

A TAXONOMIC UPDATE OF THE TYPHINAE (GASTROPODA: MURICIDAE) WITH A REVIEW OF NEW CALEDONIA SPECIES AND THE DESCRIPTION OF NEW SPECIES FROM NEW CALEDONIA, THE SOUTH CHINA SEA AND WESTERN AUSTRALIA

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Abstract. The classification of the subfamily Typhinae is revised based on a molecular phylogenetic analysis. The genera Typhina Jousseaume, 1880, Typhisopsis Jousseaume, 1880 and Typhisala Jousseaume, 1881 are here treated as synonyms, and Typhina is given precedence over Typhisopsis. Trubatsa Dall, 1889 is confirmed as a separate, valid genus, based on morphological shell characters and molecular analysis. Choreotyphis Iredale, 1936 is also regarded as a valid genus but still requires validation by molecular analysis. An appendix of Recent Typhinae includes a short description of each genus. The list of Typhinae recorded from New Caledonia is updated. The validity of Trubatsa lozoueti (Houart, 1991), a species so far known only from the empty collected holotype, is confirmed by the morphological and molecular analysis of a second specimen.

New species: Monstrotyphis adelos n. sp., M. maestratii n. sp. and Trubatsa alinkios n. sp. from New Caledonia, Siphonochelus hasegawai n. sp. from the South China Sea, and Typhina clarksoni n. sp. from Western Australia.

New record from New Caledonia: Typhinellus oclusus (Garrard, 1963) and four still unidentified species, Laevityphis sp., Monstrotyphis sp., Siphonochelus cf. S. arcuatus and Trubatsa sp.

New combinations: Choreotyphis erythrostroma (Keen & Campbell, 1964) (ex Siphonochelus); Choreotyphis pavlova (Iredale, 1936) (ex Siphonochelus); Typhina carolskoglundae (Houart & Hertz, 2006) (ex Typhisopsis); T. clarki (Keen & Campbell, 1964) (ex Typhisala); T. claydoni (Houart, 1988) (ex Typhisopsis); T. coronatus (Broderip, 1833) (ex Typhisopsis); T. grandis (A. Adams, 1855) (ex Typhisala); T. lamyi (Garrigues & Merle, 2014) (ex Typhinellus); Typhis virginiae Houart, 1986 and all other species previously classified as Siphonochelus (Trubatsa) are assigned to Trubatsa.

Keywords. Gastropoda, Muricidae, Typhinae, genetic analysis, classification, new species

INTRODUCTION

The subfamily Typhinae (Gastropoda: Muricidae) is morphologically well defined. All the species are characterized by their small size, rarely exceeding 25 mm in length, occasionally by an additional, smooth, whitish intritacalx, a whitish or light brown coloured shell and by the presence of ventrally sealed anal tubes, situated between each pair of varices, closer to the preceding or to the succeeding varix, or situated midway of each pair, or directly originating from the succeeding varix, or connected to it. The last tube is the only functional one, the others being closed progressively by the animal during shell growth. Other characteristics are the ventrally sealed siphonal canal, the 4 (rarely 5) varices per whorl, and, in some genera, the presence of a laminar extension (called "partition" in recent publications, e.g., Gertman 1969; Radwin and D'Attilio 1976; D'Attilio and Hertz 1988; Houart 2002) connecting the P2 shoulder spine of the last varix to the preceding teleoconch whorl (Fig. 1).

The classification of Typhinae has been the subject of numerous papers. After the first catalogue for the entire subfamily by Keen (1944), Vella (1961) produced a revision of the Australasian taxa; Gertman (1969) studied and illustrated the fossil species from the Western Atlantic, Radwin & D'Attilio (1976) treated the subfamily in their book on Muricidae; and D'Attilio & Hertz (1988) published an illustrated catalogue.

The number of valid species steadily increased since Keen's (1944) revision. Taking into account that some names are now placed in synonymy and some genera are assigned to the subfamily Tripterotyphinae, Keen (1944) recorded only 21 living species of Typhinae dispatched in seven genera. Radwin & D'Attilio (1976), if we respect the same criteria as for Keen (1944) and keep only those species currently considered valid, listed 32 species in 10 genera but did not mention or synonymized species now considered valid. D'Attilio & Hertz (1988) treated the Typhinae as a distinct family (as Typhidae) and divided it into Typhinae and the new subfamily Tripterotyphinae and listed all names of fossil and living species, totalling 48 Recent living species, of which 3 are now considered synonyms. Many studies have expanded this total to 76 through articles by Absalão & Santos (2003), Bozzetti (2007), Garrigues & Merle (2014), Hertz (1995), Houart (1991a, 1991b, 1994, 1999, 2002, 2013, 2015, 2017a, 2017b), Houart & Chino (2016), Houart et al. (2015, 2017), Houart & Héros (2015), Houart & Hertz (2006), Houart & Marshall (2012) and Houart & Rosado (2019).

Houart (2018) recognized 13 genera and subgenera, while 5 additional genera are known from the fossil record only. In this paper we accept 11 Recent genera and 81 species including five newly described herein.

In the first molecular phylogeny of the family Muricidae Barco et al. (2010) recovered a monophyletic Typhinae clade, and confirmed that they are defined by a clear diagnostic character, the development of an anal tube on the subsutural ramp of the shell and its preservation on all teleoconch

whorls. However, in Barco et al.'s topology the genera *Typhis* and *Siphonochelus* are not monophyletic, asking for a revision of the generic limits in the subfamily.

In the present paper,

- (1) The classification of the subfamily Typhinae is revised based on a molecular phylogenetic analysis;
- (2) The Recent Typhinae of the world are catalogued, with a short description of each genus;
- (3) New species are described and new records are reported from New Caledonia, the South China Sea, and Western Australia;
- (4) The list of Typhinae recorded from New Caledonia is updated.

Here Figure 1 if possible

MATERIAL AND METHODS

Sources of material examined

The studied material includes specimens collected on various cruises conducted by the MNHN/IRD. Other specimens are from the personal research collection of the first author.

Specimens of Typhinae were collected in New Caledonia during the following expeditions of the MNHN/IRD (not all of them mentioned in the systematics section, but the material has been examined over the years and their geographical and bathymetric distribution are evidently taken into account here).

VAUBAN, 1978–79, LAGON, 1985–93, BIOCAL, 1985, (doi.org/10.17600/85002911), MUSORSTOM 4, 1985 (doi.org/10.17600/85009111), CHALCAL 2, 1986 (doi.org/10.17600/86006511), MUSORSTOM 5, 1986 (doi.org/10.17600/86006611), BIOGEOCAL, 1987 (doi.org/10.17600/87001811), SMIB 3, 1987, CEDB, 1987 (Campagne d'essais drague épibenthique); MUSORSTOM 6, 1989 (doi.org/10.17600/89004811), BERYX 11, 1992 (doi.org/10.17600/9200501), SMIB 8, 1993 (doi.org/10.17600/93000640), BATHUS 1, 1993 (doi.org/10.17600/93000350), BATHUS 2, 1993 (doi.org/10.17600/93000360), BATHUS 3, 1993 (doi.org/10.17600/93000370), MONTROUZIER, 1993 HALIPRO 1, 1994 (doi.org/10.17600/94100010), BATHUS 4, 1994 (doi.org/10.17600/9410003), PALEO SURPRISE, 1999 (doi.org/10.17600/99100040), LITHIST, 1999 (doi.org/10.17600/99100080), NORFOLK 1, 2001 (doi.org/10.17600/1100050), NORFOLK 2, 2003 (doi.org/10.17600/3100030), EBISCO, 2005 (<http://dx.doi.org/10.17600/5100080>), CONCALIS, 2008 (<http://dx.doi.org/10.17600/8100010>), TERRASSES, 2008 (<http://dx.doi.org/10.17600/8100100>), EXBODI, 2011 (<http://dx.doi.org/10.17600/11100080>), KANACONO, 2016 (doi.org/10.17600/16003900), KANADEEP, 2017 (doi.org/10.17600/17003800), KOUMAC 2.3, 2018.

Material from three other expeditions in the Pacific have been studied:

RAPA, 2002 in the Austral Archipelago, PAPUA NIUGINI, 2012 (doi.org/10.17600/18000841) in Papua New Guinea and DongSha 2014, in the South China Sea.

The material studied is housed in MNHN, unless otherwise stated.

Morphological analysis

The characters used to describe shell morphology in Typhinae address the general aspect of the shell including its shape, size, and colour, the shape of the spire including the number and features of the protoconch and teleoconch whorls, details of the suture and of the subsutural ramp, the structure and pattern of the intritacalx, details of axial and spiral sculpture, the form, the position of the anal tubes on the shell and the angle formed by the tubes with its axis, the aperture, the siphonal canal, and when available, the characters of the operculum and radula.

The method used to determine diameter and height, and to count the number of protoconch whorls, follows Bouchet & Kantor (2004) as shown in Fig. 2. The morphology of the radula is described starting from the rachidian tooth, followed by the lateral teeth (Fig. 3). The species descriptions are based on the holotype and paratypes. The bathymetric ranges are the inner values of the recorded depths: the deepest minimum and the shallowest maximum of each recorded depth range.

TERMINOLOGY USED TO DESCRIBE THE SPIRAL CORDS (AFTER MERLE 2001, 2005)

(Figs 12L & 18I).

ABP: abapertural primary cord on the siphonal canal; **ADP:** adapertural primary cord on the siphonal canal; **MP:** median primary cord on the siphonal canal; **P:** primary cord; **P1:** shoulder cord; **P2–P6:** primary cords of the convex part of the teleoconch whorl; **s:** secondary cord (s2 = secondary cord between P2 and P3; s2 = secondary cord between P3 and P4).

Radula

Radula characters in Typhinae are very diverse (Figs 8–10) and unlike other groups they do not have constant characters. The position, the shape and the number of denticles and cusps of the rachidian tooth are sometimes different within the same genus.

The radula is muricine-like with a rachidian tooth that supports a long, narrow or broad central cusp and quite long lateral cusps, even occasionally reaching larger dimensions than the central cusp.

Lateral denticles are quite variable in size and number, even within the same species or on the ribbon of the same specimen. The lateral denticles may occasionally be simple or sometimes are duplicated or split, of different lengths, or with small **outer lateral denticles (old)** (Fig. 3). Marginal denticles are occasionally present, also without any specific or regular shapes.

Lateral teeth have a similar sickle shaped form similar to that in other Muricidae.

Protoconch

The protoconch in living Indo-West Pacific, and *ipso facto* in New Caledonian species of Typhinae is always paucispiral, consisting of 1.5 to 2 rounded whorls denoting a lecithotrophic larval development.

Here Figure 2 if possible

Here Figure 3 if possible

MOLECULAR ANALYSES

We analyzed the phylogenetic relationships in the subfamily Typhinae using 75 specimens assigned to 23 species and 6 genera (see Table 1). The dataset includes also 46 species belonging to other subfamilies, largely selected following Barco et al. (2010, 2012, 2015).

(Table here if possible)

Total genomic DNA was extracted using the Qiagen DNA Mini Kit or the Macherey-Nagel NucleoSpin 96 Tissue Kit and following the manufacturer's protocol.

We amplified three fragments, the 658 bp barcode portion of the mitochondrial cytochrome oxidase I (COI) with primers LCO1490 and HCO2198 (Folmer et al. 1994), a 505-522 bp portion of the large ribosomal subunit (16S) with primers 16SA and 16SB (Kessing et al. 1989), and a 703-1305 bp portion of the nuclear large ribosomal subunit (28S), with primers 28S-C1 (Jamieson et al., 2002) and 28S-ChiR1 (new primer: 3'-CCCACAGCGCCAGTTCTGCTTACCA-5').

Newly obtained sequences were deposited in GenBank and BOLD (Barcode of Life Datasystem) (Table 1).

The three genes were aligned with DNASTAR. After exclusion of four regions in the ribosomal genes that could not be aligned unambiguously (78 bp in total), the three genes were combined into a single dataset of 2457 bp (COI: 658 bp, 16S: 478 bp, 28S: 1321 bp). The dataset was analyzed under the maximum likelihood criterion, using RAxML-HPC2 (Stamatakis 2006), implemented on CIPRES portal (Miller et al., 2010). We selected a GTR+ Γ +I model and random starting tree, with empirical base frequencies and estimated α -shape parameters and GTR-rates. Nodal support was estimated using 100 bootstrap replicates.

ABBREVIATIONS

Repositories. AMS Australian Museum, Sydney, Australia; MNHN Muséum national d'Histoire naturelle, Paris, France; RH Collection of the first author; WAM Western Australian Museum, Perth, Australia.

Other. IRD Institut de Recherche pour le Développement (formerly ORSTOM).

Station number prefixes. CP Chalut à perche (beam trawl); DC Drague Charcot (Charcot dredge); DR Drague à roches (rocks dredge); DW Drague Warén (Warén dredge)

Specimens. dd empty shell(s); juv juvenile specimen(s); lv live collected specimen(s)

RESULTS

Molecular phylogeny

The phylogenetic analysis recovered a monophyletic Typhinae clade in the Maximum Likelihood tree (Fig. 4) but the basal node has a no support and the clade relationships within the Muricidae remain largely unresolved. Although some of the subfamilies identified by Barco et al. (2010) are here recovered monophyletic (Pagodulinae, Haustrinae, Muricinae, Ocenebrinae), the subfamilies Muricopsinae, Aspellinae and Trophoninae are paraphyletic, and other genera form distinct lineages, not belonging to any accepted subfamily (*Actinotrophon*, *Bouchetia*, *Flexopteron*, *Homalocantha*, *Pterynotus*, *Timbellus*, *Vitularia*). The association of the lineage Typhinae with the genera *Flexopteron*, *Bouchetia*, *Actinotrophon* has not been suggested before, must be considered only tentative and needs to be confirmed with a larger dataset.

Two major lineages form the clade Typhinae, one consisting of the sister genera *Typhina* and *Typhinellus*, the other with *Monstrotyphis*, *Siphonochelus*, *Typhis* and *Trubatsa*. All genera are strongly supported (bootstrap values ≥ 71). The division in two lineages matches a major morphological trait, the presence of a laminar extension in *Typhina* and *Typhinellus* vs its absence in the other genera.

All species form strongly supported, monophyletic lineages, generally with modest intraspecific genetic variability, with the exception of *Monstrotyphis maestratii*, where one specimen (MNHN-IM-2009-8449: Argo Bank) differs by 6.3% (COI *p*-distance) from two other specimens collected on the Chesterfield Plateau, and *Siphonochelus rosadoi*, where a single specimen collected at a deeper station (1092-1195 m : MNHN-IM-2009-5605) differ by (4.5%, COI *p*-distance) from the others, all obtained in 443-638 m.

Figure 4.

Figure 5.

