REDESCRIPTION OF TWO RARE HYPOGEAN SPECIES OF THE GENUS
CRYPTOCANDONA KAUFMANN (OSTRACODA)

BY

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ABSTRACT

Cryptocandona phreaticola (Kiefer & Klie, 1927) and C. leruthi (Klie, 1936) are redescribed on the basis of type specimens, which allows (1) to present their morphology in detail, (2) to compare both species, and (3) to emphasize differential diagnostic characters of these species within the genus. They appear to be similar to each other and to come close to C. kieferi (Klie, 1938). Known data on the distribution and ecology of both redescribed species are also briefly summarized.

RÉSUMÉ

Cryptocandona phreaticola (Kiefer & Klie, 1927) et C. leruthi (Klie, 1936) sont redécrites d’après les exemplaires de la série type, ce qui permet (1) de présenter en détail leur morphologie, (2) de comparer les deux espèces et (3) de mettre en évidence les traits spécifiques pour la diagnose différentielle de ces espèces à l’intérieur du genre. Ces espèces sont semblables l’une l’autre et se rapprochent de C. kieferi (Klie, 1938). Les connaissances acquises sur la distribution et l’écologie des deux espèces sont aussi brièvement résumées.

INTRODUCTION

The genus Cryptocandona was erected by Kaufmann (1900a, b) when describing a new species from Switzerland. After several additional descriptions of other closely related, living species, especially amphigonic ones, Cryptocandona nowadays constitutes a well-defined phylogenetic lineage (Meisch, 2000) comprising one of the most primitive sets of species of the tribe Candonini Kaufmann, 1900.

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However, the taxonomic status of several species of the genus still remains uncertain, whence revisions that include thorough morphological redescriptions are necessary. Also, a reliable hypothesis about the phylogenetic relationships between the various species within this genus is badly needed.

In the present paper, we carefully analyse the morphology of two rare hypogean and amphigonic *Cryptocandona* species, i.e., *C. phreaticola* (Kiefer & Klie, 1927) and *C. leruthi* (Klie, 1936). Their morphology is poorly known, which is due in part to the insufficiency of the original descriptions, and for another part to the fact that since these descriptions these species have not been collected again. Thus, our present redescriptions have been based on type specimens from the W. Klie collection, deposited in the Zoologisches Museum und Zoologisches Institut der Universität Hamburg (= ZMH).

The present contribution forms a part of a wider investigation on the species of *Cryptocandona*, which aims at reconstructing the phylogeny of this group of ostracods, and to trace its major evolutionary pathways.

*Cryptocandona* is one of the most common groups of freshwater ostracods living in hypogean environments and in ecotones between hypoe- and epigean environments, i.e., springs directly connected with the stygal (for a summary see Danielopol, 1980). Therefore, this study will be of interest to all those neontologists as well as palaeontologists who are interested in the general problem of the origin, biogeography, and speciation of the subterranean freshwater fauna.

**METHODS**

The chaetotaxic notation adopted follows the model proposed by Broodbakker & Danielopol (1982), revised for the second antenna by Martens (1987), and for the thoracopods by Meisch (1996). Contrary to the models mentioned above, names and abbreviations for the last four limbs and the caudal rami (furca) follow the pattern proposed by Smith & Martens (2000); hemipenis terminology as in Danielopol (1969). The ostracod taxonomic system used here is that of Martens et al. (1998).

Abbreviations used in text and figures. — A, anterior; a, outer lobe of hemipenis; A1, antennula; A2, antenna; b, inner lobe of hemipenis; CR, caudal ramus; D, distal; d, seta on Pr of L6; d1, d2, dp, setae on Pr of L7; E, endopod; e, setae on EI of L6 and L7; EI-EIV, 1st to 4th podomeres of E; Ex, exterior; Exo, exopod; f, setae on EII of L6 and L7; g, setae on EIII of L6 and L7; G a, anterior claw of CR; G M (G m ), major (minor) claw on EIV of A2; G p, posterior claw of CR; G1-3, anterior and internal claws (or setae) on EIII of A2; H, height; h, medial lobe of hemipenis; h1-3, setae (or claws) on EIV of L6 and L7; In, interior; L, length; l,
large (relative L of setae or claws); L5, maxilliped (5th limb); L6, walking leg (6th limb); L7, cleaning leg (7th limb); LV, left valve; M, sclerotized internal process of hemipenis; m, medium (relative L of setae or claws); Md, mandibula (3rd limb); Mdp, mandibular palp; Mx, maxilla (4th limb); P, posterior; Pr, protopod; RV, right valve; s, small (relative L of setae or claws); sa (sp), anterior (posterior) seta of CR; S1-2, plumed setae on the 1st podomere of Mdp; t1-4, internal setae on EI of A2 (t2 and t3 transformed in males into sensory bristles); W, width; Y, aesthetasc on EI of A2; y1-3, aesthetasc on EI, EIII and EIV of A2 respectively; ya, aesthetasc on the terminal podomere of A1; z1-3, external setae (or claws) on EIII of A2; α, β, γ, special setae on the 1st, 2nd, and 3rd podomeres of Mdp, respectively. Podomeres of a given limb used as reference for evaluation of the relative L of setae and claws: A1, 4th podomere; A2, EI; Mdp, 3rd podomere; Mx palp, 2nd podomere; L6, EI; L7, EI. All other symbols and their combinations as in Broodbakker & Danielopol (1982).

