

Redescription of *Stichopus naso* SEMPER, 1868 (Echinodermata, Holothuroidea, Stichopodidae)

by Claude MASSIN

Abstract

Specimens from Japan, Thailand, Papua New Guinea and Madagascar have allowed a complete redescription of *Stichopus naso* SEMPER, 1868. The species, with a wide Indo-Pacific distribution, is new to the fauna of Papua New Guinea and Madagascar. Similar to several other shallow-water holothurians it has the potential to reproduce by transversal fission. When disturbed, the body undulates in a typical fashion and it is capable of limited swimming movements.

Key words: *Stichopus naso*, distribution, Indo-Pacific, transversal fission, escape movement.

Résumé

Stichopus naso SEMPER, 1868 est redécrit en détail sur base de matériel provenant du Japon, de Thaïlande, de Papouasie Nouvelle-Guinée et de Madagascar. L'espèce qui a une large distribution Indo-Pacifique, est nouvelle pour la faune de Papouasie Nouvelle-Guinée et de Madagascar. *S. naso* a la possibilité de se reproduire par scission transversale comme d'autres holothuries littorales. Lorsqu'il est dérangé, il présente un mouvement natatoire par ondulation du corps.

Mots clés: *Stichopus naso*, distribution, Indo-Pacific, scission transversale, mouvement de retraite.

INTRODUCTION

Although *Stichopus naso* SEMPER, 1868 (non *S. naso* HAACKE, 1880 = *S. herrmanni* SEMPER, 1868) has always been considered a valid species and its

synonymy substantially determined (ROWE & GATES, 1995), its complete ossicle assemblage has never been fully described. SEMPER, (1868), MITSUKURI, (1912), and REYES-LÉONARDO (1984) only illustrated the body wall ossicles, excluding those from the papillae, tube-feet and tentacles.

Originally, *Stichopus naso* was considered an endemic of the Philippines (SEMPER, 1868; CLARK A.M. & ROWE, 1971; REYES-LÉONARDO, 1984). Its distribution has recently been extended to Australia (MARSH *et al.*, 1993; ROWE & GATES 1995), South East Asia and the China Sea (LANE *et al.*, 2000; PUTCHAKARN & SONCHAENG, 2000) and Sri Lanka (KUMARA *et al.*, 2005).

New voucher specimens from Japan, Thailand, Madagascar and Papua New Guinea have allowed a full redescription of the species and the establishment of its distribution map.

TAXONOMY

Order Aspidochirotida GRUBE, 1840
Family Stichopodidae HAECKEL, 1886
Genus *Stichopus* BRANDT, 1835
Stichopus naso SEMPER, 1868

Stichopus naso Semper, 1868 : 72, pls 18, 30, fig. 3a-c (non *Stichopus naso* HAACKE, 1880); LUDWIG, 1883 : 164 ; LAMPERT, 1885 : 107 ; THÉEL, 1886 : 192 ; LUDWIG, 1889-92 : 331 ; CLARK, 1922 : 68 ; CLARK, A.M. & ROWE, 1971 : 178 ; DANIEL & HALDER, 1974 : 423 REYES-LÉONARDO, 1984 : 151, pl. 10, fig. 2a-h ; REYES-LÉONARDO & COWAN, 1984 : 43 (colour plate) ; MARSH *et al.*, 1993 : 64; ROWE & GATES, 1995 : 325 ; LANE *et al.*, 2000 : 489 ; SAMYN, 2003 : 88 ; PUTCHAKARN & SONCHAENG, 2004 : 426 ; KUMARA *et*

al., 2005 : 25

Stichopus flaccus LIAO, 1980 : 118, fig. 6a-h ; LIAO, 1984 : 240, fig. 20(1-11) ; LIAO & CLARK, A.M. 1995 : 466, fig. 279a-b ; LIAO, 1997 : 152, fig. 88a-b ; LANE *et al.*, 2000 : 489.

Stichopus levis SLUITER, 1888: 198, pl. 1(6); CLARK, H.L. 1922: 50.

Stichopus laevis; LUDWIG, 1889-92: 331; CLARK H.L., 1922: 50.

Stichopus ohshimae MITSUKURI, 1912 : 171, fig. 30a-f ; CLARK, H.L. 1922 : 50; YAMANOUCHI, 1955 : 194 ; VERBIST, 1993 : 117 ; ? KOHTSUKA, 2006: 203 (2 colour plates).