TAXONOMIC DESCRIPTIONS

FAMILY MURICIDAE Rafinesque, 1815

SUBFAMILY TYPHINAE Cossmann, 1903

Genus *Laevityphis* Cossmann, 1903

Type species by original designation: *Typhis coronarius* Deshayes, 1865 = *T. muticus* J. Sowerby, 1834, Eocene, France

Remarks. The type species of *Laevityphis*, *Typhis coronarius* Deshayes, 1865, is based on a small fossil shell from the Eocene of France and England. It has a hollow varical shoulder spine and a multispiral, conical protoconch consisting of 3.5 whorls.

The other fossil species currently included in *Laevityphis* by Campbell (1969) fit well the type species (excluding the multispiral protoconch). For example *L. linguiferus* (Dall, 1890) from the Miocene of Florida or *L. sawkinsi* (Mansfield, 1925) from the Miocene of Venezuela. However other species included in the genus have no hollow shoulder spine, but rather a rounded shoulder as observed in *L. ludbrookae* Keen & Campbell, 1964.

The same characteristics are observed in the Recent fauna, for example *L. bullisi* Gertman, 1969 described from eastern Panama but which also occurs in the Pleistocene of Costa Rica, has hollow shoulder spines compared to *L. tubuliger* (Thiele, 1925) and *L. tillierae* who match the other shell characters of *Laevityphis* except they are lacking the hollow shoulder spine, but have rather rounded varices with rounded shoulder. *Siphonochelus transcurrens* was assigned to *Laevityphis* by several authors but was transferred to *Siphonochelus* by Houart (2017b)

Hopefully further genetic studies including the different morphs of *Laevityphis* and some Indo-West Pacific species will be able to clarify this doubtful classification, but in the meantime it is maintained here.

Species in New Caledonia. *Laevityphis tillierae* (Houart, 1986) and *Laevityphis* sp.

Laevityphis tillierae (Houart, 1986)

Fig. 11A–G

Siphonochelus (Laevityphis) tillierae Houart, 1986: 442, pl. 2, fig. 6.

Siphonochelus (Laevityphis) tillierae – Houart, 1991a: 234, figs 26, 27, 50, 64; Houart, 1991b: 51, figs 28–30, 54.

Laevityphis tillierae – Houart et al., 2010: 248.

Type locality. New Caledonia, VAUBAN 1978-79, stn DR40, 22°30'S, 166°24'E, 250–350 m (dd).

Type material. Holotype MNHN-IM-2000-237.

Distribution. North, East and South New Caledonia, living at 647–830 m; off Cairns, Queensland, Australia and Transkei, South Africa.

Remarks. Many additional specimens have been collected around New Caledonia since its description. Most of them were collected empty but the very few specimens collected alive usually live between 647 and 830 m.

A specimen examined by the first author was obtained off Cairns, Queensland, Australia, collected empty at 1161 m (AMS) while other specimens, similar to the New Caledonian shells were recorded from Transkei and Zululand, Indian Ocean, South Africa by Houart (1991b), living at 300–370 m, (Fig. 11G) but no genetic analysis has ever been made for these specimens. These analyses would be recommended before any other action is taken.

Laevityphis sp.

Fig. 11H–J

Material examined. New Caledonia, east coast, BATHUS 1, stn DW673, 20°48' S, 165°19' E, 170 m, 1 dd.

Remarks. The single examined specimen is a juvenile of 4 mm with less than 3 teleoconch whorls. However, compared to a young specimen of *L. tillierae* from New Caledonia with the same number of teleoconch whorls, it differs in having a narrower, less lanceolate shell, although with a comparatively broader last teleoconch whorl, a quite smaller protoconch and obviously narrower anal tubes. Both are undoubtedly separate.

This unidentified *Laevityphis* species is close to *L. tubuliger* (Thiele, 1925) (Fig. 11K–L) described from juvenile specimens collected north of Zanzibar. The New Caledonian specimen only differs in having an obviously broader siphonal canal.

Genus *Monstrotyphis* Habe, 1961

Type species by original designation: *Typhis tosaensis* Azuma, 1960, Japan.

Remarks. *Monstrotyphis* Habe, 1961 was a monotypic genus until Houart (2002) moved some species from *Typhina*, in which they were originally or later classified, to *Monstrotyphis*. Eight species were then assigned to the genus. Since then *M. teramachii* was reinstated by Houart & Chino (2016) and six new species were described, including *M. adelos* n. sp. and *M. maestratii* n. sp. below, raising the total number of *Monstrotyphis* species to 16 (17 with an unidentified one), of which 14 (and one unidentified) from the Indo-West Pacific and one from the western Atlantic.

Monstrotyphis is a much more intricate genus that it was thought to be some years ago. This is proved by the recent discovering of several new Indo-West Pacific species and described by Houart & Marshall (2012), Houart & Chino (2016), Houart et al. (2017) and Houart & Rosado (2019) and also by the present genetic analysis.

Species in New Caledonia. *Monstrotyphis adelos* n. sp., *M. carolinae* (Houart, 1987), *M. maestratii* n. sp., *M. singularis* Houart, 2002 and *Monstrotyphis* sp.

Monstrotyphis adelos n. sp.

Figs 7A; 12N–T; 13 A–G

Typhis (Typhina) imperialis – Houart, 1991a: 226, figs 10, 40 (only) [not *Monstrotyphis imperialis* (Keen & Campbell, 1964)].

Type material. New Caledonia, KANACONO, stn DW4715, holotype MNHN-IM-2013-69415; stn DW4677, paratype MNHN-IM-2013-68865; BATHUS 2, stn DW717, 2 paratypes MNHN-IM-2014-6907.

Material examined. New Caledonia, MUSORSTOM 4, stn DW222, 22°58' S, 167°33' E, 410–440 m, 1 lv, MNHN-IM-2014-6912 (illustrated by Houart, 1991a, fig. 10, as *Typhis imperialis*).

SMIB 8, stns DW146–147, 24°55' S, 168° 22' E, 508–532 m, 1 lv, 1 dd, juv; stns DW182–184, 23°18' S, 168°05' E, 305–330 m, 1 dd, juv, MNHN-IM-2014-6906.

BATHUS 2, stn DW717, 22°44' S, 167°17' E, 350–393 m, 2 lv, paratypes MNHN-IM-2014-6907; stn DW729, 22°52' S, 167°12' E, 400 m, 1 lv, MNHN-IM-2014-6919.

NORFOLK 2, stn DW2124, 23°18' S, 168°15' E, 260–270 m, 1 lv, MNHN-IM-2012-41626.

KANACONO, stn DW4677, 22°53' S, 167°35' E, 390–376 m, 1 lv, paratype MNHN-IM-2013-68865, (BOLD MUBA910-21; Genbank MZ364554); stn DW4715, 22°50' S, 167°27' E, 424 m, 1 lv, holotype MNHN-IM-2013-69415 (BOLD MUBA916-21; Genbank MZ364555).

Type locality. South New Caledonia, southwest of Iles des Pins, 22°50' S, 167°27' E, 424 m.

Distribution. South New Caledonia, southeast and southwest of Ile des Pins, living at 270–508 m (Fig. 7A).

Description. Shell medium-sized for the genus, up to 13.8 mm in length (paratype MNHN-IM-2014-6907). Length/width ratio 1.9–2.2, (holotype 10.4 x 5.5 mm, length/width ratio 1.9) biconical, smooth, lightly built. Subsutural ramp moderately broad, very weakly sloping, lightly convex or almost straight.

Shell light brown, tan, covered by a thin, simple, whitish intritacalx. Aperture with whitish columellar lip and outer apertural lip, white within. Protoconch glossy white.

Spire high with 1.5 protoconch whorls and teleoconch of up to 5 whorls. Suture deeply impressed. Protoconch moderately large, smooth, rounded. First whorl broad. Maximum width 850–900 μm , height 900 μm ; terminal lip shallow, delicate.

Axial sculpture of teleoconch whorls consisting of 4 low, narrow, webbed, serrated lamellae, abaperturally with 5 crenulations corresponding to P2–P6, adaperturally smooth. P1 spiral cord corresponding to anal tube, P2 shoulder cord ending as adapically curved, ventrally sealed, or very narrowly open spinelet, P3–P6 indistinct on shell. A long, ventrally sealed anal tube originates from P1, nearest or adpressed to preceding varix, forming an angle of 80–85° with the axis of shell.

Apertural tube occasionally very long.

Aperture small, broadly ovate, forming a continuous peristome. Columellar lip broadly expanded, erect, smooth. Outer lip erect, smooth within. Siphonal canal long, broken at tip in all specimens, narrow, straight, ventrally sealed on whole length; ADP extending on canal as fairly long, adaperturally curved spine. Operculum unknown.

Animal greyish white with narrow white spots (Fig. 13F–G).

Remarks. *Monstrotyphis imperialis* from Japan (Fig. 13H–J) with which *M. adelos* n. sp. was confused, differs in having a larger and broader shell, a broader subsutural ramp, a larger and broader aperture, a comparatively lower and narrower spire and a broader siphonal canal.

Monstrotyphis montfortii (Fig. 13K–M) has a comparatively smaller shell with a straighter, weakly concave subsutural ramp, a shorter and comparatively narrower siphonal canal with a less obvious or absent ADP spine. *M. montfortii* also have anal tubes which form an angle of approximately 45–50° with the axis of the shell as opposed to 80–85° in *M. adelos* n. sp.

Monstrotyphis maestratii n. sp. described below differs in having a rounder last teleoconch whorl, more indented at its base, a lower, comparatively narrower spire, a narrower siphonal canal, especially noticeable at its base and an ADP spine located farther on the canal and usually unsplit. In addition to the morphological differences, the two species differ by 9.1% in the COI gene.

Derivation of name *adelos* (G), unseen, obscure. Named for its resemblance with *M. maestratii* and the difficulties encountered for discerning it from that species.

Monstrotyphis carolinae (Houart, 1987)

Figs 8A–B; 11M–T

Typhis (Typhina) carolinae Houart, 1987: 204, figs 2–4, 12, 13.

Typhis (Typhina) carolinae — Houart, 1991a: 227, figs 3–4, 11, 42, 61.

Typhina carolinae — Houart, 2002: 148.

Type locality. New Caledonia, Programme LAGON, stn DW354, 22°32' S, 167°02' E, 78 m.

Type material. Holotype MNHN-IM-2000-1030.

New material examined. New Caledonia, Campagne d'essais drague épibenthique, stn DE33, 22°38' S, 166°38' E, 31–33 m, 1 dd, MNHN-IM-2010-4919; stn DE40, 22°31' S, 166°28' E, 52–75 m, 1 dd, MNHN-IM-2010-4920.

EXPEDITION MONTROUZIER, stn 1260, 20°44' S, 165°14' E, 49–59 m, 1 dd, MNHN-IM-2010-21591; stn 1261, 20°46' – 20°47' S, 165°15' – 165°17' E, 45–56 m, 1 dd, MNHN-IM-2010-21592.

MUSORSTOM 4, stn DW203, 22°36' S, 167°06' E, 105–110 m, 1 dd.

TERRASSES, stn DW3078, 22° 29' S, 167° 30' E, 180–210 m, 1 lv, MNHN-IM-2009-4573, (BOLD MPOM001-10; Genbank MZ364584).

KANACONO, stn DW4703, 22°46' S, 167°19' E, 350–348 m, 1 lv, MNHN-IM-2013-49551 (BOLD MUBA919-21; Genbank MZ364609); 1 lv, MNHN-IM-2013-69186 (BOLD MUBA906-21; Genbank MZ364571); stn DW4727, 22°41' S, 167°02' E, 120–129 m, 1 dd.

Distribution. Northeast, Southeast and South New Caledonia, living at 26–348 m.

Remarks. Two of the specimens used here for the genetic study were collected alive between 348 and 350 m while the material used in the original description was collected alive between 26 (LAGON, stn DW286) and 78 m (holotype). This is a considerable and noteworthy extension of the bathymetric distribution. The shell morphology is absolutely similar in both cases.

Monstrotyphis maestratii n. sp.

Figs 7; 8E–F; 12F–M

Monstrotyphis imperialis – Houart, 2002: 153, figs 8–9; Houart et al., 2010: 249 [not *Monstrotyphis imperialis* (Keen & Campbell, 1964)].

Type material. New Caledonia, EBISCO, stn CP2595, 1 paratype MNHN-IM-2009-5141; MUSORSTOM 5, stn DC368, 1 paratype RH, MUSORSTOM 6, stn DW417, 1 paratype MNHN-IM-2014-6909; KANADEEP, stn DW4977, holotype MNHN-IM-2013-65600.

Material examined. New Caledonia, MUSORSTOM 5, stn DC368, 19°52' S, 158°33' E, 305 m, 1 lv paratype RH, 1 dd, MNHN-IM-2014-6910; MUSORSTOM 6, stn DW417, 20°42' S, 167°04' E, 283 m, 1 lv, paratype MNHN-IM-2014-6909; stn DW418, 20°42' S, 167°03' E, 283 m, 1 dd, MNHN-IM-2014-6908; stn DW444, 20°54' S, 167°18' E, 300 m, 1 dd, MNHN-IM-2014-6917; stn DW451, 20°59' S, 167°25' E, 330 m, 1 lv, MNHN-IM-2014-6218 (radula illustrated); stn DW452, 21°00' S, 167°25' E, 300 m, 1 dd, MNHN-IM-2014-6915; EBISCO, stn CP2595, 19°44' S, 158°35' E, 377 m, 1 lv, paratype MNHN-IM-2009-5141 (BOLD MUBA896-21; Genbank MZ364581); stn DW2528, 22°48' S, 159° 22' E, 320–345 m, 1 lv, MNHN-IM-2009-8449 (BOLD MPOM178-10; Genbank GU575389); KANADEEP, stn DW4959, 23°04' S, 159°27' E, 300–411 m, 1 dd; stn DW4977, 19°46' S, 158°30' E, 280–304 m, 1 lv, holotype MNHN-IM-2013-65600 (BOLD MUBA918-21; Genbank MZ364602).

Type locality. Coral Sea, Chesterfield Plateau, 19°46' S, 158°30' E, 280–304 m.

Distribution. Chesterfield Plateau, Argo Bank, north and northwest of Lifou, living at 283–377 m (Fig. 7A).

Description. Shell medium-sized for the genus, up to 19.4 mm in length (paratype MNHN-IM-2009-5141). Length/width ratio 2.0–2.3 (holotype 19.0 x 8.2 mm, length/width ratio 2.3), broadly biconical, smooth, lightly built. Subsutural ramp broad, very weakly sloping, lightly convex or almost straight. Shell light brown, tan, covered by a thin, simple, whitish intritacalx. Aperture with whitish columellar lip and outer apertural lip, light tan within. Protoconch glossy white.

