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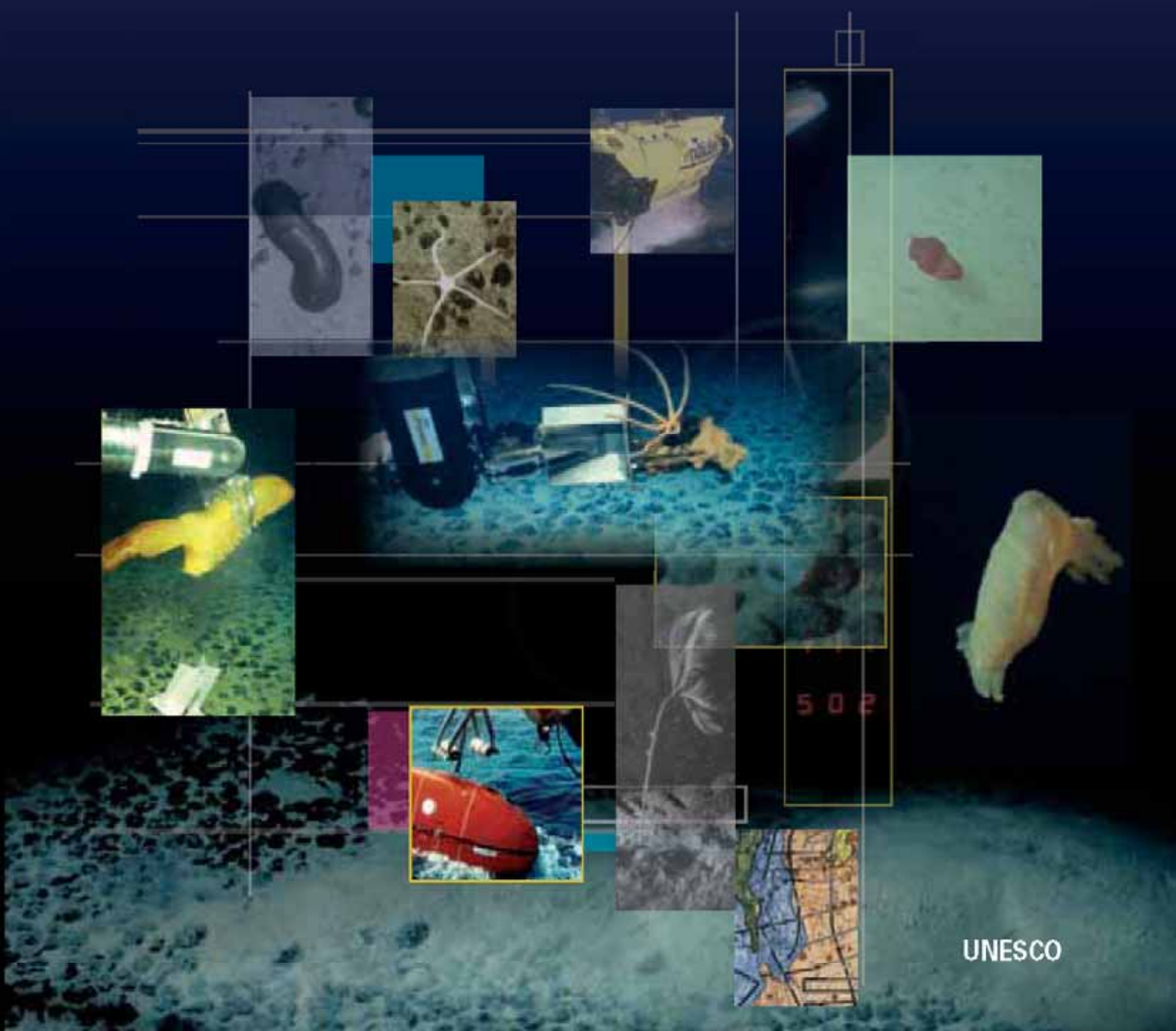
Biodiversity
and distribution of the megafauna

Vol.2 Annotated photographic Atlas of the echinoderms of the Clarion-Clipperton fracture zone



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Biodiversity and distribution of the megafauna

Vol.2 ANNOTATED PHOTOGRAPHIC ATLAS OF THE ECHINODERMS OF THE CLARION-CLIPPERTON FRACTURE ZONE

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The Echinoderms of the Clarion-Clipperton fracture zone

The method of identification used in this photographic atlas, based on descriptions of organisms observed in situ, has already been used in several publications, notably those by Macurda & Meyer (1976), Roux (1980), Pawson (1983), Ohta (1985), Pawson & Foell (1986), Fujita et al. (1987), Pawson (1988), Miller & Pawson (1990) and Bluhm & Gebruk (1999). Most of the species of this zone are probably new to science since this part of the Pacific Ocean has scarcely been sampled. Also the in situ appearance of the megafauna differs considerably from that of preserved specimens, and especially so for the echinoderms, which often loose their superfical external gelatinous layer and delicate appendages at the time of collection (Bluhm & Gebruk, 1999). Photographic and video material are also the only means that allow the collection of valuable data on the behaviour and environment of each taxon identified in the midst of the faunal assemblages which compose the benthic and suprabenthic megafauna (Owen et al., 1967; Rowe, 1971; Grassle et al., 1975; Lemche et al., 1976; Cohen & Pawson, 1977; Patil et al., 1980; Wigley & Theroux, 1981; Mauviel, 1982; Ohta, 1985; Laubier et al., 1985; Foell, 1988; Pawson, 1988a, b; Tilot et al., 1988; Foell & Pawson, 1989; Kaufmann et al., 1989; Wheatcroft et al., 1989; Bluhm, 1991; Thiel et al., 1991; Sharma & Rao, 1991; Christiansen & Thiel, 1992; Smith et al., 1992; Christiansen, 1993; Bluhm, 1994; Bluhm & Thiel, 1996; Lauerman et al., 1996; Radziejewska, 1997; Piepenburg & Schmid, 1997; Hughes & Atkinson, 1997; Fukushima & Imajima, 1997; Kaufmann & Smith, 1997; Kotlinski & Tkatchenko, 1997; Matsui et al., 1997; Tkatchenko & Radziejewska, 1998; Nybakken et al., 1999; Radziejewska & Kotlinski, 2002).

