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Olgaconcha tufari n. gen. et n. sp. – a new mesogastropod (Gastropoda: Prosobranchia) from hydrothermal vents in the Manus Back-Arc Basin (Bismarck Sea, Papua New Guinea)

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(With 2 Tables, 3 Figures and 5 Plates)

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Zusammenfassung

Während der deutschen Forschungsfahrt OLGA II mit dem Forschungsschiff „Sonne" in der Spreizungszone des Manus-Back-Arc-Beckens (Bismarck-See, Papua-Neuguinea) wurde im Hydrothermalfeld 1, „Wienerwald", neben einer ganzen Reihe von hydrothermalen Tiefseetieren auch eine größere Anzahl von mittelgroßen, bisher unbekannten Gastropoden aus dem Benthos von aktiven Sulfid-Schornsteinen („Schwarze Raucher") aus ca. 2500 m Tiefe geborgen. Die schwarze Schale dieser neuen Gattung und Art (Jugendformen sind braun) zeigt ein außergewöhnlich dickes Periostracum, das am Apex durch die sauren hydrothermalen Lösungen aufgelöst wird, sodaß weiße Schichten des ansonsten reduzierten Ostracums freigelegt werden. Am Weichkörper fallen die extrem vergrößerte Kieme, das aus mehreren Schichten bestehende Operculum und bisher unbekannte hornige Fortsätze auf den Fußseiten besonders auf. Bei der sehr kleinen Radula sind die spatelförmigen Marginalzähne hervorzuheben. Die neue Form scheint mit *Alviniconcha hessleri* OKUTANI & OHTA, 1988 nahe verwandt. Erste Vergleiche der Radula, der Schale und des Weichkörpers deuten auf eine Verwandtschaft nahe den Architaenioglossa oder Cerithiacea hin.

Summary

During the German OLGA II Research Cruise of the Research Vessel "Sonne" to hydrothermal vents in the Manus Back-Arc Basin (Bismarck Sea, Papua New Guinea) a larger number of specimens of a new medium-sized gastropod was collected from active sulfide chimneys (black smokers) occurring at water depths around 2,500 m. The particular apomorphic morphological characters of this snail justify new genus and species names. The new form seems to be closely related to *Alviniconcha hessleri* OKUTANI & OHTA, 1988. Preliminary comparisons of the radula, the shell characters and the soft parts indicate a close relationship to the Architaenioglossa or Cerithiacea.

Introduction

During the German Research Cruise OLGA II (**O**zeanische **L**agerstätten: **G**eologisch-Mineralogische **A**nalyse = Oceanic Deposits: Geological-Mineralogical Analysis) of the University of Marburg, carried out with the German Research Vessel "Sonne", under the direction of Professor Dr. WERNER TUFAR, several hydrothermal fields containing mineralizations were discovered on the Manus

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Spreading Center (Bismarck Sea, Papua New Guinea). For the first time from the ocean floor of the Bismarck Sea hydrothermal chimneys were recovered, among them a large number of active chimneys ("smokers"). Connected and associated with the active sulfide chimneys (smokers) is an abundant and diverse fauna consisting of gastropods, barnacles, bythograeid and galatheid crabs, pogonophorans, polychaetes, actinians etc. including new species previously unknown throughout the world (Tufar 1990).

Besides these very specific animals hundreds of gastropods were recovered from the deep-sea ocean floor. They belong to three species of archaeogastropod limpets, to the recently discovered *Alviniconcha hessleri* Okutani & Ohta, 1988, and to a new medium-sized black mesogastropod which is described here. Earlier reports on gastropods from hydrothermal vents (Ballard 1977; Corliss & Ballard 1977; Corliss et al. 1979; Enright et al. 1981; Rona et al. 1983; Lutz et al. 1984; Hickman 1984; Canadian American Seamount Expedition 1985; Grassle 1985; Turner & Lutz 1984; Jannasch 1985; Jones 1985; Waren & Bouchet 1986, 1989, 1990; Hessler 1988; Stein 1988; Fricke et al. 1989) do not mention anything like the new black form. Only Both et al. (1986), who examined the Manus Basin geologically, took some blurred photos of clusters of empty dark shells. As samples could not be collected, identification of the species was not possible. It therefore remains unclear whether the shells photographed belong to the species described here.

Material examined

30 specimens, including juvenile and adult, selected for this study were collected by Professor Tufar during the German OLGA II Research Cruise of the Research Vessel "Sonne" together with portions of active sulfide chimneys occurring at water depths around 2,500 meters within Hydrothermal Field 1, "Wienerwald" ("Vienna Woods"), (Figs. 1a, 1b; Plate 5). Sampling was performed by a TV-controlled electrohydraulic grab (GTVA). Specimens were fixed in buffered formalin on board the research vessel and later preserved in 70% ethanol. The specimens examined were taken from lots deriving from three sampling locations (Table 1).

Table 1: Sampling positions of *Olgaconcha tufari* n. gen. et n. sp.

Station no.	date	latitude	longitude	water depth
17 GTVA	May 20, 1990	3° 9.861' S	150° 16.777' E	2,500 m
56 GTVA	June 10, 1990	3° 9.801' S	150° 16.768' E	2,490 m
61 GTVA	June 14, 1990	3° 9.832' S	150° 16.810' E	2,488 m

In addition to the type specimens (Table 2), seven samples of *Olgaconcha tufari* and five samples of *Alviniconcha hessleri,* collected from the same sampling locations, were used for comparative studies of the radula and the soft parts. SEM studies were performed by a Hitachi S-530 scanning electron microscope (25 kV; gold covering by Balzer Union Sputter, 6 nm).