SYSTEMATICS AND MORPHOLOGICAL DESCRIPTIONS

Systematic position of the genus Cryptocandona Kaufmann, 1900

Class: Ostracoda Latreille, 1806; Subclass: Podocopa Müller, 1894; Order: Podocopida Sars, 1866; Suborder: Podocopina Sars, 1866; Infraorder: Cyprido-copina Jones, 1901; Superfamily: Cypridoidea Baird, 1845; Family: Candonidae Kaufmann, 1900; Subfamily: Candoninae Kaufmann, 1900; Tribe: Candonini Kaufmann, 1900.

Cryptocandona Kaufmann, 1900

Type species. — C. vavrai Kaufmann, 1900.

Diagnosis. — Carapace: medium sized (c. 1 mm in length), elongate, often with almost symmetrical anterior and posterior margins in lateral view, distinctly laterally compressed in dorsal view, mostly without significant sexual dimorphism. A2 of male: endopod 4-segmented (2nd and 3rd podomeres differentiated), with male bristles. Mdp: 2nd podomere ventrally with setal group of 3 setae (+2 usually shorter and different). L5: respiratory plate with 3 setae; male clasping organs asymmetrical, the right one more distinctly developed than the left one. L7: Pr with 3 setae (d1, d2 and dp); EI with distal seta ‘e’; EII + EIII with medial ‘f’ and distal ‘g’ setae; terminal setae: one very long (h3), one usually medium (h2), and one short (h1). Hemipenis: 3 distal lobes (outer, inner and medial) well developed, outer one dorsally oriented.

Comments. — The genus Cryptocandona is Palaearctic and at present includes 11 extant, epi- and hypogean species distributed in Europe, and one stygobitic
species in Japan (Danielopol, 1980; Meisch, 1996). In addition, two specific names were recently introduced by Vshivkova (1995) without any descriptions or illustrations and are thus nomina nuda: *Cryptocandona fontanea* and *C. torrensa*, both recorded from streams and springs in the Ussuri Nature Reserve, SW Sikaote-Alin, eastern Russia. Furthermore, c. 10 fossil species (some of them in open nomenclature as species inquirendae), described from Tertiary sediments (Miocene-Pliocene) of the Parathethys, are assigned to this genus (Mandelstam & Schneider, 1963; Krstić, 1968, 1972; Krstić & Bossio, 1992). However, these assignments are questionable as documented by Baltanas et al. (in prep.).

**Cryptocandona phreaticola** (Kiefer & Klie, 1927) (figs. 1-6)

Type material. — (a) One dissected male mounted in glycerin on a slide (ZMH 344a) labelled: “*Candona phreaticola* n. sp. ♀, C.J.R. Nagysalló, 27.VIII.26, Dudich”; (b) one dissected female mounted in glycerin on a slide (ZMH 344b) labelled: “*Candona phreaticola* n. sp. ♂, Nagysalló, 27.VIII.26, Dudich”; (c) 2 females, 1 male, 2 juveniles (stage 8), 1 empty broken valve of an adult and 2 empty valves of juveniles, all preserved in ethanol and kept in a tube (ZMH 344) labelled: “*Candona phreaticola* n. sp., Nagysalló (Ungarn, C.J.R.), Brunnen, 27.VIII.26, coll. Dudich”. A holotype was not designated.

Designation of lectotype. — The adult syntype female on the slide no. ZMH 344b is hereby designated the lectotype. All other material should be considered paralectotypes.

Type locality and habitat. — A well at Tekovské Luzany in the Republic of Slovakia (region of Nitra). At the time of collecting, the locality was called Nagysalló and located in Hungary. Approximate coordinates 48°06’N 18°32’E. Altitude between 100 and 200 m a.s.l. The site is situated in a valley, almost 7 km from the lower Hron river, on the edge of the Inner West Carpathian Mountains (Kiefer & Klie, 1927).