Often the study of the megafauna is limited to particular zoological groups such as echinoderms (Haedrich et al., 1980; Sibuet & Lawrence, 1981; Rice et al., 1982; Pawson, 1983; Briggs et al., 1996; Copley et al., 1996; Piepenburg et al., 1996; Bluhm & Gebruk, 1999) and sometimes limited to holothurians (Matsui et al., 1997). Echinoderms and especially holothurians are also known to be good indicator species in impact studies on the exploitation of polymetallic nodules deposits (Thiel et al., 1992; Bluhm et al., 1995; Bluhm & Gebruk, 1999) or in studies of the variation in particle flux of organic carbon (Smith et al., 1997).

The echinoderms of the Clarion-Clipperton fracture zone are presented here in the form of a photographic atlas accompanied by a commentary for each taxon. The gear that provided the photography and video of the seabed involved towed and free-moving vehicles:

The towed vehicles, generally multi-instrumented, are:

- the "Remorquage Abyssal d'Instrumentation pour l'Exploration" or "R.A.I.E." developed for Ifremer
- an epibenthic camera sled or "troika" perfected by Commander Cousteau
- The "Deep Tow Instrumentation System" or "Deep-Tow" developed for the Scripps Institute of oceanography (USA)

The remote devices, all developed by Ifremer, are:

- the automatic sampler coupled to a camera or "E.D.1"
- the unmanned free-moving submersible "Epaulard"
- the manned deep-diving submersible "the Nautile"

In the photographic atlas, each commentary is presented in the following order:

- a morphological description,
- a description of certain aspects of behaviour (such as methods of locomotion, visible tracks, swimming movements, trophic behaviour ...),

- edaphic preferences (the occurrence of a taxon on a particular substratum or nodule-facies),
- hydrological preferences (such as orientation with respect to currents)
- hypotheses of identification made in agreement with international specialists for each group,
- information on morphology extracted from the literature,
- bathymetric and geographic distributions for each taxon in relation to the proposed identification(s),
- comparative observations in relation to taxa identified from other sites in the Clarion- Clipperton fracture zone, such as the DOMES sites, and more precisely the Echo 1 site located near DOMES C (14°40'N-125°25'W). These sites were investigated by the National Oceanic and Atmospheric Administration (NOAA) and the Scripps Institution of Oceanography. Similarities are also noted with the taxa identified from a station further north-east (34°50'N, 123°00'W), near the central part of the Californian coast at 4 100 m depth (Lauerman et al., 1996; Kaufmann & Smith, 1997). Other sites of comparison outside the Clarion-Clipperton fracture zone are in a polymetallic nodules area in the abyssal Peruvian Basin in the south-east Pacific Ocean (Bluhm, 1994; Bluhm & Gebruk, 1999) and in a totally different abyssal environment at similar depth, in the Bay of Biscay in the north-east Atlantic Ocean (Sibuet et al., 1980).

- Some remarks on the preceding ideas may conclude each commentary.

The list of codes used in the identifications, following the classification of Parker (1982), is presented as Appendix 1. The international specialists on whose advice the hypotheses of identification in this study were compiled are listed in Appendix 2. The accepted hypotheses of identification are presented and commented upon in the photographic atlas. Based on these, Appendix 3 presents, in the form of a table, a synthesis of information from both specialists and the literature on the echinoderms sampled in the Clarion-Clipperton fracture zone or in the eastern Pacific Ocean region. Also for each species identified are presented the author and date of identification, the bathymetric and geographic distributions and the substrata conditions in which it was collected. The last column displays the codes for the taxa and the name of the international specialists who participated in their identification.

Crinoids

CRI 1

This species often has five arms (figure 1) or a multiple of five arms, on which pinnules can sometimes be distinguished. The arms measure between 10 and 20 cm. The longest arm in Figure 1 is 20 cm and the crown of arms is spreading, as a "feeding net", to trap food particles efficiently. This species has also been observed moving around by the alternating motion of its arms. In this figure, its star-shaped tracks can be seen situated somewhat below the animal, as though produced during its displacement.

This species was observed on the facies of polymetallic nodules as well as on purely sedimentary substratum, facies O, as in Figure 1.

