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***Symmetromphalus hageni* sp. n., a new neomphalid gastropod (Prosobranchia: Neomphalidae) from hydrothermal vents at the Manus Back-Arc Basin (Bismarck Sea, Papua New Guinea)**

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(With 3 Tables, 6 Figures and 6 Plates)

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Zusammenfassung

Eine neue Gastropoden-Art von hydrothermalen Quellen (aktiven Sulfid-Schornsteinen) in der Spreizungszone des Manus Beckens (Bismarck See, Papua Neuguinea) wird beschrieben. Die neue Form hat eine fast symmetrische, napfförmige, flache Schale mit unregelmäßigem Rand. Reste des postembryonalen Gewindes sind adult nur noch selten in Form eines sehr kleinen Schlitzes im Inneren der Schale vorhanden. Die Oberfläche des Protoconchs zeigt eine netzförmige Struktur und einen glatten Bereich an der Mündung. Am Weichkörper fallen der verlängerte, augenlose Kopf- und Nackenbereich, der zu einem komplizierten Penis umgeformte linke Kopftentakel der Männchen, die stark vergrößerte Kieme sowie an der Radula nach distal größer werdende Lateralzähne und der fehlende 5. Lateralzahn auf.

Die morphologischen Merkmale sprechen für eine mehr oder weniger festsitzende, filtrierende Lebensweise. Der neue Gastropode wird mit den bisher bekannten Neomphaliden-Arten *Symmetromphalus regularis* McLEAN, 1990, *Neomphalus fretterae* McLEAN, 1981, *Cyathermia naticoides* WARÉN & BOUCHET, 1989 und *Lacunoides exquisitus* WARÉN & BOUCHET, 1989 verglichen. Die morphologischen Ergebnisse zeigen, daß er und *S. regularis* die am stärksten abgeleiteten Arten innerhalb der Neomphalidae sind.

Summary

A new gastropod species is described from hydrothermal vents (active sulfide chimneys) at the Spreading Center of the Manus Back-Arc Basin (Bismarck Sea, Papua New Guinea). The new form shows a nearly symmetrical, limpet-shaped low shell with an uneven shell margin. Sporadically, in adults a very small slit at the inner side of the apex is the only remainder of the coiled early stages. The surface of the protoconch has an interrupted net sculpture and a smooth apertural area. On the animal the following characters are striking: the neck is elongated and the head eyeless, the left head tentacle of males is transformed to a complicated penis; the gill is very large; the lateral teeth of radula become larger from mesial to distal, while the fifth lateral tooth is lacking.

The morphological characters point to a more or less affixed, filter feeding mode of living. The new species is compared with *Symmetromphalus regularis* McLEAN, 1990, *Neomphalus fretterae* McLEAN, 1981, *Cyathermia naticoides* WARÉN & BOUCHET, 1989, *Lacunoides exquisitus* WARÉN &

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BOUCHET, 1989, the neomphalids already known. All morphological evidence shows that the new gastropod species and *S. regularis* are the most apomorphic species within Neomphalidae.

Introduction

During the last fifteen years, there have been many reports of a new gastropod fauna found at hydrothermal vents in the East Pacific (e. g. Galápagos Rift, Juan de Fuca Ridge, East Pacific Rise at 13° N and 21° N: see RONA, 1983, JONES, 1985, WARÉN & BOUCHET, 1989, WARÉN & PONDER, 1991, McLEAN, 1989 and literature quoted therein). Recently some corresponding results from hydrothermal vents of the Mid-Atlantic Ridge (FRICKE & al. 1989) and South Pacific (Lau Basin, North Fiji Basin: see JOLLIVET & al. 1989, BOUCHET & WARÉN 1991) as well as from the West Pacific (Marianas Basin, Kaikata Seamount: see OKUTANI & OHTA 1988, OKUTANI & al. 1989, OKUTANI 1990, McLEAN 1990; Manus Back-Arc Basin: see BOTH & al. 1986, TUFAR 1990, TUFAR & JULLMANN 1991, BECK 1991, 1992) have been published.

In the summer of 1990, the German Research Cruise OLGA II (i. e. Ozeanische Lagerstätten: Geologisch-Mineralogische Analyse – Oceanic Deposits: Geological-Mineralogical Analysis) under the direction of Prof. Dr. Werner TUFAR, Philipps-University Marburg, examined the Manus Back-Arc Basin (Bismarck Sea, Papua New Guinea, Fig. 1) and discovered several hydrothermal fields. A large number of active chimneys („black smokers“) were recovered from the ocean floor. The associated animal life living on the chimney surfaces could be collected on board the German Research Vessel „Sonne“. A preliminary list of this unique fauna has been given by TUFAR (1990).

The gastropod fauna is definitely dominated by the two recently described mesogastropods *Olgaconcha tufari* BECK, 1991 and *Alviniconcha hessleri* OKUTANI & OHTA, 1988. Hundreds of individuals of both species were found clustered together on active sulfide chimneys along with many archeogastropods, e. g. Shinkailepadidae (OKUTANI 1989) and a new neomphalid limpet species: *Symmetromphalus hageni*. The external morphology of the shell and animal (including radula) is described below. The new form is closely related to *S. regularis* McLEAN, 1990, *Neomphalus fretterae* McLEAN, 1981, *Cyathermia naticoides* WARÉN & BOUCHET, 1989 and *Lacunoides exquisitus* WARÉN & BOUCHET, 1989. A member of this unique family was recorded from West Pacific hydrothermal vents for the second time.

Material and methods

While other gastropods from the Manus Basin were collected in great numbers at several places, *S. hageni* was rarely found (Table 1). Five adult specimens were recovered from the surfaces of portions of larger chimney on board the Research Vessel „Sonne“ (Sample OLGA II – 15 GTVA) and 12 adults and 12 juvenile specimens were discovered while sorting sample buckets with preserved *O. tufari* and *A. hessleri* (Sample OLGA II – 17 GTVA and 42 GTVD)

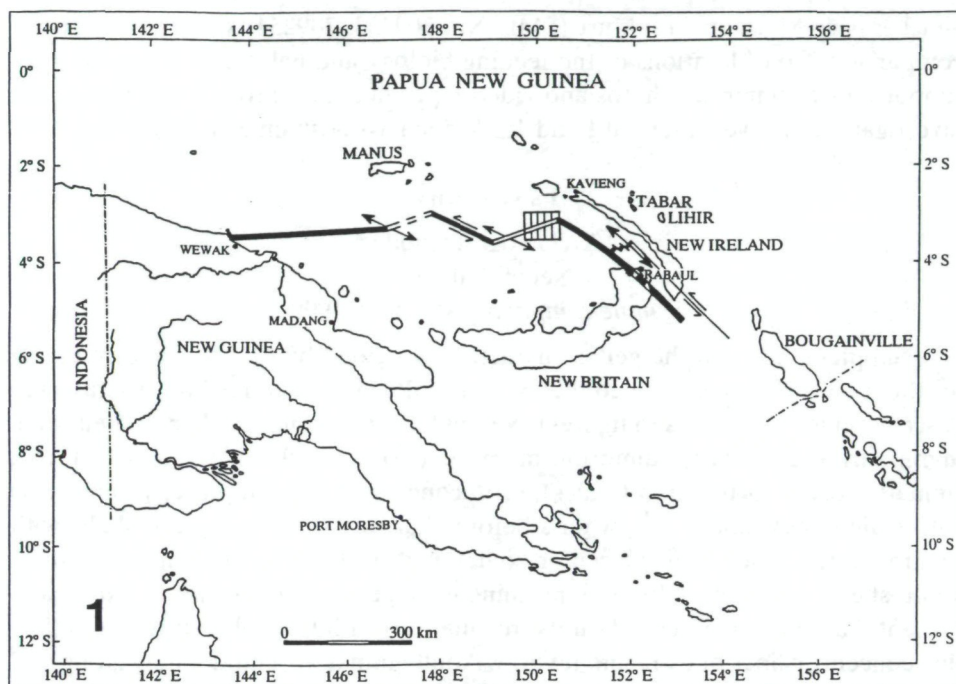


Fig. 1: Location map of Papua New Guinea and Manus Back-Arc Basin; locus typicus of *Symmetromphalus hageni* sp. n. at Hydrothermal Field 1, Wienerwald (Vienna Woods), 3° 9.8' S, 150° 16.7' E. Hatched region shows the area investigated during the German OLG II Cruise (map courtesy of W. TUFAR).