Description of female

Carapace viewed laterally (fig. 1B) elongate, with the greatest H situated in the middle and smaller than 1/2 L (see measurements below). Dorsal margin rounded, almost evenly falling towards both anterior and posterior ends. Antero-dorsal part with a very gentle concavity. Both ends broadly and almost equally rounded. Ventral margin only very weakly concave. Calcified part of the inner lamella narrow, on the anterior end it represents 11% and on the posterior 5-8% of the carapace L. According to Kiefer & Klie (1927) the greatest W equals c. 1/3 L. Surface of valves smooth. Central muscle scar arrangement typical of the tribe Candonini. Marginal zone narrow with straight, short, and almost equally dense marginal pore canals. Measurements (in mm): carapace L = 0.99-1.00, H = 0.48-0.49, H/L = 0.48-0.49 (N = 2).
Fig. 1. Cryptocandona phreaticola (Kiefer & Klie, 1927). A, juvenile carapace, 8th stage, right side (from tube ZMH 344); B, female carapace, left side (from tube ZMH 344); C, male carapace viewed laterally from the right (from tube ZMH 344); D, male carapace, dorsal view (redrawn from Kiefer & Klie, 1927); E, female A1 (lectotype ZMH 344b). Scales: A-C, 500 µm; D, 456 µm; E, 100 µm.
A1 (fig. 1E). I+II: A-2l, P-2l / III: A-1m / IV: A-1m, P-1s / V: A-2l, P-1m / VI: A-2l, P-1m / VII: A-1m-2l, P-2l / VIII: D-3l. Outer posterior seta of 7th podomere distinctly shorter than other large setae of this segment. Aesthetasc y₁ equals 2.5 times the terminal podomere length. L ratios of the last 5 podomeres (IV-VIII) from proximal to distal: 1.0:1.0:1.0:1.3:1.8 and ratio L/W of these podomeres, from proximal onwards: 1.1, 1.3, 1.7, 2.9, 7.0. L of the largest anterior setae on the penultimate podomere c. 2.5 times the L of the ramus (the last 5 podomeres combined).

A2 (fig. 2A). Pr: P-1m / Exo: D(Ex)-2s-1l / EI: P-Y, P(D)-1s-1m / E(II+III): A-2s, P-y₁, P(In)-2s(t₁,t₂)-2m(t₁,t₂), D(A)-1m(G₂), D(P)-y₂, D(Ex)-3s(z₁,z₂,z₃), D(In)-2l(G₁,G₂) / EIV: D(A)-1l(G₃), D(P)-y₃-1m, D(Ex)-1m(G₄), D(In)-1m. Aesthetasc Y equals 0.5 of EI, sensory part of this aesthetasc represents almost 0.4 of its L. EI and EIII not differentiated (joint between these not developed). Relative lengths of the A2 claws are: z₁ = 0.3, G₁ = 1.4, G₂ = 0.8, G₃ = 1.3, G₄ = 1.1, G₅ = 0.6. Aesthetasc y₃ fused at the base with another seta and equalling 0.7 of the length of EI.

Md. Masticatory part of the coxa (fig. 2C) with laterally one relatively long seta, distally 7 stout teeth with groups of diverse setae and ventrally with one plumbed seta. Mdp (fig. 2B): I: In-1s(α)-1s(S₁)-1m(S₁) / II: Ex-1m-1l, In-1s(β)-1m-3l / III: Ex-2m-1l, In-4m, D-1m(γ)-1m / IV: D-4s-2m(G). First podomere with respiratory plate. The γ is seta not clearly different, similar in shape and length to the adjoining distal seta. L of both claws of the terminal podomere c. 1.4 times the L of the 3rd palp podomere.

Mx with elongated respiratory plate (fig. 3B), 3 masticatory processes, and 2-segmented palp (fig. 3A): I: Ex-4m / II: D-4s-2m.

L5 (fig. 3C-E). Pr bears 2 anterior sub-equal ‘a’ setae and 2 exterior setae ‘b’ and ‘d’ (fig. 3D). Endite (masticatory process) with a group of 16 setae (fig. 3E). Respiratory plate consisting of 3 plumbed setae, E with 3 apical sub-equal setae (fig. 3C).

L6 missing on slide ZMH 344b. Relying on the original description, this limb very slender with the terminal claw (h₂) longer than 3 distal endopodal podomeres (EII-EIV) combined.

L7 (fig. 3F). Pr: Ex-2m(d₁,d₂), In-1m(d₃p) / EI: P-1s(e) / EII: P-1s(f) / EIII: P-1s(g) / EIV: D-1s(h₁)-1m(h₂)-1l(h₃). Cleaning leg 5-segmented, EII and EIII separated by distinctly visible suture. Relative lengths of 3 apical setae are: h₁ = 0.3, h₂ = 0.7, h₃ = 1.8. Other setae as characteristic for the genus.

Description of male

Carapace viewed laterally (fig. 1C) similar in outline to that of female, but longer and relatively higher (see measurements below). LV longer than RV and overlapping the latter along the entire valve margin. The greatest H (slightly less than half of L) lying somewhat behind the middle. Dorsal margin in the middle almost straight over the short section, then sloping towards both broadly rounded ends. Antero-dorsal part with a very gentle concavity. Ventral margin almost straight. Calcified part of the inner lamella at the anterior end amounting to
c. 12% and at the posterior end to c. 8% of carapace L. Carapace in dorsal view (fig. 1D) according to Kiefer & Klie (1927) laterally compressed, with the greatest W equalling c. 1/3 L, lateral lines almost parallel, LV overlaps RV at both ends, anterior end pointed, posterior end rounded. Measurements (in mm): carapace L = 1.10, H = 0.54, H/L = 0.49 (N = 1).
REDESCRIPTION CRYPTOCANDONA PHREATICOLA AND C. LERUTHI

Fig. 4. Cryptocandona phreaticola (Kiefer & Klie, 1927). A, female (lectotype ZMH 344b); B-E, male (paralectotype ZMH 344a). A, CR, its attachment and genital lobe; B, A1; C, left A2 external view; D, rake-like organ; E, endite of right L5. Scale: A, 200 μm; B-C, E, 100 μm; D, 80 μm.