In reference to the literature (Carpenter, 1888; Hartlaub, 1895; Clark, 1923, 1967) and in the opinion of specialists, this free-living crinoid belongs to the family Antedonidae, Order Comatulida, subclass Articulata, class Crinoidea. The hypothesis of taxonomic identification for this comatulid is *Fariometra parvula* (Hartlaub, 1895), according to the specimens identified by Hartlaub (1895) and Clark (1923, 1967) between latitudes 32°N and 2°N in the Eastern Pacific Ocean, at depths between 589 m and 1 969 m and on substrata of green mud and globigerina ooze.

The family Antedonidae is represented in the Atlantic Ocean (Sibuet et al., 1980) and the Pacific Oceans between 1 200 m and 5 000 m (Carpenter, 1888). This species was listed by Lauerman et al. (1996) from a site in the north-eastern Pacific Ocean close to the central part of the Californian coast at 4 100 m depth and it has also been observed in the Peruvian Basin (Bluhm, 1994).

CRI 2

These crinoids are yellow-orange in situ as in photographs taken by the "Nautile". Their open crown, formed of 10 pinnate arms, is 20 cm diameter and may be parallel to the substratum or flattened by the current. As rheophiles, they feed by the passive filtering of suspended particles (Roux, 1980). Their long peduncle, to which small actiniae or cirripeds are often attached, is anchored either in sediment or more often on a hard substratum such as rock outcrops or nodules (figure 2).

According to the literature (Carpenter, 1884; Clark, 1908; Roux, 1980; Luke, 1982), these fixed crinoids could be *Bathycrinus equatorialis* (Clark, 1908), a representative of the family Bathycrinidae, Order Bourgueticrinida. Pawson & Foell (1983) suggested *Rhizocrinus sp.* or *Bathycrinus sp.* for the taxa they photographed at the DOMES C site in the Clarion-Clipperton fracture zone. This taxon was also listed by Lauerman et al. (1996) at a site in the north-east Pacific close to the central part of the Californian coast at 4 100 m depth.

In view of the difficulties of distinguishing differences in photographs, specialists have also suggested that this crinoid could perhaps be *Bathycrinus affinis* (Roux, 1980), *Bathycrinus aff. australis* (Roux, 1980), *Rhizocrinus sp.* (Carpenter, 1884) or *Monachocrinus sp.* (Clark, 1917). The latter has been reported at 32°N, on the Patton Escarpment, between 3 600 m and 3 676 m (Luke, 1982). These crinoids occur in the Atlantic, Indian and Pacific Oceans at a great variety of depths (Carpenter, 1884).

Similar sedentary crinoids, but very dark in colour and larger, were identified as *Bathycrinus sp.* in photographs from the Peruvian Basin (Bluhm, 1994). The Bathycrinids (*Bathycrinus gracilis, Monachocrinus recuperatus, Zeuctocrinus gisleni*) identified by Roux (1985) in the north-east Atlantic Ocean between 2 000 m and 5 000 m are represented in photographs from the Biogas cruise (Sibuet et al., 1980) and the Cymor cruise between 49°N and 30°N on the continental margin of the Bay of Biscay.

CRI 3

This small sedentary crinoid has a peduncle 10 cm high and a crown of five arms fringed with long pinnules (figures 3, 4). Each arm measures a maximum of 5 or 6 cm.

According to specialists and information from the literature (Carpenter, 1884; Clark, 1907; Roux, 1980), the proposed identification is *Ptilocrinus sp.* (Clark, 1907), family Hyocrinidae, Order Millericrinida. Macurda & Meyer (1976) described a dense pinnulation specific to *Ptilocrinus sp.*. Some specialists are undecided between *Hyocrinus sp.* and *Ptilocrinus sp.* (Roux, 1980).

Based on photographs from the DOMES C site, Pawson & Foell (1983) proposed the identification *Hyocrinus bethellianus* (Wyville Thomson, 1876), which has a wide distribution from the equatorial Atlantic Ocean to the Crozet Islands in the Mid-Indian Ocean between 2 800 m and 3 300 m (Carpenter, 1884). This yellow hyocrinid has a smooth peduncle composed of ossicles of calcium carbonate which are shaped like dumbbells. The pinnules decrease in size distally along the arms. This hyocrinid was not found in the photographic analyses of Bluhm (1994) for the Peruvian Basin.

The crinoids identified by Roux (1980) as being *Hyocrinus sp.* were collected from a rocky substratum on the East Pacific ridge to the west of the Tres Marias Islands between 2 646 m and 2 665 m depth. A new species belonging to the family Hyocrinidae, *Laubiericrinus pentagonalis*, was described by Roux (2004) from specimens collected by submersible at 2 765 m depth in the south-west Pacific Ocean.

The Hyocrinidae *Anachalypsicrinus nefertiti* and *Hyocrinus grimaldii* were identified in photographs from the Cymor cruise exploring the Armorican margin at about 2 500 m depth and the Biogas cruise in the Bay of Biscay at about 3 000 m depth (Sibuet et al., 1980; Roux, 1985).

The collected crinoids, which on the advice of the specialists appear similar to the taxa identified in the Clarion-Clipperton fracture zone, are presented in appendix 3 with their geographic and bathymetric distribution.