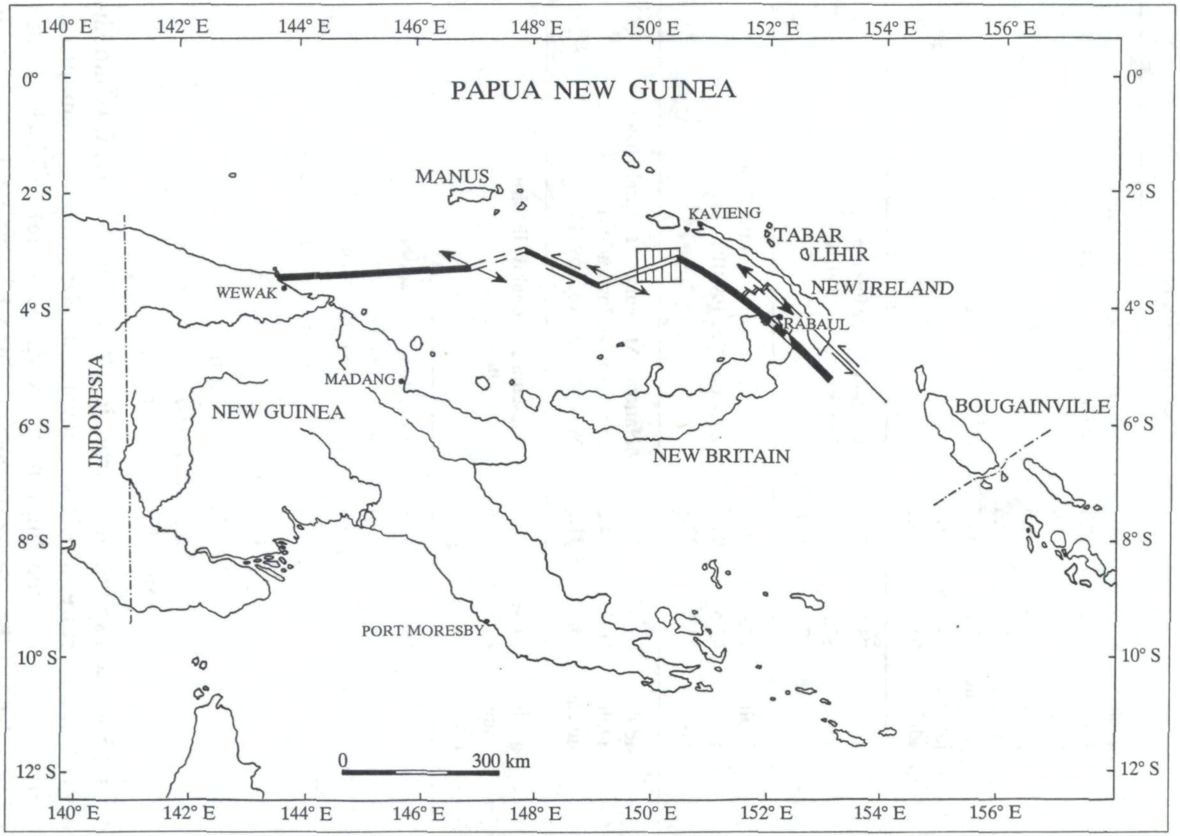

Fig. 1a: Location map of Papua New Guinea showing the area investigated (hatched region) during the German OLGA II Research Cruise in the Manus Back-Arc Basin. Spreading centers and transform faults indicate the active plate boundary.

Table 2: Shell measurement and repository (length and width maximum measurable).

		length (in mm)	width (in mm)	repository
Holotype	adult	92.9	90.7	Naturhistorisches Museum Wien, Inv. No. 85900
Paratype 1	adult	85.5	95.2	Naturhistorisches Museum
Paratype 2	adult	94.2	91.1	Wien, Inv. No. 85901
Paratype 3	juvenile	16.6	14.9	
Paratype 4	juvenile	17.6	16.6	
Paratype 5	juvenile	22.3	20.6	
Paratype 6	juvenile	35.6	33.5	
Paratype 7	juv./ad.	46.1	42.4	
Paratype 8	adult	65.1	60.8	
Paratype 9	adult	75.8	74.2	Senckenberg Museum
Paratype 10	adult	84.6	80.3	Frankfurt, No. 309208
Paratype 11	juvenile	28.5	25.8	
Paratype 12	adult	74.6	70.7	British Museum (Natural History)
Paratype 13	adult	95.5	90.7	London, No. 1990109
Paratype 14	juvenile	31.6	28.1	
Paratype 15	adult	88.4	79.0	National Museum of Natural History
Paratype 16	adult	70.5	64.2	(Smithsonian Institution)
Paratype 17	juvenile	34.5	31.2	Washington, No. 859442
Paratype 18	adult	74.8	82.5	Museum National d'Histoire
Paratype 19	adult	82.5	84.6	Naturelle Paris
Paratype 20	juvenile	31.3	27.6	
Paratype 21	adult	78.3	76.5	Sammlung TOLLMANN,
Paratype 22	adult	73.0	67.3	Institut für Geologie
Paratype 23	juvenile	35.0	33.6	der Universität Wien

Taxonomy

Ordo Mesogastropoda
Familia indet.
Genus *Olgaconcha* n. gen.

Diagnosis: Shell conispiral, orthostrophic, 1½–3½ whorls only, with umbilicus and nearly circular aperture, which is somewhat elastic; juveniles unomphalous with oval aperture; periostracum thickened, brown (juvenile) to black (adult), faintly glossy, dissolved at the apex; ostracum shining white, very thin at the body whorl but unusually thickened at the apex; while the shell is growing at the aperture the apex is dissolved by the hydrothermal solutions, so that the apex has to be repaired with calcium and is a secondary structure.

Operculum: horny, convex, oval, lamellar.