A1 (fig. 4B). Arrangement of setae as in female. Posterior apical seta of 4th podomere of medium length (small in female). L ratios of the last five podomeres (IV-VIII) from proximal to distal: 1.0 : 0.9 : 0.9 : 1.2 : 1.5 and ratio
L/W of these podomeres, from proximal onwards: 1.5, 1.4, 1.6, 3.3, 7.5. Fourth podomere distinctly more elongated than in female, thus relative L of the remaining podomeres of the ramus also slightly different from those in female. The largest anterior setae on the penultimate podomere ca. 2.4 times as long as the last five podomeres combined (IV-VIII).

A2 (fig. 4C). Pr: P-1m / Exo: D(Ex)-2s-1l / EI: P-Y, P(D)-1s-1m / EII: A(D)-2s, P-y1, D(In)-1s(t4)-3m(t1,t2,t3) / EIII: D(P)-y2, D(A)-1l(G2), D(Ex)-1s(z3)-1m(z2;G)-1l(z1), D(In)-1s(G3)-1m(G1) / EIV: D(A)-1l(GM), D(P)-y3, D(Ex)-1m(Gm), D(In)-1s. Endopod 4-segmented. Aesthetasc Y, as in female, equalling 0.5 of EI, sensory part of this aesthetasc c. 1/2 of its L. Setae t2 and t3 transformed into male bristles and their lengths represent almost 0.7 and 0.5 of the length of EI, respectively; t1 slightly longer than t3, t4 very short. Relative lengths of claws and setae on EIII and EIV are: G1 (claw) = 0.6, G2 (claw) = 1.4, G3 (seta) = 0.4, z1 (claw) = 1.2, z2 (claw) = 0.6, z3 (seta) = 0.4, Gm (claw) = 1.0, Gm (claw) = 0.6. Seta which in female is fused at the base with aesthetasc y3 not seen in male. Relative L of this aesthetasc as in female.

Rake-like organ (fig. 4D) with 12-13 teeth.

Mdp and Mx palp without sexual dimorphism.

L5 (figs. 4E, 5A-B). Pr and respiratory plate as in female. E developed into asymmetrical, prehensile palps. Right palp better developed, arched, and distally helmet-shaped (fig. 5B); left one slimmer, its finger with marked concavity (fig. 5A).

L6 (fig. 5C). Pr: A(D)-1s(d) / EI: A(D)-1s(e) / EII: A(D)-1s(f) / EIII: A(D)-2s(g) / EIV: P-1s(h3), D-1s(h1)-1l(h2; G). Terminal claw (h2) serrated and equalling 2.5 of the length of EII.

L7 (fig. 5D) without sexual dimorphism. Relative lengths of 3 apical setae are: h1 = 0.4, h2 = 0.7, h3 = 1.9.


Hemipenis (fig. 6B). Lobe ‘b’ broadly extended with conical protrusion; lobe ‘a’ well developed, sub-rectangular; lobe ‘h’ wide and concave. M process with elongated and broadened distal part (6C).

Zenker’s organ (fig. 6D) with 7 internal rings of spines.

Description of carapace of the 8th stage juvenile

Carapace viewed laterally from the right (fig. 1A) bean-shaped, with the greatest H situated in the middle and equalling c. 1/2 L. Dorsal margin rounded, almost evenly falling towards both broadly rounded anterior and posterior ends. Ventral margin of RV slightly concave, whereas this margin of LV weakly convex.
Fig. 5. Cryptocandona phreaticola (Kiefer & Klie, 1927), male (paralectotype ZMH 344a). A, left L5 with prehensile palp (distal part of endite with setal group not shown); B, right prehensile palp; C, L6; D, L7. Scale: A-B, 100 µm; C-D, 125 µm.
Fig. 6. Cryptocandona phreaticola (Kiefer & Klie, 1927), male (paralectotype ZMH 344a). A, CR; B, right hemipenis external view; C, M process of hemipenis; D, Zenker’s organ. Scale: A-C, 125 µm; D, 300 µm.

Calcified part of the inner lamella narrow, on the anterior end it represents 9% of the carapace L (on the posterior end not seen). Measurements (in mm): carapace L = 860-900, H = 440, H/L = 0.49-0.51 (N = 2).

