BASTERIA, 63: 89-105, 1999

The Moroccan stygobiont genus *Heideella* (Gastropoda, Prosobranchia: Hydrobiidae)

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A number of hydrobiids recently discovered in wells and hyporheic waters of streams in various sites of central Morocco, have been found to have all the conchological characters typical of the type species of the genus *Heideella* Backhuys & Boeters, 1974, *H. andreae* Backhuys & Boeters, 1974, which is reported from southern Morocco. The anatomical characters confirm that *Heideella*, originally described on the basis of shell characters only, is a valid genus of the Hydrobiidae endemic to Morocco. The populations of central Morocco differ to some extent in their shell shape from *H. andreae*. Since no direct comparison of their anatomical characters and those of topotypes of *H. andreae* can be made because the latter have never been found complete with soft parts, all the newly discovered populations except one are referred to as *H.* cf. *andreae*. Anatomical study of the other population which has a more cylindrical-elongated shell, brought to light additional characters which support the creation of a new species, *H. makhfamanensis* n. sp. A redescription of *Heideella* and a list of characters which distinguish it from the other genera of the Hydrobiidae conclude the paper.

Key words: Gastropoda, Prosobranchia, Hydrobiidae, *Heideella*, systematics, stygobiont snails, Morocco.

INTRODUCTION

Many stygobiont hydrobiid species have recently been discovered in Morocco. Some have been reported in a summary way without specific diagnoses and provisionally attributed to European genera, such as *Hadziella* and *Horatia* (cf. Kristensen, 1985) or *Belgrandiella*, *Hadziella*, *Hauffenia*, *Horatia*, *Iglica*, *Moitessieria*, *Neohoratia* and *Paladilhiopsis* (cf. Ghamizi & Gofas, 1995). Only three species have been described: *Heideella andreae* Backhuys & Boeters, 1974 (type locality: "Oued Seyad (Genist) östlich Fask, Südmarokko"), *Iglica seyadi* Backhuys & Boeters, 1974 (type locality: "Oued Noun (Genist) westlich Targouasis und nordwestlich Goulimime ..... Südmarokko") and *Atebbania bernasconii* Ghamizi, Bodon, Boulal & Giusti, 1999 (type locality: well at Atebbane, 5 km north of Tiznit, province of Tiznit, Wilaya d'Agadir, south Morocco) (Backhuys & Boeters, 1974; Ghamizi et al., 1999). The species referred to as "*Iglica seyadi*" is not known anatomically

and its attribution to *Iglica* is consequently highly speculative. *H. andreae* has also been described on the sole basis of shell characters and thus *Heideella*, the genus introduced for it, is in need of an anatomical confirmation. *Atebbania bernasconii* has been described completely and no problem exists as regards its generic status.

The present paper is devoted to the genus *Heideella* Backhuys & Boeters, 1974. Populations sharing all the conchological characters typical of *H. andreae* have subsequently been discovered in central Morocco (near Marrakech). Most of them, differing little in shell shape from topotypical specimens of *H. andreae*, are probably conspecific. Data on their anatomical structure make it possible to confirm the validity of *Heideella* and to complete its diagnosis. Since anatomical comparison with topotypical material of *H. andreae* (never found complete with soft parts) is impossible, these populations will be referred to as *H.* cf. *andreae*. A population with a different shell shape, from the same area near Marrakech, was found to be anatomically characterized with respect to the others and is consequently considered to be a distinct new species: *H. makhfamanensis* n. sp.

MATERIAL AND METHODS

Empty shells and living specimens were collected by selecting variable amounts of sediment from wells and hyporheic waters of streams by procedures used for stygobiont fauna (Dalmas, 1973; Boutin & Boulanouar, 1983; Boutin & Idbennacer, 1989). The phreatobiological net described by Cvetcov (1968) gave the best results for collecting stygobiont hydrobiids in wells. For collecting in hyporheic streams, variable amounts of sediment were selected by filtering water with a 300 μm mesh cloth (Ginet & Decou, 1977).

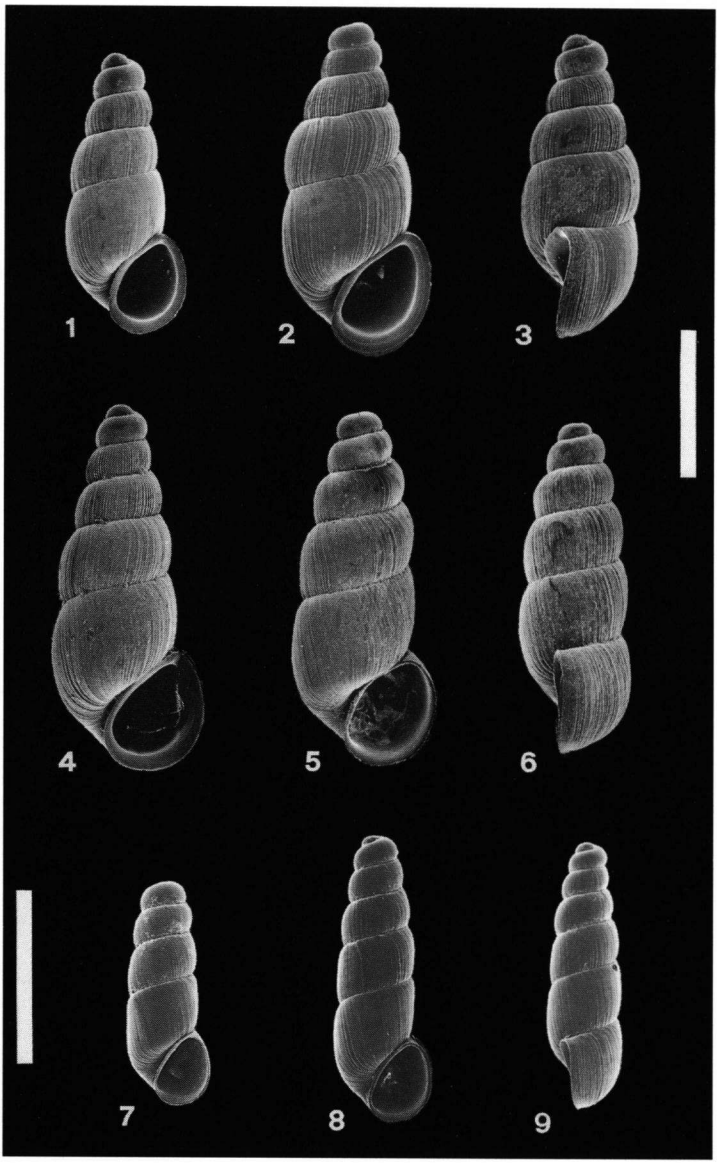
The material was collected by one of us (M. Ghamizi) and by a number of researchers on stygobiont crustacean fauna of Morocco (M. Messouli, M. Yacoubi-Khebiza, M. Boulal, M. Boulanouar, M. Fakher, B. Idbennacer, C. Boutin and N. Coineau).

Unrelaxed material, preserved in formaldehyde or 75% ethanol, was studied by optical stereomicroscope. Bodies, isolated after crushing the shell, were dissected using very thin, pointed watchmaker's forceps. Images of the whole body and isolated parts of the genitalia were drawn using a Wild camera lucida. Shell surface details were photographed under scanning electron microscope at the Muséum National d'Histoire Naturelle de Paris and at the Dipartimento di Biologia Evolutiva, Università di Siena. Soft parts (penis) and radulae (obtained by dissecting out buccal bulbs), washed in distilled water, mounted on copper blocks with electronconductive glue and sputter-coated with gold, were photographed using a Philips 505 SEM at the Dipartimento di Biologia Evolutiva, Università di Siena. The conchological parameters were measured using a micrometer lens on a Wild stereomicroscope.