Table 1: Sampling positions of *Symmetromphalus hageni* sp. n.

Station No.	date	latitude	longitude	water depth	number
15 GTVA	May 20, 1990	3° 9.876' S	150° 16.792' E	2491 m	5
17 GTVA	May 20, 1990	3° 9.86' S	150° 16.777' E	2500 m	12
42 GTVD	June 3, 1990	3° 9.885' S	150° 16.788' E	2488 m	12

in Marburg. The specimens were preserved in buffered formaldehyde on board and later transferred to 70% ethanol. Sampling was performed by TV-controlled electrohydraulic grab (GTVA and GTVD). Sampling stations (Table 1) were located at Hydrothermal Field 1 „Wienerwald“ („Vienna Woods“) with coordinates 3° 9.8' S, 150° 16.7' E, at approximately 2500 m water depth (TUFAR 1990, TUFAR & JULLMANN 1991, BECK 1991, 1992). Three females and three males were removed from their shells and opened for morphological studies, including the radula (by a Hitachi S-530 Scanning Electron Microscope; 25 kV, gold covering 6 nm). SEM photos were taken at the middle third of the radula. One male and one juvenile were critical point dried (via acetone and carbon dioxide) and examined by SEM. For type specimens and measurements see Table 2. Some specimens will be serially sectioned for anatomical studies, the results of which will be reported later. Two paratypes of *Neomphalus fetterae* from the

Senckenberg Museum Frankfurt (SMF, No. 309253, 309254) were examined for comparison. Considerations of the feeding biology and habitat of *S. hageni* were supported by numerous photos and video-tapes taken by Prof. TUFAR during the investigation of Hydrothermal Field 1, „Vienna Woods“, in May and June 1990.

Taxonomy

Archaeogastropoda

Neomphalidae

Symmetromphalus McLEAN, 1990

Supplementary to the genus characters described by McLEAN and referring to the new species described below the following features are useful (see description for references to figures): Neomphalids with limpet-shaped shell, shell margin irregular, sexual dimorphism in shell size: shell length up to 21 mm (females) or up to 10.6 mm (males); protoconch with net sculpture, young shells with coiled apex, about 1 $\frac{1}{2}$ whorls before changing to limpet, adult shells with fine radial ribs, apex near the center, sometimes eroded (cf. coiled apex in adults; adult shells with fine ribs and prominent ridges in *Neomphalus*). No nacre present, but inner side of shell (at its free margin) with light silky luster caused by fine concentric lines of ostracum texture. Adult animal with moderately elongated neck. Neck in males with a seminal groove as well as with left head tentacle modified to function as a penis. As typical for neomphalids, the perioral area of the head is expanded laterally and equipped with a ventral, transverse furrow. The snout is reduced and the eyes are lacking. Lateral lappets of the neck are thin and narrow. The broad and flat foot is weakly muscular, the anterior opening of the foot gland is small, and strikingly numerous (up to 20) epipodial tentacles are present. There are two large shell muscle arms ordered left-right symmetrically, their posterior ends united by a tissue (cf. one crescent shaped shell muscle in *Neomphalus*). The bipectinated gill has a straight axis and is very large; it is certainly used for filter feeding. A food groove as in *Neomphalus* is absent.

The radula is rhipidoglossate, its indentation similar to *Neomphalus*, formula: (13–15) – 4 – 1 – 4 – (13–15) (cf. about 20 – 5 – 1 – 5 – about 20 in *Neomphalus*); fourth lateral teeth comparatively large, with cusps nearly twice as large as cusps of first lateral (cf. a similar formula, rhachidian cusp enlarged and cusps of the laterals becoming smaller distally in *Cyathermia* and *Lacunoides*, WARÉN & BOUCHET 1989, Figs. 15–20), in the marginals inner and outer teeth are discernible.

All evidence points to a benthic filter-feeding mode of living, depending on hydrothermal environments.

Type species: *Symmetromphalus regularis*

Symmetromphalus hageni sp. n.

Description. (Compilation of differences in external morphology to *S. regularis* see Table 3) In addition to genus characters, the following characters

Table 2; *Symmetromphalus hageni* sp. n., sampling position, repository, age, shell measurement and sex (length, width and height in mm, maximum measurable).

Sampling position	repository	age	length	width	height	sex	remarks
15 GTVA	holotype	adult	18.2	14.3	4.0	♀	Pl. 1, Figs. 1–3
15 GTVA	NHMW, Inv. No. 85981						
15 GTVA	paratype 1	adult	8.5	6.8	2.5	♂	Pl. 2, Figs. 1–3
	NHMW, Inv. No. 85982						
17 GTVA	paratype 2	juvenile	2.8	1.8	0.8	–	Pl. 2, Fig. 4
	NHMW, Inv. No. 85983						
15 GTVA		adult	8.5	6.2	2.4	♂	Figs. 3, 4, 5, 6
15 GTVA		adult	14.5	10.0	3.0	♀	Pl. 1, Fig. 4; Pl. 4, Fig. 1; Fig. 2
17 GTVA		adult	21.0	18.0	3.0	♀	
15 GTVA		adult	6.0	4.0	2.0	♂	
17 GTVA		adult	5.5	3.8	1.9	♂	
17 GTVA		adult	5.0	3.5	1.5	♀	
17 GTVA		juvenile	3.8	2.7	1.1	–	
17 GTVA		juvenile	3.5	2.6	1.2	–	
17 GTVA		juvenile	3.0	2.2	1.0	–	
17 GTVA		juvenile	3.0	2.2	1.0	–	
17 GTVA		juvenile	2.8	1.8	0.8	–	
17 GTVA		juvenile	2.5	1.8	0.8	–	
17 GTVA		juvenile	2.5	1.8	0.8	–	
17 GTVA		juvenile	1.3	0.8	0.5	–	Pl. 3, Figs. 4, 5; Pl. 4, Figs. 2–4
42 GTVD		adult	8.0	5.6	2.8	♂	
42 GTVD	SMF	adult	8.6	5.7	2.8	♂	
42 GTVD		adult	7.1	5.1	2.1	♂	
42 GTVD		adult	6.1	4.1	1.8	♂	
42 GTVD		adult	6.3	4.2	2.2	♂	
42 GTVD	SMF	adult	7.8	4.8	2.3	♀	
42 GTVD		adult	8.2	4.1	2.7	♀	
42 GTVD		adult	9.0	6.0	2.3	♀	
42 GTVD		juvenile	4.9	3.3	1.5	–	
42 GTVD		juvenile	4.5	3.0	1.4	–	
42 GTVD	SMF	juvenile	3.0	2.0	1.0	–	
42 GTVD		juvenile	2.5	1.7	0.8	–	