Stichopus variegatus pallidus CLARK, H.L. 1938: 514.

Stichopus horrens; KOHTSUKA *et al.*, 2005: 23 (non *Stichopus horrens* SELENKA, 1867).

TYPE LOCALITY

Philippines (Bohol).

TYPE MATERIAL

Two according to SEMPER (1868); their whereabouts unknown according to ROWE & GATES (1995).

MATERIAL EXAMINED

- Two specimens (IRSNB IG 28679/30) from Madagascar (Tuléar, middle of the Grand Récif, internal slope, Station 20) collected by I. EECKHAUT, at low tide at 2-3 m depth on a sandy muddy bottom, November 1998.

- Two specimens (IRSNB IG 29142/42) from Madagascar (Tuléar, Belaza) collected by C. MASSIN in a sea-grass bed close to a mangrove at low tide, March 2000.

- Three specimens from Madagascar (Tuléar, Belaza: 23°30'S- 43°45'E) collected by R. RASOLOFORINA in a sea-grass bed at low tide, March 2006.

- One specimen from Japan (Awaze, Okinawa Prefecture) collected by SHOGO ARAI at 10 m depth on a soft mud with fine sand, December 2004.

- Two specimens (IRSNB IG 27754/177 and IG 27754/178) from Papua New Guinea (Hansa Bay, Madang Province), collected by C. MASSIN at 7 m depth on

a muddy bottom with sparse sea-grass bed, October 1990.

- Microscopic preparations from four specimens (labelled I 1206, I 1207, I 1208 and I 1209) from Thailand (Gulf of Thailand, Kho Lan Islands) collected by S. PUTCHAKARN, May 2001.

DESCRIPTION

Small to medium holothuroid (10-20 cm long). Body quadrangular in cross section; trivium with well defined sole. Tube feet of trivium densely crowded in 4-6 rows along each of the ambulacra (fig. 1C); two narrow interambulacral zones devoid of tube-feet (fig. 1C). Mouth ventral, surrounded by 18 tentacles; anus terminal without anal papillae. Bivium with four more or less distinct rows of very large papillae (figs. 1A, B). Along the ventral lateral edges, between the bivium and trivium, a row of prominent papillae occurs (figs. 1A-C).

Dorsal body wall yellowish beige, mottled with brown, or uniform yellow brown (figs 1A, B) ; ventral body wall light beige with a brown line along central ambulacrum (fig.1C). Tip of podia and dorsal papillae deep brown; specimens from Madagascar with dorsally brown lines perpendicular to each other. Small specimens with grey patches or nearly uniform grey (fig. 1B). Body wall thick (3-5 mm). Polian vesicles 2-4, large (1/10 to 1/20 of body length), one contorted stone canal embedded in dorsal mesentery, ending in spherical madreporic plate (fig. 4A) located at the level of the calcareous ring. Tentacle ampullae very short (1/50 of body length). Calcareous ring well developed, stichopodid like, i.e. dorsal radial pieces with two posterior process and interradial pieces narrow, (1/2 of radial length) each with a prominent anterior tooth (fig. 2B). Longitudinal muscles well developed, wide, bifid, attached. Gonads absent in all specimens studied.

Ossicles of body wall comprise tables, rosettes and C-shape rods. Tables nearly all of similar size (disc 25 µm across, pillars 30 µm high); disc of table perforated by 4 central holes and 4-8 peripheral holes (fig.2C); disc of table smooth to spiny. Rosettes present, (fig. 2D) more numerous ventrally than dorsally. C-shape rods numerous, 90-180 µm long dorsally and gathered in heaps (fig. 2E); ventrally, C-shape rods 60-110 µm long. Tube feet with two types of tables: small ones similar to those of body wall (fig. 2F) and some larger ones with up to 20 peripheral holes (fig. 2G). Rods narrow, spiny, 200-400 µm long (fig. 2J) sometimes with forked extremities (fig. 4K). Rosettes numerous and irregular (fig. 2L). Close to end plate large perforated plates