Spire high with 1.5–1.75 protoconch whorls and teleoconch of up to 5 whorls. Suture deeply impressed. Protoconch moderately large, smooth, rounded. First whorl broad. Maximum width 800–900 µm, height 1000 µm; terminal lip shallow, delicate.

Axial sculpture of teleoconch whorls consisting of 4 low, narrow, webbed, serrated lamellae, abaperturally with 5 crenulations corresponding to P2–P6 (Fig. 12L) adaperturally smooth. P1 spiral cord corresponding to anal tube, P2 shoulder cord ending as fairly long, weakly or strongly curved, ventrally sealed, spinelet, P3–P6 indistinct on shell. A long, ventrally sealed anal tube originates from P1, nearest or adpressed to preceding varix, forming an angle of 80–85° with the axis of shell.

Apertural tube occasionally very long.

Aperture small, rounded, forming a continuous peristome. Columellar lip broadly expanded, erect, smooth. Outer lip erect, smooth within. Siphonal canal long, narrow, straight, ventrally sealed on whole length; ADP in adult specimens split, resulting in two moderately long, webbed spinelets halfway down the canal. Operculum unknown.

Radula with a rachidian tooth bearing a long, narrow central cusp, narrow, small, lateral denticles of variable length, occasionally split, long, broad lateral cusps, occasionally with adpressed outer lateral denticle. Marginal areas smooth. Lateral teeth sickle shaped with broad base (Fig. 8E–F).

Remarks. *Monstrotyphis imperialis* (Fig. 13H–J), with which *M. maestratii* n. sp. had previously been confused, differs in having a smaller protoconch although the shell is broader with a fairly broader and larger teleoconch whorl, a larger and broader aperture, a broader and shorter siphonal canal with a less apparent ADP spine. *M. imperialis* is still known today from only two specimens, the holotype, now in Toba Aquarium, and a paratype in California Academy of Sciences, both from Tosa Bay, Japan, living in approximately 200 m.

Tsuchiya (2000: 379, pl. 188, fig. 79) illustrated a specimen of *M. teramachii* as *M. imperialis*. This was judiciously corrected by the same authors in (Ibid. 2017: pl. 246, fig. 4) where this shell was correctly identified. Higo et al. (1999: 205) considered *M. imperialis* a synonym of *M. tosaensis* and illustrated the holotype (Higo et al., 2001: fig. 2263s).

Monstrotyphis singularis of which the protoconch was wrongly illustrated as *M. imperialis* auct. (now in part *M. maestratii* n. sp.) by Houart (1991a: fig. 60) is obviously smaller, with a maximum length of 7.6 mm (Figs 11U–Za; 12A–E). The species could be confused with young specimens of *M. maestratii*, however, *M. singularis* differs constantly from *M. maestratii* of approximately the same size in having a quite smaller and more acute protoconch (Fig. 11Za), more numerous and broader teleoconch whorls and dorsally curved, broader siphonal canal.

Monstrotyphis montfortii (Fig. 13K–M) differs in having narrower teleoconch whorls, a less angulate last whorl, a clearly shorter and dorsally recurved siphonal canal with a less pronounced ADP spine, and anal tubes forming an angle of approximately 45–50° with the axis of the shell.

Monstrotyphis tosaensis, type species of the genus, differs in many aspects, the only similar point being the long siphonal canal. It is here illustrated for comparison (Fig. 13N–P).

For a comparison with *M. adelos* n. sp. described above see under that species.

The presence of *Monstrotyphis maestratii* in South Africa, as reported by Houart et al. (2010) (as *M. imperialis*) is not confirmed here. This is probably a misidentification (no photographs were taken) and the material studied at that time should be re-examined.

The specimens included in the molecular analysis were collected in two different locality, the Argo Bank (MNHN-IM-2009-8449) and the Chesterfield Plateau (MNHN-IM-2009-5141, MNHN-IM-2013-65600). Although not showing any appreciable morphological difference, the former differs by 6.3% (COI *p*-distance) from the latter, indicating that further investigations using a larger sample

could clarify if they might represent a case of cryptic species, a strong geographic structuring or a simple case of large, intraspecific genetic variability.

Derivation of name *Maestratii* (L): Named for Philippe Maestrati, MNHN, in recognition for his collaboration in many ways.

Monstrotyphis singularis Houart, 2002

Figs 8C–D; 11U–Za; 12A–E

Typhis (*Typhina*) *imperialis* — Houart, 1991a: fig. 60 (only) [not *Monstrotyphis imperialis* (Keen & Campbell, 1964)].

Monstrotyphis singularis Houart, 2002: 150, figs 3, 4–6, 10–13.

Monstrotyphis singularis — Houart & Tröndlé, 2008: 86, figs 140–145.

Type locality. New Caledonia, EXPEDITION MONTROUZIER, stn 1261, 20°46' S–20°47' S, 165°15' E–165°16.5' E, 45–56 m.

Type material. Holotype MNHN-IM-2000-293.

New material examined. New Caledonia, BIOCAL, stn DW64, 24°48' S, 168°09' E, 250–250 m, MNHN-IM-2014-6916, 2 dd.

MUSORSTOM 5, stn DW274, 24°45' S, 159°41' E, 285 m, MNHN-IM-2014-6914, 1 dd.

LAGON, stn DW830, 20°49' S, 165°19' E, 105–110 m, MNHN-IM-2014-6911, 5 dd.

BERYX 11, stn DW18, 24°48' S, 168°10' E, 250–270 m, MNHN-IM-2014-6905, 1 dd.

NORFOLK 1, stn DW1675, 24°44' S, 168°09' E, 233–231 m, MNHN-IM-2012-9276 and MNHN-IM-2012-9314, 2 dd.

KOUMAC 2.3, stn KL36, 20°50'S, 164°16,7'E, 60 m, MNHN-IM-2019-9150 (BOLD MUBA920-21; Genbank MZ364547), 1 lv.

French Polynesia, RAPA 2002, stn 8, 27°36.5' S, 144°17.7' W, 52–57 m, MNHN-IM-2008-2481, 7 lv & dd; stn 44, 27°36.3' S, 144°18.2' W, 30 m, MNHN-IM-2008-2479 and MNHN-IM-2008-2480, 8 lv & dd.

Distribution. Northeast New Caledonia, off Touho, living at 6–45 m. Empty shells were collected south of New Caledonia and off the Chesterfield Islands. Also off the Island of Rapa, living at 30–52 m.

Remarks. Some specimens among the new material examined were previously misidentified in the collection of MNHN by the senior author and consist only of dead shells. The bathymetric distribution of living specimens of *M. singularis* is therefore not modified by this material.

As observed above, the protoconch illustrated by Houart (1991a) belongs to a specimen of *M. singularis* and not to the shell then misidentified as *M. imperialis* auct. [Not *M. imperialis* (Keen & Campbell, 1964)] which is now here described as *M. maestratii* n. sp. The protoconch of *M. maestratii* is larger, broader and rounder (see Figs 11Za and 12M for comparison).

On the other hand, 15 live and dead specimens collected off the Island of Rapa, located at some 5000 km from New Caledonia were recorded by Houart & Tröndlé (2008). These specimens (Fig. 12D–E) are perfectly similar to those collected in New Caledonia and could not be separated on basis of the shell characters only.

Monstrotyphis sp.

Fig. 14A–D

Material examined. New Caledonia, SMIB 8, stn DW182-184, South New Caledonia, Banc Aztèque, 23°18' – 23°19' S, 168°05' E, 305–367 m, MNHN-IM-2014-6906, 1 lv.

Remarks. This specimen is close to a young *Monstrotyphis maestratii* n. sp., but it is different from that species. Compare Fig. 12F and 14A.

Monstrotyphis montfortii differs in having a comparatively broader aperture, broader teleoconch whorls, a narrower and more strongly abapically tapered siphonal canal with visible ADP spine, narrower anal tubes forming an angle of approximately 45° with the axis of the shell, and a more acute spire. *Monstrotyphis teramachii* also differs in having a larger and broader shell and in many other ways.

The shell morphology of *Monstrotyphis* sp. reminds *M. singularis*, one of the other New Caledonian species. However, *M. singularis* differs in having a smaller shell with narrow anal tubes as opposed to the broad tubes in *Monstrotyphis* sp. The siphonal canal is also quite narrower, comparatively shorter, with a narrow, open spinelet corresponding the ADP. In *Monstrotyphis* sp. the canal is longer, broader and entirely smooth (compare Fig11X; 12A and 14A).

Looking at the shell outline, the peculiar siphonal canal, the strongly adapically, broad and sculptured apertural anal tube, it is more than likely that this is a new species but in the absence of additional intact specimen(s) it seems preferable avoiding to describe it now.

Genus *Siphonochelus* Jousseaume, 1880

Type species by original designation: *Typhis arcuatus* Hinds, 1843, South Africa

Synonym: *Eotyphis* Tembrock, 1963 (fossil species only)

Type species by original designation: *Typhis sejunctus* Semper, 1861, Upper Oligocene, Germany

Species in New Caledonia. *Siphonochelus angustus* Houart, 1991, *S. cf. S. arcuatus* (Hinds, 1843), *S. boucheti* Houart, 1991

Siphonochelus angustus Houart, 1991

Fig. 14E–J

Siphonochelus angustus Houart, 1991a: 230, figs. 15, 16, 43, 65.

Type locality. New Caledonia, Coral Sea, MUSORSTOM 5, stn DW304, Lord Howe Ridge, Banc Nova, 22°10' S, 159°25' E, 385–420 m.

Type material. Holotype MNHN-IM-2000-33.

New material examined. New Caledonia, KANADEEP, stn DW4956, 23°13' S, 159°35' E, 295 m, Argo Bank, 1 dd; BATHUS 3, stn DW824, 23°19' S, 168°00' E, 601–608 m, 1 dd.

Distribution. Off Chesterfield Islands and south New Caledonia, dead collected at 295–601 m.

Remarks. *Siphonochelus angustus* was described from two empty specimens. Two additional ones were collected during the BATHUS 3 (1993) and KANADEEP (2017) expeditions (Fig. 14G–J), the latter close to the type locality, eastwardly distant but on the same latitude for the BATHUS 3 specimen. Both were dead collected but have the same characteristics as the holotype and paratype, namely a small shell with flattened anal tubes, a somewhat flattened protoconch, a narrow, small aperture and a narrow, strongly tapered siphonal canal. The specimen collected during the BATHUS 3 expedition is slightly larger (8.3 mm), but has ½ additional teleoconch whorl.

Siphonochelus boucheti Houart, 1991

Figs 9A–B; 14K–O

Siphonochelus (Siphonochelus) boucheti Houart, 1991a: 230, Figs 5–6, 17–18, 47, 68.

Type locality. New Caledonia, CHALCAL 2, stn DW72, Norfolk Ridge, 24°54' S, 168°22' E, 527 m.

Type material. Holotype MNHN-IM-2000-46.

Distribution. New Caledonia: South of New Caledonia and South of Chesterfield Islands; Fiji (Houart & Héros, 2008), living at 285–680 m.

Remarks. Many specimens of *Siphonochelus boucheti* from several expeditions have been collected since its description and confirm the validity of the species as well as the very little variable shell morphology.

Initially, *S. boucheti* was compared in particular to *S. japonicus* and *S. nipponensis*, but the identification of these species proved to be incorrect, or rather reversed. Figures identified then as *S. japonicus* should be interpreted as *S. nipponensis* and *vice versa*, as demonstrated by Houart (2017a). *Siphonochelus boucheti* is more strongly shouldered than *S. japonicus* (Fig. 14P–Q), has higher, rounded varices and axial folds with a deeper depression between them, the spire is obviously less acute and the protoconch is broader, approximately 1000µm broad and 900 µm high, opposed to 800 µm x 900 µm in *S. japonicus*. The last teleoconch whorl in *S. boucheti* is also comparatively less globose.

Siphonochelus boucheti differs from *S. nipponensis* (Fig. 14R) in having also a clearly less acute spire, a broader protoconch, 1000 µm opposed to 800 µm in *S. nipponensis*, less broad and flattened anal tubes and in having also a deeper depression between the axial varices and folds due to the higher axial folds in *S. boucheti*.

Siphonochelus cf. *S. arcuatus* (Hinds, 1843)

Fig. 15A–D

Material examined. New Caledonia, KANADEEP, stn DW4999, Lord Howe Rise, 23°53' S, 161°46' E, 1060 m, 1 dd.

Remarks. This *Siphonochelus* species differs from the other New Caledonian species in many respects. It differs from *S. angustus* in having a broader and larger shell with a higher and broader protoconch, more angular, strongly shouldered teleoconch whorls with a broader subsutural ramp and broader, much flatter anal tubes.

It is different from *S. boucheti* in having a more angular shell with a broad subsutural ramp, obviously flatter anal tubes and very narrow, sharp, low axial varices opposed to rounded and high varices in *S. boucheti* which also has higher and broader axial, intervarical folds near preceding varices.

It also differs significantly from *S. japonicus* and *S. nipponensis*, both species not yet recorded from New Caledonia, in having a more angular shell, narrow, sharp varices instead rounded in both other species and also in having a broader subsutural ramp and broader, flat anal tubes.

Siphonochelus cf. *S. arcuatus* is closer to the South African *S. arcuatus* because that species also has sharp varices, but the New Caledonian specimen is still different in having a more strongly shouldered shell with a broader subsutural ramp.

In conclusion, the single examined specimen seems different from any other *Siphonochelus* species, although close to *S. arcuatus*. Nevertheless, as we only have one dead collected specimen, it seems preferable to wait for any additional sample before making a final decision on this shell.

Siphonochelus hasegawai n. sp.

Fig. 7C; 14S–Za

Siphonochelus nipponensis — Radwin & D'Attilio, 1976: pl. 32, fig. 9; D'Attilio & Hertz, 1988: 56, fig. 64 (paratype of *S. nipponensis* figured in both publications).

Siphonochelus sp. — Houart, 2017a: 27–28, fig. 2C, D (paratype of *S. nipponensis*), 4E–G.

Type material. DongSha 2014, stn CP4130, 20°16' N, 116°08' E, 02/05/2014, 795–822 m, lv, holotype MNHN-IM-2013-50304 (BOLD MUBA899-21; Genbank MZ364561); 1 paratype MNHN-IM-2013-50305 (BOLD MUBA898-21; Genbank MZ364559); stn CP4131, 20°06' N, 116°08' E, 02/05/2014, 916–1012 m, lv, 1 paratype MNHN-IM-2013-50327 (BOLD MUBA900-21; Genbank MZ364586); Japan, Wakayama Prefecture, off Kushimoto, 384–402 m, lv, 2 paratypes RH

Other material. Japan, off Tosa, in excess of 200 m, 33°20' N, 133°40' E, paratype of *Siphonochelus nipponensis* (see Houart, 2017a).

