marinov (1971) is treated as a taxon of doubtful identity.

Arenopontia subterranea Kunz, 1937 *sensu* Apostolov (1973)

Marinov's (1971) publication had apparently remained unnoticed to Apostolov (1973) when he stated that *A. pontica* may well be a synonym of *A. subterranea*. Apostolov referred to the variability previously reported for the French Mediterranean (Chappuis, 1954a) and Romanian "populations" (Şerban, 1959) of *A. subterranea* as evidence in support of his claim, however fueled the confusion by stating that the Black Sea specimens (from an unspecified locality in Bulgaria) represented a new but unnamed subspecies of *A. subterranea*. Although Apostolov (1973: 104–105; Fig. 18-(1–8)) claimed that his material exhibited considerable variability in the caudal rami, P1 exopod and P5, he did state that it agreed with Şerban's (1959) observations based on Romanian specimens, confirming the absence of the foliaceous condition of caudal ramus seta VII and the penicillate condition of the inner distal seta on P1 exp-3. It is not clear which variability in caudal ramus and P1 endopod morphology Apostolov referred to. As pointed out by Sak *et al.* (2008) Apostolov (1973) clearly had two or more co-existing species in his samples and failed to distinguish between them as indicated by his illustrations of the female P5. His Figure 18-5 shows a fifth leg of the *subterranea*-type which is remarkably similar to that of *A. anatolica* **sp. nov.** (compare Fig. 6C) while Sak *et al.* (2008) had previously noted that his Figure 18-6 was almost certainly based on the species previously identified by Marinov (1971) as *A. stygia* Noodt, 1955c (= *Psammoleptastacus barani* Sak, Huys & Karaytuğ, 2008). An alternative interpretation is that the latter is based on *A. basibuyuki* **sp. nov.** (compare Fig. 8A) which is known to be widely distributed along the Turkish Black Sea coast. Since Apostolov (1973: Fig. 18-1) did not provide any information about the ornamentation of P1 enp-1, his material (whichever species he depicted) cannot be assigned to either of the two groups defined here.

Arenopontia subterranea Kunz, 1937 *sensu* Cottarelli (1975)

Cottarelli (1975: 69–70; Figs 12, 17, 20) illustrated the mandibular palp, P1 and ♀ P5 of a population from Riu Ciuchesu near San Teresa di Gallura in the Strait of Bonifacio (northern Sardinia, Italy) which he assigned to *A. subterranea*. There is a remarkable similarity in P5 structure (vestigial 5th seta along the distal margin; proportional setal lengths) with Mielke's (1975) Isle of Sylt material but the P1 endopod is shorter than in the type population (enp-1 5.9 times as long as wide; enp-1:exp ratio 1.27), resembling the condition in *A. anatolica* **sp. nov.** The ornamentation of the P1 endopod confirms placement in Group I but in the absence of information on the caudal rami and remaining swimming legs the true identity of Cottarelli's (1975) material remains to be confirmed.

Arenopontia subterranea Kunz, 1937 *sensu* Lindgren (1976)

Lindgren (1972, 1976) found several females in a fully exposed high-energy sandy beach, west of Ocean Steamer Pier on the oceanic side of Bogue Bank (76°50'00" W, 34°41'30" N), in North Carolina (U.S.A.). No body length measurements were given but some illustrations of the female were presented. Lindgren (1976: 229–231; Fig. 2c, e–g) maintained that his specimens were not notably different from Kunz's (1937) description, having the same setal formula on P2–P4 but lacking the foliaceous seta VII on the caudal ramus. His illustration of the P1 lacks the inner penicillate seta, showing only three elements on exp-3, but confirms that the North Carolina material belongs to

Group I. More detailed information (*e.g.* caudal ramus, ♂ P5–P6) is needed before Lindgren's (1976) material can be confirmed as the first amphi-Atlantic record of the species, however, the relative length of P1 enp-1 (enp-1 8.2 times as long as wide; enp-1:exp ratio 1.35) appears to refute this.