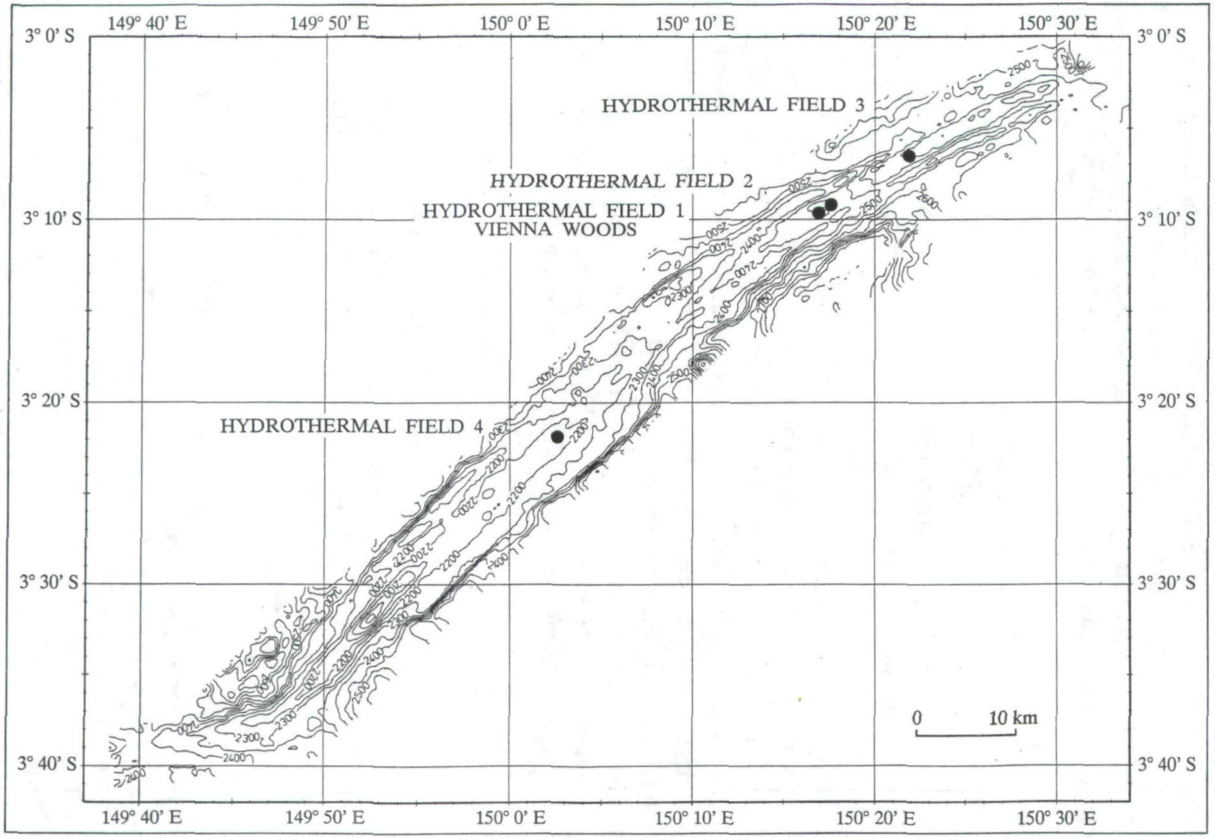

Fig. 1b: Bathymetric map of the Manus Spreading Center from 3° 42′ S, 149° 37′ E to 3° 0′ S, 150° 34′ E showing the location of the four major hydrothermal fields (depths are in meters, with 50 m contour intervals) (after TUFAR 1990). Locus typicus of *Olgaconcha tufari* n. gen. et n. sp. is at Hydrothermal Field 1, Vienna Woods.

Radula: central and lateral teeth with several similar cusps, main cusp enlarged but blunt; with four spatula-like marginal teeth, each with 15–22 small cusps.

Type species: *Olgaconcha tufari.*

Etymology: Genus epithet named after Research Project OLGA (**O**zeanische **L**agerstätten: **G**eologisch-Mineralogische **A**nalyse = Oceanic Deposits: Geological-Mineralogical Analysis) of the Philipps University Marburg, Chief Scientist Professor Dr. TUFAR, and funded by the Federal German Minister for Research and Technology (Bundesminister für Forschung und Technologie).

Olgaconcha tufari n. sp.

Description: Shell shows, in addition to characters used to define the genus, spiral belts of convex upright periostracum-scales: one belt of scales close to the suture (50–60 scales at the last whorl) and two or three similar belts around the umbilicus (Plate 1, Figs. 2–3). These structures cause some small notches in the otherwise holostomous peristome: one on top of the outer lip, two at the base of the columellar lip, simulating small siphonal notches (Plate 1, Fig. 1; Plate 2, Figs. 4–5). The orthocline growth lines are coarse and irregular, corresponding to the periostracum scales. The last whorl is somewhat inflated towards the aperture. At the penultimate whorls (if present), adults show up to twelve flat spiral ribs which form a lattice with the growth lines (Plate 1, Fig. 3). In juveniles, this character is much clearer and extends even to the last whorl. Sometimes the ribs may be ornamented with tiny knobs (Plate 2, Fig. 3). Because of the continuous chemical dissolving processes, the white apex is irregularly shaped in all age groups. Differently dissolved thin ostracum layers form patterns of fine lines (Plate 1, Fig. 4). Unfortunately, the protoconch is not preserved in all the specimens available.

All shells are covered with white oval dots (diameter about 1 mm) mainly present between the upper periostracum scales and the suture, but also occurring around the umbilicus and between growth lines. These white dots seem to be egg-capsules of an unknown animal. Small limpets (about 8 mm) were found on the shell surface. Sporadically, the umbilicus is colonized by small sedentary polychaetes. The operculum (Plate 2, Fig. 6; Plate 3, Fig. 2) is spiral and oligogyruous, formed of several conchin layers, which seem to fray out at the outer margin; the nucleus is on the left side near the fringe.