Type locality. South China Sea, 20°16' N, 116°08' E, 795–822 m.

Distribution. South China Sea and northeast Japan, living at 402–916 m (Fig. 7C).

Description. Shell small for the genus, up to 9.2 mm in length (paratype RH). Length/width ratio 1.9 – 2.1 (holotype 7.4 x 3.8 mm, length/width ratio 1.9). Lanceolate, smooth. Subsutural ramp moderately broad, weakly sloping, weakly convex.

Shell covered by a uniform off white or dirty white intritacalx. Aperture white within.

Spire high, narrow relative to the breadth of last teleoconch whorl, with 1.5–1.75 protoconch whorls and teleoconch of up to 4 broad, convex, strongly shouldered whorls. Suture impressed. Protoconch large, broad, whorls rounded, smooth, glossy. Width and height 1000 µm. Terminal lip unknown (eroded).

Axial sculpture of teleoconch whorls consisting of 4 low, strong, narrow, rounded varices from first to last teleoconch whorl, extending to tip of siphonal canal. Other axial sculpture of single, low, weakly

swollen, intervarical ridge, nearest to preceding varix. Spiral sculpture of P1 with anal tube connected to axial varix and P2 (shoulder cord). Anal tubes rounded, weakly flattened at base, weakly tapered and rounded at extremity, forming an angle of approximately 40–70° with axis of shell. Only apertural tube open and functional, other tubes closed.

Aperture large, roundly ovate, forming a continuous peristome. Columellar lip narrow, smooth, rim erect. Outer lip smooth within. Siphonal canal short, 17–22% of total shell length, narrow, strongly tapered abapically, straight. Ventrally sealed.

Operculum light brown, roundly ovate with strong concentric ridges and apical nucleus. Radula unknown.

Remarks. *Siphonochelus hasegawai* n. sp. was confused with *S. nipponensis* Keen & Campbell, 1964, starting with its description. Keen & Campbell (1964: 50) have indeed designated a specimen of the new species as the paratype of *S. nipponensis*.

As noted by the first author (Houart, 2017a): "The paratype of *S. nipponensis* is actually a young specimen of a probably still undescribed species with a broad last teleoconch whorl, narrower spire whorls, more rounded anal tubes and a broad, rounded protoconch, but it is not conspecific with *S. nipponensis* which has a more elongate last whorl and flattened tubes. This paratype was later illustrated by D'Attilio (1975: 53) who figured a detail of the anal tube, by Radwin & D'Attilio (1976: pl. 32, fig. 9) and by D'Attilio & Hertz (1988: 56)". See Houart (2017a) for more details.

Three specimens of this until now nameless species have been recently collected in the South China Sea, while two specimens, already reported by Houart (2017a) are recorded from the Wakayama Prefecture, Japan.

Siphonochelus hasegawai n. sp. differs from *S. japonicus* (Fig. 14P–Q) from Japan, in having comparatively narrower spire whorls, a last teleoconch whorl with a broader subsutural ramp, a narrower siphonal canal and a broader protoconch. *S. hasegawai* n. sp. is also relatively larger, reaching the same length of *S. japonicus* with one less teleoconch whorl.

The confusion that existed in the identification of *S. japonicus* and *S. nipponensis* does not at present allow us to have a precise idea of the actual geographical distribution of *S. japonicus*. For example, Houart (1997: 291) reported it from Indonesia and Houart & Héros (2008: 478, Fig. 6H, K) from Tonga and Fiji, but it now appears that these specimens are in fact *S. nipponensis*.

Siphonochelus hasegawai n. sp. differs from *S. nipponensis* (Fig. 14R) in having a less high spire and a quite broader protoconch, a less elongate shell with clearly narrower axial ribs and anal tubes, a last whorl with a broader subsutural ramp and a narrower siphonal canal.

Derivation of name Named for Kazunori Hasegawa, of the National Museum of Nature and Science, Ibaraki, Japan, in recognition for his continuous help in many ways and for his contributions to Japanese malacology.

Genus *Trubatsa* Dall, 1889

Type species by original designation: *Typhis longicornis* Dall, 1888, Cuba.

Remarks. *Trubatsa* differs from *Siphonochelus* in having anal tubes with a broader base, they extend almost on the entire intervarical area, being flattened at their base. The tubes and the axial varices also extend as a broad buttress on preceding whorl (Fig. 6B). In *Siphonochelus* the tubes have a narrower base and they lack the broad buttress observed in *Trubatsa* (Fig. 6A). *Trubatsa* also differs from *Siphonochelus* in having the intervarical fold (or ridge) closer to the preceding varix. *Trubatsa* is here also separated from *Siphonochelus* on basis of genetic differences.

In *Choreotyphis* Iredale, 1936 the axial varices are much broader and rounder than in *Trubatsa*, without the presence of any intervarical axial fold (Fig. 6C), while the anal tubes originates directly from the varices. The validity of *Choreotyphis* needs still to be confirmed by genetic analysis.

Here Figure 6 if possible

Species in New Caledonia. *Trubatsa alinkios* n. sp., *T. lozoueti* (Houart, 1991), *T. saltantis* (Houart, 1991), *T. undulata* (Houart, 1991), *T. unicornis* (Houart, 1991), *T. virginiae* (Houart, 1986) (new combination), *T. wolffi* (Houart, 2013).

Trubatsa alinkios n. sp.

Figs 7B; 15E-L

Type material. New Caledonia, KANACONO stn DW4700, 22°43' S, 167°16' E, 245–295 m, 1 lv; holotype MNHN-IM-2013-69028 (BOLD MUBA912-21; Genbank MZ364596); stn DW4713, 22°47' S, 167°24' E, 356–380 m, 1 lv, paratype MNHN-IM-2013-69293 (BOLD MUBA915-21; Genbank MZ364600); stn DW 4714, 22°49' S, 167°25' E, 394–443 m, 1 lv; paratype MNHN-IM-2013-68291 (BOLD MUBA908-21; Genbank MZ364568).

Type locality. New Caledonia, South of Iles des Pins, 22°43' S, 167°16' E, 245–295 m.

Distribution. New Caledonia, Southwest of Iles des Pins, living at 295–394 m (Fig. 7B).

Description. Shell medium sized for the genus, up to 10.3 mm in length (paratype MNHN-IM-2013-68291). Length/width ratio 2.0–2.2 (holotype 9.5 x 4.6 mm, length/width ratio 2.1). Slender, lanceolate, narrow, ovate, lightly built, smooth. Subsutural ramp very weakly sloping, strongly concave. Shell glossy greyish-white, broad base of anal tubes tinged with orange-brown on buttress

extending on previous whorl and orange-brown narrow band at base of siphonal canal. Aperture glossy white within.

Spire high with 1.5 protoconch whorls and teleoconch of up to 5 weakly convex, strongly shouldered whorls. Suture impressed. Protoconch moderately large, weakly elongate. Whorls smooth with a narrow first whorl. Maximum height 1100 μm , width 700 μm . Terminal lip shallow, delicate, thin, opisthocline.

Axial sculpture of teleoconch whorls consisting of 4 high, broad, shouldered varices from first to last whorl. Varices more broadly expanded apically, largely extending above shoulder, forming broad buttress, fused to preceding whorl. Intervarical axial sculpture of a narrow rounded ridge, closer to preceding varix, shell very weakly excavated between ridge and succeeding varix. Spiral sculpture of very shallow P1 with anal tube and P2 (shoulder). Other spiral sculpture of numerous shallow spiral and axial striae; spiral striae more obvious on axial varices. Anal tubes ventrally sealed, rounded, broader at base, forming an angle of approximately 30°–45° with axis of shell. Aperture small, 18% of shell length in holotype, broadly ovate, rim forming a continuous peristome, smooth within. Siphonal canal long, broad, ventrally sealed, weakly abaxially and dorsally bent, broad at base, strongly tapered abapically.

Operculum and radula not examined.

Remarks. *Trubatsa alinkios* n. sp. is very close to *T. unicornis* (Fig. 16L–T) and shells of both species were confused until it became obvious from the phylogenetic analysis that they were separate.

Although the shell morphology is practically the same in both species which makes them very difficult to separate, a careful examination of the specimens at our disposal showed some consistent differences.

Specimens of *Trubatsa unicornis* with the same number of whorls as in the new species are larger; the spire is slightly broader and the axial varices are weakly sharper than in *T. alinkios* n. sp. Finally, the protoconch in *T. unicornis* is rounded instead of more elongate in *T. alinkios* n. sp. and obviously broader, with a width ratio of 900–1000 μm as opposed to 700 μm in the new species.

Derivation of name *Alinkios* (G), resembling, like. Named for its striking resemblance with *T. unicornis*.

Trubatsa lozoueti (Houart, 1991)

Fig. 15M–Q

Siphonochelus (*Siphonochelus*) *lozoueti* Houart, 1991b: 51, figs 25–27.

Siphonochelus (*Trubatsa*) *lozoueti* — Houart, 2013: 7.

Type locality. New Caledonia, BIOGEOCAL, stn DW253, 21°32' S, 166°29' E, 310–315 m.

Type material. Holotype MNHN-IM-2000-213.

New material examined. New Caledonia, off Thio, EXBODI, stn CP3799, 21°33' S, 166°20' E, 461–466 m, 1 lv, MNHN-IM-2009-22828 (BOLD MUBA001-15; Genbank MZ364548).

Distribution. Eastern New Caledonia, Loyalty Basin, off Thio, empty shell collected at 310–315 m (holotype), living at 461 m (new material).

Remarks. *Trubatsa lozoueti* is known today from only two specimens. One, the holotype, was collected during the BIOGEOCAL expedition in 1987, the second specimen was collected more recently, in 2011, during the EXBODI expedition at almost exactly the same location. Nothing has been reported between 1987 and 2011, and nothing since 2011, notwithstanding the numerous expeditions in the New Caledonia area.

The genotyping of the second specimen proved that it is distinct from other congeners, confirming that *T. lozoueti* is a valid species. Although larger than the holotype, this second specimen is strikingly similar with its broad spire, very broad, strongly shouldered last teleoconch whorl, broad anal tubes and comparatively broad, tapered, short siphonal canal.

The protoconch was broken in the holotype but the last whorl is partially intact in the second specimen and measures 800 µm in width.

Trubatsa saltantis differs in having a smaller shell with a narrow aperture and obviously narrower anal tubes. *T. unicornis* has a higher and broader spire, and narrower anal tubes. *T. undulatus* differs in having a spirally sculptured shell and a more elongate last teleoconch whorls.

Finally, *T. wolffi* has comparatively narrower spire whorls with a sharper apex, narrower anal tubes and a narrower and longer siphonal canal. The last teleoconch whorl in adult specimens of *T. wolffi* is narrower than in adults of *T. lozoueti* while adults of *T. wolffi* with a similar number of teleoconch whorls are bigger than *T. lozoueti*.

Trubatsa sp.

Siphonochelus pavlova — Barco et al. 2010: 1032 (not *Typhina pavlova* Iredale, 1936).

Locality. New Caledonia, EBISCO, stn DW2632, S Lansdowne, 21° 3' S, 160° 44' E, 297–378 m, 1 lv, MNHN-IM-2009-8590.

Remarks.

Taking into account the numerous examined specimens of *S. wolffi*, previously misidentified as *S. pavlova* (see Table 1), a species occurring in Australia, from Queensland to New South Wales, the sequenced specimen from New Caledonia identified as *Siphonochelus pavlova* by Barco et al. (2010: 1032) may have also been misidentified. Regrettably the voucher has been mislaid and the definitive identification of this specimen will remain an enigma until the shell is found.

Trubatsa saltantis (Houart, 1991)

Figs 9C–D; 15R–V

Siphonochelus (Siphonochelus) saltantis Houart, 1991a: 232, figs 7–8, 9, 19–20, 46, 70.

Siphonochelus (Trubatsa) saltantis — Houart, 2013: 7.

Type locality. New Caledonia, Coral Sea, MUSORSTOM 5, stn DW303, 22°12' S, 159°23' E, 332 m.

Type material. Holotype MNHN-IM-2000-896.

New material examined. More than 30 specimens, empty and live collected, from numerous expeditions.

Distribution. Chesterfield and Bellona Plateau, Argo and Capel Bank, Northeast and South New Caledonia, and the Loyalty Islands, living at 225–425 m.

Remarks. *Trubatsa saltantis* is another small deep-water species with a shell morphology only weakly variable and that rarely exceeds 9 mm in length. It cannot be confused with any of the Indo-West Pacific *Trubatsa* species occurring in New Caledonia, in having the smallest shell in that group, with a broad last teleoconch whorl and a narrow spire, very narrow, rounded anal tubes, a narrow, broadly ovate aperture and a small protoconch of 650–700 µm wide and 700 µm high.

Trubatsa undulata (Houart, 1991)

Fig. 16A–K

Siphonochelus (Siphonochelus) undulatus Houart, 1991a: 233, figs 24–25, 49, 69.

Siphonochelus (Trubatsa) undulatus — Houart, 2013: 7.

Type locality. New Caledonia, MUSORSTOM 4, stn DW203, south of Grande-Terre, 22°36' S, 167°05' E, 105–110 m.

Type material. Holotype MNHN-IM-2000-891.

New material examined. New Caledonia, LAGON, stn DW830, 20°49' S, 165°19' E, 105–110 m, 1 dd, MNHN-IM-2015-4618.

BATHUS 1, stn DW666, 20°57' S, 165°34' E, 105–110 m, 7 dd, juv, MNHN-IM-2015-4617; stn CP713, 21°45' S, 166°37' E, 250 m, 1 lv, 1 dd.

BATHUS 2, stn DW714, 22°38' S, 167°10' E, 124 m, 5 dd, juv, MNHN-IM-2014-2454; stn DW715, 22°39' S, 167°11' E, 202–227 m, 2 dd, juv, MNHN-IM-2015-4619.

EXPEDITION MONTROUZIER, stn 1237, 20°46.9' S, 165°13.8' E, 0–1 m, 1 dd, MNHN-IM-2010-21594; stn 1249, 20°49' S, 165°19' E, 80–140 m, 8 lv & dd, MNHN-IM-2010-21593; stn 1260, 20°44' S, 165°14' E, 49–59 m, many specimens, lv & d, MNHN-IM-2010-21599; stn 1261, 20°46–47' S, 165°15–17' E, 45–56 m, 3 lv, MNHN-IM-2010-21598; stn 1270, 20°45' S, 165°17' E, 10–35 m, 1 lv MNHN-IM-2010-21596; stn 1271, 20°53' S, 165°20' E, 5–25 m, 1 lv, MNHN-IM-2010-21597; stn 1275, 20°49' S, 165°17' E, 50–62 m, 3 lv, MNHN-IM-2010-21595.