Arenopontia subterranea Kunz, 1937 *sensu* Arlt (1983)

Arlt (1983: 73–74; Fig. 17) collected a single female (body length 310 μm) from fine sand at 13 m depth, east of Darss Sill in the Baltic Sea (Germany) and provided a concise illustrated description. Based on his figures it appears that he was dealing with an aberrant specimen, displaying five setae on one member of the fifth pair of legs and three setae (the outer basal one definitely lacking) on the other side. His statement that "... the terminal segment of enp P1 had only normal setae and no surface seta..." is puzzling since his illustration shows exactly the same condition as in other members of the genus. Assuming Arlt's (1983) drawing of the P1 endopod is correct there is a hint that his female specimen belongs to Group II. The author also mislabelled the P3 as the P2 and showed two (!) setae on the antennary exopod. The caudal ramus appears to have a raised spinular row on its dorsal surface and setae VII is not foliaceous. The P1 endopod is considerably longer than in Kunz's (1937) type material, approaching the condition of *A. syltensis* **sp. nov.** It is highly likely that Arlt (1983) has either illustrated the latter or another closely related species, casting further doubt on the validity of other Baltic records of *A. subterranea*. This is the only illustrated mesohaline record of the genus.

Arenopontia subterranea Kunz, 1937 *sensu* Apostolov & Marinov (1988)

The illustrations of *A. subterranea* provided by Apostolov & Marinov (1988) in their catalogue of Bulgarian harpacticoids are useless for identification purposes since the majority of them are not based on Black Sea material but were either redrawn from Kunz's (1937) or Mielke's (1975; *i.e.* P1) re(descriptions), both of which refer to German specimens of genuine *A. subterranea* or *A. syltensis* **sp. nov.** Only the illustration of the second caudal ramus type (without the foliaceous setae) was reproduced from Apostolov's (1973) Bulgarian material that was attributed to *A. subterranea*.

Arenopontia cfr. *subterranea* Kunz, 1937 *sensu* Cottarelli & Venanzetti (1989)

Cottarelli & Venanzetti (1989) recorded *A. subterranea* from three circumsardinian islands: Isola Budelli (Arcipelago de La Maddalena), Isola Tavolara and Isola di San Pietro. From the latter island and Isola Asinara, they also collected specimens which they classified as *A.* cfr. *subterranea* (see also Cottarelli & Forniz 1995). The latter temporary name denotes specimens that are very similar to *A. subterranea* but can be differentiated by the length of the P1 endopod and other characteristics. Although the authors announced a forthcoming description of the latter species this has never been published. Cottarelli *et al.* (1994) listed a number of localities with freshwater influence where *A.* cfr. *subterranea* has been recorded from: mouth of River Trigno, Molise; mouth of Ombrone River, Tuscany; shore of Tiberio on the littoral of Sperlonga, Latium; and shore of S. Agostino near Gaeta, Latium. Cottarelli *et al*. (1998) recorded it from the mouth of the Valfragida Stream in the Viterbo province. It is not clear whether all these records refer to the same morphotype of *A.* cfr. *subterranea*.

Arenopontia subterranea Kunz, 1937 *sensu* Rao (1991)

Rao (1991) provided a brief text description based on two specimens (body length 300–320 μm; no sex specified) collected from medium coralline sand near the mid-water level of lagoon beaches on Kavaratti and Agatti, Lakshadweep (India). He claimed that his material showed minor variations with Kunz's (1937) description in the armature of the body appendages, in particular the shape of the modified setae on P1 exp-3 and the distal endopod segment of P2 and P4. Rao (1991) also stated that the antennary exopod carried two setae, a unique character within the Arenopontiidae (see also Arlt 1983: Fig. 17). Without any illustrations given, the authenticity of this record cannot be confirmed.

Arenopontia nesaie Cottarelli, 1975 *sensu* Mitwally & Montagna (2001)

Description. Mitwally & Montagna (2001): 535–538; Figs 11–12.

Distribution. Egypt, Alexandria; Bir Masoud, El Mamoura and El Shatby beaches.

Body length. 305–427 μm (♀), 244–305 μm (♂).