NHMW = Naturhistorisches Museum Wien;

SMF = Senckenberg Museum Frankfurt (Reg.-Nr. 309436)

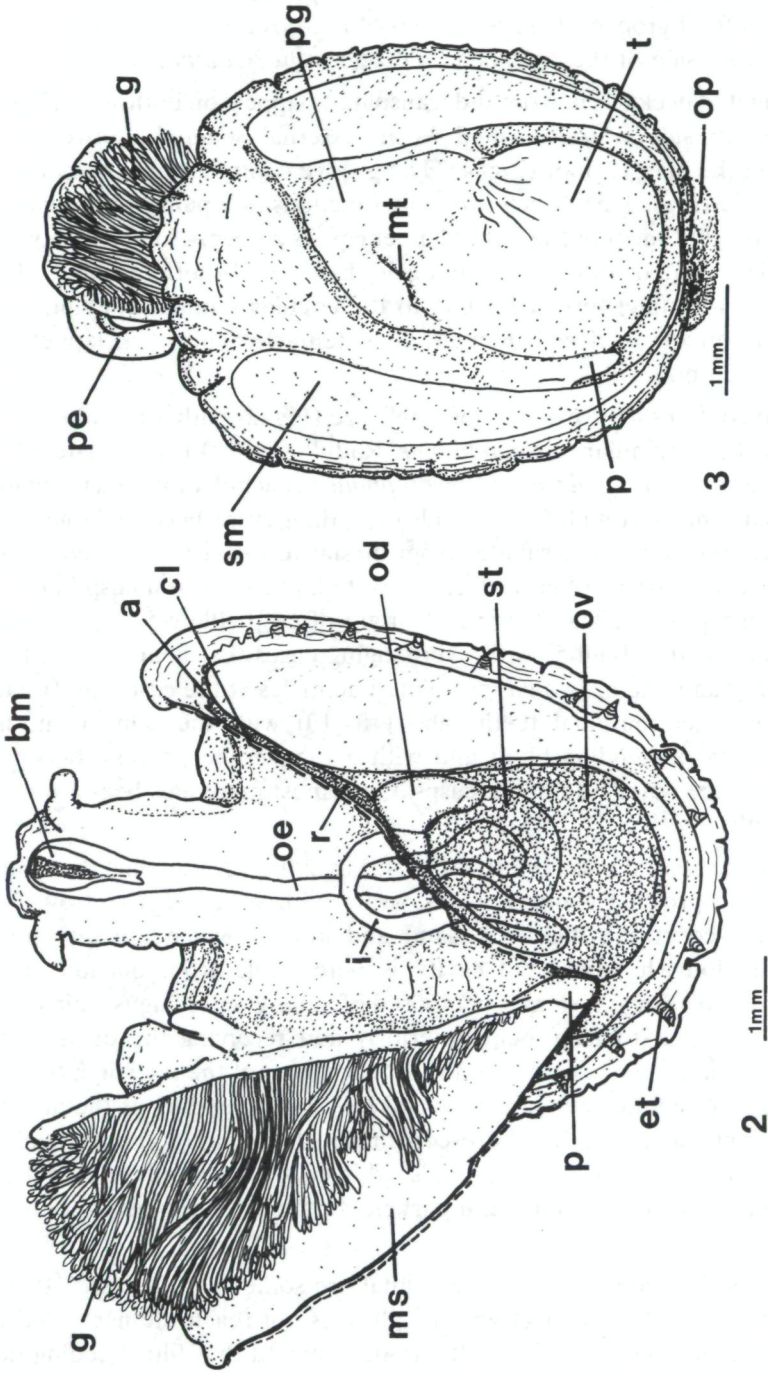
are essential. Shell: shell profile lowly elevated, protoconch structure (Plate 2 Fig. 4; Plate 3 Figs. 4, 5) similar to *S. regularis*, *Neomphalus*, *Cyathermia* and *Lacunoides* (cf. McLEAN 1990 Figs. 13, 14; WARÉN & BOUCHET 1989, Figs. 89 ff.), but with net sculpture often interrupted and a smooth apertural area (Plate 3 Fig. 5), diameter of protoconch 0.18 mm maximally; teleoconch smooth with opisthocline growth lines; apex in young limpet-shaped shells at the posterior shell margin and right of the center line, radial ribs start at 1.3 mm shell length, consisting of very fine knobs; number of ribs: young shells about 50, adult males

about 70, adult females about 140; ribs not spiral-shaped as in *Neomphalus*, somewhat wriggled in adults, apex in adults somewhat beyond the center in the center line; apex mostly eroded, erosion begins at about 5 mm shell length, shell color white, light brown or rarely black caused by fine mineral incrustations (iron and aluminum compounds, see WARÉN & BOUCHET 1989). The thin periostracum projects beyond the shell margin as in *Neomphalus*; most shells have signs of intermittent growth, i. e. small irregular concentric interruptions. The shell margin of adults is not plain, but is adapted to the pertinent surface as shell deformations of some specimens clearly show; inner side of shell shows the scars of left and right shell muscle (including the scar of the uniting tissue) and, sporadically, at its deepest depression a residual coiling: a very small triangular or roundish slit (cf. a small spiral ridge in *Neomphalus*). This corresponds to the mantle tip (Fig. 3).

Animal (Plate 1 Fig. 4; Plate 2 Fig. 2; Plate 3 Figs. 1, 2, 3; Plate 4 Figs. 1, 2, 3, 4; Fig. 2; Fig. 6): The head-foot and mantle are whitish, except for the dark mantle margin. The foot is spotted with mineral incrustations and reduced under the visceral mass to nearly transparent tissue. The foot surface is smooth except for the wrinkled margin (Plate 3 Figs. 2, 3, arrows); epipodial tentacles connected by thin lappets (Fig. 2), all tentacles often covered with mineral crystals or yellow sulfuric crumbles glued to the tentacles by mucus, number of tentacles equal on left and right sides. The operculum (Plate 4 Fig. 2; Fig. 3; Fig. 6) is corneous, transparent and multispiral (up to 7 whorls), nucleus in the center in juveniles, more in the upper left in adults, spiral cords growing broader; the operculum is present in all specimens up to 8.6 mm, but in the three largest females (Table 2) it is missing; in the other larger specimens the operculum is more or less perpendicular to the foot. Apparently, the operculum loses its original function in early life stages.

The mantle cavity reaches the origin of the gill on the left side and is narrowed along the rectum on right hand side. Apart from the thickened and smooth margin, the mantle skirt is very thin. The margin is strongly folded, left and right, above the notch between the neck and foot. These folds seem to be able to shut the mantle cavity. Sometimes, at the tip of the mantle skirt, a small lappet exists, which is fitted to the triangular or roundish slit at the inner side of shell apex.