KANACONO, stn DW4695, 22°47' S, 167°27' E, 200–290 m, 1 lv, MNHN-IM-2013-68961 (BOLD MUBA911-21; Genbank MZ364552); stn CP4709, 22°45' S, 167°24' E, 66–73 m, 1 lv, MNHN-IM-2013-69206 (BOLD MUBA907-21; Genbank MZ364598).

Distribution. Northeast and South New Caledonia, and Loyalty Islands, living at 25–80m. One live collected specimen was dredged from 200–290 m during the KANACONO expedition.

Remarks. *Trubatsa undulata* was described from a single specimen. Examination of additional material proved its validity.

Trubatsa undulata is close to *Choreotyphis erythrostigma* (Fig. 17P–S), however, *T. undulata* differs constantly in having a comparatively smaller and narrower shell with obviously narrower, higher and less rounded varices, a smaller aperture and a typical intervarical axial fold, absent in *Choreotyphis*. Moreover, in *T. undulata* the anal tube originates just behind the varix, although less obvious than in other *Siphonochelus* species, while in *C. erythrostigma* it originates directly from the broad, rounded varix.

Trubatsa unicornis (Houart, 1991)

Fig. 16L–T

Siphonochelus (Siphonochelus) unicornis Houart, 1991a: 233, figs 21–23, 48, 67.

Siphonochelus (Trubatsa) unicornis — Houart, 2013: 7.

Type locality. New Caledonia, MUSORSTOM 4, stn DW226, south of Grande-Terre, 22°47' S, 167°22' E, 395 m.

Type material. Holotype MNHN-IM-2000-890.

New material examined. KANACONO stn DW4666, 22°53' S, 167°17' E, 530–545 m, 4 lv; MNHN-IM-2013-68579 (BOLD MUBA905-21; Genbank MZ364592); MNHN-IM-2013-68627 (BOLD MUBA909-21; Genbank MZ364550); MNHN-IM-2013-68630; MNHN-IM-2013-68666, 1 lv, juv; stn DW4711, 22°47' S, 167°24' E, 335–338 m, 1 lv; MNHN-IM-2013-69452 (BOLD MUBA917-21; Genbank MZ364573); stn DW4698, 22°47' S, 167°18' E, 460–460 m, 3 lv, MNHN-IM-2013-69086 (BOLD MUBA913-21; Genbank MZ364611); MNHN-IM-2013-69105; MNHN-IM-2013-69109, 1 lv, juv.

Distribution. East and South New Caledonia, living at 345–530 m.

Remarks. Many specimens from several expeditions have been collected since its description, extending its geographical distribution to East New Caledonia and confirming the validity of the species as well as the weakly variable shell morphology. Moreover a few specimens have been recently collected during the KANACONO expedition and 4 of them are here included in the phylogenetic tree (Fig. 5).

Trubatsa unicornis has a high, broad spire, a relatively small, roundly ovate aperture, rounded anal tubes, forming an angle of approximately 80° with the axis of the shell, and a large protoconch of 900–1000 µm wide and 900–1200 µm high.

Trubatsa virginiae (Houart, 1986) (new combination)

Figs 9G; 17A–F

Typhis (Typhina) virginiae Houart, 1986: 440, pl. II, figs 7, 7A–B.

Typhis (Typhina) virginiae — Houart, 1991a: 227, figs 12, 41, 62.

Siphonochelus virginiae — Houart, 2002: 148.

Type locality. New Caledonia, VAUBAN 1978–79, stn DR2, 22°17' S, 167°14' E, 425–430 m.

Type material. Holotype MNHN-IM-2000-877.

New material examined. As for other species, many specimens from several expeditions have been collected since its description and confirm the validity of the species as well as the very little variability in the shell morphology.

Distribution. East New Caledonia, 20°35'–22°44' S, 164°59'–167°14' E, East Ile des Pins, 21°00' S, 167°25' E, and East Lifou, Loyalty Islands, living at 110–440 m.

Remarks. This is a small species, not exceeding 8 mm in length at maturity. It was originally assigned to *Typhis* (*Typhina*). Thereafter Houart (2002) transferred it to *Siphonochelus*. Based on genetic analysis it is here assigned to *Trubatsa*. This is supported by the presence of narrow intervarical folds and small buttresses connecting the preceding teleoconch whorl, a feature typical to that genus.

Trubatsa wolffi (Houart, 2013)

Fig. 17G–K

Siphonochelus (*Trubatsa*) *wolffi* Houart, 2013: 7, figs 11–16, 17–18, 34, 37.

Type locality. Eastern New Caledonia, BATHUS 1, stn CP668, 20°57' S, 165°35' E, 205–219 m.

Type material. Holotype MNHN-IM-2000-25089.

New material examined. New Caledonia, EXBODI, stn CP3795, 21°32' S, 166°21' E, 240–245 m, 2 lv, MNHN-IM-2009-22972 (BOLD MUBA517-15; Genbank MZ364587); MNHN-IM-2009-22973 (BOLD MUBA518-15; Genbank MZ364576); stn CP3807, 21°43' S, 166°36' E, 352–372 m, 4 lv, MNHN-IM-2009-23027 (BOLD MUBA558-15; Genbank MZ364588); MNHN-IM-2009-23028 (BOLD MUBA559-15; Genbank MZ364601); MNHN-IM-2009-23029 (BOLD MUBA560-15; Genbank MZ364589); MNHN-IM-2009-23030 (BOLD MUBA561-15; Genbank MZ364558); stn CP3810, 21°44' S, 166°38' E, 384–385 m, 1 lv, MNHN-IM-2009-22997 (BOLD MUBA537-15; Genbank MZ364594); stn CP3814, 21°49' S, 166°44' E, 331–344 m, 4 lv, MNHN-IM-2009-22988 (BOLD MUBA530-15; Genbank MZ364567); MNHN-IM-2009-22991 (BOLD MUBA532-15; Genbank MZ364590); MNHN-IM-2009-22992 (BOLD MUBA533-15; Genbank MZ364612); MNHN-IM-2009-22993 (BOLD MUBA534-15; Genbank MZ364614); stn CP3821, 21°53' S, 166°50' E, 211–440 m, 4 lv, MNHN-IM-2009-23039 (BOLD MUBA565-15; Genbank MZ364608); MNHN-IM-2009-23040 (BOLD MUBA566-15; Genbank MZ364551); MNHN-IM-2009-23041 (BOLD MUBA567-15; Genbank MZ364591); MNHN-IM-2009-23042 (BOLD MUBA568-15; Genbank

MZ364597); stn CP3823, 21°55' S, 166°55' E, 246–255 m, 1 lv, MNHN-IM-2009-22978 (BOLD MUBA523-15; Genbank MZ364593); stn CP3824, 21°57' S, 166°58' E, 280–296 m, 1 lv, MNHN-IM-2009-22975 (BOLD MUBA520-15; Genbank MZ364599); stn CP3825, 21°58' S, 166°59' E, 349–405 m, 1 lv, MNHN-IM-2009-22980 (BOLD MUBA524-15; Genbank MZ364570); stn CP3827, 21°58' S, 166°57' E, 220–232 m, 1 lv, MNHN-IM-2009-22971 (BOLD MUBA897-21; Genbank MZ364560); stn CP3828, 22°00' S, 167°01' E, 300–302 m, 1 lv, MNHN-IM-2009-22990 (BOLD MUBA531-15; Genbank MZ364572); stn CP3834, 22°06' S, 167°04' E, 257–258 m, 1 lv, MNHN-IM-2009-22998 (BOLD MUBA538-15; Genbank MZ364578).

Papua New Guinea, PAPUA NIUGINI, stn CP40324°52' S, 145°50' E, 610–620 m, 24 lv & dd, MNHN-IM-2012-19991; stn CP4038, 4°26' S, 145°34' E, 800–840 m, 5 lv & dd, MNHN-IM-2012-19990.

Distribution. Chesterfields Islands, East and South New Caledonia and northern Papua New Guinea (new record), living at 180–800 m (new bathymetric record).

Remarks. *Trubatsa wolffi* was wrongly identified as "*Siphonochelus*" *pavlova* by Houart (1986, 1991a, 2002) but it differs from that species by the same shell characters that differentiate *Trubatsa* from *Choreotyphis*, *i.e.* in having a narrow, obvious intervarical fold rather than having the intervarical fold entirely covered by the broad, rounded preceding varix in *Choreotyphis pavlova* (Fig. 17L–O). It also differs in having narrower varices, a narrower base of the anal tubes, a more elongate and higher spire and a quite smaller protoconch with a height of 800 µm opposed to 1000 µm in *Choreotyphis pavlova* and a width of 700 µm opposed to 800 µm.

Live and empty shells were also collected during the PAPUA NIUGINI expedition extending considerably its geographical and bathymetric distribution.

The 21 specimens included in the molecular analysis were collected along a rather short transect facing the NE coast of New Caledonia. Even if the tree topology might suggest a strong structuring, comparing the haplotypes with the collection stations reveals no matching pattern.

Genus *Choreotyphis* Iredale, 1936

Type species by original designation: *Typhina pavlova* Iredale, 1936, NSW, Australia (not in New Caledonia).

Remarks. No species of *Choreotyphis* are recorded from New Caledonia but *Trubatsa wolffi* was initially identified as *C. pavlova* in Houart (1986, 1991a, 2002) (see Table 2).

The genus *Choreotyphis* was not listed in Houart (2018), however, its type species, *C. pavlova*, was illustrated (fig. 18E) but wrongly as *Siphonochelus* (*Trubatsa*). *Choreotyphis* was reinstated by Houart

(2013) and is also retained here. Nevertheless, genetic studies would be welcome to confirm this status.

Radwin & D'Attilio (1976: 206) and D'Attilio & Hertz (1988: 62) considered *Choreotyphis* a junior synonym of *Trubatsa*. However, in *Choreotyphis pavlova* the axial varices are much broader and rounder than in *Trubatsa*, without the presence of any intervarical axial fold (Fig. 6), while the anal tubes originate directly from the varices. In *Siphonochelus* and *Trubatsa* the tubes are connected to the succeeding varices but they originate just behind them, while the varices are narrower and less rounded and that an axial fold is always present near the preceding varix.

Choreotyphis Iredale, 1936 was described for a single species from eastern Australia but based on these differences, *C. erythrostigma*, another species from eastern Australia is here also assigned to *Choreotyphis* (Fig. 17P–S).

Genus *Typhina* Jousseume, 1880

Type species by original designation: *Typhis belcheri* Broderip, 1833, West Africa and East Atlantic.

Remarks. The genetic analysis groups three genera of Typhinae previously considered separate taxa into the same clade (Fig. 5), indicating that they must be synonymized. These are *Talityphis* Jousseume, 1882 (= *Typhina* Jousseume, 1880), type species by original designation: *Typhis expansus* Sowerby, 1874, East Atlantic; *Typhisopsis* Jousseume, 1880 (new synonym), type species by original designation: *Typhis coronatus* Broderip, 1833 and *Typhisala* Jousseume, 1881 (new synonym), type species by original designation: *Typhis grandis* A. Adams, 1855.

As First Revisers we here give precedence to *Typhina* over *Typhisopsis* Jousseume, 1880 (ICZN 1999, art. 24.2.1).

Species in New Caledonia. *Typhina neocaledonica* (Houart, 1987)

Typhina neocaledonica (Houart, 1987)

Figs 1, 18A–C

Typhis (Talityphis) neocaledonicus Houart, 1987: 208, figs. 8, 9, 16.

Typhina neocaledonica — Houart, 2002: 148.

Type locality. New Caledonia, Programme LAGON, stn DW354, Grand Récif Sud, 22°38' S, 167°14' E, 40–50 m.

Type material. Holotype MNHN-IM-2000-191.

Distribution. Only known from the holotype, living at 40–50 m.

Remarks. No additional material was collected since the description of this shallow-water species.

Typhina clarksoni n. sp.

Figs 7D; 18D–I

Material examined. Western Australia, North of Exmouth, Northeast side of Peak Island, 27–29 m, reef covered sparsely with small sponges and hard corals, 2 dd, holotype WAMS_29958; 1 paratype RH.

Type locality. Western Australia, North of Exmouth, Northeast side Peak Island, 27–29 m.

Distribution. Only known from the type locality, dead collected (Fig. 7D).

Description. Shell up to 20.8 mm in length (holotype), broad, heavy. Spire moderately high. Protoconch unknown, partially broken, last whorl rounded. Teleoconch with 5 broad, strongly shouldered whorls. Suture impressed. Length/width ratio 1.48 (holotype). Subsutural ramp broad, very weakly sloping, lightly concave.

Shell off white, light brown or grey coloured on subsutural ramp.

Axial sculpture of first 3 teleoconch whorls with sharp varices; remaining teleoconch whorls with 4 strong, broad, rounded varices; each varix with a narrow, flat, short, strongly inwards pointed triangular, flat spine at apical extremity. Anal tube adjacent to leading edge of varix and adpressed to previous laminar extension. Varices broader and swollen at shoulder periphery. Apertural varix with a broad, very weakly sinuous flange, attached to previous whorl by a broad laminar extension.

Dorsal part of varices, including siphonal canal, with strong spiral cords. Last whorl with 9 rounded cords, increasing in strength abapically. P1 with sealed, rounded anal tube near preceding varix. P2 with flat, triangular spine at intersection with varices, followed by s2, P3, s3, P4–P6, ADP, MP, ABP. Intervarical sculpture faint. Sealed rounded anal tube adpressed to laminar extension on preceding varix, forming an angle of approximately 80–90° with axis of shell. Spiral cords ending as very short, weakly backward curved spines at the edge of the apertural flange in the holotype (flange partly broken in paratype).

Aperture broadly ovate, forming a continuous peristome, erect at outer lip and abapical portion of columellar lip and adpressed adapically. Siphonal canal long, broad, ventrally sealed. Sutural line strongly shifted to the right, left side of canal broadly overlapping right side. Holotype ending with the siphonal canal dorsally curved at the extremity.

Remarks. *Typhina claydoni* (Houart, 1988) (Fig. 18J–M) from Port Hedland and Broome, Western Australia, differs from *T. clarksoni* n. sp. in having a smaller, more globose shell with broader, rounder, axial varices with strongly dorsally curved axial lamellae, a shorter spire and a strongly dorsally bent siphonal canal.

Derivation of name This species is dedicated to the memory of Peter Clarkson, South Australian commercial abalone diver, amateur shell diver and collector who sent me these two specimens in the nineties. Peter lost his life to a shark attack on 17/2/2011 off Coffin Bay, near Port Lincoln, South Australia.

Here Figure 7 if possible (Distribution maps)

Genus *Typhinellus* Jousseaume, 1880

Type species by original designation: *Typhis sowerbyi* Broderip, 1833 = *Murex labiatus* Cristofori & Jan, 1832, Mediterranean, East Atlantic.