Cryptocandona leruthi (Klie, 1936) (figs. 7-10)

Type material. — (a) One dissected female mounted in glycerin with picric acid on a slide (ZMH 341a) labelled: “Candona leruthi n. sp. ♀, Hermalle, Brunnen: H.D., coll. Rob. Leruth”; (b) one dissected female mounted in glycerin on a slide (ZMH 341b) labelled: “Candona leruthi n. sp. ♀, Hermalle, Brunnen: H.D., coll. Rob. Leruth”; (c) 7 females, several juveniles, one broken female and one broken male valve, all preserved in ethanol and kept in a tube (ZMH 341) labelled: “Candona leruthi n. sp., Belgien, Hermalle, Brunnen, 1935, coll. Leruth”. A holotype was not designated.
Designation of lectotype. — The adult syntype female on the slide no ZMH 341a is hereby designated the lectotype. All other material should be considered paralectotypes.

Type locality and habitat. — Two wells (indicated in Klie, 1936 as H.D. and M.H. and in Leruth, 1938 as well 1 and well 3) at Hermalle-sous-Argenteau in Belgium (Province of Liège, Commune d’Oupeye). The sites are located in the valley of the river Meuse (approximate coordinates 50°42’N 5°40’E; altitude 57 m a.s.l.).

Description of female

Carapace viewed laterally from the left (fig. 7A) elongate, with the greatest H located just behind mid-length and usually smaller than 1/2 L, but with a surprisingly large variability in this character (see measurements below). Dorsal margin almost evenly rounded, sloping more steeply backwards than forwards. Transitions into anterior and posterior margin unnoticeable. Anterior margin evenly and broadly rounded, posterior margin less curved in its upper part than in its lower part. Ventral margin almost straight, only slightly swollen at mid-length. Calcified part of the inner lamella narrow, on the posterior end equalling 6% of the carapace L, on the anterior end not seen, but according to Klie (1936) broader than in the posterior one. Relying on the original description, carapace in dorsal view (fig. 7B) narrow, lateral lines almost parallel, the greatest W equalling less than 1/3 L. LV overlapping RV at both ends, anterior end more obtuse than posterior end. Valves light with smooth surface and rare setae. Measurements (in mm): carapace L = 1.02 (0.98-1.06), H = 0.48 (0.46-0.50), H/L = 0.48 (0.45-0.51) (N = 7).

A1 (fig. 7F). I+II: A-2, P-2 / III: A-1m / IV: A-1m, P-1m / V: A-2l, P-1m / VI: A-2l, P-1m / VII: A-1s-2l, P-2l / VIII: D-y2-3l. The shortest anterior seta on the 7th podomere as long as the 4th podomere. Aesthetasc y2 equalling 1.4-1.9 of the terminal podomere length. L ratios of the last 5 podomeres (IV-VIII) from proximal to distal: 1.0:0.9:0.9:1.4:2.0 and ratio L/W of these podomeres, from proximal onwards: 1.1, 1.1, 1.4, 3.1, 6.9. The largest anterior setae on the penultimate podomere c. 2.2 times as long as the ramus (last 5 podomeres combined).

A2 (fig. 8A). Pr: P-1m / Exo: D(Ex)-2s-1m / EI: P-Y, P(D)-1s-1m / E(I+II+III): A-2s, P-y1, P(In)-4s(t1-4), D(A)-1m(G2), D(P)-y2, D(Ex)-3s(z1,z2,z3), D(In)-2/(G1, G3) / EIV: D(A)-1/(Gm), D(P)-y3-1m, D(Ex)-1m(Gm), D(In)-1s. Aesthetasc Y equalling c. 0.5 of EI, sensory part of this aesthetasc slightly more than 1/2 of its L. EIi and EIII forming compound podomere, not separated by articulated joint. Seta t1 (longest of the ‘t’ setae) represents 0.5-0.6 of the length of EI. Relative lengths of the A2 claws are: z1 = 0.4, G1 = 1.4, G2 = 0.8, G3 = 1.2-1.3, Gm = 1.1, Gm = 0.7-0.8. Aesthetasc y3 fused at the base with another seta. L of y3 equalling 0.6 of EI length; sensory part of this aesthetasc represents c. 1/5 of its L.
Md. Coxa (fig. 8C) with 7 stout teeth and a set of various setae between them as well as one plumed seta placed ventrally and one relatively long lateral seta. Mdp (fig. 8B): I: In-1s(α)-1s(S₂)-1m-1m(S₁) / II: Ex-1m-1l, In-1s(β)-3m-1l /
Fig. 8. Cryptocandona leruthi (Klie, 1936), female. A-D, lectotype ZMH 341a; E, paralectotype ZMH 341b. A, A2 external view; B, Mdp; C, coxa of Md; D, Mx palp; E, Mx respiratory plate. Scale: A-E, 100 μm.

III: Ex-3m, In-3s-1m, D-1m(γ)-1m / IV: D-4s-2m(G). First podomere with small respiratory plate. Second podomere internally with a group of 5 setae: a short β seta, 3 medium and smooth setae (so-called setal group) clustered together, and one seta similar but longer, and set more apically. The γ seta is not clearly different,
and similar in shape and length to the adjoining distal seta. L of both claws of the terminal podomere c. 1.3 of the 3rd palp podomere L.