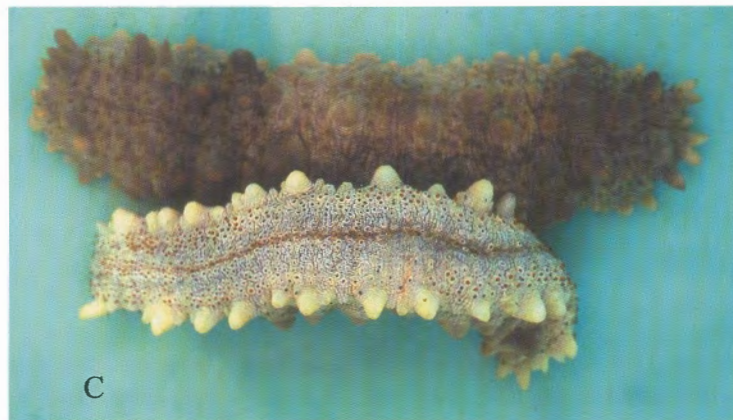


Fig. 1. *Stichopus naso* SEMPER, 1868. A: Madagascar, Tuléar, Belaza; low tide, on sandy-muddy bottom with sea-grass beds (photo R. RASOLOFONIRINA); B: Papua New Guinea, Madang Province, Hansa Bay, 7 m depth on sparse sea-grass beds (photo C. MASSIN); C: Madagascar, Tuléar, Belaza, dorsal and ventral view (photo C. MASSIN).