The gill (Plate 4 Fig. 1; Fig. 2; a bipectinated ctenidium) is enlarged and modified for filter feeding. The ciliary equipment at the filaments (frontal, abfrontal and lateral cilia) is very similar to that of *Neomphalus* (FRETTER & al. 1981, personal observations by SEM). Because of the more symmetrical form of *S. hageni*, the gill axis is straighter and not bent as in *Neomphalus*; the number of gill filaments is 130–150 pairs in adults; SEM shots of the surface of filaments had no sign of covering with bacteria as described for other filter-feeding hydrothermal animals (e. g. DE BURGH & SINGLA 1984; BAROSS & DEMING 1985, STEIN & al. 1988; BECK 1992); endosymbiosis with chemoautotrophic bacteria has not been demonstrated yet; filaments are short in the depth of the mantle cavity, but much larger anteriorly (largest filaments around the middle of the gill axis),



Figs. 2-3: *Symmetromphalus hageni* sp. n., animal removed from shell, dorsal view. - Fig. 2. Female, length 9 mm (shell length 14.5 mm), mantle cavity opened; buccal mass, digestive system and epipodial tentacles (in transparency technique). - Fig. 3. Male, length 6 mm (shell length 8.5 mm). - (a) anus; (bm) buccal mass; (cl) cutting line; (et) epipodial tentacle; (g) gill; (i) intestine; (mt) mantle skirt; (mt) mantle tip; (od) oviduct; (oe) oesophagus; (op) operculum; (ov) ovary; (p) penis; (pe) pericard; (r) rectum; (sm) shell muscle; (st) stomach; (t) testis.

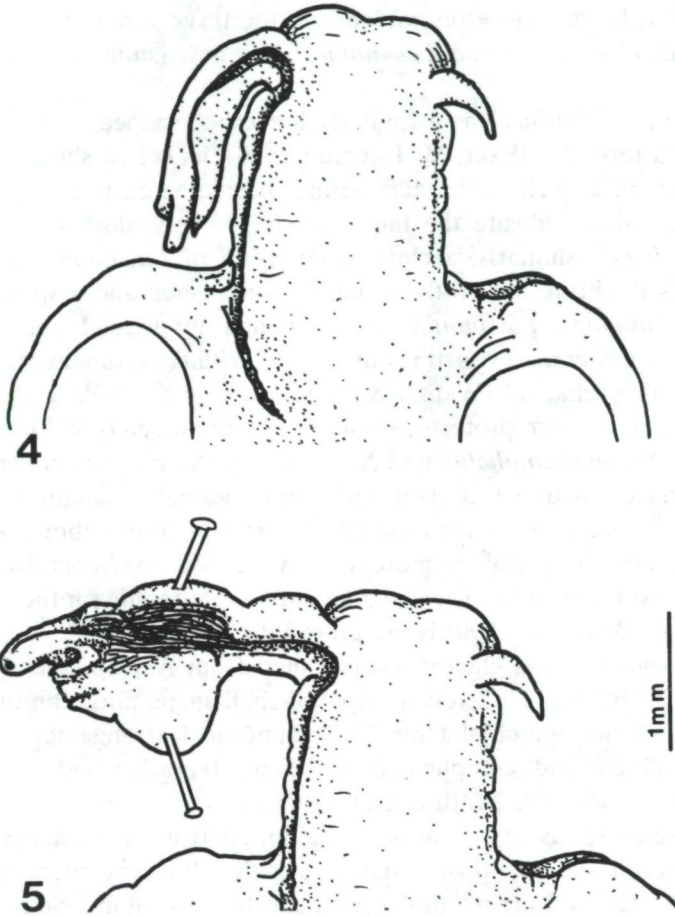
and most filaments point towards the dorsal right side of the neck, while the shape of the gill is more or less triangular. Unlike in *Neomphalus*, filter feeding seems to work without a food groove; there is no sign of a groove at the right side of the neck or the dorsal side of the right head tentacle as in *Neomphalus*.

The elongated neck has narrow and transparent lappets on both sides (Fig. 2). In males the left side is transformed to an external seminal groove, which originates from the mantle floor (Fig. 4). The groove continues on a complicated left head tentacle (Figs. 4, 5), which probably functions as a penis during mating; in the middle third of the tentacle a thin lappet covers a deeply folded cavity with about 20 ciliary-coated ridges; the tentacle has an abruptly smaller distal appendage with a distinct furrow leading to the circular seminal opening; at its distal part this furrow is closed. Female head tentacles and neck lappets are equally shaped on both sides.

The head contains a buccal mass of small size (Fig. 2) with a rhipidoglossate radula and weak jaws similar to *Neomphalus*. Radula (Plate 4 Fig. 4; Plate 5 Figs. 1–4) indentation like *S. regularis* and *Neomphalus*; rhachidian monocuspidated, overhanging cusp not serrated; four laterals only, their cusps become larger from mesial to distal (cf. somewhat smaller from mesial to distal in *Cyathernia* and *Lacunoides*), distal margins of cusps finely serrated, fourth lateral cusp barely or not serrated, except one distal denticle at origin of cusp (Plate 5 Fig. 4 arrow); marginals: inner teeth (about 5) with overhanging cusps that bear about 28 fine denticles distally and one or two larger pointed denticles at the cusps' tip (Plate 5 Fig. 3 arrow); outer marginal teeth (about 8–10) with the same comb-like denticles but with tips ending blunt and with a tongue-like process, becoming larger distally at the outer side of the cusps. Outermost marginals bear a tongue-like process only.

Dorsally the visceral mass (Plate 1 Fig. 4; Fig. 2, Fig. 3) contains the gonads (males: testis and prostate gland; females: ovary with yolky eggs and oviduct); they completely cover the digestive gland and kidney, which are difficult to distinguish; the longish pericardial cavity is perceptible from outside at the posterior left; the digestive system is composed of: a long oesophagus which leads to a slightly enlarged stomach, bent anteriorly and receiving the ducts of the digestive gland, the stomach leading to the anterior loop of the intestine; the long rectum crosses the mantle cavity at its dorsal side before ending at the anterior margin of the right shell muscle. Microscopic tests of stomach contents, made at random (3 specimens), yielded about 80% whitish, flaky organic material and about 20% small (up to 50 μm) mineral particles. Planctonic fragments could not be found.

In juveniles the proportions of the animal are somewhat different (Plate 4 Fig. 3). The neck is not yet elongated, the gill does not reach the neck, and the mantle skirt rises far above the head. It can be assumed that filter feeding does not function in very young, so that they must be grazers. This assumption is supported by radula characters of juveniles (Plate 4 Fig. 4): rhachidian and lateral



Figs. 4–5: *Symmetromphalus hageni* sp. n., male, head and neck in dorsal view. – Fig. 4. Seminal groove reaching from mantle floor to penis. – Fig. 5. Penis opened with needles, a folded cavity with about 20 ridges is visible.

cusps are distinctly serrated. However, juvenile radula characters should not be used to define species status (WARÉN 1990).

Etymology. The species name is in honor of my teacher, Prof. Dr. Heinrich-Otto VON HAGEN, Philipps-Universität Marburg, Fachbereich Biologie.

Discussion

Doubtlessly, a systematic inclusion of *Symmetromphalus* in the recently established neomphalacean family Peltospiridae McLEAN, 1989 is prevented by the special shell and protoconch form of *Symmetromphalus* as well as its *Neomphalus*-like radula characters (cf. McLEAN 1989, FRETTER 1989). Evidence from morphological characters requires assignment to the Neomphalidae

McLEAN, 1981. Having close resemblance to the three genera already described (*Neomphalus*, *Cyathermia* and *Lacunoides*), the new genus must be compared with these.