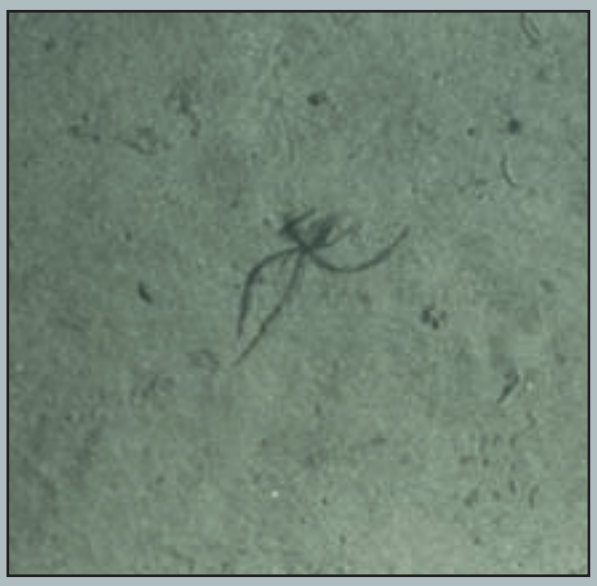

Fig. 1. Fig. 1. Photograph taken by the 'Epaulard' at the NIXO 45 site: nodule-facies O, crinoid *Fariometra parvula* (CRI 1)
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Fig. 4. Photograph taken by 'Deep Tow' at the DOMES C site: mixed nodule-facies, crinoid *Hyocrinus bethellianus* (CRI 3)
© Ifremer

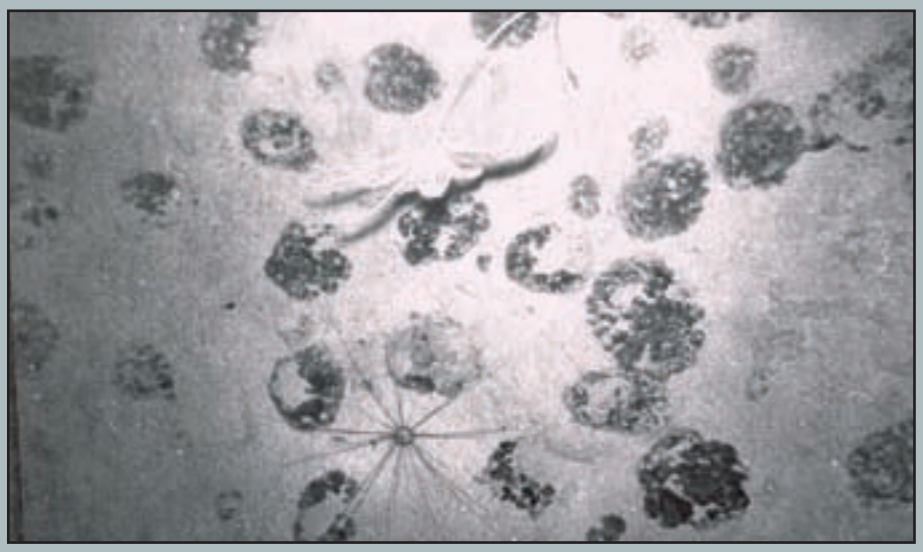

Fig. 2. Photograph taken by the "E.D.1" device during the Copano cruise: nodule-facies C+, crinoid *Bathycrinus sp.* (CRI 2) and echinoid *Pleisiodiadema globulosum (OUR 1)*
© Ifremer

Fig. 3. Photograph taken by the 'Epaulard' at the NIXO 45 site: crinoid *Hyocrinus bethellianus* on a cliff (CRI 3)
© Ifremer

Echinoids

OUR 1

This echinid with long slightly recurved radioles about 10 to 15 cm long has a body 2 to 5 cm diameter (figure 5). In the images taken by the 'Nautile' it appears violet, often with a paler region on the aboral face (lightly covered with sediment, reminiscent of the camouflage commonly found in littoral species). OUR 1 was observed on substrata with sediments and nodules as well as on the ocean floor in the Peruvian Basin.

Based on the literature (Agassiz, 1898, 1904, 1908; Mortensen, 1903, 1940, 1951; Downey, 1968) and the advice of specialists, the hypothesis of identification for this taxon is *Pleisiodiadema globulosum* (Agassiz, 1898), family Aspidodiadematidae, Order Diadematoida. It is a regular sea urchin which shares the abyssal environment of the Pacific and Atlantic Oceans with another genus, *Aspidodiadema* (Agassiz, 1898).

In the eastern Pacific Ocean, *Pleisiodiadema globulosum* has been collected between 8°N and 10°S, between Malpelo Island and Valparaiso from depths between 2830 m and 3900 m. This echinid was identified by Pawson & Foell (1983) from the Domes C site in the Clarion-Clipperton fracture zone, and in the inventory of the megafauna of the Peruvian Basin, it was also present, along with Plesiodiana sp. and at least three other undetermined echinids (Bluhm, 1994).

The family Aspidodiadematidae is characterised by a very fragile, globular test and long brittle spines (often in photographs, the echinids have radioles that are shorter in certain places, probably having been broken and in the process of regeneration). The radioles of the adoral side in contact with the benthos are terminated by a suction pad, in the form of a club that has a locomotary function, while those on the aboral surface end in a point and are specialised for respiratory and tactile roles (Cuénot, 1948). The presence of a weak shadow next to the animal suggests that it is raised up on its adoral radioles.

It is possible to observe in figure 5 the bioturbulent activity of these oral radioles on the substratum, uncovering a paler sediment and providing evidence of non-selective feeding behaviour in OUR 1, by ingesting sediment as well as detritus.