Collecting sites of the material examined are cited with UTM references according to the 1:1.200.000 scale map of Morocco (UTM 10 km square map).

The terms used in the description of shell and soft parts are those in Bodon & Giovannelli (1993) and Bodon et al. (1996). The terms recently proposed by Hershler & Ponder (1998) for the same parts have been added in parentheses when available.

The material is preserved in the collections of M. Ghamizi, F. Giusti, M. Bodon and R. Bernasconi.



Figs. 1-9. 1-6, shells of *Heideella* cf. *andreae* Backhuys & Boeters, 1974, collected in a well near ridge on Tensift river near the Marrakech-Safi road, 4 km from Marrakech, 29R NR 90 (figs. 1-4) and in hyporheic waters of the Ourika river at Oulmes, 29R PQ 26 (figs. 5-6); 7-9, shells of *Heideella makhfamanensis* n. sp. collected in hyporheic waters of Oued Makhfamane (tributary of N'fis river), near Lalla Takerkoust dam, 31 km south of Marrakech, centre of Haouz plain, 29R NQ 86 (central Morocco). Scale bar 1 mm (upper for figs. 1-6, lower for figs. 7-9).

SYSTEMATIC PART

Heideella Backhuys & Boeters, 1974

Diagnosis. — Shell very small, conical to cylindrical, formed by 4¼-6¼ slightly convex or flat whorls; surface of teleoconch with more or less marked radial ribs. Operculum with thickening on its inner side. Foot sole with central longitudinal groove. Males with penis conical, cylindrical or cylindro-conical, with a small non-glandular lobe on left (inner) side at ca. half penis length, and apex either slender, elongated and giving rise to a sort of filament with cuticularized tip, or short, conical, pointed and without cuticularized tip. Females with renal oviduct having only one large seminal receptacle, peduncle of which arising far from last loop of oviduct (thus corresponding to that usually defined distal or RS1) and very large bursa copulatrix with duct entering near centre of ventral side of bursa. Radula with rachidian teeth having 1-3 basal cusps at base of each lateral wing.

Type species. — *H. andreae* Backhuys & Boeters, 1974, by original designation.

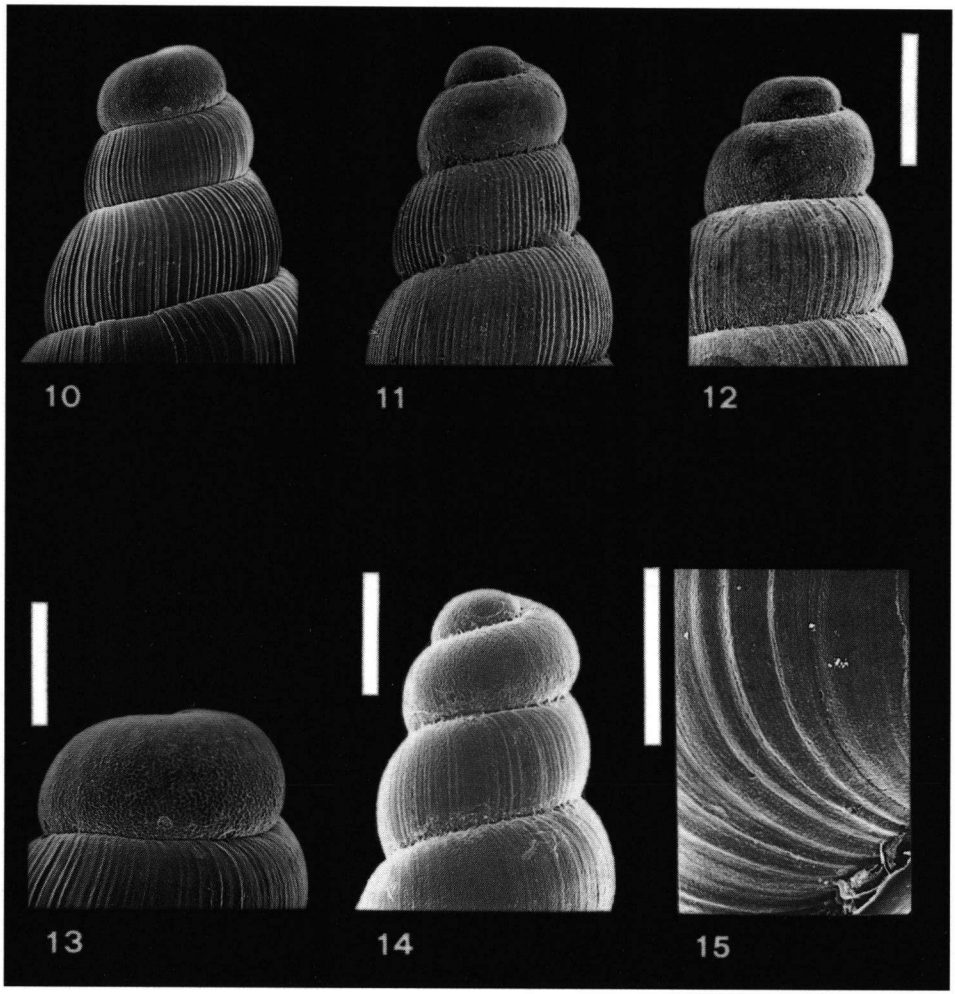
Description. — Shell (figs. 1-15; see also Backhuys & Boeters, 1974: 112, figs. 1-3) very small (height 1.3-2.33 mm), conical to cylindrical, sometimes elongated, rather slender and turreted, sometimes short and rather obese, pointed at apex, waxen, whitish and translucent when fresh; spire consisting of 4¼-6¼ slightly convex or flat whorls, last (body) whorl varying in width, ½ to ³/₅ of total shell height; sutures from deep to moderately deep; aperture not very wide, crescent-like or ovoid to pyriform, more or less angled at its superior apex; peristome uninterrupted, adhering to the last (body) whorl wall, its margins more or less thickened and reflexed, upper portion of external margin sometimes sinuous; umbilicus very narrow, slit-like; external surface of protoconch well malleated (pitted); external surface of teleoconch with more or less evident and raised radial ribs, sometimes followed by very thin, longitudinal crests more evident on last whorl.

Operculum (figs. 16-17, 22, 32). — Corneous, paucispiral, thin, yellowish-red to pale yellowish in colour with subcentral nucleus and oval-elongated thickening and whitish granular deposit on inner face.

Body (figs. 21, 31). — Almost totally unpigmented, traces of pigment only on walls of visceral sac; eye spots absent; pallial tentacle absent; foot sole with median, longitudinal groove.

Male genitalia (figs. 18-20, 23, 25-27, 33-34). — Testis near apex of visceral sac; vas efferens convoluted, its distal portion functioning as seminal vesicle; prostate gland elongated, sausage-like, its distal half projecting into pallial cavity; vas deferens thin, starting from distal side of prostate, crossing body wall to enter base of penis, running as penial duct all along right (outer) side of penis to end at penis tip; penis unpigmented, conical, cylindrical or cylindroconical in shape, more or less elongated, wrinkled near base, with one, more or less developed and bulging, non-glandular lobe on left (inner) side at ca. half penis length; penis apex sometimes slender, filament-like, with cuticularized, stylet-like tip, sometimes rather short and wide, pointed, without cuticularized tip.