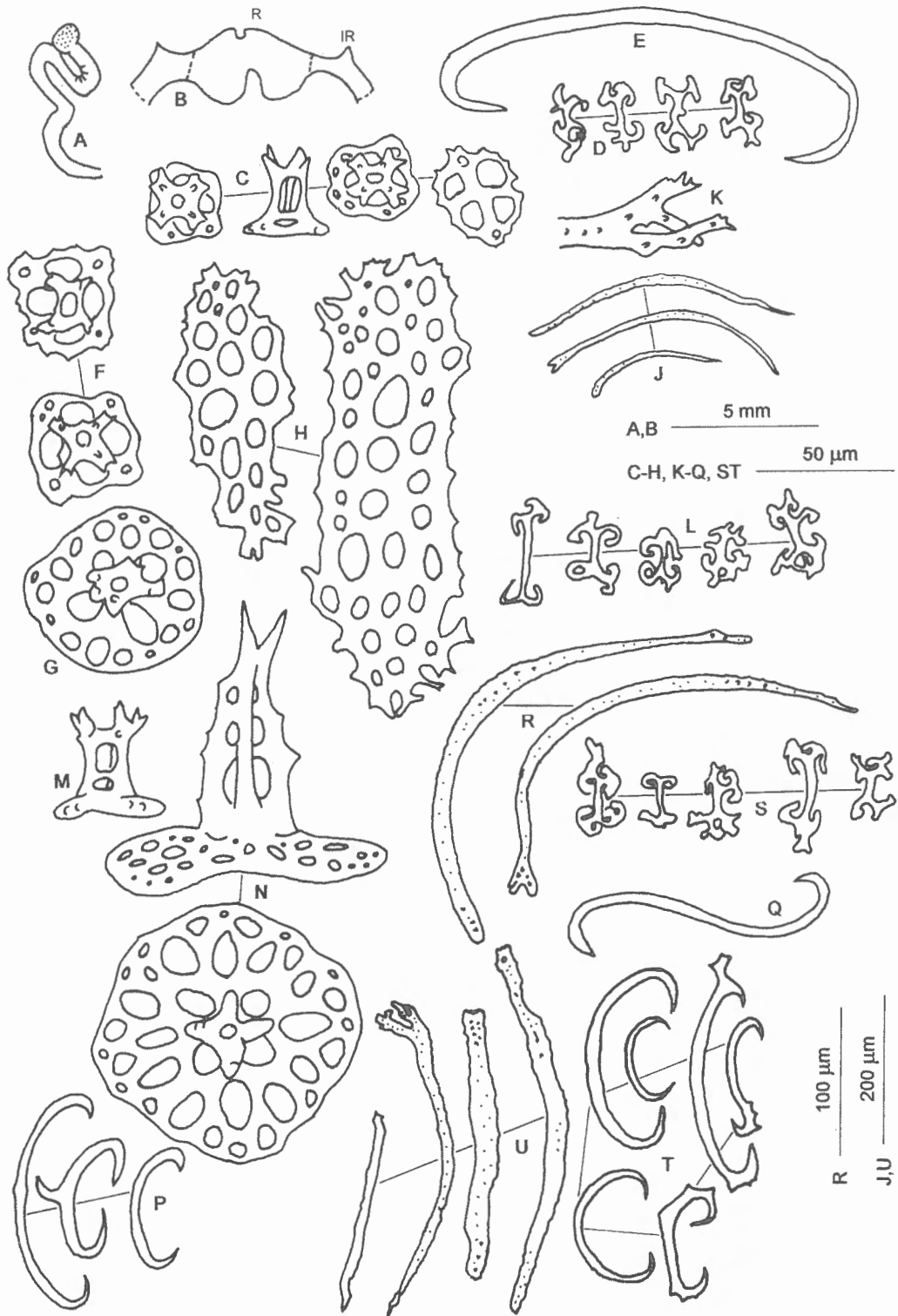


Fig. 2. *Stichopus naso* SEMPER, 1868, specimen from Papua New Guinea. A: stone canal; B.: calcareous ring (r: radial piece; ir: interradial piece); C: tables from dorsal body wall; D: rosettes from ventral body wall; E: C-shape rod from dorsal body wall; F: small table from tube feet; G: large table from tube feet; H: perforated plates from tube feet; J: rods from tube feet; K: forked extremity of a tube feet rod; L: rosettes from tube feet; M: small table from dorsal papillae; N: large tables from dorsal papillae; P: C-shape rods from dorsal papillae; Q: spiny rods from dorsal papillae; R: S-shape rod from dorsal papillae; S: rosettes from dorsal papillae; T: C-shape rods from tentacles; U: spiny rods from tentacles.

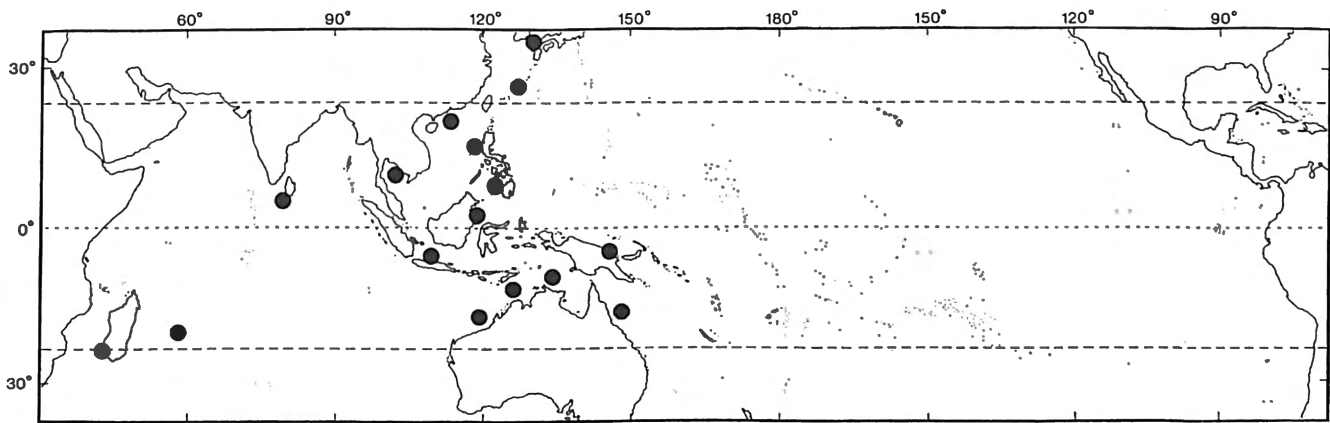


Fig. 3. *Stichopus naso* SEMPER, 1868. Distribution map.

present, 100-160 μm long with spiny edge (fig. 2H). End plate of the tube feet 300-600 μm across, made of several pieces. Dorsal papillae with tables, rosettes, large spiny rods and C- and S-shape rods. Two kinds of tables are present: small tables (disc 25-40 μm across) (fig. 2M) very similar to those of body wall and large tables (disc 80-120 μm across) with numerous peripheral holes (fig. 2N); last type tack like, with 4 spiny pillars ending into 2-4 spines; pillars united by 2-4 transversal beams (fig. 2N). Spiny rods similar to those of tube feet: narrow, up to 400 μm long, some with forked extremities (fig. 2R); C-shape rods 40-130 μm long (fig. 2P); S-shape rods rare (fig. 2Q). Rosettes numerous (fig. 2S). Tentacles with large spiny rods, 150-620 μm long, sometimes with forked extremities (fig. 2U), located in the shafts, and small C-shape rods, 25-65 μm long, regular or irregular (fig. 2T) located at base of tentacle.