OUR 2

One sees here a very sinuous track which could have been created by an animal living in the sediment. Similar tracks from the Peruvian Basin have been identified as having been made by irregular echinids (figure 6).

This irregular echinid has a fragile oral skeleton with a depressed region on the aboral surface encircled by a well-defined narrow brown band. The podia with terminal dics are localised in this depressed region and their function is similar to that of the sweeping podia of numerous burrowing spatangoids, which construct a chimney that communicates between the open water and the burrow (Smith, 1980). This irregular echinid has been identified as *Aceste ovata* (Agassiz & Clark, 1907), family Aeropsidae, suborder Aphisternata, Order Spatangoida. Since this sea urchin has an endobenthic way of life, its white skeleton can only be partially seen, lying on the sediment when it is dead, and it then resembles an ovoid sponge.

Pawson & Foell (1983) identified this echinid in images and from specimens collected at the DOMES C site in the Clarion-Clipperton region. It has also been observed near Hawaii, off Japan and in the Indian Ocean at depths between 450 m and 4 800 m (Koehler, 1914), as well as amongst the megafauna of the Peruvian Basin (Bluhm, 1994).

The spatangoids are heart-shaped sea urchins that feed on mud or are microphages. Their spines are very small and numerous. The cosmopolitain family Aeropsidae is exclusively abyssal and bathyal. It contains only two genera, *Aeropsis* and *Aceste*, collected in particular in the Bay of Biscay (Cuénot, 1948; David & Sibuet, 1985).

Lauerman et al. (1996) and Kaufman & Smith (1997) idenitifed an echinoid *Echinocrepis sp.* at 4 100 m at a station further north and close to the central part of the Californian coast.

The other regular and irregular echinids that can be observed and identified in the Clarion-Clipperton region are listed in appendix 3 with their geographic and bathymetric distribution.

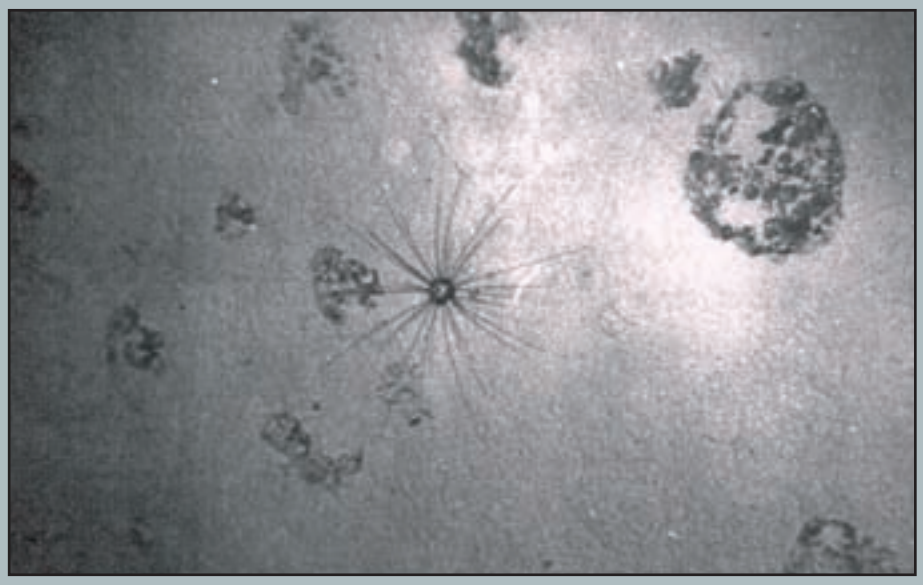

Fig. 5. Photograph taken by the "E.D.1" device during the Copano cruise: nodule-facies C+ sparse, echinoid *Pleisiodiadema globulosum* (OUR 1) © Ifremer