Female genitalia (figs. 28-30, 35-36). — Ovary near apex of visceral sac; gonadal oviduct thin, ending where gonopericardial duct enters same oviduct and renal oviduct begins; renal oviduct twisted on itself to form loop which adheres to inner wall of pallial oviduct; only one, large, club-like seminal receptacle with well evident, slender duct arising from wall of renal oviduct far from end of loop (between where loop ends and



Figs. 10-15. 10-13, microsculpture of external surface of protoconch and teleoconch of *Heideella* cf. *andreae* Backhuys & Boeters, 1974 collected in a well near ridge on Tensift river near the Marrakech-Safi road, 4 km from Marrakech, 29R NR 90 (figs. 10-11, 13) and in hyporheic waters of the Ourika river at Oulmes, 29R PQ 26 (fig. 12); 14-15, microsculpture of *Heideella makhfamanensis* n. sp. collected in hyporheic waters of Oued Makhfamane (tributary of N'fis river), near Lalla Takerkoust dam, 31 km south of Marrakech, centre of Haouz plain, 29R NQ 86 (central Morocco). 10-12, 14, microsculpture of protoconch and first whorls; 13, detail of microsculpture of protoconch; 15, surface of last whorl near aperture. Scale bar 200 μm (figs. 10-12, 14); 100 μm (figs. 13, 15).

duct of bursa copulatrix arises), thus corresponding to first, distal or RS1 seminal receptacle; bursa copulatrix very large and wide, oval in shape, adjacent to wall of albumen gland portion of pallial oviduct; bursa copulatrix duct thin, entering bursa at central or subcentral point of ventral side; pallial oviduct bulging well into pallial cavity, formed by albumen and capsule gland; lower portion of capsule gland internally traversed by seminal groove; gonopore small, open on lower side of capsule gland near distal apex; distal apex of capsule gland situated far from pallial margin (at ca. half the pallial cavity length).

Radula (figs. 38-43). — Taenioglossate, consisting of many rows, each of seven teeth. Central teeth trapezoidal, with: lateral wings (lateral margins) long and slender; body (face) extended to form a basal tongue; apical margin V-like, with row of 9-13 denticles, central longer than laterals which progressively diminish; 1-3 basal cusps arising between base of each lateral wing (lateral margins) and body (face) of tooth. Lateral teeth with: body wide, basally elongated; anterior margin with row of 9-13 denticles, central longer than laterals which progressively diminish. Inner marginal teeth rake-like, with: body elongated; apex long, apically pointed, its anterior margin with row of 20-27 denticles. Outer marginal teeth spoon-shaped, with: body elongated; apex short and wide, its latero-posterior margin with row of ca. 20-22 denticles.

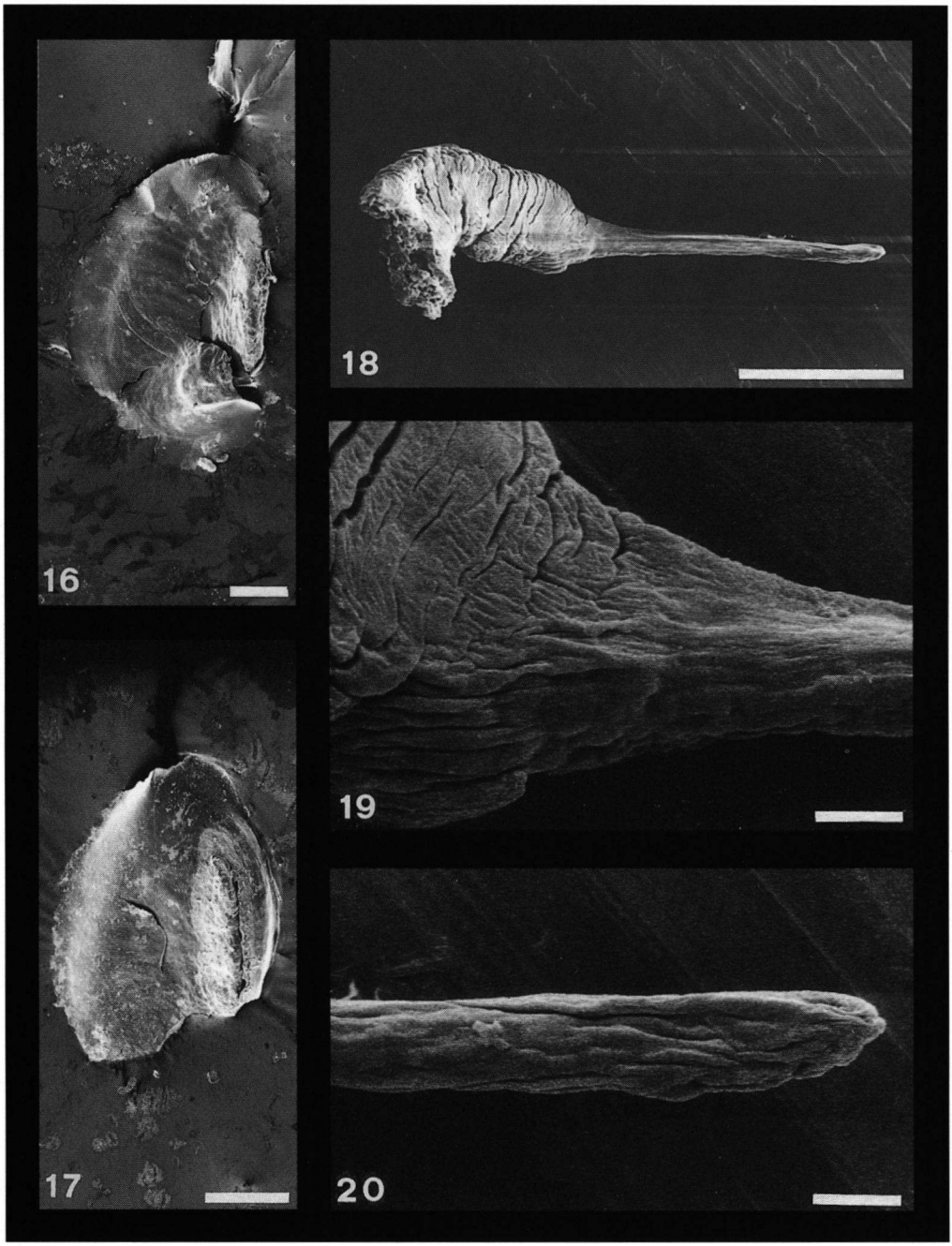
Stomach and intestine (figs. 23-24, 28, 33, 35, 37). — Stomach without gastric (posterior) caecum; first portion of intestine running not far from wall of style sac, forming U-like loop near stomach, then straight or slightly sinuous but not forming loop on pallial wall; anus near pallial margin.

Pallial organs (figs. 23, 28, 33, 35). — Osphradium oval or kidney-shaped, near pallial margin; ctenidium consisting of 10-16 branchial lamellae; pallial tentacle absent.