ECOLOGY

Stichopus naso has a very wide Indo-Pacific distribution. It is now recorded not only from the Philippines (Bohol, Manila, Calatagan) but also from Madagascar (Tuléar), Mauritius, Sri Lanka, Thailand, Indonesia (Java), Borneo, Australia (NE coast, W coast, NW coast, Ashmore Reef, Timor Sea, N coast, QLD, WA, NT), South China Sea, China, Japan, and Papua New Guinea (Madang)(see fig. 3). The records from Madagascar and Papua New Guinea are newly recorded in this paper. Whatever the locality, *S. naso* has always been collected in shallow-waters (1-19 m) on sandy muddy bottoms (figs 1A, B) with or without sparse sea-grass beds. *S. naso* reproduces by transversal fission of the

body. When disturbed *S. naso* exhibits an undulatory movement of the body wall to escape. Because of this behaviour, local people from Madagascar call *S. naso* "the smurf holothurian" (EECKHAUT, pers. comm.).

DISCUSSION

Superficial examination shows that *Stichopus naso* and *S. horrens* SELENKA 1867 bear a lot of resemblance. However, they are easy to separate from each other in the field because of their colour pattern, and their behaviour. *S. horrens* lives most of the time on the reef flat, under large coral slabs or boulders during day time and is only active at night (see among others ROWE & DOTY, 1977; FÉRAL & CHERBONNIER, 1986; LIAO & CLARK, A.M. 1995; FORBES *et al.*, 1999; SCHOPPE, 2000; ROWE & RICHMOND, 2004; RASOLOFORINA, pers. Comm.). *S. naso* lives on sandy muddy bottom (SEMPER, 1868; REYES-LÉONARDO, 1984; KOHTSUKA *et al.*, 2005 (cited as *S. horrens*); present observations). *S. naso* reproduces by transversal fission. This kind of asexual reproduction is well known among echinoderms (EMSON & WILKIE, 1980) and particularly among holothuroids (HARRIOTT, 1985; CONAND, 1996; CONAND & UTHICKE, 1999; CONAND *et al.*, 2002; LANE, 2004; UTHICKE, 1997; UTHICKE *et al.*, 1999). Asexual reproduction by transversal fission has not yet been reported for *S. horrens*.

S. naso presents a behaviour observed in a few species of shallow-water stichopodid holothurians: the undulatory (swimming action: escape behaviour) movement of the body wall when disturbed (see GLYNN, 1965; PAWSON, 1966; MAUZEY *et al.* 1968; MARGOLIN, 1976). It is most probably related to the

presence of strong longitudinal muscles.

When comparing the ossicles, *S. naso* differs from *S. horrens* by the presence of spines on the pillars of the large tables from the dorsal papillae and by the size of the C-shape rods located in the body wall (90-200 µm long for *S. naso* and 45-100µm long for *S. horrens*) (see CHERBONNIER, 1980; CHERBONNIER, 1988; CLARK, H.L. 1922; CLARK, A.M. & ROWE, 1971; HICKMAN, 1988; LIAO; 1980, LIAO & CLARK, A.M.1995; MASSIN *et al.*, 2002).

The synonymy here presented follows ROWE (in ROWE & GATES, 1995). Moreover, the specimens collected by KOHTSUKA *et al.* (2005), identified as *Stichopus horrens* are in fact *S. naso* (personal observation). A doubt remains about the material identified by KOHTSUKA (2006) as *S. ohshimae*. Specimen size (250-360 mm long) and the type of bottom (rocky) do not fit with *S. naso*. Unfortunately, it was not possible to have this material on loan to check the ossicle assemblage. These synonymies together with the new collecting localities considerably widens the range of distribution of *S. naso*, which can no longer be considered endemic to the Philippines but a species with a very wide Indo-Pacific distribution.