The animal (Plate 3, Figs. 1–5; Drawing, Fig. 2) is very muscular and solid, of rubber-like consistence; the well-developed foot has a large opening of the anterior pedal gland (Plate 3, Fig. 4, arrow) and, on its posterior flanks, many very unusual horny protuberances which are also present at the swollen warty epipodium (Plate 3, Figs. 1, 3). The snout is of moderate size, while the mouth and buccal mass are comparatively minute. The two cephalic tentacles are well-developed, with the eyes missing. The mantle cavity is filled with a very hypertrophic gill (of ctenidium type) with very long lamellae, these lamellae being abruptly reduced at

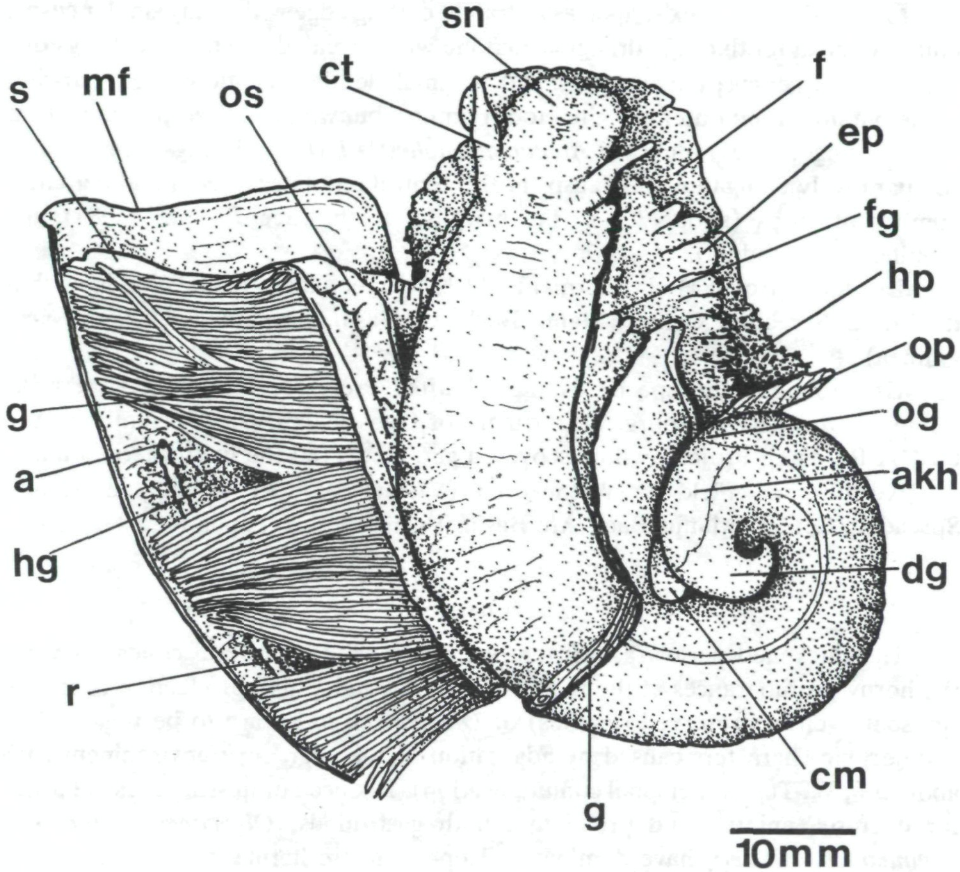

Fig. 2: *Olgaconcha tufari* n. gen. et n. sp. animal, dorsal view, mantle cavity half opened. Abbreviations: (a) anus, (akh) area of kidney and heart, (cm) columellar muscle, (ct) cephalic tentacle, (dg) digestive gland, (ep) epipodium, (fg) food groove, (f) foot, (g) gill, (hp) horny protuberances, (hg) hypobranchial gland, (mf) mantle fringe, (o) operculum, (og) origin of gill, (os) osphradium, (r) rectum, (s) septum leading to the osphradium, (sn) snout.

the tip of the gill (Drawing, Fig. 2). A folded osphradium is present at the edge of an additional septum, which secondarily closes the mantle cavity. A remarkable groove leading along the right cephalic tentacle to the notch between the snout and the foot is located dorsally at the right side of the foot (Plate 3, Fig. 5; Drawing, Fig. 2).

Radula (Plate 4, Figs. 1–5) taenioglossate, formula 2 : 1 : 1 : 1 : 2, very small (length 8 mm at most), about 30 rows of teeth per millimeter. Central tooth: cutting edge with non-serrated more or less blunt main cusp and five flanking cusps, becoming smaller distally; basal platform with marginal ridges of moderate size.

Lateral teeth: cutting edge similar to that of central tooth, with six flanking cusps on each side, basal platform with a central ridge, and outer posterior corner elongated to base of marginal teeth.

Marginal teeth: apex shaped as a straight cutting edge with many similar cusps; inner marginal tooth of quadrangular outline with a weak distal ridge, cutting edge with 15–17 larger cusps of equal size and 4–5 small denticles (Plate 4, Fig. 2, arrow) at the outer margin; outer marginal tooth similar, but with 20–22 cusps and a distal convex fringe. The radula of *Alviniconcha hessleri* (Plate 4, Figs. 4, 5) shows comparatively elongated main cusps at the central and lateral teeth and a greater number of cusps (about 30) at the marginal teeth. (See Bandel (1984), for terminology of radula).

Locus typicus: Hydrothermal Field 1, Wienerwald (Vienna Woods) within the Manus Spreading Center (Manus Back-Arc-Basin, Bismarck Sea, Papua New Guinea).

Etymology: the species is named after Professor Dr. Werner Tufar, Philipps University Marburg, Department of Geosciences, Chief Scientist of the OLGA Research Project, who discovered and recovered the hydrothermal fauna of Hydrothermal Field 1, Wienerwald (Vienna Woods) within the Manus Spreading Center (Manus Back-Arc Basin, Bismarck Sea, Papua New Guinea).

Discussion

The thickened periostracum, the operculum with its several conchin layers, the horny protuberances at the flanks of the foot and a high production of mucus (present even in preserved samples) of *Olgaconcha tufari* are to be regarded as apomorphic characters caused by adaptation to the aggressive environment (pH about 3.6, W. Tufar, personal communication). Reduced or missing eyes are usual for deep-sea animals and prove that both gastropods, *Olgaconcha tufari* and *Alviniconcha hessleri,* have dominated deep-sea hydrothermal ecosystems over a very long time. Both species are living sympatrically in the Manus Basin on active chimneys or near hydrothermal fissures in a hydrothermal environment. Hundreds of individuals were found clustering together. It can therefore be assumed that the trophic strategy of *Olgaconcha tufari* is the same as of *Alviniconcha hessleri* (see Stein 1988; Mc Quitty in Hessler 1988). The extensively developed gills are very similar, but endosymbiosis with archaebacteria must still be proved for *Olgaconcha tufari.* The remarkable food groove leading to the notch between snout and foot (also present in *Alviniconcha hessleri*) suggests that filter feeding is probable, as well. The very small radula and buccal mass indicate that both species are not mainly grazers.