Species in New Caledonia. *Typhinellus insolitus* (Houart, 1991), *T. occlusus* (Garrard, 1963) (new record in New Caledonia)

Typhinellus insolitus (Houart, 1991)

Fig. 19G–H

Typhis (Typhinellus) insolitus Houart, 1991b: 49, figs 22–24.

Type locality. New Caledonia, Loyalty Ridge, MUSORSTOM 6, stn DW406, 20°41' S, 167°07' E, 373 m.

Type material. Holotype MNHN-IM-2000-991.

Distribution. Only known from the holotype, collected dead at 373 m in the vicinity of the Loyalty Islands.

Remarks. No additional material was collected since the description of this very peculiar shell.

Typhinellus occlusus (Garrard, 1963)

Fig. 19A–F

Typhisopsis occlusus Garrard, 1963: 46, pl. 7, figs 9, 10.

Type locality. Australia, Queensland, off Hayman Is, Withsunday Group, 20°3' S, 148°53' E, 31 m.

Type material. Holotype AMS C.64072.

New material examined. Northern New Caledonia, PALEO-SURPRISE, stn CP1379, Atoll de Surprise, 18°25' S, 163°05' E, 46 m, 1 dd; stn DW1397, 18°22' S, 163°04' E, 43 m, juv., 1 lv.

Distribution. Australia, Queensland, Withsunday Group, lv, 31 m; north of New Caledonia, lv, 43 m (new record); southern Philippine Islands, lv, 150–200 m.

Remarks. The holotype of *Typhinellus occlusus* (Fig. 19D–F) was described from Queensland, Australia and similar specimens have been live collected in southern Philippine Islands in 150–200 m through the use of tangle nets.

One empty collected specimen was dredged from 46 m from the Surprise Atoll, north of New Caledonia and a juvenile of 9.2 mm was collected alive in 43 m at the same locality. The subadult specimen collected dead has not completed its growth (Fig. 19A–C) and the wing of the last (apertural) varix is incomplete and partly broken. However, the preceding varix bears a broadly winged varix as observed in *T. occlusus* while the anal tube is long, adpressed to preceding varix and laminar extension and forms an angle of approximately 50° with the axis of the shell. Philippine specimens usually have anal tubes forming an angle of 45–90°.

CHECKLIST OF THE TYPHINAE IN NEW CALEDONIA

The Typhinae of New Caledonia were studied by Houart (1991a), who listed 11 species, most of them occurring in deep water, living between 250 and 600 m. Since then new species and new information (Houart, 1991b, 2002, 2013, this paper) and new records (this paper) have increased the number of valid species to 17 from New Caledonia and four still unidentified species, as follows (see also Table 2 and appendix):

Laevityphis tillierae (Houart, 1986); *Laevityphis* sp.; *Monstrotyphis adelos* n. sp.; *M. carolinae* (Houart, 1987); *M. singularis* Houart, 2002; *M. maestratii* n. sp.; *Monstrotyphis* sp.; *Siphonochelus angustus* Houart, 1991; *S. boucheti* Houart, 1991; *Siphonochelus* sp. cf. *S. arcuatus* (Hinds, 1843); *Trubatsa alinkios* n. sp.; *Trubatsa* sp.; *T. lozoueti* Houart, 1991; *T. saltantis* Houart, 1991; *T.*

undulatus Houart, 1991; *T. unicornis* Houart, 1991; *T. virginiae* Houart, 1986 (new combination); *T. wolffi* (Houart, 2013); *Typhina neocaledonica* (Houart, 1987); *Typhinellus insolitus* (Houart, 1991); *T. occlusus* (Garrard, 1963) (new record).

A total of 13 species out of the 17 identified species, i.e. 76 %, are endemic to New Caledonia.

APPENDIX

CATALOGUE OF RECENT TYPHINAE

● *Species studied or mentioned in this paper*; ◆ *Living in New Caledonia*; ■ *Species included in the phylogenetic analysis*.

***Brasityphis* Absalão & Santos, 2003**

Type species by original designation: *Brasityphis barrosi* Absalão & Santos, 2003, Brazil (Fig. 20A–B).

Short description: No laminar extension; four axial varices; strong spiral sculpture; presence of strong denticles within the aperture; anal tube not originating from varix; close to succeeding varix.

Length of the holotype: 4 mm.

Included species

Brasityphis barrosi Absalão & Santos, 2003

***Choreotyphis* Iredale, 1936**

Type species by original designation: *Typhina pavlova* Iredale, 1936, NSW, Australia (Fig. 20C–D).

Short description: No laminar extension; teleoconch whorls with four axial varices; varices rounded, smooth, without spines; anal tubes directly originating from broad, rounded varix; no intervarical fold.

Tubes and axial varices extending as a broad buttress over preceding whorl.

Average length of the type species: 16 mm.

Included species

Choreotyphis erythrostroma (Keen & Campbell, 1964) ● (new combination)

C. pavlova (Iredale, 1936) ●

***Distichotyphis* Keen & Campbell, 1964**

Type species by original designation: *Distichotyphis vema* Keen & Campbell, 1964, off Panama and Costa Rica (Fig. 20E).

Short description: No laminar extension; two axial varices; anal tube originating from varix; varices rounded, smooth.

Length of the holotype: 8 mm.

Included species

Distichotyphis vema Keen & Campbell, 1964

***Haustellotyphis* Jousseume, 1880**

Type species by original designation: *Typhis cumingii* Broderip, 1833, West Mexico to Ecuador (Fig. 20F).

Short description: Presence of a laminar extension; four axial varices; long, straight, spineless siphonal canal, without distinct previous canals; intervarical nodes; anal tubes not originating from varix, closer to preceding varix.

Average length of the type species: 25 mm.

Included species

Haustellotyphis cumingii (Broderip, 1833)

H. wendita Hertz, 1995

***Hirtotyphis* Jousseume, 1880**

Type species by original designation: *Murex horridus* Brocchi, 1814, Pliocene, Italy (Fig. 20G).

Short description: No laminar extension; four axial varices per whorl; varices rounded with hollow, conical spines arranged in a linear series along the crest and decreasing in strength adapically; anal tube not originating from varix, situated between each varix. Varices of last whorl each with broadly enlarged, sealed, straight or nearly straight, radial spines.

Average length of the type species: 21 mm.

Included species

Hirtotyphis trispinosus Houart, 1991

***Laevityphis* Cossmann, 1903**

Type species by original designation: *Typhis coronarius* Deshayes, 1865 = *T. muticus* J. Sowerby, 1834, Eocene, France (Fig. 20H–I).

Short description: No laminar extension; teleoconch whorls with four axial varices; varices rounded, occasionally topped adapically by a vertical, hollow, conical spine; anal tubes not originating from varix, closer to preceding varix.

Average length of the type species: 7 mm.

Included species

Laevityphis bullisi Gertman, 1969

L. libos Houart, 2017

L. tillierae (Houart, 1986) ● ◆

L. tubuliger (Thiele, 1925)

***Monstrotyphis* Habe, 1961**

Type species by original designation: *Typhis (Typhinellus) tosaensis* Azuma, 1960, Japan (Fig. 20J).

Short description: No laminar extension; teleoconch whorls with four axial varices; varices narrow, frilled, spined or webbed; flange not extending farther than adapical portion of siphonal canal; straight, spinose or webbed, rarely smooth siphonal canal; anal tube not originating from varix, closer to preceding varix. Siphonal canal usually with the presence of a short or long, occasionally split and webbed spine, extension of ADP spiral cord.

Average length of the type species: 25 mm.

Included species

Monstrotypis adelos n. sp. ● ◆ ■

M. anapaulae Houart & Rosado, 2019

M. bivaricata (Verco, 1909)

M. carolinae (Houart, 1987) ● ◆ ■

M. goniodes Houart, Gori & Rosado, 2017

M. imperialis (Keen & Campbell, 1964)

M. jardinreinensis (Espinosa, 1985)

M. montfortii (A. Adams, 1863)

M. pauperis (Mestayer, 1916)

M. singularis Houart, 2002 ● ◆

M. maestratii n. sp. ● ◆ ■

M. takashigei Houart & Chino, 2016

M. tangaroa Houart & Marshall, 2012

M. teramachii (Keen & Campbell, 1964)

M. tosaensis (Azuma, 1960)

M. yatesi (Crosse & Fischer, 1865)

***Siphonochelus* Jousseaume, 1880**

Type species by original designation: *Typhis arcuatus* Hinds, 1843, South Africa (Fig. 20K–L).

= *Eotyphis* Tembrock, 1963

Type species by original designation: *Typhis sejunctus* Semper, 1861, Upper Oligocene, Germany.

Remarks. The genus *Siphonochelus* is here restricted to the exclusion of the species previously included in the subgenus *Trubatsa* (Houart, 2013), following the preliminary findings of Barco et al. (2010) and our phylogenetic analysis.

Short description: No laminar extension; teleoconch whorls with four, rarely five axial varices; varices rounded, smooth, without spines; anal tubes weakly flattened at base, connected to succeeding varix; presence of a single intervarical fold close to preceding varix.

Average length of the type species: 16 mm.

Included species

Siphonochelus aethomorpha Houart & Héros, 2015

S. angustus Houart, 1991 ●◆

S. arcuatus (Hinds, 1843)

S. boucheti Houart, 1991 ●◆■

S. generosus Iredale, 1936

S. hasegawai n. sp. ●■

S. japonicus (A. Adams, 1863)

S. mozambicus Houart, 2017

S. nipponensis Keen & Campbell, 1964

S. pentaphasios (Barnard, 1959)

S. radwini Emerson & D'Attilio, 1979

S. riosi (Bertsch & D'Attilio, 1980)

S. rosadoi Houart, 1999 ●■

S. solus Vella, 1961

S. stillacandidus Houart, 1985

S. syringianus (Hedley, 1903)

S. transcurrens (von Martens, 1902)

***Trubatsa* Dall, 1899**

Type species by original designation: *Typhis longicornis* Dall, 1888, Cuba (Fig. 20M–N).

Remarks. Although previously treated as subgenus within *Siphonochelus* (Houart, 2013), our molecular analysis confirms preliminary results in Barco et al. (2010) that the species here included form a distinct lineage of equal rank, justifying the recognition of *Trubatsa* as valid genus.

Short description. No laminar extension; teleoconch whorls with four axial varices; varices rounded, smooth, without spines; tubes connected to succeeding varix; broad buttress connecting varix to preceding whorl; presence of a single axial intervarical fold; anal tubes with broad base, stretching across almost the entire intervarical area.

Average length of the type species: 9 mm.

Included species

Trubatsa alinkios n. sp. ●◆■

T. longicornis (Dall, 1888) ■ (new combination)

T. lozoueti (Houart, 1991) ●◆■ (new combination)

T. saltantis (Houart, 1991) ●◆ (new combination)

T. tityrus (Bayer, 1971) (new combination)

T. unicornis (Houart, 1991) ●◆■ (new combination)

T. undulata (Houart, 1991) ●◆■ (new combination)

T. virginiae (Houart, 1986) ●◆■ (new combination)

T. wolffi (Houart, 2013) ● ◆ ■ (new combination)

***Typhina* Jousseume, 1880**

Type species by original designation: *Typhis belcheri* Broderip, 1833, West Africa (Fig. 200–P).
= *Talityphis* Jousseume, 1882

Type species by original designation: *Typhis expansus* Sowerby, 1874, East Atlantic
= *Typhisala* Jousseume, 1881 (new synonymy)

Type species by original designation: *Typhis grandis* A. Adams, 1855, Gulf of California
= *Typhisopsis* Jousseume, 1880 (new synonymy)

Type species by original designation: *Typhis coronatus* Broderip, 1833, eastern Pacific.

Remarks. The genera *Typhisala* Jousseume, 1881 and *Typhisopsis* Jousseume, 1880 are here synonymized with *Typhina* Jousseume, 1880 based on the molecular phylogenetic tree that places *Typhis grandis* A. Adams, 1855 and *Typhis coronatus* Broderip, 1833, the respective type species of the two former genera, in the same clade with the other *Typhina* species included in the molecular analysis.

Short description: Presence of a laminar extension; teleoconch whorls with four flange-like or rounded, ropelike, frilled axial varices; varix with curved, sharp, shoulder spine; varical flange broadly expanded adapically, extending to midway or almost the tip of siphonal canal; occasionally with weak or moderately strong spiral sculpture; anal tube originating near preceding varix.

Average length of the type species: 21 mm.

Included species

Typhina belcheri (Broderip, 1833)

T. campbelli (Radwin & D'Attilio, 1976)

T. carolskoglundae Houart & Hertz, 2006 (new combination, ex *Typhisopsis*)

T. clarki (Keen & Campbell, 1964) (new combination, ex *Typhisala*)

T. clarksoni n. sp. ●

T. claydoni (Houart, 1988) (new combination, ex *Typhisopsis*)

T. coronatus (Broderip, 1833) ● ■ (new combination, ex *Typhisopsis*)

T. expansa (Sowerby, 1874) ■

T. grandis (A. Adams, 1855) ● ■ (new combination, ex *Typhisala*)

T. lamyi (Garrigues & Merle, 2014) ● ■ (new combination, ex *Typhinellus*)

T. latipennis (Dall, 1919)

T. neocaledonica (Houart, 1987) ● ◆

T. nitens (Hinds, 1843)

T. puertoricensis (Warmke, 1964)

***Typhinellus* Jousseume, 1880**

Type species by original designation: *Typhis sowerbyi* Broderip, 1833 = *Murex labiatus* Cristofori & Jan, 1832, Mediterranean, East Atlantic (Fig. 20Q–R).

Short description: Presence of a laminar extension; teleoconch whorls with four flange-like, frilled axial varices. Varices constricted above the aperture and flaring at its abapical end; varical flange of last teleoconch whorl extending to almost the tip of siphonal canal; anal tubes situated near preceding varix, adpressed to preceding laminar extension.

Average length of the type species: 17 mm.

Included species

Typhinellus amoenus Houart, 1994

T. androyensis Bozzetti, 2007 ● ■

T. bicolor Bozzetti, 2007

T. constrictus Houart & Héros, 2015 ● ■

T. insolitus (Houart, 1991) ● ◆

T. jacolombi Houart, 2015

T. labiatus (Cristofori & Jan, 1832) ● ■

T. laminatus Houart & Héros, 2015

T. mirbatensis Houart, Gori & Rosado, 2015

T. oclusus (Garrard, 1963) ● ◆

***Typhis* Montfort, 1810**

Type species by original designation: *Typhis tubifer* Bruguière, 1792, Eocene, France (Fig. 20S).