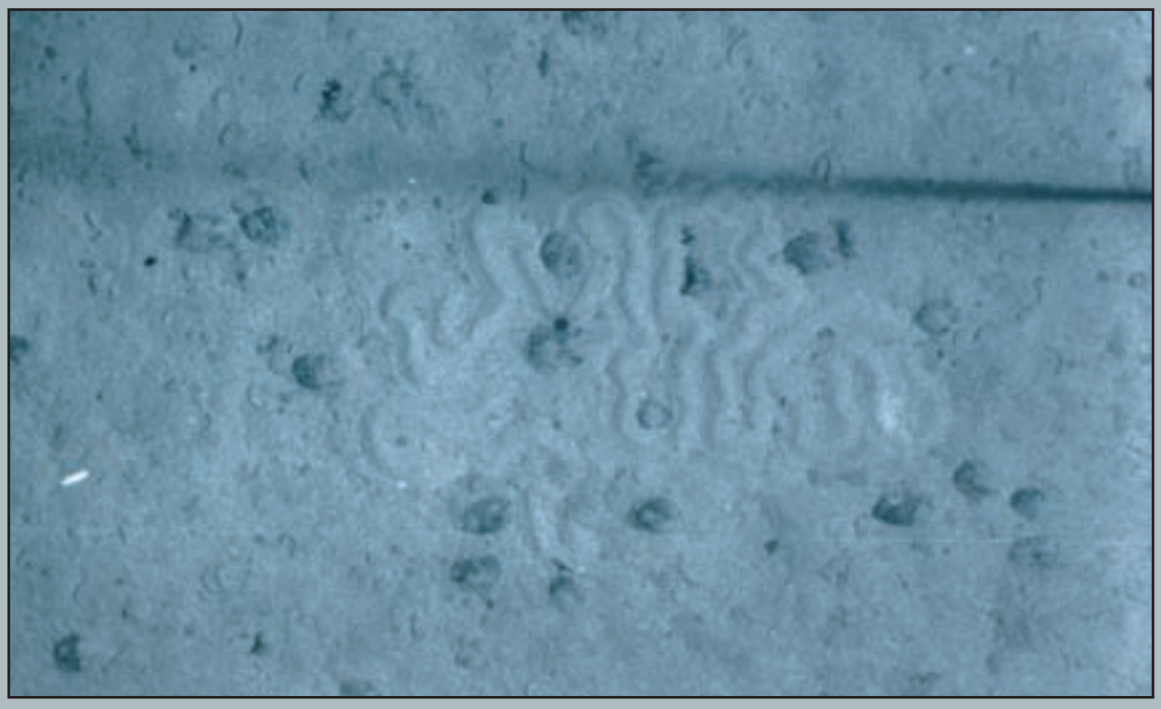

Fig. 6. Photograph taken by the 'Epaulard' at the NIXO 45 site: nodule-facies C, tacks of irregular echinoid *Aceste ovata* (OUR 2) © Ifremer

Ophiuroids

OPH 1

This species is 6-14 cm diameter with a very white, flat central disc and five spindly arms, which are 4-5 times as long as the diameter of the central disc (figures 7 and 9). These taxa are found on all forms of substratum from rock outcrops to sediments with or without nodules.

In agreement with specialists and after referring to the literature (Lyman, 1882; Lütken & Mortensen, 1899; Clark, 1915; Koehler, 1922; Downey, 1969), the proposed identification is *Ophiomusium armatum* (Koehler, 1922), family Ophiuridae, suborder Chilophiurina, Order Ophiurida, subclass Ophiuroidea, class Stelleroidea. Members of the family Ophiuridae are relatively large with long, slender arms, and this family presents the characteristics of the true ophiurids, in which the arms are never branched and not readily moved except in a horizontal plane. The discriminant characters for this family are only visible by microscope. The ophiurids are one of the most ancient forms, dating from the Ordovician. They are cosmopolitan in abyssal environments with more than 30 species in the genus *Ophiomusium*. According to the specialists, OPH 1 could equally belong to the genus *Ophiomusium*, family Ophiuridae, or to the genus *Amphiophiura*, family Amphiuridae, or to either *Ophiura* or *Stegophiura*, although *Ophiomusium* has the longest legs. Superficially, all these ophiurids closely resemble one another.

Several undetermined forms of ophiuroids have been reported from the Clarion-Clipperton fracture zone by Pawson & Foell (1983) and from the Peruvian Basin by Bluhm (1994). Lauerman et al. (1996) and Kaufman & Smith (1997) identified ophiuroids at a site in the northeast Pacific Ocean close to the central part of the Californian coast at 4100 m depth as *Ophiura bathybia, Amphilepsis patens* and *Amphiura carchara* on sediments, and *Ophiacantha spp.* on rocky substrata.

Various ideas on the feeding behaviour of these abyssal brittle stars have been proposed in the literature. According to David & Sibuet (1985), they selectively ingest detritus and sediment particles, whereas Litvinova & Sokolova (1971) and Pearson & Gage (1984) consider them to be non-selective euryphagous (omnivores), which are motile and opportunist, feeding on all prey or detritus found in their path. On the other hand, Sokolova (1972) says that abyssal cosmopolitan brittle stars are essentially carnivores, and in particular the semi-microphagous species. However, Fell (1961) suggests that some ophiuroids could be suspension feeders, based on observations of Antarctic specimens that produce a thread of mucus which is held between the spines of the arms in order to trap the small nekton, transported towards the mouth by movements of the flagella. Another way of being a suspension feeder, as in the case described by Fujita & Ohta (1988) for ophiuroids associated with gorgonians, involves capturing particles in suspension, transported by currents. In the Clarion-Clipperton study zone an association was frequently seen between ophiurids and sponges of the genus *Hyalonema*, which are attached by long peduncles. This would confirm the hypothesis of Fujita & Ohta (1988) of suspension feeding by the ophiuroids of the Clarion-Clipperton fracture zone.

OPH 1'

According to the specialists, this ophiuroid is a dark version of the same genus as the preceding taxon, *Ophiomusium armatum* (Koehler, 1922). It appears smaller and more slender, and is difficult to identify from photographs (figure 8).

Another ophiure, *Amphiophiura convexa* (Lyman, 1878), family Ophiuridae, suborder Chilophiurina, Order Ophiurida, has been identified from the Clarion-Clipperton Zone (Pawson & Foell, 1983). It is characterised by short arms that taper rapidly and bear three small spines on each side of the joints. The aboral surface of the central disc comprises large plates surrounding a single broad central plate. This generally small brittle star is difficult to detect in photographs and in addition, it generally lives buried close to the water-sediment interface. This taxon has been collected in many locations in the northern Atlantic Ocean, in the western part of the Indian Ocean and in the Arabian Sea at depths between 1 997 m and 6 810 m (Lyman, 1882; Bortsch, 1983; Vadan & Guille, 1984).