It is difficult to decide whether the permanently repaired apex of *Olgaconcha tufari* (the apex of *Alviniconcha hessleri,* however, is dissolved, but not thickened by calcium layers) is an apomorphic character which is fixed genetically or whether it is the normal ability of gastropods to repair parts of their damaged shell.

Contrary to Okutani & Ohta (1988), our evidence suggests that both species have to be ranked close to the Architaenioglossa or to the Cerithiacea (see Fretter & Graham 1962; Hyman 1967; Warén & Bouchet 1988; Okutani 1990). Primitive holostomuous peristomes, radula characters such as spatula-like marginal teeth

(e. g. *Viviparus,* HYMAN 1967, Fig. 105; *Provanna,* OKUTANI 1990), filter-feeding with gill and food groove as well as periostracum hairs are also known in these old Mesogastropods. The primitive folded osphradium of *Olgaconcha tufari* prevent a systematic arrangement in the Calyptracea (all with bipectinated osphradia, shell mostly limpet-shaped), although it cannot be denied that the filter-feeding mechanism (e. g. *Crepidula, Calyptraea*) seems to be very similar.

There remains some uncertainty with respect to the taxonomic status of*Alvinia concha hessleri* from the Manus Basin. Not all details of the radula and shell are in accordance with the description given by OKUTANI & OHTA (1988) for specimens from the Mariana Back-Arc Basin. However, it seems premature to propose subspecific rank.

It is expected that additional anatomical data will clarify phylogenetic and systematic questions, as well as certain biological problems, above all with respect to nutrition and reproduction.

Acknowledgements

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Plate explanations

Plate 1

Figs. 1–4: Holotype of *Olgaconcha tufari* n. gen. et n. sp. from Hydrothermal Field 1, Vienna Woods, Manus Back-Arc Basin, shell length 92.7 mm.

Fig. 2: Umbilicus surrounded by two belts of periostracum scales; note coarse growth lines.

Fig. 3: Belt of periostracum scales close to the suture, white apex, lattice formed by spiral ribs and growth lines.

Fig. 4: White apex with fine lines of thin ostracum layers.

Fig. 5: Paratype No. 1, length 85.5 mm.

Fig. 6: Paratype No. 2, length 94.2 mm.

L. A. BECK: *Olgaconcha tufari* n. gen. et n. sp. – a new mesogastropod (Gastropoda: Prosobranchia) from hydrothermal vents in the Manus Back-Arc Basin (Bismarck Sea, Papua New Guinea) — Plate 1