Although *Cyathermia* has a similarly horseshoe-shaped shell muscle and a similar radula formula (WARÉN & BOUCHET 1989), its coiled shell with a unique notch for the gill as well as the dominating rhachidian cusp and smaller lateral cusps of the radula indicate the improbability of very close relationship with *Symmetromphalus*. Similarly, a close relationship of *Lacunoides* with *Symmetromphalus* is doubtful, due to the minutely coiled shell and a specially formed penis of *Lacunoides*. *Lacunoides* was obtained by mussel and mussel bed washings and *Cyathermia* by sorting out tubes of *Riftia* (Vestimentifera) and tubes of *Alvinella* (Polychaeta) (WARÉN & BOUCHET 1989). These genera are also supposed to live in more protected habitats, i. e. in an ecological niche different from that of *Symmetromphalus* und *Neomphalus*: the two latter were found on chimney surfaces in direct contact with hydrothermal emanatings. Therefore, ecological differences, as well as the characters mentioned above, suggest that *Symmetromphalus* is certainly more closely related to *Neomphalus* than to *Cyathermia* and *Lacunoides*. The assignment of a new family for the latter genera (Cyathermiidae McLEAN, 1990) is therefore fully justified.

Symmetromphalus is clearly distinguished from *Neomphalus* (cf. McLEAN 1990) by such obvious characters as: Special shell shape and sculpture, position and number of the epipodial tentacles, symmetrical arrangement of the shell muscles, modified and complicated left head tentacle, and special radula characters (e. g. lack of the fifth lateral tooth).

The species status of *S. hageni* is delimited from *S. regularis* by several characters (see Table 3). Most essential are the different characters of shell (especially the size and surface of the protoconch), of shell muscle and of several features of the radula. In addition to these differences of external morphology the geographical separation is of importance: the next known places of animal life associated with active hydrothermal vents are located at the Mariana Trough and the North-Fiji-Basin (HESSLER & LONSDALE 1991 Fig. 2). The great distances separating them (about 1500–2500 km) indicate that direct interchange between these hydrothermal ecosystems is not likely. Even if new stepping stones of hydrothermal vents at the Woodlark Basin and Sorol Basin or at cold sulfide seeps were to be discovered the large gaps (at least 850–1000 km) cannot be bridged by migration or larval dispersal. The protoconch of *S. hageni* does not point to planktotrophic development (just as the protoconch of *Neomphalus*, cf. TURNER & LUTZ 1984). The large yolky eggs found in female gonads indicate free-swimming, non-feeding trochophore larvae (cf. TURNER & al. 1985); this would allow larval dispersal only over relatively short distances. It is therefore estimated that there is no direct gene flow between *S. regularis* at the Mariana Trough and *S. hageni* at the Manus Basin at present. The species separation must have occurred when step by step migration was probably possible: about 5 m. y. ago (cf. HESSLER & LONSDALE 1991).

Table 3: *Symmetromphalus regularis* and *Symmetromphalus hageni* sp. n., differences of external morphology.

<i>S. regularis</i> (after McLEAN 1990)	<i>S. hageni</i> sp. n. (pers. observations)
Shell	
shell profile moderately elevated;	shell with low profile;
radial ribs strongly beaded,	radial ribs weakly beaded,
radial sculpture arising at shell length of 1 mm	radial sculpture arising as beaded cords at shell
beading appears at shell length of 2 mm;	length of 1.3 mm:
maximum length 14.0 mm (females);	maximum length 21.0 mm (females)
maximum length 10.6 mm (males);	maximum length 8.6 mm (males),
	distinct sexual dimorphism;
thick, pale tan periostracum without biogenic or	thin, white or light brown periostracum some-
mineral encrustations, never damaged;	times with black encrustations, punctately dama-
	ged, often eroded at apex:
protoconch diameter 220 µm, surface sculpture of	protoconch diameter 160–180 µm, surface sculp-
irregular network of low ridges;	ture of interrupted irregular network of low
	ridges except at the broad apertural area which is
	smooth;
apical pit at interior of shell remaining open;	apical pit at interior of shell closed, sporadically a
	triangular or roundish slit is present;
Animal	
left head tentacle of male with a deep sperm	left head tentacle of male with deep sperm groove
groove dorsally;	dorsally, covered by a thin lappet, distal appen-
	dage with a partly closed groove leading to a
	circular opening;
mantle margin with fine papillae;	mantle margin smooth;
posterior part of shell muscle:	posterior part of shell muscle:
one-fifth the maximum width of shell muscle;	one-eighth the maximum width of shell muscle,
	sometimes totally reduced;
Radula	
cusps rows of all teeth forming a circular arc;	cusps of rhachidian and the first and second
	lateral forming a straight line before the row
	becomes an arc;
rhachidian cusp at its posterior edge tapered to an	rhachidian symmetrically tapered;
acute tip;	
outer edge of fourth lateral sharply serrated, its	outer edge of fourth lateral barely or not
lowermost serration most prominent;	serrated, prominent denticle at the origin of cusp
	present;
cusps edges of inner marginals deeply serrate.	cusps edges of inner marginals deeply serrate and
	equipped with one or two larger pointed
	denticles.

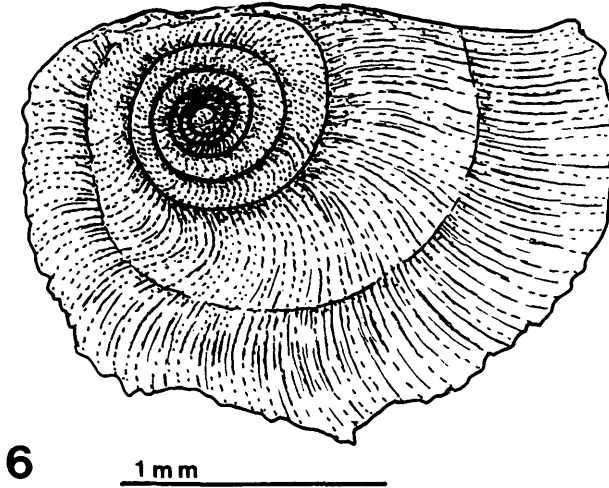


Fig. 6: *Symmetromphalus hageni* sp. n., operculum (of specimen Fig. 3.), nucleus at upper left.

Although the apomorphic character of *Neomphalus*, the food groove, could not be confirmed in *Symmetromphalus*, the following characters point out that this genus seems to be the most highly evolved neomphalid known so far: the adult shell is nearly symmetrical and distinctly limpet-shaped, with radial (not spiral) ribs, while the apex is situated a little beyond the center in the center line, with no or only a minute remainder of coiling present in the deep interior of the shell, corresponding to a minute lappet at the mantle tip; finally, two symmetrical and equal parts of shell muscle and the lack of the fifth lateral tooth are to be mentioned. Two evolutionary tendencies of *Symmetromphalus* are clearly visible: the adaptation to hydrothermal environments by developing a limpet-shaped shell (corresponding to changing to filter feeding) and the partial reduction of the radula. Contrary to McLEAN (1990), it is therefore assumed that *Neomphalus* is regarded as more primitive than *Symmetromphalus*, although the latter genus has a somewhat smaller gill and apparently no food groove. Further phylogenetic considerations will be possible only when more biological and anatomical data (e. g. serial sectioning of *Symmetromphalus*, in process; or of *Cyathernia* and *Lacunoides* as announced by A. WARÉN) become available.