Short description: No laminar extension; four axial varices per whorl; varices rounded with hollow, conical spines arranged in a linear series along the crest and decreasing in strength adapically; anal tube not originating from varix, situated between each varix. Varices of last whorl each with backward curving, sealed spines of moderate size. Shoulder spine strongly adapically bent.

Average length of the type species: 22 mm.

Included species

Typhis phillipensis Watson, 1883

T. ramosus Habe & Kosuge, 1971 ● ■

T. wellsii Houart, 1985

T. westaustralis Houart, 1991

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REFERENCES

ABSALÃO, R.S. & SANTOS, F.N. DOS 2003 A new genus and species of Typhinae (Mollusca, Gastropoda, Muricidae) from off northeastern Brazil. *Zootaxa* **279**: 1–6.

BARCO, A., CLAREMONT, M., REID, D.G., HOUART, R., BOUCHET, P., WILLIAMS, S.T., CRUAUD, C., COULOUX, A., OLIVERIO, M. 2010 A molecular phylogenetic framework for the Muricidae, a diverse family of carnivorous gastropods. *Molecular Phylogenetics and Evolution* **56**: 1025–1039.

- BARCO, A., MARSHALL, B., HOUART, R., & OLIVERIO, M. 2015 Molecular phylogenetics of Hastrinae and Pagodulinae (Neogastropoda: Muricidae) with a focus on New Zealand species. *Journal of Molluscan Studies* **81**(4), 476-488.
- BARCO, A., SCHIAPARELLI, S., HOUART, R. & OLIVERIO, M. 2012 Cenozoic evolution of Muricidae (Mollusca, Neogastropoda) in the Southern Ocean, with the description of a new subfamily. — *Zoologica Scripta* **41**, 596–616.
- BOUCHET, P. & KANTOR, YU. I. 2004 New Caledonia: the major center of biodiversity for volutomitrid molluscs (Mollusca: Neogastropoda: Volutomitridae). *Systematics and Biodiversity* **1**: 467–502.
- BOZZETTI, L. 2007 Quattro nuovi muricidi (Gastropoda: Hypsogastropoda: Muricidae: Muricopsinae, Coralliophilinae, Typhinae) dal Madagascar Meridionale. *Malacologia Mostra Mondiale* **57**: 6–10.
- D'ATTILIO, A. 1975 The typhine shell: theme, development and elaboration. *The Festivus* **6**(9): 53–60.
- D'ATTILIO, A. & HERTZ, C.M 1988. An illustrated catalogue of the family Typhidae Cossmann, 1903. *The Festivus* **20** (supplement): 1–73.
- FOLMER, O., BLACK, M., HOEH, W., LUTZ, R. & VRIJENHOEK, R. 1994 DNA primers for amplification of mitochondrial cytochrome c oxidase subunit I from diverse metazoan invertebrates. *Molecular Marine Biology and Biotechnology* **3**:294-299.
- GARRARD, T.A. 1963 New species of Mollusca from eastern Australia. *Journal of the Malacological Society of Australia* **7**: 42–46.
- GARRIGUES, B. & MERLE, D 2014. Nine new species of Muricidae Rafinesque, 1815 (Mollusca, Gastropoda) from the French Antilles. *Zoosystema* **36**(4): 841–864.
- GERTMAN, R.L., 1969 Cenozoic Typhinae (Mollusca: Gastropoda) of the Western Atlantic region. *Tulane Studies of Geology and Paleontology* **7**(4): 143–191.
- HERTZ, C.M., 1995 A second species of *Haustellotyphis* (Gastropoda: Typhidae) from Costa Rica. *The Veliger* **38**(2): 158–161.

HIGO, S., CALLOMON, P., & GOTŌ, Y. 1999 *Catalogue and bibliography of the marine shell-bearing Mollusca of Japan. Gastropoda. Bivalvia. Polyplacophora. Scaphopoda*. Elle Scientific Publications, Japan, 749 pp.

HIGO, S., CALLOMON, P., & GOTŌ, Y. 2001 *Catalogue and bibliography of the marine shell-bearing Mollusca of Japan. Gastropoda. Bivalvia. Polyplacophora. Scaphopoda. Type figures*. Elle Scientific Publications, Japan, 208 pp.

HOUART, R. 1986 Mollusca Gastropoda: Noteworthy Muricidae from the Pacific ocean, with description of seven new species. *Mémoires du Muséum national d'Histoire naturelle série a., zoologie*, **133**. Résultats des campagnes Musorstom I & II, Philippines: 427–455.

HOUART, R. 1987 Description of four new species of Muricidae (Mollusca: Gastropoda) from New Caledonia. *Venus* **46**(4): 202–210.

HOUART, R. 1991a Mollusca, Gastropoda: The Typhinae (Muricidae) from the New Caledonian region with description of five new species. *Mémoires du Muséum national d'Histoire naturelle*, (A), 150. Résultats des Campagnes MUSORSTOM **7**: 223–241.

HOUART, R. 1991b Description of thirteen new species of Muricidae (Gastropoda) from Australia and the New Caledonian region, with range extensions to South Africa. *Journal of the Malacological Society of Australia* **12**: 35–55.

HOUART, R. 1994 Description of a new species of Typhinae (Muricidae) from the Western Indian Ocean. *Annals of the Natal Museum* **35**: 153–155.

HOUART, R. 1997 Mollusca, Gastropoda: The Muricidae collected during the KARUBAR Cruise in eastern Indonesia. Résultats des Campagnes MUSORSTOM, vol. 16, *Mémoires du Muséum national d'Histoire naturelle* **172**: 287–294.

HOUART, R. 1999 Description of two new species of Muricidae (Gastropoda) from Mozambique, east Africa, and range extension of *Chicoreus (Triplex) elisae* Bozzetti, 1991. *Iberus* **17**(2): 123–130.

HOUART, R. 2002 Description of a new typhine (Gastropoda: Muricidae) from New Caledonia with comments on some generic classifications within the subfamily. *Venus* **61**(3–4): 147–159.

- HOUART, R. 2013 Description of two new species of Trophoninae s.l. and Typhinae (Gastropoda: Muricidae) from New Caledonia and comments on *Litozamia* Iredale, 1929 and *Siphonochelus* Jousseume, 1880. *Venus* **71**(1–2): 1–11.
- HOUART, R. 2015 Description of a new species of *Typhinellus* (Gastropoda: Muricidae: Typhinae) from the Western Atlantic. *Zootaxa* **4007**(3): 427–432.
- HOUART, R. 2017a *Siphonochelus japonicus* (A. Adams, 1863) and *Siphonochelus nipponensis* Keen & Campbell, 1964, and their intricate history with the description of a new *Siphonochelus* species from Mozambique. *Venus* **75**(1–4): 27–38.
- HOUART, R. 2017b Description of eight new species and one new genus of Muricidae (Gastropoda) from the Indo-West Pacific. *Novapex* **18**(4): 81–103.
- HOUART, R. 2018 Historique et classification des espèces actuelles de Muricidae (Neogastropoda: Muricoidea). *Novapex* **19**(2): 37–66.
- HOUART, R. & CHINO, M. 2016 Description of *Monstrotyphis takashigei* n. sp. (Muricidae: Typhinae) from Akino-hama, Izu-Oshima, Izu Islands, Japan. *Venus* **74**(3–4): 94–97.
- HOUART, R., GORI, S. & ROSADO, J. 2015 Description of new species of *Favartia* (*Pygmaeptyrys*) and *Typhinellus* (Muricidae: Muricopsinae and Typhinae) from Southern Oman. *Novapex* **16**(4): 121–128.
- HOUART, R., GORI, S. & ROSADO, J. 2017 The Muricidae (Gastropoda: Muricoidea) from Oman with the description of four new species. *Novapex* **18**(3): 41–69.
- HOUART, R. & HÉROS, V. 2008 Muricidae (Mollusca: Gastropoda) from Fiji and Tonga, in Héros V, Cowie R.H. & Bouchet, P. (eds), Tropical Deep-Sea Benthos 25. *Mémoires du Muséum national d'Histoire naturelle* **196**: 437–480.
- HOUART, R. & HÉROS, V. 2015 New species of Muricidae Rafinesque, 1815 (Mollusca: Gastropoda) from the Western Indian Ocean. *Zoosystema* **37**(3): 481–503.
- HOUART, R. & HERTZ, C. 2006 A review of *Typhisopsis* Jousseume, 1880, and *Typhisala* Jousseume, 1881 (Gastropoda, Muricoidea) of the eastern Pacific. *The Nautilus* **120**(2): 52–65.

- HOUART, R., KILBURN, R.N. & MARAIS, A.P. 2010 Muricidae. In Marais, A.P and Seccombe, A.D. *Identification Guide to the Seashells of South Africa*. Vol. 1: 177–270. Centre for Molluscan Studies, Groenkloof, South Africa, pp 376.
- HOUART, R. & MARSHALL, B. 2012 The Recent Typhinae (Gastropoda: Muricidae) of New Zealand. *Molluscan Research* **32**(3): 137–144.
- HOUART, R. & ROSADO, J. 2019 *Monstrotypis anapaulae* n. sp. a remarkable new Typhinae (Gastropoda: Muricidae) from Mozambique. *Novapex* **20**(4): 121–126.
- HOUART, R. & TRÖNDLÉ, J. 2008 Update of Muricidae (excluding Coralliophilinae) from French Polynesia with description of ten new species. *Novapex* **9**(2–3): 53–93.
- INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE 1999. *International code of zoological nomenclature*. 4th ed. Natural History Museum, London, United Kingdom.
- JAMIESON, B. G., TILLIER, S., TILLIER, A., JUSTINE, J. L., LING, E., JAMES, S., ... & HUGALL, A. F. 2002 Phylogeny of the Megascolecidae and Crassicitellata (Annelida, Oligochaeta): combined versus partitioned analysis using nuclear (28S) and mitochondrial (12S, 16S) rDNA. *Zoosystema* **24**(4): 707–734.
- KEEN, A.M. 1944 Catalogue and revision of the gastropod subfamily Typhinae. *Journal of Paleontology* **18**(1): 50–72.
- KEEN, A.M. & CAMPBELL, G.B. 1964 Ten new species of Typhinae (Gastropoda: Muricidae). *The Veliger* **7**(1): 46–57.
- KESSING B., CROOM H., MARTIN A., MCINTOSH C., MCMILLAN W.O., AND PALUMBI S.P. 1989. The simple fool's guide to PCR. Version 1.0. Special publication. Honolulu, Department of Zoology, University of Hawaii
- KOOL, S.P. 1993. Phylogenetic analysis of the Rapaninae (Neogastropoda: Muricidae). *Malacologia* **35**(2): 155–259.
- MERLE, D. 2001 The spiral cords and the internal denticles of the outer lip in the Muricidae: terminology and methodological comments. *Novapex* **2**(3): 69–91.

- MERLE, D. 2005 The spiral cords of the Muricidae (Gastropoda, Neogastropoda): importance of ontogenetic and topological correspondences for delineating structural homologies. *Lethaia* **38**: 367–379.
- MILLER M.A., PFEIFFER W., SCHWARTZ T. 2010 Creating the CIPRES Science Gateway for inference of large phylogenetic trees. Proceedings of the Gateway Computing Environments Workshop (GCE), pp 1-8. LA, New Orleans.
- MOLLUSCABASE 2018 Typhinae Cossmann, 1903.
<http://www.marinespecies.org/aphia.php?p=taxdetails&id=391512> (Accessed on 2021-01-07).
- RADWIN G. & D'ATILIO, A. 1976 *Murex shells of the world. An illustrated guide to the Muricidae*. Stanford University Press, Stanford, 284 pp.
- STAMATAKIS, A. 2006 RAxML-VI-HPC: maximum likelihood-based phylogenetic analyses with thousands of taxa and mixed models. *Bioinformatics*, **22**: 2688-2690. DOI 10.1093/bioinformatics/btl446
- VELLA, P. 1961 Australasian Typhinae (Gastropoda) with notes on the subfamily. *Paleontology* **4**(3): 362–391.
- TSUCHIYA, K. 2000 Muricidae. In: Okutani, T. (ed.), *Marine Mollusks in Japan*, Tokai University Press, Tokyo: 364–421.
- TSUCHIYA, K. 2017 Muricidae. In: Okutani, T. (ed.) 2nd edition, *Marine Mollusks in Japan*, Tokai University Press, Tokyo, I. Atlas: 1–711; II. Text: 715–1375.
- ZUCCON A & ZUCCON D. 2014 MrEnt: an editor for publication-quality phylogenetic tree illustrations. *Molecular Ecology Resources* **14**(5): 1090-1094.

Captions

Figure 1 Shell morphology in *Typhina neocaledonica* (Houart, 1987)

Figure 2 Method for determining diameter, height and counting the number of protoconch whorls, here *Monstrotyphis maestratii* n. sp.

Figure 3 Terminology used to describe the radula, here *Monstrotyphis maestratii* n. sp.
cc: central cusp; **ld:** lateral denticle; **lc:** lateral cusp; **lt:** lateral teeth; **ma:** marginal area; **old:** outer lateral denticle (following Kool 1993)

Figure 4 Phylogenetic relationships (Maximum Likelihood) of Typhinae. Clades in the Typhinae have been compressed to highlight the generic relationships within the subfamily and in regard to the other subfamilies/lineages in the Muricidae. Bootstrap values are indicated at the nodes.

Figure 5 Phylogenetic relationships (Maximum Likelihood) of Typhinae. The topology has been trimmed to show only the Typhinae clade. Bootstrap values are indicated at all major nodes. For clarity, these are omitted for intraspecific nodes. The tree has been edited in MrEnt v.2.5 (Zuccon & Zuccon, 2014).

Figure 6 Intervarical sculpture and sutural morphology

A. *Siphonochelus boucheti* Houart, 1991; **B.** *Trubatsa wolffi* (Houart, 2013); **C.** *Choreotyphis pavlova* (Iredale, 1936).

Figure 7 Distribution maps of the new species here described. Black symbols denote the type localities while other collection localities are indicated by white symbols. **A** *Monstrotyphis adelos* n. sp. (circles) and *M. maestratii* n. sp. (triangles); **B** *Trubatsa alinkios* n. sp.; **C** *Siphonochelus hasegawai* n. sp.; **D** *Typhina clarksoni* n. sp.

Figure 8 (radulae)

A–B. *Monstrotyphis carolinae* (Houart, 1987). Lagon, New Caledonia, scale bars: 10 μ m (SEM P. Bouchet).

C–D. *Monstrotyphis singularis* Houart, 2002. Montrouzier, stn 1271, New Caledonia, 20°52.7' S, 165°19.5' E, 5–25 m, scale bars 10 μ m (SEM A. Warén).

E–F. *Monstrotyphis maestratii* n. sp. MUSORSTOM 6, stn DW451, New Caledonia, 20°59' S, 167°25' E, 330 m, scale bars 50 μ m (SEM Y. Kantor).