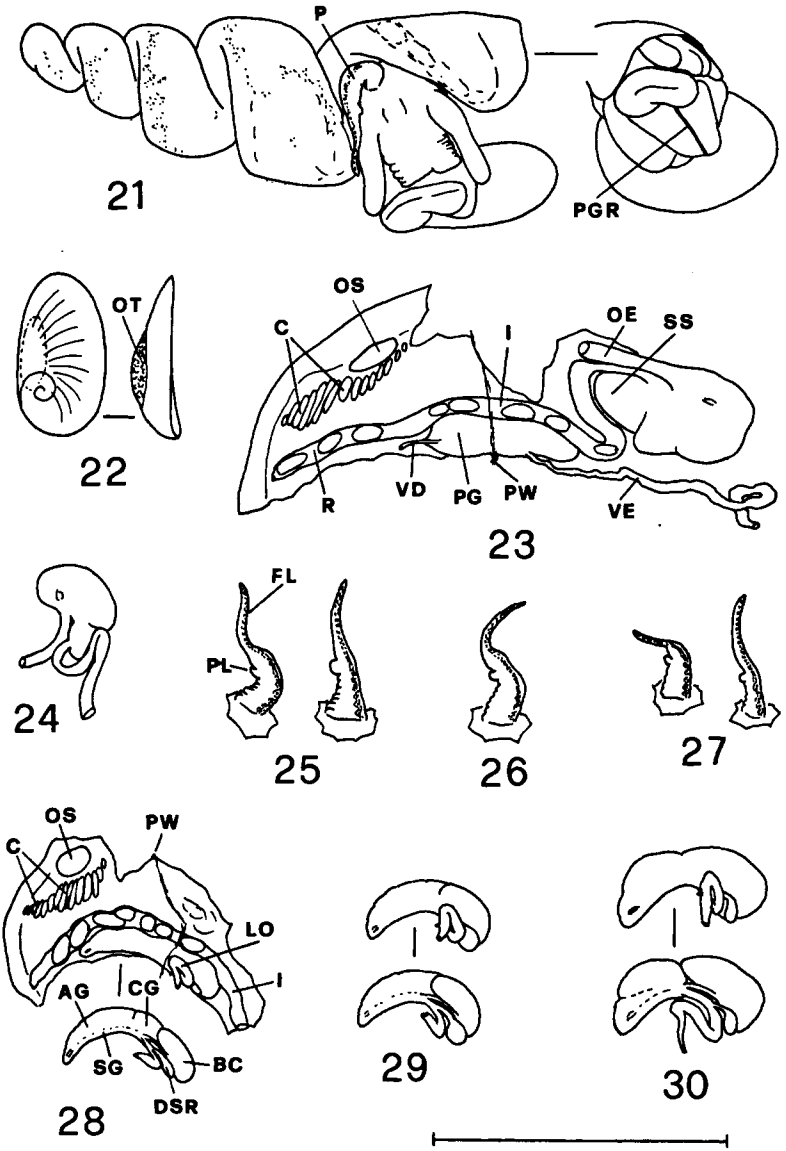
Remarks. — As mentioned in the introduction, some hydrobiid species recently collected in central Morocco had conchological characters which Backhuys & Boeters (1974) considered diagnostic for the new genus *Heideella* introduced for a new species of the Hydrobiidae, *H. andreae*, living in southern Morocco. This authorizes inclusion of the above material in the same genus and use of the data resulting from its anatomical study for the revision and completion of the diagnosis and description of *Heideella*.

Heideella is very well distinguished from the only other stygobiont genus of the Hydrobiidae anatomically studied and described for the Moroccan fauna: *Atebbania* Ghamizi et al, 1999 (a number of bythinelloid hydrobiids from Algeria are being studied in our labs but none of them has anatomical characters similar to those of *Heideella*). *Atebbania* differs markedly from *Heideella* by virtue of: the different ornamentation of the external surface of teleoconch whorls (spiral microsculpture present; axial ribbing absent); female genitalia lacking a seminal receptacle but with a bean-like bursa copulatrix which is entered by the bursa duct on its proximal (posterior) side; operculum with no thickening on inner face; foot sole without the median longitudinal groove; posterior end of foot indented (Ghamizi et al., 1999).

As far as the other hydrobiid genera with elongated, non-valvatoid shell are concerned, only *Phreatica* Velkovrh, 1970, *Pontobelgrandiella* Radoman, 1978 and *Cavernisa* Radoman, 1978, all from SE. Europe, have a similar set of genital characters, i. e. penis with non-glandular lobe/s on left side, only the distal (RS1) seminal receptacle present, thin bursa copulatrix duct entering the ventral side of bursa (level varies from close to distal side of bursa to half way along bursa length) (cf. Bodon & Giovannelli, 1993, tables I-II; Bodon et al., 1992, table 1). All three genera are nevertheless different in that their opercula have no thickening on the inner face and their shells have a different shape and never externally ribbed teleoconch whorls (for *Phreatica*, see Velkovrh, 1970: 99-102,



Figs. 16-20. 16, operculum and 18-20, penis of *Heideella* cf. *andreae* Backhuys & Boeters, 1974, collected in well near ridge on Tensift river near Marrakech-Safi road, 4 km from Marrakech, 29R NR 90 (central Morocco); 17, operculum of *Heideella makhfamanensis* n. sp. collected in hyporheic waters of Oued Makhfamane (tributary of N'fis river), near Lalla Takerkoust dam, 31 km south of Marrakech, centre of Haouz plain, 29R NQ 86 (central Morocco). 16-17, inner face of the operculum; 18, penis apex, "filament-like, with cuticularized "stylet-like" tip; 19, basal portion of penis apex; 20, "stylet-like" tip of penis apex. Scale bar 100 μm (figs. 16-18), 10 μm (figs. 19-20).



Figs. 21-30. Operculum and anatomical details of *Heideella* cf. *andreae* Backhuys & Boeters, 1974, collected in wells near ridge on Tensift river near Marrakech-Safi road, 4 km from Marrakech, 29R NR 90 (figs. 21-23, 25-26, 28-29) and from the "Khettara" channel draining subterranean water, 10 km south of Marrakech, 29R NR 90 (figs. 24, 27, 30) (central Morocco). 21, body of a male with pallial cavity open to show penis (left) and ventral side of foot (right); 22, outer face (left) and profile (right) of operculum; 23, male genitalia (testis and penis excluded), stomach, intestine and pallial organs; 24, stomach; 25-27, penis in five males; 28, genitalia (gonadal oviduct excluded) and pallial organs in a female; 29-30, distal portion of genitalia in two other females. Abbreviations: AG = albumen gland; BC = bursa copulatrix; C = ctenidium; CG = capsule gland; DSR = distal seminal receptacle (RS1); FL = penis apex "filament-like" with cuticularized, "stylet-like" tip; I = intestine; OE = oesophagus; OS = osphradium; OT = opercular thickening; P = penis; PG = prostate gland; PGR = pedal groove; PL = penial lobe; PW = posterior wall of pallial cavity; R = rectum; SG = seminal groove (ventral channel); SS = style sac; VD = vas deferens; VE = vas efferens (seminal vesicle). Scale bar 1 mm.

figs. 2-4; Pezzoli & Giusti, 1975: 21, pl. 2 figs. 3-5; for *Pontobelgrandiella*, see Radoman, 1978: 30-31, pl. 4 figs. 5-6; 1983: 112-113, pl. 8 fig. 129; for *Cavernisa*, see Radoman, 1978: 31-32, pl. 4 figs. 7-8; 1983: 113, pl. 8 fig. 130). *Phreatica* moreover differs in that its penis has no penial lobe. The presence of a penial lobe in the type species of *Phreatica*, *P. bolei*, reported by Velkovrh (1970: 99-100, fig. 4), has not in fact been confirmed by recent studies (personal unpublished data). The type species of *Pontobelgrandiella*, *P. nitida* (Angelov, 1972), also differs in that its penis has not one, but two very small lobes on its left side, a smaller seminal receptacle and a longer sinuous duct of bursa copulatrix (cf. Radoman, 1978: 30-31, fig. 3; 1983: 112, fig. 59 b-c). The type species of *Cavernisa*, *C. zaschevi* (Angelov, 1959), also differs by virtue of a smaller seminal receptacle and a bursa copulatrix duct which enters the bursa anteroventrally (cf. Radoman, 1978: 31, fig. 4; 1983: 113, fig. 60).