Mx bearing a large branchial plate (fig. 8E) and consists of three masticatory endites and 2-segmented palp (fig. 8D): I: Ex-2m-2l / II: D-4s-2m.

L5 (fig. 9A). Pr carrying two anterior sub-equal ‘a’ setae and two exterior setae ‘b’ and ‘d’. Endite apically with a group of 14 setae. Respiratory plate consisting of 3 plumed filaments. Palp-shaped endopod with 3 apical sub-equal setae.

L6 (fig. 9B). Pr: A(D)-1s(d) / EI: A(D)-1s(e) / EII: A(D)-1s(f) / EIII: A(D)-2s(g) / EIV: P-1s(h1), D-1s(h1)-1l(h2): G). Terminal claw serrated, and equalling 2.6 of the length of EII.

L7 (fig. 9C-D). Pr: Ex-2m(d1,d2), In-1m(d_p) / EI: P-1s(e) / EII: P-1s(f) / EIII: P-1s(g) / EIV: D-1s(h1)-1m(h2)-1l(h3). Cleaning leg 5-segmented but EII and EIII not very distinctly differentiated. Relative lengths of 3 apical setae as: h1 = 0.3, h2 = 0.7, h3 = 1.7. Arrangement of the other setae as characteristic for the genus.

CR and genital lobe (fig. 9E). Posterior margin almost straight, anterior slightly rounded. Ratio of lengths of anterior margin, s_a, G_a, G_p, s_p and the distance between s_p and G_p as: 100:17:71:62:12:22. Genital lobe broadly rounded and distinctly protruding. Maximal oocyte diameter recorded: c. 80-100 µm.

Description of male

RV viewed laterally (fig. 7C) similar in outline and size to that of female. The greatest H (slightly less than half of L) lying somewhat behind the middle, at about 0.57 of L. Calcified part of the inner lamella on the posterior end narrow, representing c. 4% of the valve L, on the posterior end distinctly broader and equalling c. 12% of the valve L. Central muscle scar arrangement typical of the tribe. Marginal zone narrow with straight, short, and almost equally dense marginal pore canals. Carapace in dorsal view (fig. 7D) according to Klie (1936) slender, lateral lines almost parallel, the greatest W equalling slightly less than 1/3 L; LV overlaps RV at both ends, posterior end rounded, anterior end indistinctly rostriform. Measurements (in mm): RV: L = 1.01, H = 0.49, H/L = 0.49 (N = 1).

Appendages. Since there were no male soft parts in the type collection, we follow the original description of Klie (1936), here. Podomeres EII and EIII of A2 subdivided, male bristles reach almost to the end of the anterior claw (? G1). All terminal claws of A2 smooth. Right claspers reach almost to the end of the anterior claw (? G1). Dorsal and ventral margins of the left clasper (fig. 10B) evenly curved, finger short and obtuse. Sensory setae of both organs very fine and short. Outer lobe of hemipenis (fig. 10C) broadly extended with rounded ventral protrusion, auricle-shaped dorsal part and a groove descending from the middle of the distal margin to the peniferum. Medial lobe angular and fine. Inner lobe regularly rounded with marginal strengthening.
Description of carapace of the 7th stage juvenile

Carapace viewed laterally from the left (fig. 7E) very elongated, the largest H is situated just in front of mid-length and distinctly less than a half of the total L.
Dorsal margin sloping more steeply anteriorly than posteriorly. Measurements (in mm): carapace $L = 0.69$, $H = 0.32$, $H/L = 0.46$ ($N = 1$).

**DISCUSSION**

Comments on the original description of *Cryptocandona phreaticola*

a. Carapace size and shape. Although lack (or damage) of valves of dissected type specimens ($\varphi$ and $\sigma'$) precluded verification of their carapaces’ size and shape, we believe these to be higher (more compact), both in females and males, than described and illustrated by Kiefer & Klie (1927). These authors give the $L$ and $H$ for the female as 0.9 mm and 0.43 mm, respectively (hence $H/L = 0.48$ and even an $H/L$ of 0.46 can be calculated from their fig. 3), while those for the male are given as 1.0 mm and 0.47 mm, respectively ($H/L = 0.47$). The carapaces of both females and of one male that we measured, were higher and relatively less elongate (especially the male, for which $H/L = 0.49$). Contrary to Kiefer & Klie’s (1927) indication (the greatest $H$ situated in the posterior third of the male carapace) we recorded that the greatest $H$ of the male carapace was in fact just behind mid-length.
b. A1. Our estimate of the L of the largest setae (2.4-2.5 times as long as the L of the last 5 podomeres combined) is slightly different from Kiefer & Klie's (1927) twice as long as the A1 ramus.

c. L7. Following the original description: h2 is almost 3 times as long as h1, while h3 almost 3 times as long as h2. However, we were able to verify that these setae are shorter (h2 is 2.0-2.6 times as long as h1, while h3 is 2.5-2.6 times as long as h2).

d. Male A2. Kiefer & Klie (1927) write that both male bristles slightly exceed the distal end of EIV. However, it appeared that t2 extends beyond the end of the terminal segment, while t3 only reaches to the distal end of EIV.

e. Hemipenis. Most likely, the names of medial and inner lobes have been mixed up in the original description, since we noticed that the medial lobe was concave, whereas the inner lobe is convex, exactly opposite to Kiefer & Klie's (1927) indication.