Living habits. It is believed that members of the new species *Symmetromphalus hageni* live mostly by grazing on bacterial mats during the juvenile phases and then progress to filter feeding in the adult stage of life. Life habit is controlled by the hydrothermal environment. A comparatively weak foot (especially in adults) indicates that there is minimal locomotion on the active chimneys where *Symmetromphalus* has been found. Numerous photos (e. g. Plate 6) as well as video tapes filmed by Prof. TUFAR at Hydrothermal Field 1, Vienna Woods, prove that active chimneys are densely coated by filter-feeding gastropods, e. g. *Olgaconcha tufari*, *Alviniconcha hessleri*, phenacolepadid limpets (BECK 1992) and in part with *Symmetromphalus hageni*. These

gastropods are in interspecific competition with very abundant cirripeds (?*Eochionelasmus*) and locally with several species of small sedentary polychaetes (e. g. Alvinellidae) and pogonophorans. The active habitat thus features not only hydrothermal solutions, with very high bacterial density, but also high animal competition. Interpretation of samples collected to date indicate (1) that epizoic-bacterial mats on shell surfaces of *O. tufari* are food-sources for young individuals (sample 17 GTVA and 42 GTVD) and (2) adult specimens (Sample OLGA II – 15 GTVA) are lightly affixed to the chimney surfaces. The prediction is that bythograeid and galatheid crabs as well as polynoid polychaetes (up to 4 cm), prey on *S. hageni*, especially on younger members of this species.

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Plate explanations

Plate 1

Symmetromphalus hageni sp. n. – Figs. 1–3. female, 18.2 mm, (holotype). – Fig. 4. animal (female) removed from shell, in dorsal view, length 9.0 mm (shell length 14.5 mm).

Plate 2

Symmetromphalus hageni sp. n. – Figs. 1–3. male, 8.5 mm, (paratype 1). – Fig. 4. juvenile, 2.8 mm, (paratype 2).

Plate 3

Symmetromphalus hageni sp. n., critical point dried specimens. – Figs. 1–3. male (shell length 8.5 mm). – 1. anterior view of head, note perioral area of snout, expanded laterally and equipped with a ventral transverse furrow, left head tentacle enlarged to form a penis. – 2. ventral view from right side showing tips of gill filaments, opening of the anterior food gland and wrinkled margin (arrow). – 3. ventral view from left side, elongated neck with the seminal groove and penis are visible. – Figs. 4–5. juvenile, shell length 1.3 mm (same specimen as in Plate 4, Figs. 2–4). – 4. protoconch, teleoconch with opisthocline growth lines. – 5. protoconch with interrupted net-sculpture and smooth apertural area, covered with bacterial mats.

Plate 4

Symmetromphalus hageni sp. n., gill of the specimen in Fig. 2, young animal (Figs. 2–4) and radula. – Fig. 1 tip of the gill, dorsally viewed. – Fig. 2. ventral view of operculum and teleoconch. – Fig. 3. ventral view on anterior part of juvenile animal, gill not yet protruding, neck not yet elongated, mantle skirt rising far above the head. – Fig. 4. radula and jaws in protruded position.

Plate 5

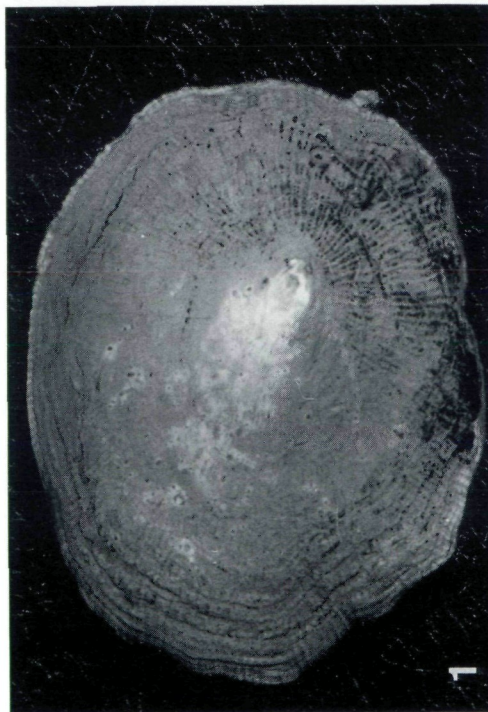
Symmetromphalus hageni sp. n., radula of adults, Fig. 1. overview of middle third. – Fig. 2. as in Fig. 1., but seen from posterior. – Fig. 3. marginal teeth and enlarged cusps of fourth lateral teeth (arrow: enlarged denticle at inner marginal teeth). – Fig. 4. half row, note the enlarged non-serrated cusp of the fourth lateral and its distal denticle (arrow) at origin of cusp.

Plate 6

Hydrothermal Field 1, Vienna Woods, 3° 9.40' S, 150° 16.92' E, water depth 2495 m. Active sulfide chimney (black smoker) totally coated by living gastropods, mostly *Olgaconcha tufari* BECK, 1991, along with *Alviniconcha hessleri* OKUTANI & OHTA, 1988 (probably subspecies). Locally bythograeid crabs are marching over the gastropod coated chimneys. More or less colorless hydrothermal solutions are seen to emanate from the sulfide chimney running through the dense coating of living gastropods and causing „defocussing“ effects (formation of schlieren). The 26 cm diameter instrument basket at the end of the cable serves as a scale. (after TUFAR 1990).

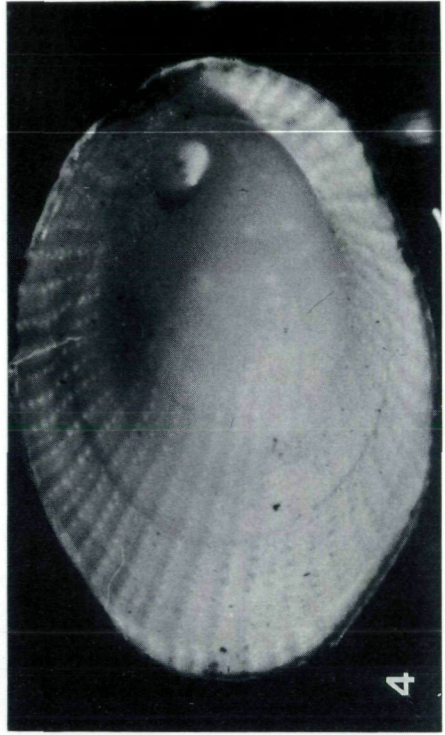
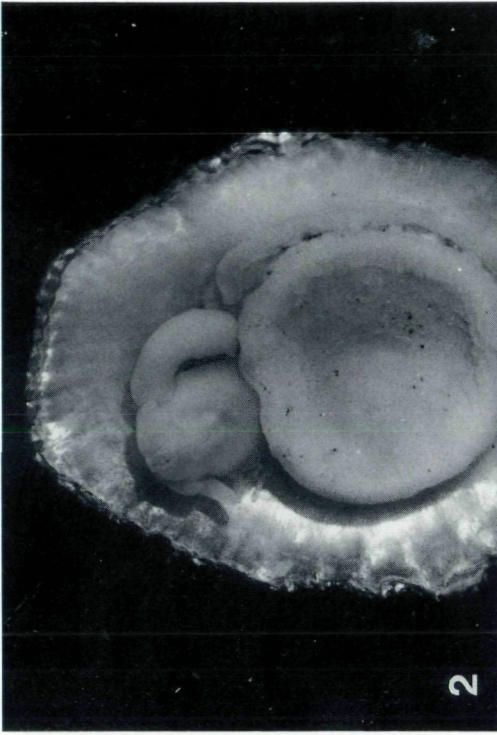
L. A. BECK: *Symmetromphalus hageni* sp. n., a new neomphalid gastropod
(Prosobranchia: Neomphalidae) from hydrothermal vents at the Manus Back-Arc Basin
(Bismarck Sea, Papua New Guinea)