Figure 9 (radulae)

A–B. *Siphonochelus boucheti* Houart, 1991. New Caledonia, CHALCAL 2, stn DW72, 24°54' S, 168°22' E, 527 m, scale bars 10 μ m (SEM P. Bouchet).

C–D. *Siphonochelus saltantis* Houart, 1991. New Caledonia, MUSORSTOM 5, stn DW263, 25°21' S, 159°46' E, 225–150 m, scale bars 10 μ m (SEM P. Bouchet).

E–F. *Trubatsa undulata* (Houart, 1991), New Caledonia, KANACONO, stn DW4695, MNHN-IM-2013-68961, 22°47' S, 167°27' E, 200–290 m, scale bars 10 μ m (SEM Y. Kantor).

G. *Trubatsa virginiae* (Houart, 1986). New Caledonia, KANACONO, stn DW4703, MNHN-IM-2013-69222, 22°46' S, 167°19' E, 350–348 m, scale bar 10 μ m (SEM Y. Kantor).

Figure 10 (radulae)

A. *Typhina claydoni* (Houart, 1988), West Australia, Port Hedland, 12 m (holotype WAMS_13958), scale bar 50 μ m (SEM A. Warén)

B. *Typhis phillipensis* Watson, 1883, New South Wales, Australia, scale bar 50 μ m (SEM A. Warén)

Figure 11 (scale bars 500 μ m)

A–G. *Laevityphis tillierae* (Houart, 1986). A–C. South of New Caledonia, 22°30'S, 166°24'E, 250–350 m, holotype MNHN-IM-2000-237, 5.4 mm (photo M. Caballer); D–F. New Caledonia, 22°19' S, 167°23' E, 825–860 m, RH, 7.3 mm; G. South Africa, off Mgazi River, 31°44' S, 29°32' E, 350 m, RH, 8.9 mm; **H–J.** *Laevityphis* sp., New Caledonia, east coast, 20°48' S, 165°19' E, 170 m, MNHN, 4 mm; **K–L.** *Laevityphis tubuliger* (Thiele, 1925), Sansibar-Kanal, 5°27' S, 39°18' W, 463–465 m, syntype ZMB109314, 5.1 mm; **M–T.** *Monstrotyphis carolinae* (Houart, 1987). M–O. New Caledonia, 22°32' S, 167°02'E, 78 m, holotype MNHN-IM-2000-1030, 20.5 mm (photo M. Caballer); P–T. New Caledonia, KANACONO, stn DW4703, 22°46' S, 167°19' E, 350–348 m, MNHN-IM-2013-69186, 17.5 mm; **U–Za.** *Monstrotyphis singularis* Houart, 2002. U–W. New Caledonia, 20°46' S–20°47' S, 165°15' E–165°16.5' E, 45–56 m, holotype MNHN-IM-2000-293, 6.3 mm (photo M. Caballer); X–Y. New Caledonia, 20°46'–47' S, 165°15'–17' E, 45–56 m, paratype RH, 6 mm; Z. New Caledonia, MUSORSTOM 5, stn DW274, 24°45' S, 159°41' E, 285 m, MNHN-IM-2014-6914, 7.6 mm; Za. Protoconch,

Figure 12 (scale bar 500 µm)

A–E. *Monstrotyphis singularis* Houart, 2002. A–C. KOUMAC 2.3, stn KL36, 20°50'S, 164°16.7'E, 60 m, MNHN-IM-2019-9150, 5.2 mm; D–E. Austral Archipelago, Rapa, NW of Tauna Id, 27°36.3' S, 144°18.2' W, 30 m, MNHN-IM-2008-2480, 5.7 mm; **F–M.** *Monstrotyphis maestratii* n. sp. F–I. Coral Sea, Chesterfield Plateau, 19°46' S, 158°30' E, 280–304 m, holotype MNHN-IM-2013-65600, 19.0 mm; J–M. New Caledonia, Loyalty Ridge, MUSORSTOM 6, stn DW417, 20°42' E, 167°04' E, 283 m, MNHN-IM-2014-6909, 17.3 mm; M. Protoconch (holotype); **N–T.** *Monstrotyphis adelos* n. sp. N–Q. South New Caledonia, KANACONO, stn DW4715, 22°50' S, 167°27' E, 424 m, holotype MNHN-IM-2013-69415, 10.4 mm; R–T. BATHUS 2, stn DW717, 22°44' S, 167°17' E, 350–393 m, paratype MNHN-IM-2014-6907, 13.8 mm.

Figure 13 (scale bar 500 µm)

A–G. *Monstrotyphis adelos* n. sp. KANACONO, stn DW4677, 22°53' S, 167°35' E, 390–376 m, paratype MNHN-IM-2013-68865, 7.5 mm (F–G: photo courtesy D. Masseurin); **H–J.** *Monstrotyphis imperialis* (Keen & Campbell, 1964), Japan, Shikoku, Kochi, Tosa Bay, 33°20' N, 133°40' E, 200 m, holotype Toba Aquarium, TT n° 1013, 16.5 mm, photo courtesy K. Hasegawa; **K–M.** *Monstrotyphis montfortii* (A. Adams, 1863), Philippines, Cebu, Mactan Id, Punta Engano, tangle nets, 50–100 m, RH, 10 mm; **N–P.** *Monstrotyphis tosaensis* (Azuma, 1960), South China Sea, 200 m, RH, 25.4 mm.

Figure 14 (scale bars 500 µm)

A–D. *Monstrotyphis* sp. New Caledonia, SMIB 8, stn DW182-184, South New Caledonia, 23°18' – 23°19' S, 168°05' E, 305–367 m, MNHN-IM-2014-6906, 7 mm; **E–J.** *Siphonochelus angustus* Houart, 1991. E–F. New Caledonia, Coral Sea, Lord Howe Ridge, Banc Nova, 22°10' S, 159°25' E, 385–420 m., holotype MNHN-IM-2000-33, 6.7 mm (photo M. Caballer); G–J. New Caledonia, Argo Bank, KANADEEP, stn DW4956, 23°13'S, 159°35' E, 295 m, MNHN, 5.2 mm; **K–O.** *Siphonochelus boucheti* Houart, 1991. K–L. New Caledonia, Norfolk Ridge, 24°54' S, 168°22' E, 527 m, holotype MNHN-IM-2000-46, 10.1 mm (photo M. Caballer); M–O. South New Caledonia, Chalcal 2, stn DW72, 24°55' S, 168°22' E, 527 m, paratype RH, 9.2 mm; **P–Q.** *Siphonochelus japonicus* (A. Adams, 1863). Japan, Wakayama Prefecture, Nada-cho, neotype NHMUK 20170292, 8.9 mm; **R.** *Siphonochelus nipponensis* (Keen & Campbell, 1964). Philippines, Aliguay Island, 380 m, RH, 13.7 mm; **S–Za.** *Siphonochelus hasegawai* n. sp. S–W. DongSha 2014, stn CP4130, 20°16' N, 116°08'E, 795–822 m, holotype MNHN- IM-2013-50304, 7.4 mm, W. Operculum; X–Y. DongSha 2014, stn CP4131, 20°06'N, 116°08'E, 916–1012 m, paratype MNHN- IM-2013-50327, 7.5 mm; Z–Za. Japan, off Kushimoto, 384–421 m, RH, 9.2 mm.

Figure 15 (scale bar 500 µm)

A–D. *Siphonochelus* cf. *S. arcuatus* (Hinds, 1844), New Caledonia, KANADEEP, stn DW4999, Lord Howe Rise, 23°53' S, 161°46' E, 1060 m, MNHN, 6.9 mm; **E–L.** *Trubatsa alinkios* n. sp. E–I. New Caledonia, South of Iles des Pins, 22°49' S, 167°25' E, 394–443 m, holotype MNHN-IM-2013-69028, 9.5 mm; J. New Caledonia, KANACONO, stn DW 4714, 22°49' S, 167°25' E, 394–443 m, paratype

MNHN-IM-2013-68291, 10.3 mm; K–L. New Caledonia, KANACONO, stn DW4713, 22°47' S, 167°24' E, 356–380 m, paratype MNHN-IM-2013-69293, 9.8 mm; **M–Q.** *Trubatsa lozoueti* (Houart, 1991). M–N. New Caledonia, BIOGEOCAL, stn DW253, 21°32' S, 166°29' E, 310–315 m, holotype MNHN-IM-2000-213, 9.4 mm (photo M. Caballer); O–Q. New Caledonia, EXBODI, stn CP3799, off Thio, 21°33' S, 166°20' E, 461–466 m, MNHN-IM-2009-22828, 12.9 mm; **R–V.** *Trubatsa saltantis* (Houart, 1991). R–T. New Caledonia, Coral Sea, MUSORSTOM 5, stn DW303, 22°12' S, 159°23' E, 332 m., holotype MNHN-IM-2000-896, 9.2 mm (photo M. Caballer); U–V. Coral Sea, 25°21' S, 159°46' E, 150–225 m, RH, 7.8 mm.

Figure 16 (scale bars 500 µm)

A–K. *Trubatsa undulata* (Houart, 1991). A–B. New Caledonia, south of Grande-Terre, 22°36' S, 167°05' E, 105–110 m, holotype MNHN-IM-2000-891, 5.9 mm (photo M. Caballer); C–F. New Caledonia, KANACONO, stn DW4695, 22°47' S 167°27' E, 200–290 m, MNHN-IM-2013-68961, 4.8 mm; G–K. New Caledonia, BATHUS 1, stn CP713, 21°45' S, 166°37' E, 250 m, MNHN, 10.9 mm; K. Protoconch; **L–T.** *Trubatsa unicornis* (Houart, 1991). L–M. New Caledonia, MUSORSTOM 4, stn DW226, south of Grande-Terre, 22°47' S, 167°22' E, 395 m, holotype MNHN-IM-2000-890, 12.0 mm (photo M. Caballer); N–O. New Caledonia, KANACONO, stn DW4711, 22°47' S, 167°24' E, 335–338 m, MNHN, 11.7 mm; P–T. New Caledonia, KANACONO, stn DW4666, 22°53' S, 167°17' E, 530–545 m; P. MNHN-IM-2013-68579, 11.6 mm; Q–T. MNHN-IM-2013-68627, 8.7 mm; T. Protoconch.

Figure 17 (scale bars 500 µm)

A–F. *Trubatsa virginiae* (Houart, 1986). A–C. New Caledonia, VAUBAN 1978–79, stn DR2, 22°17' S, 167°14' E, 425–430 m, holotype MNHN-IM-2000-877, 7.8 mm (photo M. Caballer); D–F. New Caledonia, KANACONO, stn DW4703, 22°46' S, 167°19' E, 350–348 m, MNHN-IM-2013-69222, 7.6 mm; **G–K.** *Trubatsa wolffi* (Houart, 2013). G–I. Eastern New Caledonia, BATHUS 1, stn CP668, 20°57' S, 165°35' E, 205–219 m, holotype MNHN-IM-2000-25089, 14.3 mm; J–K. New Caledonia, EXBODI, stn CP3821, Passe de Kouakoué-Canyon, 21°53' S, 166°50' E, 211–440 m, MNHN-IM-2009-23040, 11.8 mm; **L–O.** *Choreotyphis pavlova* (Iredale, 1936), Australia, Queensland, Off Cape Moreton, 11.2 mm, RH; P–S. *Choreotyphis erythrostroma* (Keen & Campbell, 1964), Australia, Queensland, east of Noosa, 65 m, 17.1 mm, RH.

Figure 18

A–C. *Typhina neocaledonica* (Houart, 1987), New Caledonia, Programme LAGON, stn DW354, Grand Récif Sud, 22°38' S, 167°14' E, 40–50 m, holotype MNHN-IM-2000-191, 18.00 mm (photo M. Caballer); **D–I.** *Typhina clarksoni* n. sp., West Australia, North of Exmouth, Northeast side Peak Island, 27–29 m. D–F. Holotype WAMS_29958, 20.8 mm; G–I. Paratype, RH, 18.1 mm; **J–N.** *Typhina claydoni* (Houart, 1988). J–L. West Australia, off Broome, 16 m, RH, 15.8 mm; M–N. West Australia, Port Hedland, 12 m, holotype WAMS_13958, 18.5 mm (photo courtesy WAM).

Figure 19 (scale bar 500 µm)

A–F. *Typhinellus oclusus* (Garrard, 1963). A–C. Northern New Caledonia, PALEO SURPRISE, stn CP1379, 18°25,2'S 163°05'E, 46 m, MNHN, 20.9 mm; D–F. Australia, Queensland, off Hayman Is, Withsunday Group, GBE, 20°3' S, 148°53' E, 31 m, holotype AMS C.64072, 27.7 mm (photo courtesy AMS); **G–H.** *Typhinellus insolitus* (Houart, 1991), New Caledonia, Loyalty Ridge, MUSORSTOM 6, stn DW406, 20°41' S, 167°07' E, 373 m, holotype MNHN-IM-2000-991, 16.9 mm (photo M. Caballer).

Figure 20 (type species of valid genera)

A–B. *Brasityphis barrosi* Absalão & Santos, 2003, Brazil, off Sergipe state, 37°05' S, 11°24' W, 99 m, paratype RH, 3.3 mm; **C–D.** *Choreotyphis pavlova* (Iredale, 1936), Australia, Queensland, off Cape Moreton, RH, 16.1 mm; **E.** *Distichotyphis* Keen & Campbell, 1964, off the Panama-Costa Rica coast, 06°21' N, 85°17' W, 1892 m, holotype AMNH 110459, 8.0 mm (photo courtesy AMNH); **F.** *Haustellotyphis cumingii* (Broderip, 1833), West Mexico, Manzanillo, RH, 24.1 mm; **G.** *Hirtotyphis horridus* (Brocchi, 1814), Italy, Siena, Pliocene, 19.3 mm; **H–I.** *Laevityphis muticus* (J. Sowerby,

1834), Paris Basin, France, Eocene, RH, 6.2 mm; **J.** *Monstrotypis tosaensis* (Azuma, 1960), South China Sea, RH, 25.4 mm; **K–L.** *Siphonochelus arcuatus* (Hinds, 1843), South Africa, Algoa Bay, RH, 12.8 mm; **M–N.** *Trubatsa longicornis* (Dall, 1888), Cuba, Bahia de Cochinos, 296–475 m, RH, 4.5 mm; **O–P.** *Typhina belcheri* (Broderip, 1833), Senegal, south of Goree, RH, 16.4 mm; **Q–R.** *Typhinellus labiatus* (Cristofori & Jan, 1832), Tunisia, Kerkennah, RH, 20.1 mm; **S.** *Typhis tubifer* Bruguière, 1792, Paris Basin, France, Eocene, RH, 19 mm.