All differences mentioned above are most probably due to inaccuracies in Kiefer & Klie's (1927) description.

Comments on the original description of Cryptocandona leruthi

a. Carapace size and shape. Klie (1936) gives the L and H for the females as 0.95 mm and 0.45 mm, respectively (hence H/L = 0.47). However, all female carapaces we measured (N = 7) were longer (L at least 0.98 mm) and generally higher. The dorsal margin of the carapace in females we observed is more distinctly convex than shown in the original description. This may be explained by the fact that there were no valves of both dissected females in the collection that had been measured by Klie, thus possibly there exists a great variability in carapace size and shape in this species. New measurements of one male RV almost agreed with Klie’s measurements (L = 1.05 mm, H = 0.50 mm, H/L = 0.48). Although this valve was somewhat damaged, which precluded the possibility of a careful comparison with the shape given in the original description, the posterior margin seemed to be more broadly rounded than shown by Klie (1936) in his fig. 14.

b. Female A1. According to Klie (1936) the length of the two distal podomeres (VII and VIII combined) equals 1.5 of L of the remaining three podomeres of the ramus (IV-VI combined). However, we were able to verify that L of VII+VIII equals only c. 1.2 of the length of IV+V+VI combined.

c. Female L7. Contrary to Klie’s (1936) indication, a separation between EII and EI III appeared not to be distinct and the longest seta of the terminal podomere (h3) is actually slightly shorter (h3 = 2.3 h2) than Klie (1936) writes (h3 = 2.5 h2).
Differential-diagnostic characters of *C. phreaticola* and *C. leruthi*

The most important differences between the appendages of *Cryptocandona phreaticola* and *C. leruthi* are summarized in table I. From these data it becomes apparent that there are only a few relevant characters that distinguish these species.

**Table I**
Differences between appendages of *Cryptocandona phreaticola* (Kiefer & Klie) and *Cryptocandona leruthi* (Klie)

<table>
<thead>
<tr>
<th>Cryptocandona phreaticola</th>
<th>Cryptocandona leruthi</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1. The shortest anterior seta on the penultimate podomere of medium length (longer than IV podomere L)</td>
<td>A1. The shortest anterior seta on the penultimate podomere short (shorter than or equalling IV podomere L)</td>
</tr>
<tr>
<td>A1. The largest anterior setae on the penultimate podomere c. 2.4-2.5 times as long as the ramus (IV-VIII podomeres combined)</td>
<td>A1. The largest anterior setae on the penultimate podomere c. 2.2 times as long as the ramus (IV-VIII podomeres combined)</td>
</tr>
<tr>
<td>A1. yₐ 2.5 times as long as the terminal podomere</td>
<td>A1. yₐ 1.4-1.9 times as long as the terminal podomere</td>
</tr>
<tr>
<td>A2. Gₗₗ equalling 0.6 of EI</td>
<td>A2. Gₗₗ equalling 0.7-0.8 of EI</td>
</tr>
<tr>
<td>A2. EII+III of female longer than 1/2 of EI</td>
<td>A2. EII+III of female equalling 1/2 of EI or only indistinctly longer than a half of EI</td>
</tr>
<tr>
<td>Mdp. Chaetotaxic notation of the internal margin of 2nd podomere: II: In-1s(β)-1m-3l (setae of the setal group large)</td>
<td>Mdp. Chaetotaxic notation of the internal margin of 2nd podomere: II: In-1s(β)-3m-1l (setae of the setal group medium)</td>
</tr>
<tr>
<td>L5. Endite apically with 16 setae</td>
<td>L5. Endite apically with 14 setae</td>
</tr>
<tr>
<td>L7. EII and EIII distinctly separated</td>
<td>L7. EII and EIII weakly separated</td>
</tr>
<tr>
<td>Female CR. Gₐ and Gₚ represent 0.6 and 0.5 of the anterior margin L, respectively</td>
<td>Female CR. Gₐ and Gₚ represent 0.7 and 0.6 of the anterior margin L, respectively</td>
</tr>
<tr>
<td>Female genital lobe distinctly protruding backwards, conical with obtuse end</td>
<td>Female genital lobe distinctly protruding, broadly rounded</td>
</tr>
<tr>
<td>Right male clasping organ arched, distally helmet-shaped with long finger</td>
<td>Right male clasping organ distally concave with short finger</td>
</tr>
<tr>
<td>Hemipenis. Inner lobe with distinct ventrally oriented conical protrusion</td>
<td>Hemipenis. Inner lobe short and evenly rounded</td>
</tr>
</tbody>
</table>
C. phreaticola can best be identified within the genus Cryptocandona by the traits of the copulatory organs: (a) distinctly protruding, conical, obtusely ending genital lobe in females; (b) distinct, ventrally oriented, conical protrusion of the inner lobe of the hemipenis; and (c) strongly arched, distally helmet-shaped and not inflated right male clasping organ. There are also differences between these species in the shape of the carapace (compare fig. 1B-D and fig. 7A-D), but the carapace shape in C. leruthi seems to be fairly variable (see measurements above), and most probably there is an overlapping variability with that of C. phreaticola. Thus, in our opinion, these two species cannot be separated with confidence, based on the shape of the carapace only.