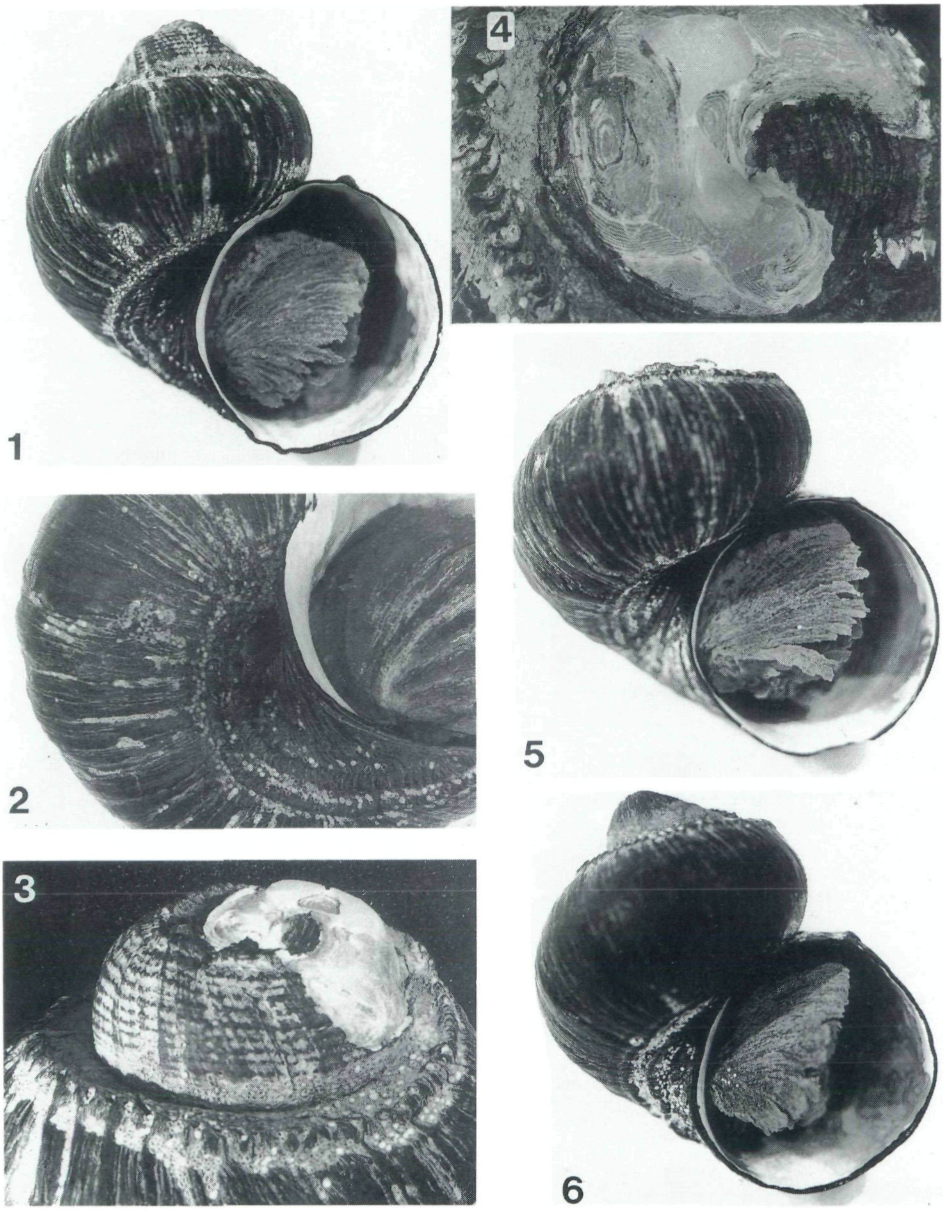

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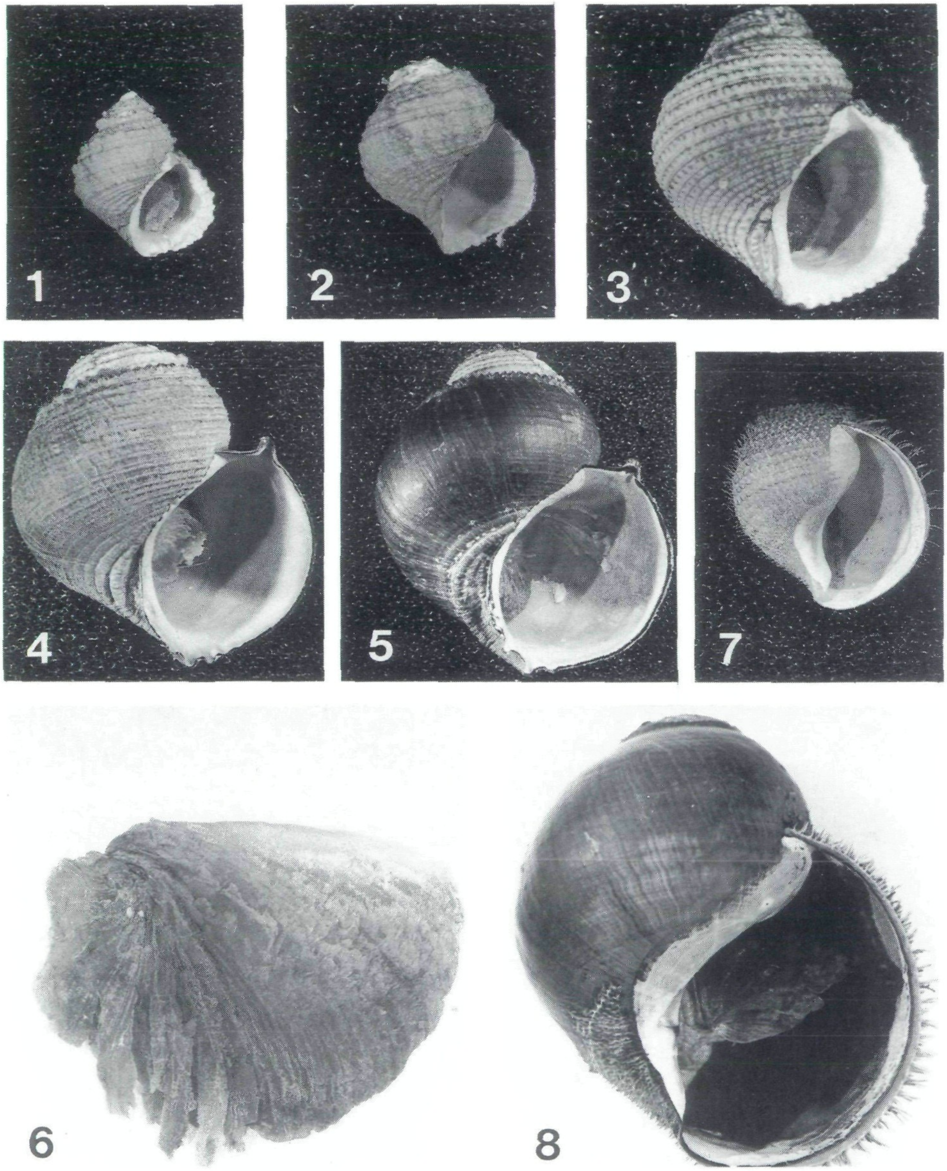
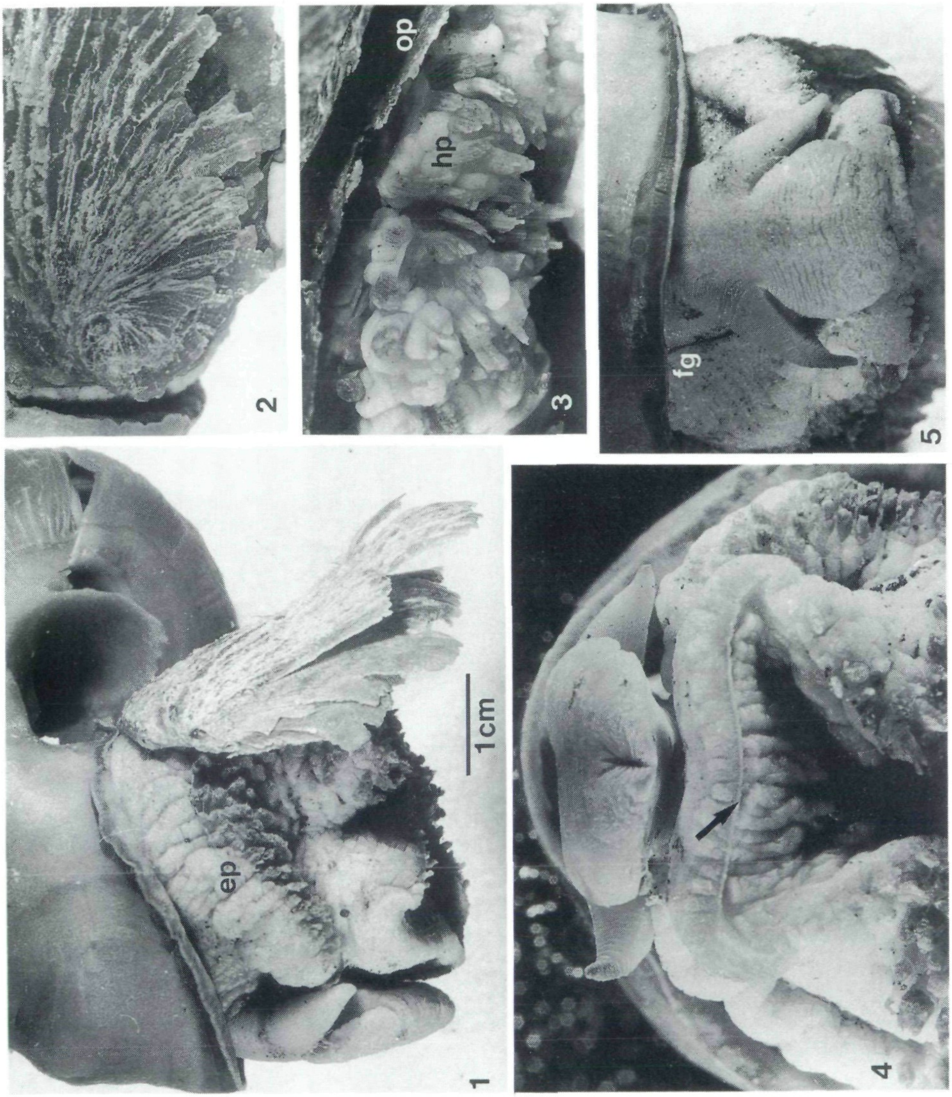
Plate 2