ACKNOWLEDGEMENTS

It is a pleasure to thanks Drs FWE. ROWE and Y. SAMYN for improving the English and for their constructive comments on the manuscript; Dr. H. KOHTSUKA for the loan of material from Japan; Dr. S. PUTCHAKARN and Mr. R. RASOLOFORINA for sending me material from Thailand and Madagascar, respectively. The expedition to Papua New Guinea in 1990 has been financially supported by the King Léopold III Fund for Nature Exploration and Conservation, the Fund for Scientific Research-Flanders (project G 2908-90) and the Royal Belgian Institute of Natural Sciences. This is the publication 361 of the Laing Island Biological Station.

LITERATURE

- CHERBONNIER, G., 1967. Deuxième contribution à l'étude des Holothuries de la mer Rouge collectées par des Israéliens. *Bulletin of the Sea. Fishery Research Station, Haifa*, 43: 55-68.
- CHERBONNIER, G., 1979. Holothuries nouvelles ou peu connues de la Mer Rouge (Echinodermes). *Bulletin du Muséum national d'Histoire naturelle de Paris*, 4(1), section A4: 861-870.
- CHERBONNIER, G., 1980. Holothuries de Nouvelle-Calédonie. *Bulletin du Muséum national. d'Histoire naturelle de Paris*, 4ème sér., 2, section A (3): 615-667.
- CHERBONNIER, G., 1988. Echinodermes: Holothurides. *Faune de Madagascar*, 70: 1-292.
- CLARK A.M. & F.W.E. ROWE, 1971. Monograph of shallow-water Indo-West Pacific echinoderms: i-vii, 1- 238, pls 1-31. London, Trustees of the British Museum (natural History).
- CLARK, H.L., 1922. The holothurians of the genus *Stichopus*. *Bulletin of the Museum of comparative Zoology, Harvard*, 65 (3): 39-74.
- CLARK, H.L., 1938. Echinoderms from Australia. *Memoirs of the Museum of Comparative Zoology, Harvard*, 55 (VIII): i-viii, 1-596, pls 1-28.
- CONAND, C., 1996. Asexual reproduction by fission in *Holothuria atra*: variability of some parameters in population from the tropical Indo-Pacific. *Oceanologica Acta*, 19(3-4): 209-216.
- CONAND, C. & S. UTHICKE, 1999. Asexual reproduction in populations of *Stichopus chloronotus* (Holothuroidea): A comparison between pacific and Indian Ocean populations. Abstract P. 145. In: M.D. CANDIA-CARNEVALI & F. BONASORO (eds), *Echinoderm Research*, Proceedings 5th European Echinoderm Conference, BALKEMA, Rotterdam, v-xvi + 550 pp.
- CONAND, C., S. UTHICKE & TH. HOAREAU 2002. Sexual and asexual reproduction of the holothurian *Stichopus chloronotus* (Echinodermata): A comparison between La Réunion (Indian Ocean) and east Australia (Pacific Ocean). *Invertebrate reproduction and Development*, 41 (1-3): 235-248
- DANIEL, A. & B.P. HALDER, 1974. Holothuroidea of the Indian Ocean with remarks on their distribution. *Journal of the Marine Biological Association of India*, 16(2): 412-436
- EMSON R.H. & I.C.WILKIE, 1980. Fission and autotomy in Echinoderms. *Oceanography and Marine Biology, Annual Review*, 18: 155-250.
- FÉRAL, J-P & G. CHERBONNIER, 1986. Les Holothurides. In Guide des étoiles de mer, oursins et autres échinodermes du lagon de Nouvelle-Calédonie, A. GUILLE, P. LABOUTE et J-L. MENUU (eds), *Collection Faune tropicale*, 25: 55-107, Editions ORSTOM, Paris, 238 pp.
- FORBES, R. Z. ILIAS, M. BAINE, P.S. CHOO & A. WALLBANK, 1999. *A Taxonomic Key and Field Guide to the Sea Cucumbers of Malaysia*. Publication of the Heriot-Watt University, Stromness, 62 pp.
- GLYNN, P.W., 1965. Active movements and other aspects of the biology of *Astichopus multifidus* and *Leptosynapta*. *Biological Bulletin of the Marine biological Laboratory, Woods Hole*, 129: 106-127.
- HAACKE, W., 1880. *Holothurien*. In *Beiträge zur Meeresfauna*