Of the hydrobiid genera with a valvatoid shell, none has a set of conchological and anatomical characters corresponding to that in *Heideella*: the shells usually have a smooth external surface or, in very rare cases, different sculpture/microsculpture; the foot soles have no longitudinal groove; the opercula have no thickening on the inner face or have a peg. *Kerkia*, Radoman, 1978, is the only genus with genitalia having a similar general appearance to those of *Heideella* (for a diagram of genital characters in European valvatoid hydrobiids see: Bodon & Giusti, 1986, table 1; Bodon et al., in press, table 2). This similarity is probably due to symplesiomorphy or convergence and is therefore of no use for inferring relationships. Moreover the anatomical similarity is not complete: *Kerkia kusceri* Bole, 1961 and *K. brezicensis* Bodon & Cianfanelli, 1996, have a bursa copulatrix duct which always enters the bursa in the centre of the distal side (i.e. anterior) (cf. Radoman, 1978: 29-30, fig. 2; Radoman, 1983: 110, fig. 58 A-B; Bodon & Cianfanelli, 1996: 20, figs. 13-15).

Kristensen (1985) hypothesized that *Heideella* was a junior synonym of the Algerian genus *Lhotelleria* Bourguignat, 1887 (type species: *L. letourneuxi* Bourguignat, 1887). The status of this genus is uncertain because its anatomical details are unknown. However, Kristenen's hypothesis seems untenable since *L. letourneuxi* is an epigean freshwater species ("... a Baraki, dans le canal formé par un ruisseau qui se jette dans l'Harrash ..." and ... "dans le petit ruisseau de Chabet-Beinan, près du cap Caxines, à l'Ouest d'Alger.") and has a larger shell (shell height 3-4 mm, shell diameter 1.25-1.5 mm), with a finely ("argutissime") striated teleoconch formed by 7 whorls, the latter slightly angled at the periphery (only *Lhotelleria ornata* Bourguignat, 1877, is described as having a shell with traces of ribbing along the suture of the last whorl; cf. Bourguignat, 1877: 49-52).

Heideella cf. *andreae* Backhuys & Boeters, 1974

Diagnosis. — A species of the genus *Heideella*, characterized by: shell conical to cylindro-conical, from rather slender and turreted to obese; spire formed by 4½-6¼ slightly convex whorls; aperture well angled and sinuous at its superior apex; margins of peristome rather well thickened and reflexed; external surface of teleoconch with marked radial ribbing. Males with penis conical or cylindro-conical, with one non-glandular, small but bulging lobe on left side at ca. half penis length; penis apex slender, elongated, pointed and filament-like, with cuticularized stylet-like tip.

Description. — Shell (figs. 1-6; 10-13) as in the genus, but characterized by: shape conical to cylindro-conical, from rather slender and turreted to obese; spire consisting of 4½-6¼ slightly convex whorls, last (body) whorl wide, about 3/5 of shell height;

sutures deep; aperture well angled and sinuous at superior apex; margins of peristome rather well thickened and reflexed; external surface of teleoconch with marked radial ribbing.

Population	H	D	h	d	ah	ad	H/D
1	1,78	0,80	0,97	0,71	0.58	0,40	2,19
(N = 4)	(1.40 - 2.30)	(0.66 - 0.98)	(0.77 - 1.12)	(0.66 - 0.84)	(0.42 - 0.70)	(0.31 - 0.49)	(2.05 - 2.34)
2	2.03	0.86	1.04	0.79	0.75	0.49	2.37
(N = 19)	(1.80 - 2.25)	(0.80 - 0.95)	(0.92 - 1.08)	(0.67 - 0.88)	(0.67 - 0.80)	(0.42 - 0.57)	(2.19 - 2.51)
3	2.05	0.80	1.00	0.66	0.61	0.42	2.58
(N = 14)	(1.46 - 2.33)	(0.56 - 0.90)	(0.93 - 1,16)	(0.53 - 0.83)	(0.46 - 0.72)	(0.33 - 0.50)	(2.33 - 2.91)
4	1.91	0.67	0.89	0.58	0.54	0:37	2.86
(N = 16)	(1.70 - 2.15)	(0.60 - 0.75)	(0.80 - 0.95)	(0.53 - 0.66)	(0.46 - 0.58)	(0.33 - 0.40)	(2.65 - 3.04)

Table 1. Shell dimensions of *H. andreae* Backhuys & Boeters, 1974 (1), *H.* cf. *andreae* (2-3) and *H. makhfamanensis* n. sp. (4). Populations: 1 = Oued Seyad; 2 = Marrakech area (wells near ridge on Tensif river); 3 = Ourika river area; 4 = Oued Makhfamane, Marrakech. N = number of specimens. Shell parameters: H = shell height; D = shell diameter; h = height last whorl; d = diameter last whorl; ah = height aperture; ad = diameter aperture; H/D = ratio shell height/shell diameter (mean; range in parenthesis; values in mm).

Dimensions (table 1, fig. 44). — Shell height 1.43-2.33 mm; shell diameter 0.56-0.95 mm; aperture height 0.46-0.84 mm; aperture diameter 0.33-0.57 mm.

Operculum (figs. 16, 22). — As in the genus, but yellowish red in colour.

Body (fig. 21). — As in the genus.

Male genitalia (figs. 18-20, 23, 25-27). — As in the genus, but characterized by: penis with a small, but well bulging, lobe and with apex slender, elongated, pointed and filament-like, with cuticularized, stylet-like tip.

Female genitalia (figs. 28-30). — As in the genus.

Radula (figs. 38-41). — As in the genus, but with the following formula: C = 5-6 + 1+ 5-6 / 2-3 + 2-3; L = 6 + 1 + 6 = 13; M1 = 25-27; M2 = ca. 20-22. Central teeth with apical margin having row of 11-13 denticles and 2-3 basal cusps on each side; lateral teeth with anterior margin having 13 denticles; inner marginal teeth with anterior margin of apex having 25-27 denticles; outer marginal teeth with ca. 20-22 denticles on latero-posterior margin of apex.

Stomach and intestine (figs. 23-24, 28). — As in the genus.

Pallial organs (figs. 23, 28). — As in the genus; ctenidium consisting of 10-16 branchial lamellae.

Collecting sites. — Marrakech area, in the centre of Haouz plain, central Morocco (fig. 45).

- Wells near ridge on Tensift river near Marrakech-Safi road, 4 km from Marrakech, 29R NR 90 (M. Boulanouar leg. 6.1987, 15 shells; M. Ghamizi leg. 12.5.1994, 10 dissected specimens, 19 shells).

-"Khettara" channel draining subterranean water, 10 km south of Marrakech, 29R NR 90 (M. Ramdani leg., 18.5.1983, 7 dissected specimens; Z. El Mezdi leg. 1988, 2 shells; M. Ghamizi leg. 17.9.1995, 3 shells).

- Wells at Gueliz, Marrakech, 29R NR 90 (M. Fakher leg., 20.9.1995, 6 shells).

Ourika river area, central Morocco.