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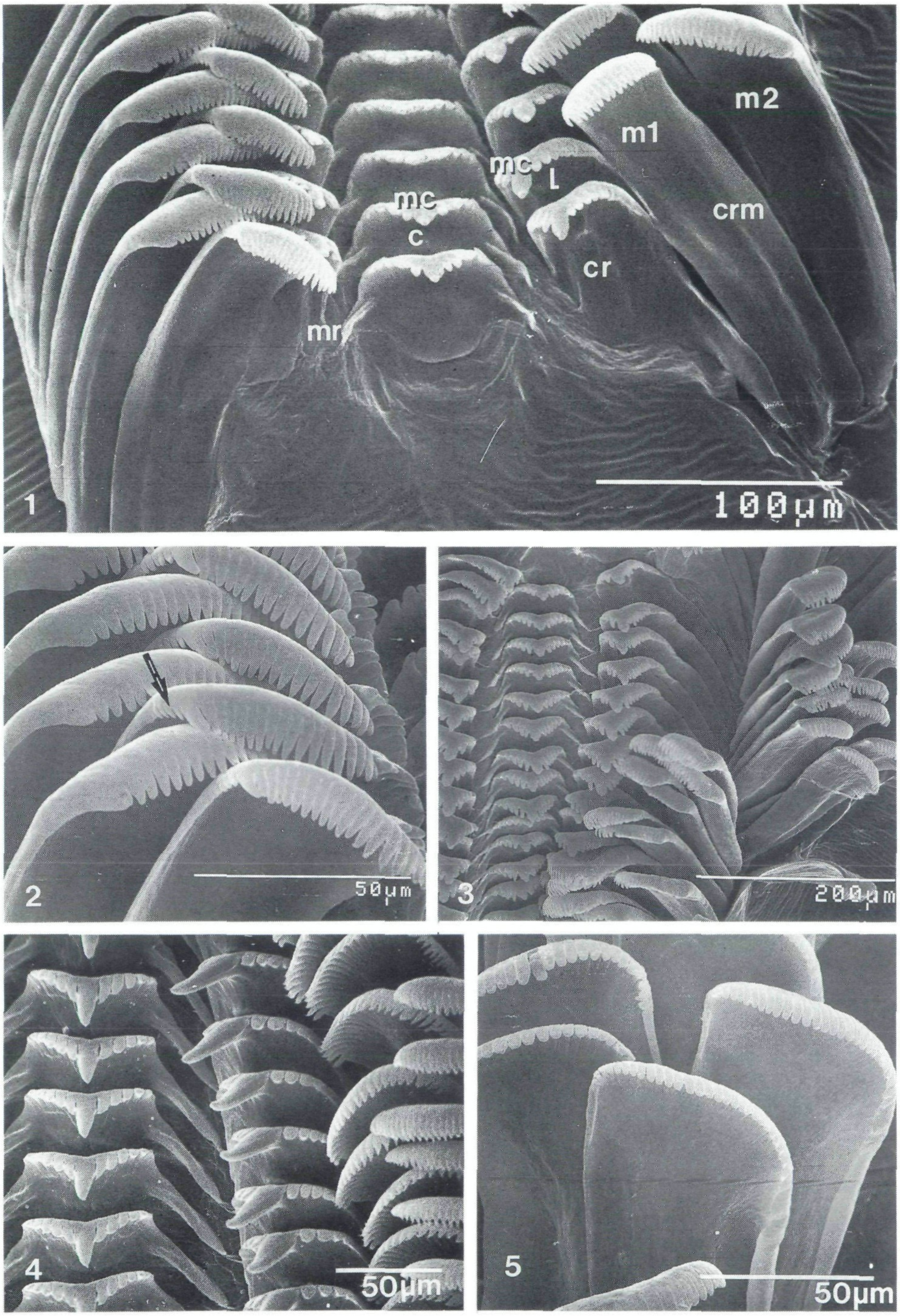
L. A. BECK: *Olgaconcha tufari* n. gen. et n. sp. – a new mesogastropod (Gastropoda: Prosobranchia) from hydrothermal vents in the Manus Back-Arc Basin (Bismarck Sea, Papua New Guinea)