- der Insel Mauritius und der Seychellen. GUTMANN, Berlin, pp 46-48.
- HARRIOTT, V.J., 1985. Reproductive Biology of Three Congeneric Sea Cucumber Species, *Holothuria atra*, *H. impatiens* and *H. edulis* at Heron Reef, Great Barrier Reef. *Australian Journal of Marine and Freshwater Research*, 35(1): 51-57.
- HICKMAN, C.P., 1988. *A field guide to Sea Stars and other Echinoderms of Galapagos*. Sugar Spring Press, Lexington, 83 pp.
- KUMARA, P.S.T.P., P.R.T. CUMARANATHUNGA & O. LINDEN, 2005. Etat de la pêche des holothuries de Sri Lanka: une activité qui s'éteint faute de ressources. *Bêche-de-mer Information Bulletin*, 22: 24-25.
- KOHTSUKA, H., 2006. First Record of *Stichopus ohshimae* MITSUKURI (Echinodermata, Holothuroidea) from the Sea of Japan. *Bulletin of the Hoshizaki Green Foundation*, 9: 203-206.
- KOHTSUKA, H. S. ARAI & M. UCHIMURA, 2005. Observation of asexual reproduction by natural fission of *Stichopus horrens* SELENKA in Okinawa Island, Japan. *Bêche-de-mer Information Bulletin*, 22: 23.
- LAMPERT, K., 1885. Die Seewalzen. Eine systematische Monographie. In: SEMPER, C.(ed), *Reisen im Archipel der Philippinen, Teil 2, Wissenschaftliche Resultat*, 4: 1-310, pl. 1, Wiesbaden.
- LANE, D.J.W., 2004. Sea cucumber diversity and resources in Brunei, Borneo Island. In: T. HEINZELLER & J.H. NEBELSKI (eds), *Echinoderm*. München, Proceedings of the 11th International Echinoderm Conference, 231-237, A.A BALKEMA, Leiden: i-xxvi, 1-633
- LANE, D.J.W., L.M. MARSH, D. VANDENSPIEGEL & F.W.E. ROWE, 2000. Echinoderm fauna of the South China Sea: an inventory and analysis of distribution patterns. *The Raffles Bulletin of Zoology*, Supplement, 8: 459-493.
- LIAO, Y., 1980. The Aspidochirote holothurians of China with erection of a new genus. In: M. JANGOUX, (ed.), *Echinoderms: Present and Past*, Proceedings of the European Colloquium on Echinoderms, Brussels 3-8 September 1979: 115-120, BALKEMA, Rotterdam: i-xviii, 1-428.
- LIAO, Y., 1984. The Aspidochirote Holothurians of China. *Studia Marina Sinica*, 23: 221-247.
- LIAO, Y., 1997. Fauna Sinica. Phylum Echinodermata: class Holothuroidea: i-ix, 1-334, pls 1-2. Science Press, Beijing.
- LIAO, Y. & A.M. CLARK, 1995. *The echinoderms of southern China*. pp. i-iii, 1-1.614, pls 1-23, Science Press, Beijing, New York.
- LUDWIG, H. 1883. Verzeichniss der Holothurien des Kieler Museums. *Bericht der Oberhessischen Gesellschaft für Natur und Heilkunde*, 22: 155-176.
- LUDWIG, H., 1889-92. Echinodermen: Die Zeewalzen. In: H.G. BRONN, (ed), *Bronn's Klassen und Ordnungen des Thier-reichs*, Bd 2, Abtheilung 3, Buch 1: i-vi, 1-460, pls 1-17.- C.F. Winter'sche, Leipzig.
- MARGOLIN, A.S., 1976. Swimming of the sea cucumber *Parastichopus californicus* (STIMPSON) in response to sea stars. *Ophelia*, 15(2): 105-114.
- MARSH, L.M., L.L. VAIL, A.K. HOGGETT & F.W.E. ROWE, 1993. Echinoderms of Ashmore Reef and Cartier Island. In: P.F. BERRY, (ed), Marine faunal surveys of Ashmore Reef and Cartier Island, North-western Australia. *Records of the Western Australian Museum*, Supplement 44: 53-65.
- MASSIN, C., Y. ZULFIGAR, A. TAN SHAU HWAI & S.Z. RIZAL BOSS, 2002. The genus *Stichopus* (Echinodermata: Holothuroidea) from the Johore Marine Park (Malaysia) with the description of two new species. *Bulletin de l'Institut Royal des Sciences Naturelles de Belgique, Biologie*, 72: 73-99.
- MAUZEY, K.P., CH. BIRKELAND & P.K. DAYTON, 1968. Feeding behavior of asteroids and escape responses of their prey in the Puget Sound region. *Ecology*, 49(4): 603-619
- MITSUKURI, K., 1912. Studies on Actinopodous Holothuroidea. *Journal of the College of Science, Imperial University of Tokyo*, 39 (2): 1-284, pls 1-8.
- PAWSON, D.L., 1966. Ecology of holothurians. In R.A. BOOLOTIAN (ed.): *Physiology of Echinodermata*, pp 63-71, Interscience Publ, New-York, i-xviii + 822 pp.
- PUTCHAKARN, S. & R.SONCHAENG, 2004. Echinoderm Fauna of Thailand: History and Inventory Reviews. *Science Asia*, 30: 417-428.
- REYES-LÉONARDO, L.D., 1984. A taxonomic report of shallow-water Holothurians of Calatagan, Batangas. *Philippines Journal of Sciences*, 113 (3-4): 137-172.
- REYES-LÉONARDO, L.D. & M.E. COWAN, 1984. Shallow-water holothurians of Calatagan, Batangas, Philippines. University of the Philippines, Marine Science Centre and Philippines Foundation Inc, Manilla, 55 pp.
- ROWE, F.W.E & J.E. DOTY 1977, The Shallow-water Holothurians of Guam. *Micronesica*, 13(2): 217-250.
- ROWE, F.W.E. & J. GATES, 1995. Echinodermata. In: A. WELLS, (ed.), *Zoological Catalogue of Australia* vol. 33: i-xiii, 1-510. CSIRO Australia, Melbourne.
- ROWE F.W.E. & M.D. RICHMOND, 2004. A preliminary account of the shallow-water echinoderms of Rodrigues, Mauritius, western Indian Ocean. *Journal of Natural History*, 38: 3273-3314.
- SAMYN, Y., 2003. Shallow-water Holothuroidea (Echinodermata) from Kenya and Pemba Island, Tanzania. *Studies in Afrotropical Zoology*, 292: 1-158.
- SCHOPPE, S., 2000. *Echinoderms of the Philippines*. Times Media Private Limited, Singapore, 144 pp.