- Hyporheic waters of Ourika river at Tnine Ourika, 29R PQ 18 (M. Yacoubi-Khebiza leg. 1988, 8 shells).
- Hyporheic waters of Ourika river at Oulmes, 29R PQ 26 (M. Yacoubi-Khebiza leg. 1988, few shells).
- Hyporheic waters of Ourika river at Aghbalou, 29R PQ 26 (M. Yacoubi-Khebiza leg. 1988, many shells).

Zat river area, central Morocco.

- Hyporheic waters of Zat river, 40 km south of Ait Ourir, 29R PQ 47 (M. Yacoubi-Khebiza leg. 1988, 5 shells).
- Well near Zat river at Ait Ourir, 29R PQ 29 (M. Fakher leg., 21.12.1995, 1 shell).

Remarks. — Comparative study of shell characters of specimens of *H. andreae* from the type locality in southern Morocco (Backhuys & Boeters, 1974: 112, figs. 1-3; Kristensen, 1985: 8, fig. 12; Van Damme, 1984: 18, fig. 20c; a paratype, Boe 493a, in collection F. Giusti) and specimens from populations from the Marrakech, Ourika and Zat areas in central Morocco is complicated by remarkable variations in shell shape and longitudinal ribbing of the external shell surface (figs. 1-6, 10-12, 44). Nevertheless, the shells of *H. andreae* appear to differ from those of the populations from central Morocco by virtue of a thinner, non- sinuous peristome, a non-pyriform opening and a wider umbilicus.

Since these features are not significant enough to support distinct specific status for the populations from central Morocco and since an anatomical comparison of the two groups of populations is impossible (as mentioned above, complete specimens of *H. andreae* have never been found), we abstain from categorical determination and refer to the populations from central Morocco as *H.* cf. *andreae.*

Heideella makhfamanensis n. sp.

Diagnosis. — A species of the genus *Heideella*, characterized by: shell cylindrical to cylindro-conical, slender; spire consisting of 5-6 flat whorls; external surface of teleoconch with weak radial ribbing. Males with penis cylindro-conical, with a wide, only modestly bulging, non-glandular lobe on left side at ca. half penis length; penis apex short, wide, not cuticularized at tip.

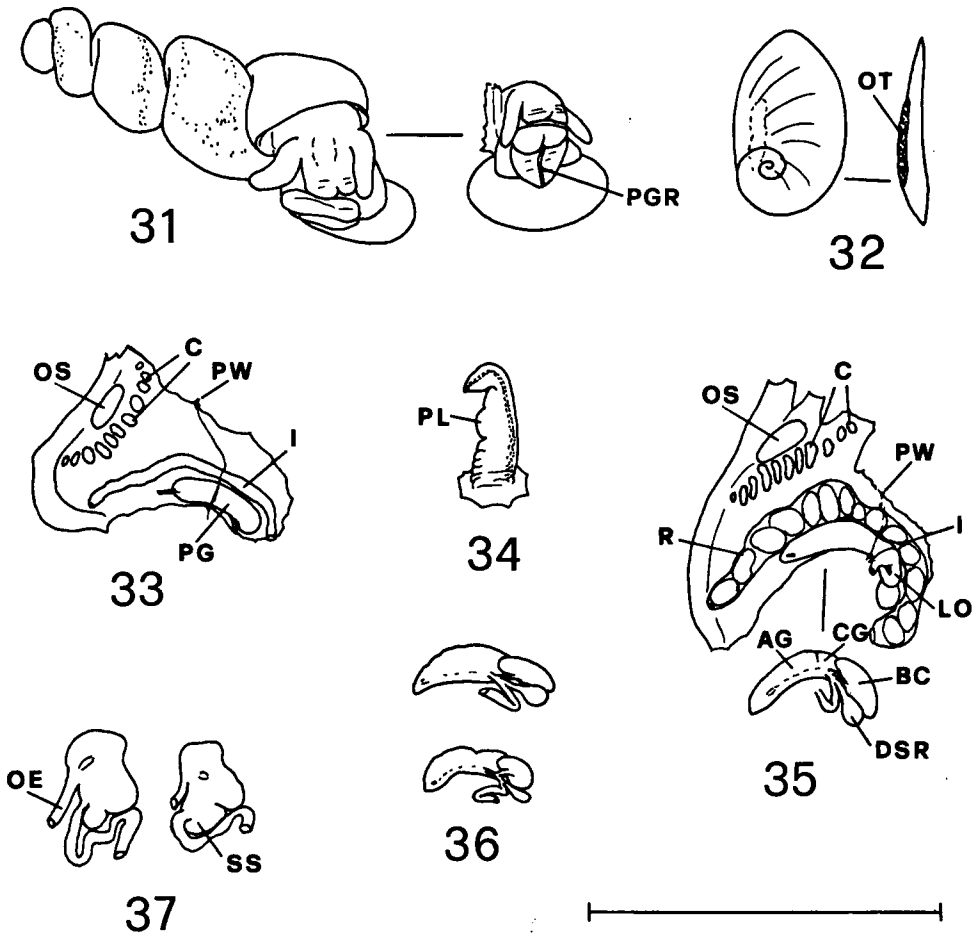
Description. — Shell (figs. 7-9, 14-15) as in the genus, but characterized by: shape cylindrical to cylindro-conical, slender, more or less elongated; spire formed by 5-6 flat whorls, last (body) whorl ca. 1/2 of shell height; sutures moderately deep; aperture not very wide, pyriform to ovoid, slightly angled at upper apex; margins of peristome slightly thickened and reflexed, external margin slightly sinuous in upper portion; external surface of teleoconch with weak radial ribbing and very fine spiral crests sometimes visible on last whorl.

Dimensions (table 1; fig. 44). — Shell height 1.47-2.15 mm; shell diameter 0.51-0.75 mm; aperture height 0.44-0.60 mm; aperture diameter 0.31-0.40 mm.