Wells (2007) noted that, assuming Mitwally & Montagna's (2001) setation formula of P1–P4 is correct, their material cannot be assigned to *Arenopontia*. Sak *et al.* (2008) pointed out that the unorthodox armature pattern results from failure to distinguish between ornamentation elements (such as long spinules) and genuine setae/spines. Obvious observational errors include the 3-segmented condition of the mandibular palp and the reported presence of an outer seta on P1 enp-1 and P3–P4 enp-1, and of four elements on P2 exp-3. The distal segment of the P4 exopod also appears to be rotated in their Fig. 11G probably as a result of imperfect mounting. The presence of a prominent spinule [misinterpreted as a setation element by Mitwally & Montagna (2001)] at the outer distal corner of P1 enp-1 places their material in Group II. Within this group, the Egyptian population shares the dorsal spur on the caudal ramus with *A. nesaie* and *A. gunduzi* **sp. nov.**, however, displays a P1 enp-1:exp ratio (1.85) that is intermediate between the respective values of these species. The elements on the female P5 are distinctly longer than in *A. nesaie* and the caudal rami appear shorter. No information was given on the number of setae on the male P6 but the variability illustrated for the male P5 indicates that there was more than one species in their samples. Consequently, *A. nesaie sensu* Mitwally & Montagna (2001) is considered a taxon of doubtful identity pending the re-examination of additional material.

Species identification

The nine valid species of *Arenopontia* can be divided in two groups based on the number of spatulate setae on the apical segment of the antennule, spinular ornamentation along the outer margin of P1 enp-1, and the number of elements on the male P6. Although the respective states of these three characters appear to be linked in each group, there is no congruence with other characters such as the number of elements on the fifth legs, the ornamentation of the anal operculum and the presence/absence of a dorsal spur on the caudal ramus. With the exception of *A. riedli*, which can readily be distinguished from its congeners by the more primitive armature on the endopods of P2–P3, accurate identification of *Arenopontia* species is notoriously difficult. A simple dichotomous identification key is difficult to construct, however species can reliably be identified by considering the differentiating characters summarised in Table 1. Identifications made with the key below must be confirmed by reference to the original descriptions in the literature.

1. P2–P3 with two apical elements on enp-2 . . . . . *A. riedli.*
   P2–P3 with one apical element on enp-2 . . . . . .2.
2. P1 enp-1 with single prominent spinule near outer distal corner of segment (*e.g.* Fig. 15E) . . . . . .3.
   Outer margin of P1 enp-1 with three sets of (typically two, occasionally three) spinules, more or less evenly distributed along length of segment (*e.g.* Fig. 4A). . . . . .5.
3. Caudal ramus with raised spinular row dorsally near inner margin; P5 of both sexes with five elements . . . . . *A. basibuyuki* **sp. nov.**
   Caudal ramus with dorsal spur; P5 of both sexes with four elements . . . . . .4.
4. P1 enp-1 1.7 times as long as exopod; P4 enp-1 distincly shorter than exopod; P5 ♀ innermost element at least as long as outer apical element. . . . . .*A. gunduzi* **sp. nov.**
   P1 enp-1 twice as long as exopod; P4 enp-1 as long as exopod; P5 ♀ innermost element distinctly shorter than outer apical element . . . . . *A. nesaie.*
5. Anal operculum spinulose, with coarse spinules; P5 ♀ with five elements. . . . . *A. syltensis* **sp. nov.**
   Anal operculum pinnate with fine spinules, or smooth; P5 ♀ with four spinules . . . . . .6.
6. P1 enp-1 1.3 times as long as exopod and 5.0 times as long as wide. . . . . *A. anatolica* **sp. nov.**
   P1 enp-1 at least 1.5 times as long as exopod and at least 6.9 times as long as wide . . . . . .7.
7. P1 enp-1 1.5 times as long as exopod and 6.3 times as long as wide. . . . . .*A. subterranea.*
   P1 enp-1 1.7 times as long as exopod and 8.5 times as long as wide. . . . . .*A. adriatica* **sp. nov.**
   P1 enp-1 1.7 times as long as exopod and 6.9 times as long as wide. . . . . .*A. problematica.*

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