- SEMPER, C., 1868. *Reisen im Archipel der Philippinen. Holothurien.2.* Wissenschaftliche Resultate: i-x, 1-288, pls 1-40., Leipzig.
- SLUITER, C.P., 1887. Die Evertebraten aus der Sammlung des königlichen naturwissenschaftlichen Vereins in Niederländisch Indien in Batavia. *Natuurwetenschappelijk Tijdschrift voor Nederlandsch-Indië*, 47, 8ste ser. (8): 181-220, pls 1-2.
- THÉEL, HJ., 1886. Holothurioidea. Part 2. *Report of the Scientific Results of the Voyage of the Challenger (Zoology)*, 39: 1-290, pls 1-16.
- UTHICKE, S., 1997. Seasonality of asexual reproduction in *Holothuria (Halodeima) atra*, *H. (H.) edulis* and *Stichopus chloronotus* (Holothuroidea: Apidochirotida) on the Great Barrier Reef. *Marine Biology*, 129(3): 435-441.
- UTHICKE, S., JAH, BENZIE & E. BALMENT, 1999. Population genetics of the fissiparous holothurian *Stichopus chloronotus* (Aspidochirotida) on the Great Barrier Reef, Australia. *Coral Reefs*, 18: 123-132.
- VERBIST, J.F., 1993. Pharmacological effects of compounds from echinoderms. In: M. JANGOUX & J. LAWRENCE (eds), *Echinoderm Studies*, vol. 4: 111-136, BALKEMA, Rotterdam.
- YAMANOUCI, T., 1955. On the 'poisonous' substance contained in holothurians. *Publications of the Seto Marine Biological Laboratory*, 4: 183-203.

Claude MASSIN
Malacology Section
Royal Belgian Institute of Natural Sciences
29 rue Vautier
B-1000 Brussels, Belgium
E-mail: claudemassin@naturalsciences.be