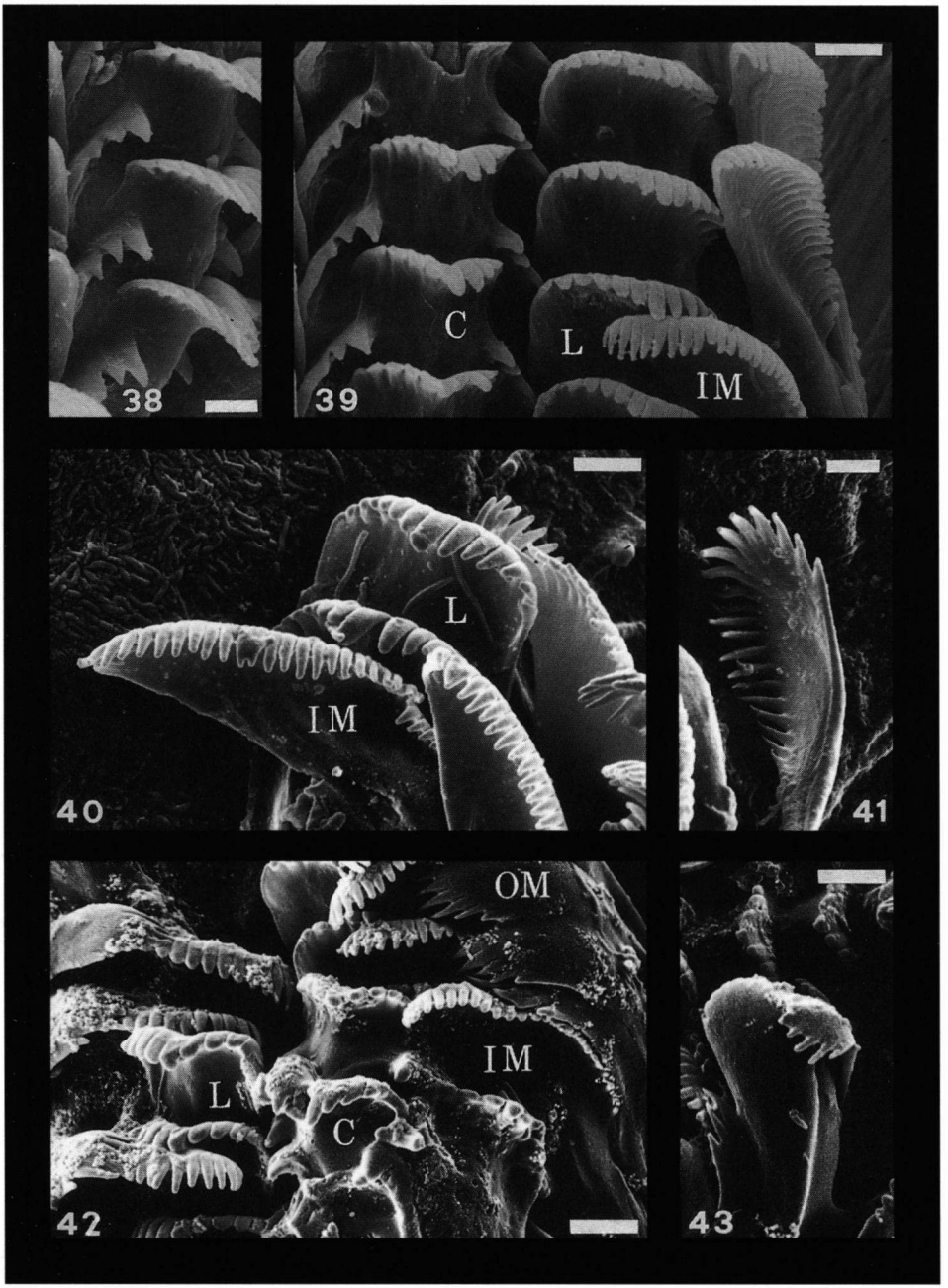
Operculum (figs. 17, 32). — As in the genus, but very thin and pale yellowish in colour.

Body (fig. 31). — As in the genus.

Male genitalia (figs. 33-34). — As in the genus but characterized by: penis cylindro-conical in shape, with a wide, only modestly bulging, non-glandular lobe on left side



Figs. 31-37. Operculum and anatomical details of *Heideella makhfamanensis* n. sp. collected in hyporheic waters of Oued Makhfamane (tributary of N'fis river), near Lalla Takerkoust dam, 31 km south of Marrakech, centre of Haouz plain, 29R NQ 86 (central Morocco). 31, body of a male (left) and ventral side of foot (right); 32, outer face (left) and profile (right) of operculum; 33, male genitalia (testis and penis excluded), intestine and pallial organs; 34, penis in a male; 35, genitalia (gonadal oviduct excluded) and pallial organs in a female; 36, distal portion of genitalia in two other females; 37, stomach in two specimens. Abbreviations as in figs. 21-30. Scale bar 1 mm.



Figs. 38-43. 38-41, radula of *Heideella* cf. *andreae* Backhuys & Boeters, 1974, collected in well near ridge on Tensift river near Marrakech-Safi road, 4 km from Marrakech, 29R NR 90 (central Morocco); 42-43, radula of *Heideella makhfamanensis* n. sp. collected in hyporheic waters of Oued Makhfamane (tributary of N'fis river), near Lalla Takerkoust dam, 31 km south of Marrakech, centre of Haouz plain, 29R NQ 86 (central Morocco). 38, central tooth seen in profile showing basal cusps; 39, central portion of radula with central (C), lateral (L) and inner marginal (IM) teeth; 40, lateral (L) and inner marginal (IM) teeth; 41, outer marginal tooth; 42, central portion of radula with central (C), lateral (L), inner (IM) and outer marginal (OM) teeth; 43, two outer marginal teeth. Scale bar 2 μm.

at ca. half penis length; penis apex short, conical, apically pointed, not cuticularized at tip.

Female genitalia (figs. 35-36). — As in the genus.

Radula (figs. 42-43). — As in the genus, but with the following formula: C = 4+1+4/1+1; L = 4+1+4 = 9; M1 = 20 ca.; M2 = 20 ca. Central teeth with apical margin having row of 9 denticles and one basal cusp on each side; lateral teeth with anterior margin having 9 denticles; inner marginal teeth with anterior margin of apex having ca. 20 denticles; outer marginal teeth with ca. 20 denticles on latero-posterior margin of apex.

Stomach and intestine (figs. 33, 35, 37). — As in the genus.

Pallial organs (figs. 33, 35). — As in the genus; ctenidium consisting of 11-15 branchial lamellae.

Type locality. — Hyporheic waters of Oued Makhfamane, tributary of N'fis river near Lalla Takerkoust dam, 31 km south of Marrakech, in the centre of Haouz plain, central Morocco, 29R NQ 86 (M. Yacoubi-Khebiza leg. 1989, 26 shells, 4 dissected specimens) (fig. 45).

Type material. — Holotype (fig. 2): shell collected in the type locality, M. Yacoubi-Khebiza leg. 1989, kept in the Muséum National d'Histoire Naturelle de Paris (France). Paratypes: 25 shells and 4 dissected specimens collected in the type locality, M. Yacoubi-Khebiza leg. 1989, kept in the Muséum National d'Histoire Naturelle de Paris and in the collections of M. Ghamizi (Département de Biologie, Faculté des Sciences Semlalia, B.P.S. 15 Marrakech, Morocco), F. Giusti (Dipartimento di Biologia Evolutiva dell'Università, Via Mattioli 4, Siena, Italy) and M. Bodon (Via delle Eriche 100/8, Genova, Italy).

Etymology. — From the stream Makhfamane, in the hyporheic waters of which the new species was found.

Remarks. — From the above diagnosis and description it is clear that *H. makhfamanensis* n. sp. differs from *H. andreae* and from *H.* cf. *andreae* by virtue of a more slender, cylindrical to cylindro-conical shell, with flat whorls and weak radial ribbing. It also differs at least from *H.* cf. *andreae* (*H. andreae* is not known anatomically) in some anatomical characters, particularly the penis which has a wide, but only modestly bulging lateral lobe, and a short apex, without cuticularized tip.

ACKNOWLEDGEMENTS

We thank colleagues working on the stygobiont crustacean fauna of Morocco (Project on groundwaters financed by the French Cooperation, A.I. 364) who helped in collecting the material: M. Messouli, M. Yacoubi-Khebiza, M. Boulal, M. Boulanouar, M. Fakher, B. Idbennacer, C. Boutin and N. Coineau. We also thank Dr. Serge Gofas for SEM images of shells and Dr. Reno Bernasconi for his preliminary comments. This research was partly financed by CNR (Sistematica e Zoogeografia della Regione Paleartica) and MURST 40% and 60% grants.