The collected ophiurids, which according to specialists appear similar to the taxa identified in the Clarion-Clipperton fracture zone, are given in Appendix 3 with their geographic and bathymetric distribution.

Fig. 7. Photograph taken by 'Deep Tow' at the Echo I site: nodule-facies C, ophiuroid *Ophiomusium armatum* (OPH 1) © Ifremer

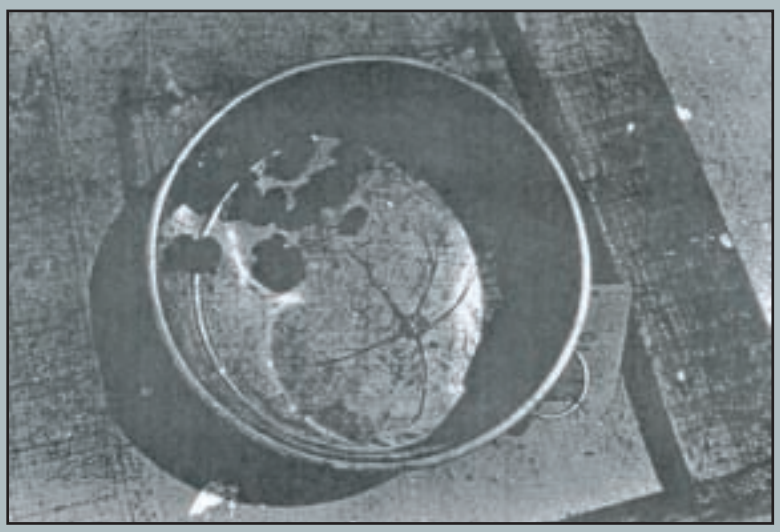

Fig. 8. Photograph of a sample from the Copano cruise, dark ophiuroid *Amphiophiura convexa* (OPH 1') © Ifremer

Fig. 9. Photograph taken by the 'Nautile' during the NIXONAUT cruise: nodule-facies C sparse, ophiuroid *Ophiomusium armatum* (OPH 1)

Asteroids

AST 1

This asteroid is about 12 cm diameter, with thick, almost cylindrical arms that lack marginal spines, a slightly prominent disc and a somewhat rough appearance (figure 10). In some photographs, the central disc can sometimes be very swollen due to ingested sediment, indicating a detritvorous feeding habit. These asteroids are most often observed on substratum with a dense covering of nodules.

In agreement with specialists and after referring to the literature (Fisher, 1905, 1911, 1928, 1930; Ludwig, 1905; Clark, 1913, 1923; Madsen, 1951; Downey, 1970; Luke, 1982), the proposed identification is a representative of the family Zoroasteridae, in the Order Forcipulatida, either *Zoroaster hirsutus* (Ludwig, 1905) or *Zoroaster ophiurus* (Fisher, 1905). The latter has been collected in the south-eastern Pacific Ocean (Fisher, 1905) but has not been recorded in the photographs from the Peruvian Basin (Bluhm, 1994).

AST 2

This asteroid is about 15 cm diameter and is generally buried, leaving only its central disc of about 5 cm diameter prominent (figures 11 and 12). Pentahedral tracks on the circular mounds in which they are buried can probably be attributed to them. Similar asteroids have been observed in the Bay of Biscay (Sibuet et al., 1980).

Based on the literature (Sladen, 1883; Ludwig, 1905, 1907; Fisher, 1955; Madsen, 1961; Luke, 1982; Belyaev, 1985) and in agreement with specialists, the proposed identification for this taxon is a member of the family Porcellanasteridae, Order Paxillosida. Some specialists have suggested *Hyphalaster inermis* (Sladen, 1883), which has been reported in the Clarion-Clipperton region (Pawson & Foell, 1983), as have the following Porcellanasterids: *Eremicaster pacificus* (Ludwig, 1905), *Eremicaster crassus gracilis* (Sladen, 1883) and *Thoracaster cylindratus* (Sladen, 1983) (cf. Appendix 3). This asteroid has not been recorded in photographs from the Peruvian Basin (Bluhm, 1994).

Although they do not appear in the photographs, the distinctive characteristics of *Hyphalaster inermis* are the spines at the rounded extremity of the arms and the aboral marginal plates which join the arms midway (Madsen, 1961).

Because of the burrowing nature of this animal, which is rarely visible at the sediment surface, the distinctive characters of *Thoracaster cylindratus* (Sladen, 1883), i.e. the two single marginal plates on the dorsal and ventral sides at the centre of each inter-radius, cannot be seen either. In fact one part of the aboral surface is kept out of the sediment due to the presence of paxillae (small erect columns on the plates of the test that bear spreading spines at their free end), which on contact draw together to form an impenetrable roof (Fell, 1982).

AST 3

This asteroid has a fairly well developed disc and rigid, tapering arms with pointed ends. Its diameter is about 15 cm and it is seen especially on sedimentary substrata.

In accordance with the specialists and by reference to the literature (Ludwig, 1905; Fisher, 1910, 1911; Clark, 1913, 1920, 1923; Clark, 1981; Luke, 1982), the proposed identification of this asteroid is *Pectinaster sp.,* a representative of the family Benthopectinidae, Order Paxillosida. Sometimes aggregates can be distinguished along its arms, which could be attached to the well-developed spines found on the aboral marginals (Fell, 1982).