Plate 1



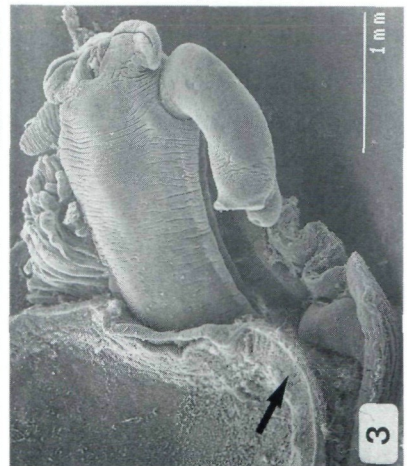
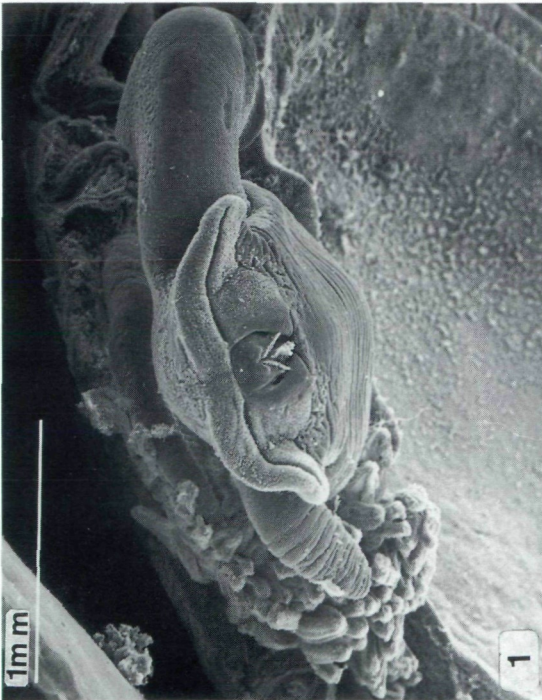
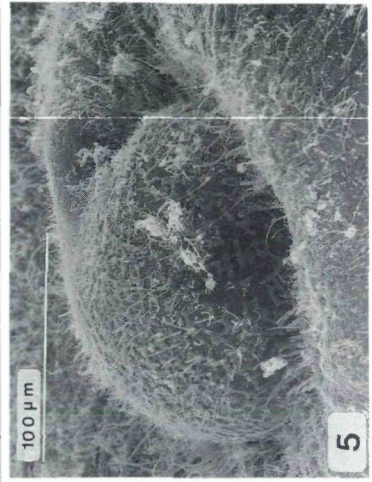
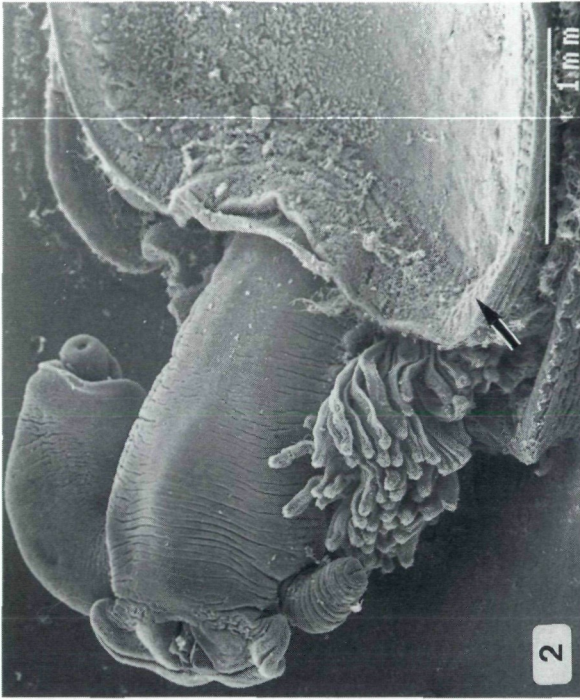
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Plate 2



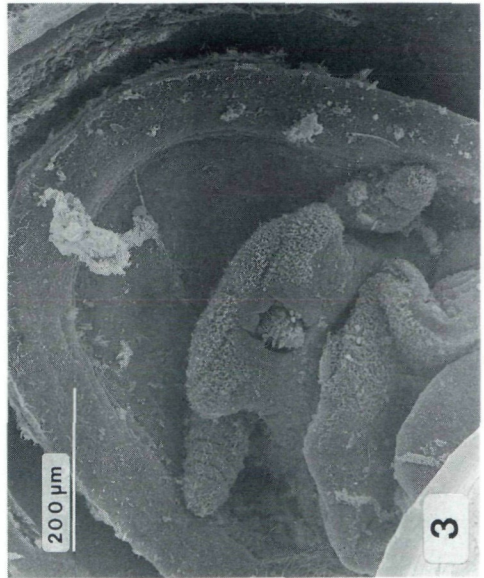
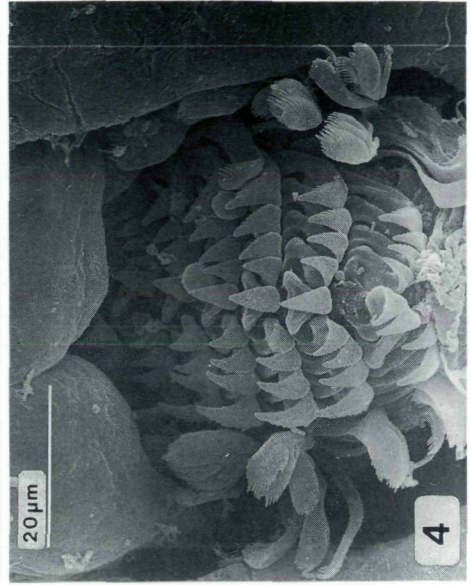
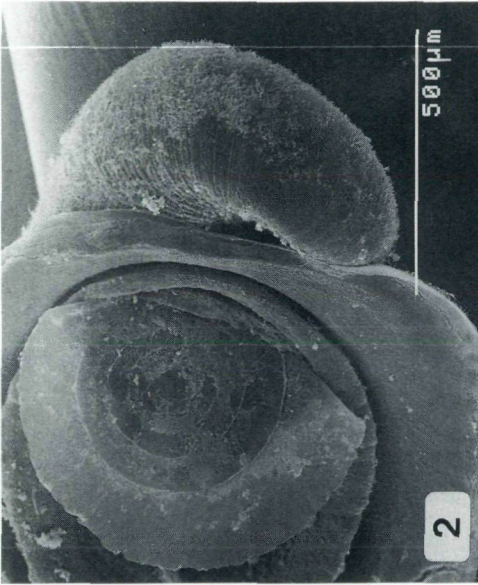
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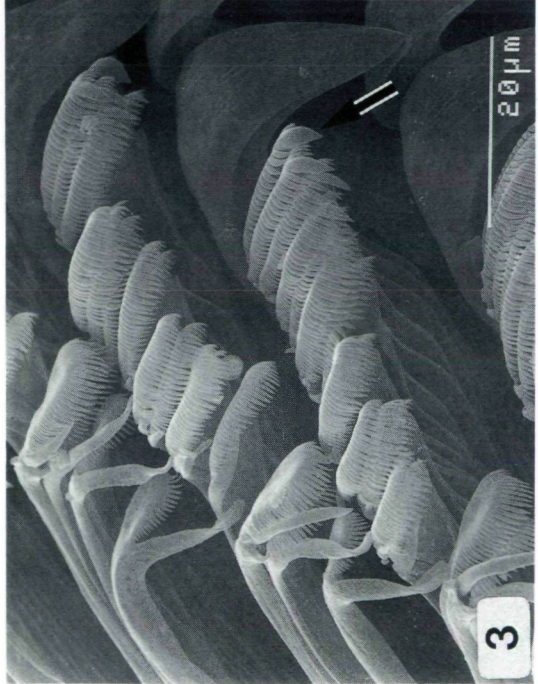
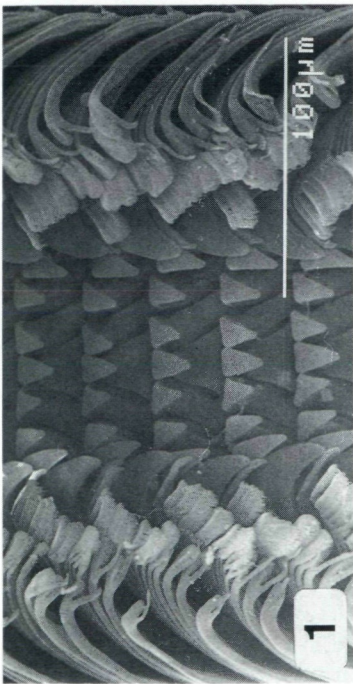
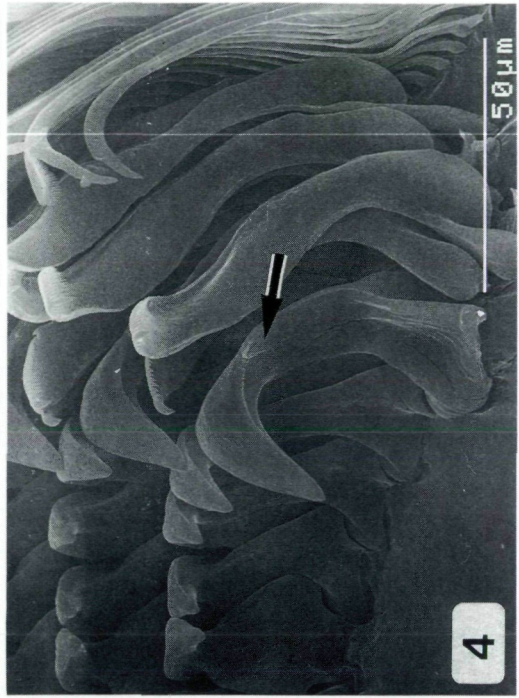
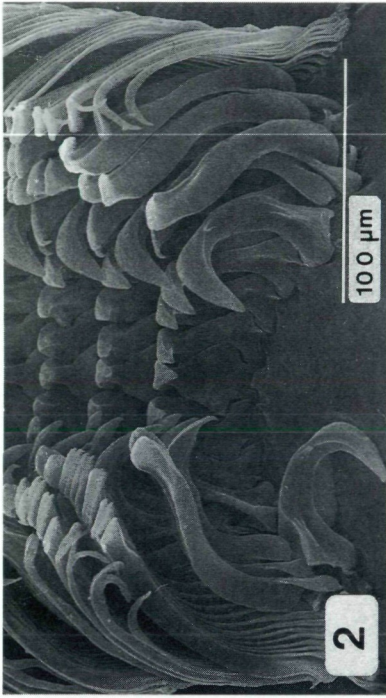
Plate 3