Plate 4



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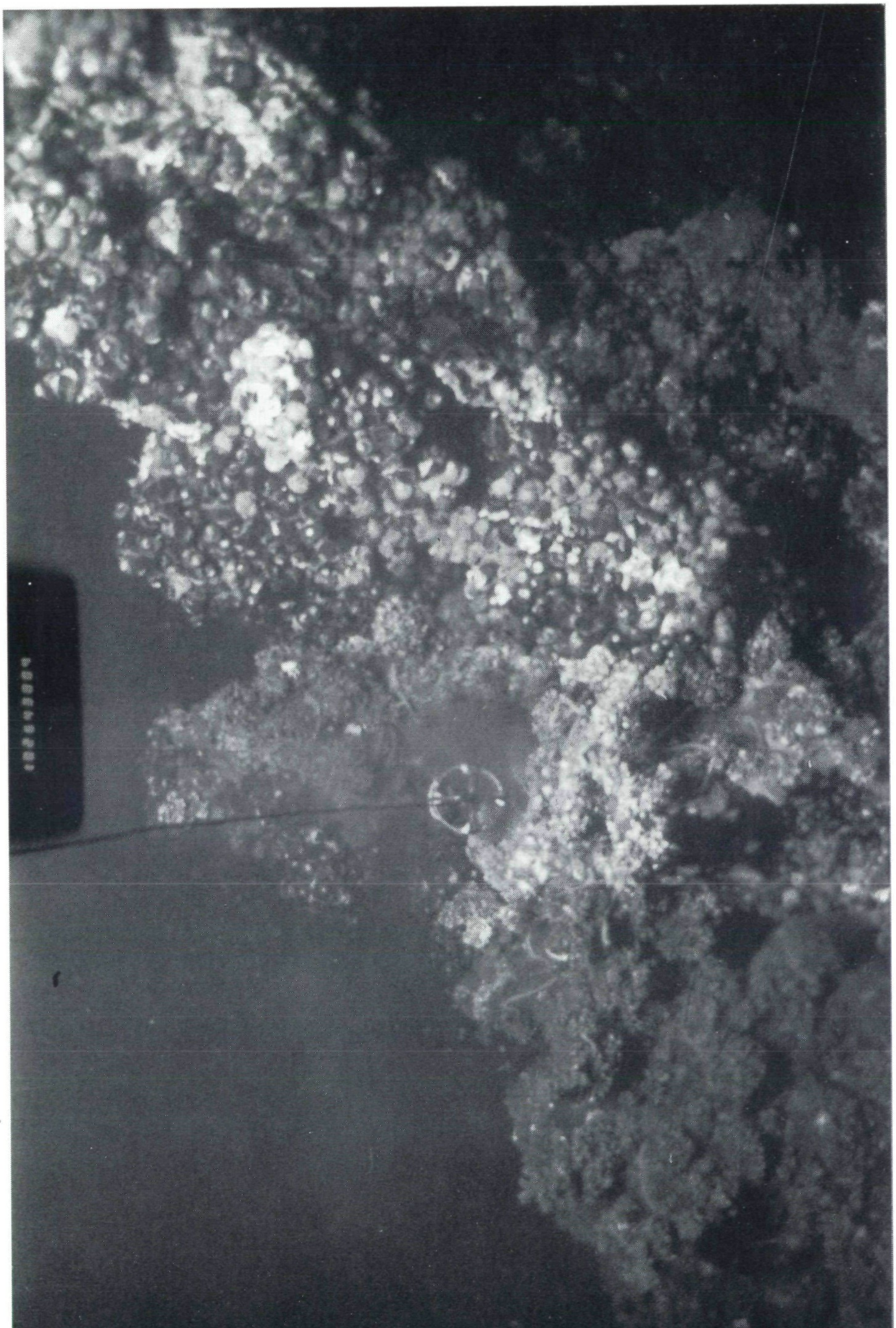

Plate 2

Figs. 1–5: *Olgaconcha tufari* n. gen. et n. sp., series from juvenile to adult.
Fig. 1: Paratype No. 3, length 16.6 mm.
Fig. 2: Paratype No. 4, length 17.6 mm.
Fig. 3: Paratype No. 5, length 22.3 mm.
Fig. 4: Paratype No. 6, length 35.6 mm.
Fig. 5: Paratype No. 7, length 46.1 mm.
Fig. 6: Operculum of *Olgaconcha tufari*.
Fig. 7: *Alviniconcha hessleri* from Manus Basin, juvenile, length 35 mm.
Fig. 8: *Alviniconcha hessleri,* adult, length 90.2 mm.

Plate 3

Figs. 1–5: Animal (removed from shell) of *Olgaconcha tufari* n. gen. et n. sp. from Manus Basin.
Fig. 1: Viewed from the left.
Fig. 2: Detail of the operculum showing the nucleus and the corroded margin.
Fig. 3: Left epipodium with many horny protuberances near the operculum.
Fig. 4: Foot and snout viewed ventrally, showing the large anterior pedal gland opening.
Fig. 5: Viewed frontally: note the food groove. Abbreviations see Drawing, Fig. 2.

Plate 4

Figs. 1–3: Radula of *Olgaconcha tufari* n. gen. et n. sp. from Manus Basin.
Fig. 1: Radula of an adult specimen (shell length 80 mm) seen from posterior.
Fig. 2: Marginal teeth with many similar cusps (15–22) and denticles (arrow) on the inner marginal teeth.
Fig. 3: Radula of a juvenile specimen (shell length 31 mm).
Figs. 4–5: Radula of *Alviniconcha hessleri* from same locality.
Fig. 4: Central and lateral teeth with elongated main cusps.
Fig. 5: Marginal teeth with numerous (23–30) cusps. Abbreviations: (c) central tooth, (cr) central ridge at lateral teeth, (crm) central ridge of inner marginal tooth, (dr) distal ridge of inner marginal teeth, (l) lateral tooth, (ml) inner marginal tooth, (m2) outer marginal tooth, (mc) main cusp, (mr) marginal ridges at central tooth.

Plate 5

Hydrothermal Field 1, Vienna Woods, 3° 9.79′ S, 150° 16.79′ E, water depth 2,494 m. Active sulfide chimney (smoker) densely coated by living gastropods, mostly *Olgaconcha tufari* n. gen. et n. sp., along with *Alviniconcha hessleri,* as well as by barnacles (lower left of center, below instrument basket) and some pogonophorans. In places some bythograeid crabs are seen marching over the chimney (difficult to distinguish in photo). More or less colorless hydrothermal solutions emanate from the sulfide chimney running through the dense coating of living gastropods etc. and causing „defocussing“ effects because of the shimmering hydrothermal solutions (formation of schlieren). The 26 cm diameter instrument basket at the end of the cable (left of center) serves as a scale (after TUFAR 1990).