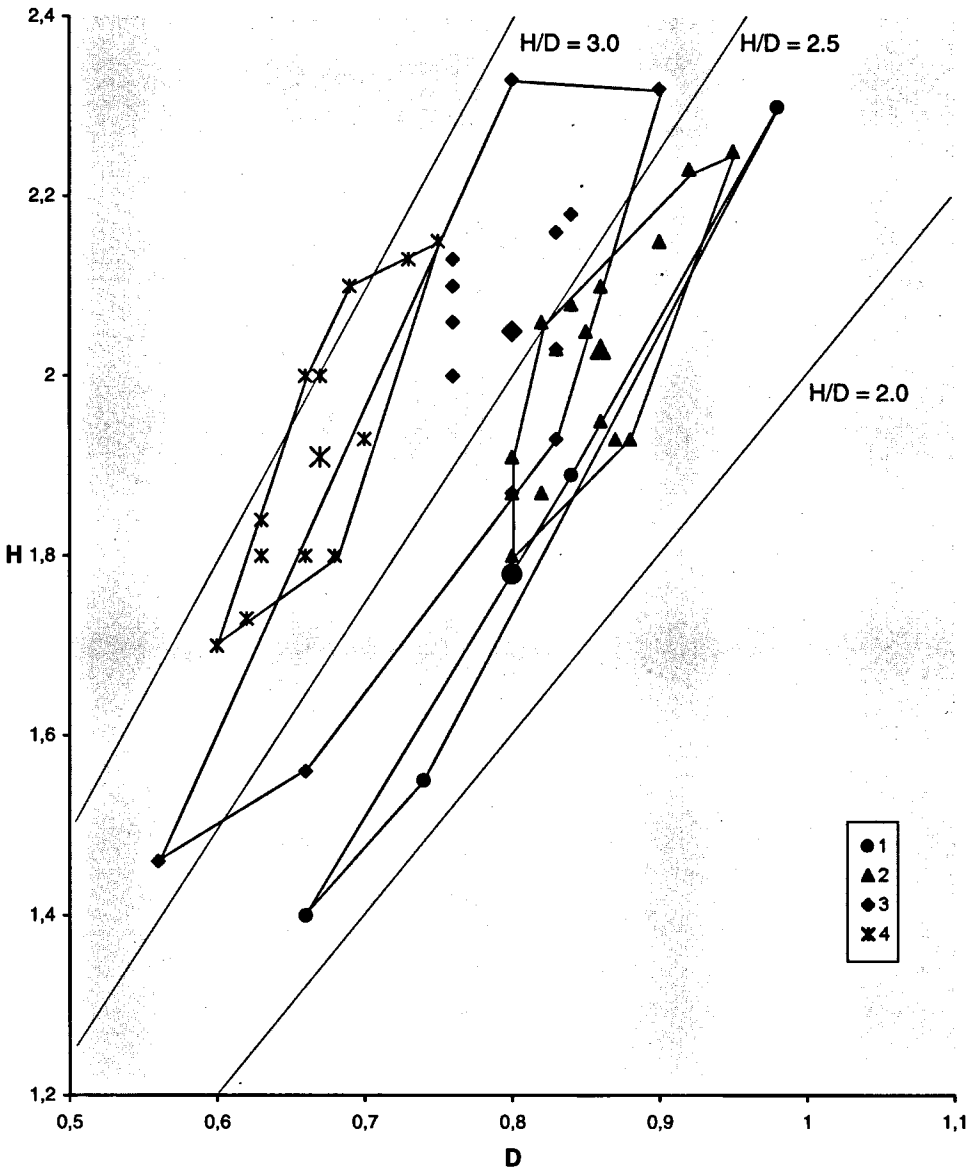


Fig. 44. Biometric analysis of shells of *H. andreae* Backhuys & Boeters, 1974 (1), *H.* cf. *andreae* (2-3) and *H. makhfamanensis* n. sp. (4) from Morocco. Populations: 1 = Oued Seyad; 2 = Marrakech area (wells near ridge on Tensif river); 3 = Ourika river area; 4 = Oued Makhfamane, Marrakech. The larger symbols indicate the mean value for each population. Shell parameters: H = shell height; D = shell diameter. For data see table 1.

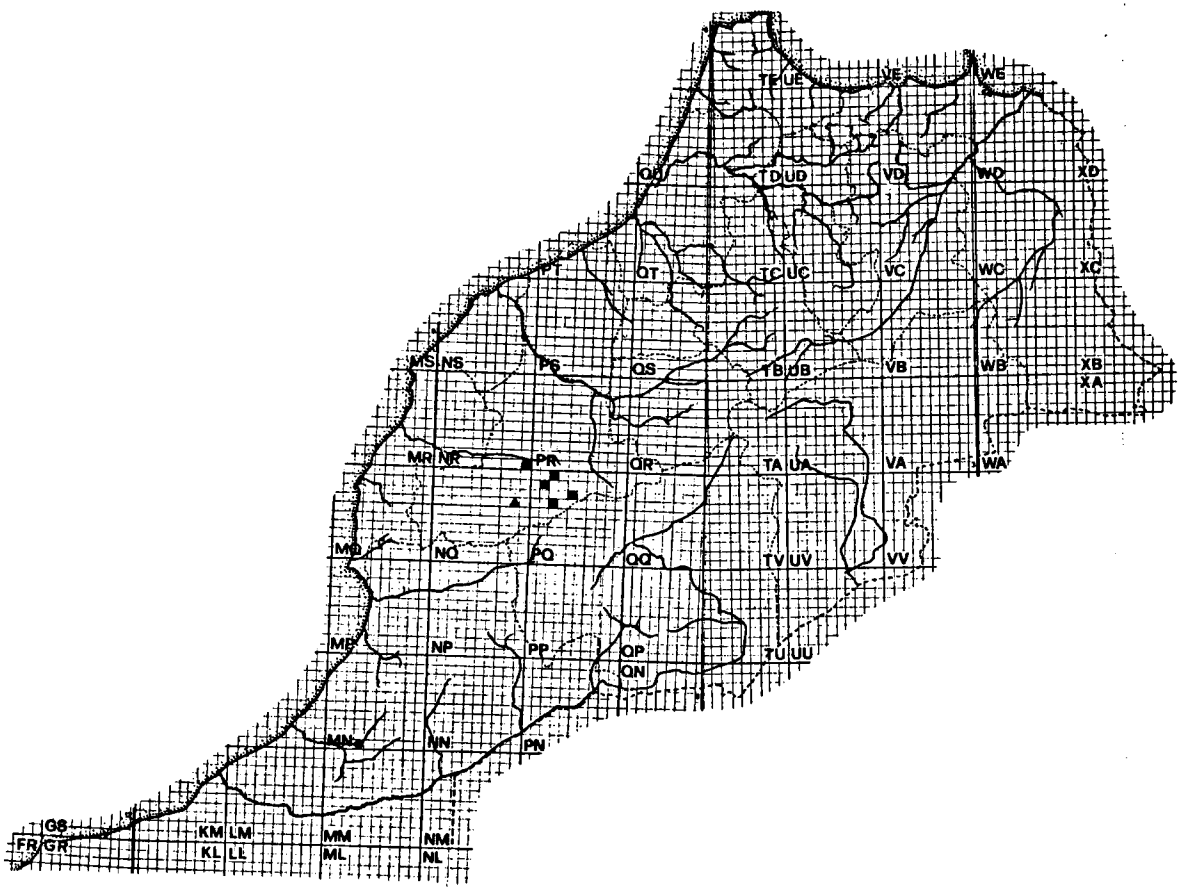


Fig. 45. Distribution of the genus *Heideella*, on UTM map of Morocco north of Sahara, with on 10 X 10 kilometre squares. ● = *H. andreae* Backhuys & Boeters, 1974; ■ = *H.* cf. *andreae*; ▲ = *H. makhfamanensis* n. sp.

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