L. A. BECK: *Symmetromphalus hageni* sp. n., a new neomphalid gastropod
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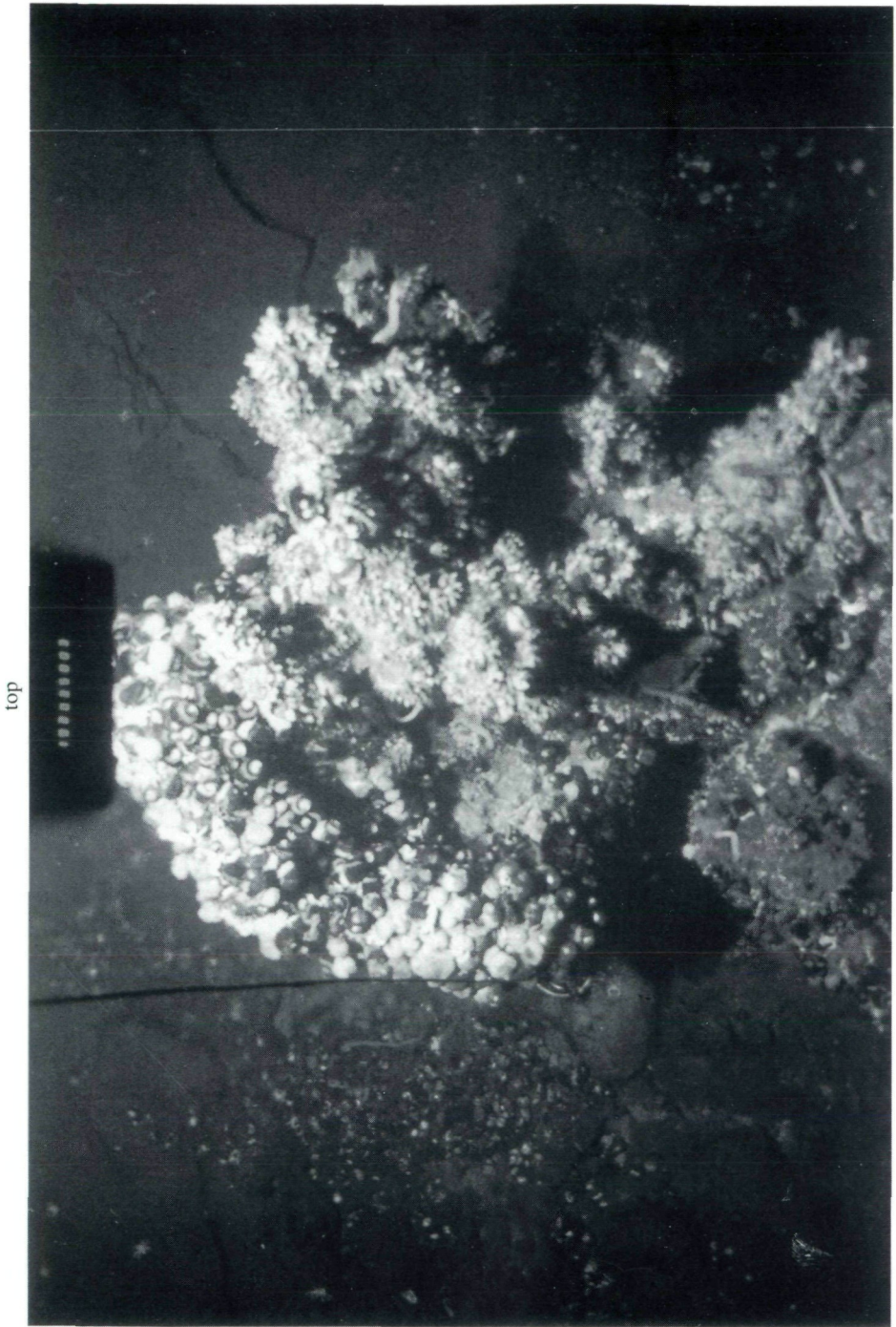
Plate 4





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(Bismarck Sea, Papua New Guinea)

Plate 6



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