Although an assessment of phylogenetic relationships between Cryptocandona species is beyond the scope of this paper, and will be published elsewhere, both species here redescribed appear to have many similarities with Cryptocandona kieferi (Klie, 1938), as already noted by Klie (1938) himself. We could not find any reliable diagnostic characteristics distinguishing the females of C. leruthi from those of C. kieferi. We observed only a few differences of probably minor importance: (a) the aesthetasc yₐ on the terminal podomere of A1 is shorter than the double L of this podomere in C. leruthi, and this aesthetasc is longer than the double L of this podomere in C. kieferi; (b) the internal setae on EII+EIII of A2 (t₁₃) are small in C. leruthi (shorter than a half of EI length) and in C. kieferi these setae are medium in length (longer than a half of EI length); (c) the so-called seta ‘g’ on the terminal podomere of A2 small in C. leruthi (shorter than a half the length of EI) and in C. kieferi this seta is of medium length (longer than the length of EI); (d) the chaetotaxic notation of the Mx palp in C. leruthi is: I: Ex-2m-2l / II: D-4s-2m, whereas in C. kieferi it reads: I: Ex-4l / II: D-4m-2l.

At present, C. leruthi can be identified within Cryptocandona by the following combination of characters: (a) posterior seta on the 6th podomere of A1 present; (b) female genital lobe protruding but broadly rounded, without any conical protuberance; (c) dorsal and ventral margins of the left clasping organ evenly curved, finger short and obtuse, not pointed; (d) outer lobe of hemipenis broadly extended with auricle-shaped dorsal part and with rounded ventral protrusion; (e) inner and medial lobes of hemipenis only insignificantly protruding beyond the outer lobe, medial lobe angular and fine, inner lobe regularly rounded with marginal strengthening.

Distribution and ecology

Cryptocandona phreaticola is a stygobitic or stygophilic species with a known geographical range that so far is limited to Slovakia. At the type locality of C. phreaticola at Tekovské Luzany, the species was collected from porous groundwater reached through a well. The material was sampled from a pump-well covered
at the top, 5 m deep (the water level at about 2 m) and with a 10 cm thick layer of mud on the bottom; water temperature 11°C. At the time of sampling, this well was used for obtaining high-quality drinking water (Kiefer & Klie, 1927). The species, reaching 25% of total ostracod numbers in the sample, was accompanied by only one stygobitic ostracod, i.e., *Pseudocandona eremita* (Vejdovsky, 1882) as well as by some stygobitic amphipod and copepod species (Kiefer & Klie, 1927). Petkovski (1966), quoted this species, with some reservation with regard to the correctness of the identification, from three other sites located less than 150 km away from the type locality: (a) Zliechov (48°57′N 18°26′E): a few juvenile specimens collected from the hyporheic habitat of a stream (accompanying ostracod fauna: numerous *Pseudocandona pratensis* (Hartwig, 1901) and a few specimens of *Cryptocandona vavrai*); (b) Východná (49°04′N 19°54′E): one juvenile (a male) collected in a spring (accompanying ostracod fauna: numerous females of *Can-dona candida* (O. F. Müller, 1776)); (c) Bojnice (48°47′N 18°35′E): several juvenile specimens collected in a spring within a castle moat (accompanying ostracod fauna: a few empty valves of *P. eremita*). Most likely, the actual geographical range of *C. phreaticola* is underestimated: it might occur at least in other relatively poorly explored parts of the Carpathian Mountains.

*Cryptocandona leruthi* (which we assume for the moment to be a stygobitic species) is known only from a shallow porous groundwater aquifer located in the Meuse Valley. The groundwater table was at 2-3 m depth at the time of sampling (Leruth, 1938). The ostracods were sampled at Hermalle-sous-Argenteau by pumping up groundwater with a Norton pump and by filtering water from a large covered well. From the chemical data mentioned by Leruth (1938) for the wells were *C. leruthi* appeared (i.e., Norton pump 1) one can assume that the groundwater was well oxygenated throughout the year and that the yearly temperature amplitude was very low (9.6-11.5°C). *C. leruthi* was accompanied in both wells by two other stygobitic ostracods, i.e., *Schellencandona triquetra* (Klie, 1936) and *Pseudocandona zschokkei* (Wolf, 1920). We suspect that this species is more widely distributed along the Meuse, and may also be present in the Rhine drainage system. Our assumption is based on the fact that during the Upper Pliocene and the Quaternary, the Meuse flew into the Rhine (Henry, 1976).

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