This taxon resembles *Pectinaster agassizii* (Ludwig, 1905), sampled notably in the north-east Pacific Ocean at medium depths (Clark, 1981), as well as another Benthopectinid, *Benthopecten acanthonotus* (Fisher, 1905), which has been collected in the tropical east Pacific Ocean between 1 157 m and 2 761 m (cf. appendix 3).

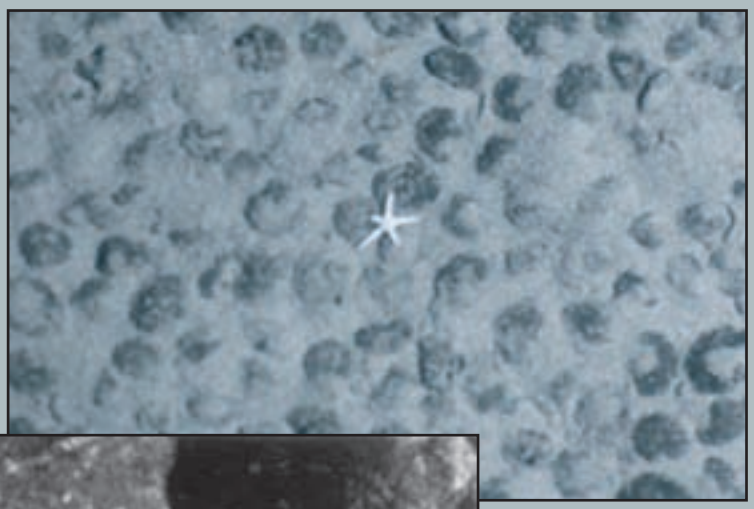

Fig. 10. Photograph taken by the 'Epaulard' at the NIXO 45 site: nodule-facies C, asteroid *Zoroaster hirsutus* (AST 1) © Ifremer

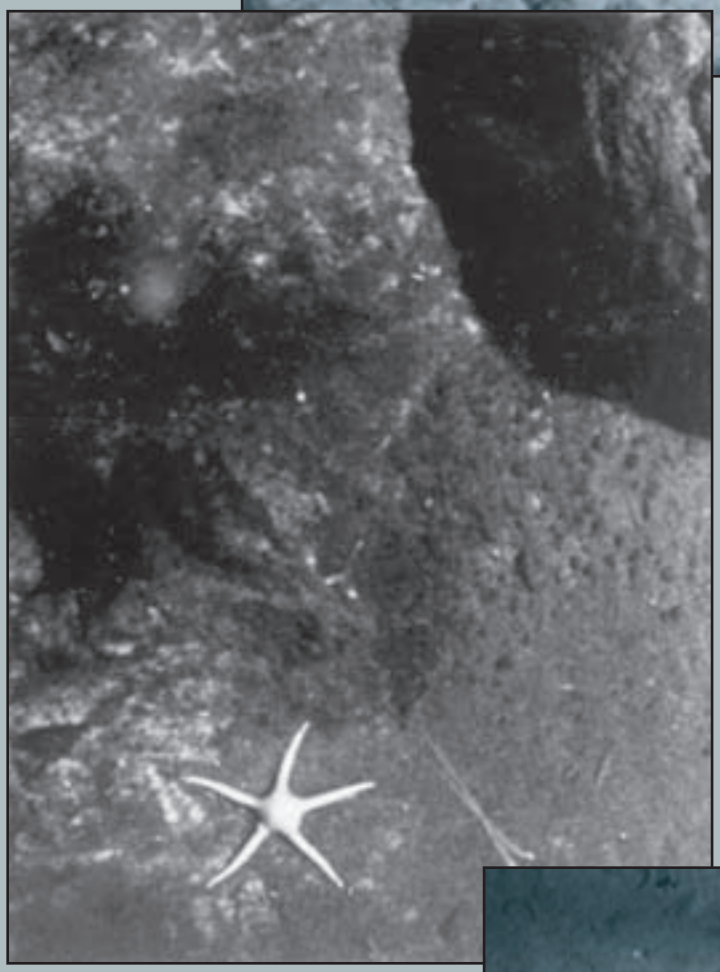

Fig. 11. Photograph taken by the 'Epaulard' at the NIXO 45 site: rock outcrop and nodule-facies O, asteroid *Hyphalaster inermis* (AST 2)
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Fig.12. Photograph taken by the 'Epaulard' at the NIXO 45 site: nodule-facies O, asteroids *Hyphalaster inermis* (AST 2) and *Hymenaster violaceus* (AST 5)
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AST 4

This species is about 5 cm diameter with a pentagonal body. It was mostly observed on ocean floor with a dense covering of polymetallic nodules. It is present in some photographs from the Peruvian Basin (Bluhm, 1994).

According to the literature (Ludwig, 1905; Clark, 1920; Madsen, 1951) and in agreement with the specialists, the pentahedral shape of this asteroid and the translucent membrane on the aboral surface are typical of representatives of the family Pterasteridae, in the Order Spinulosida. This level of identification must suffice as the elements for greater precision are lacking. In some photographs, long, fine, prickly adambulacra can be seen, perpendicular to the arms and enclosed in the membrane. In typical members of this family, with the exception of *Hymenaster*, the prickles on the adambulacra subtend two lateral palmate membranes (Fell, 1982).

AST 5

In figures 12, 13 and 14, an asteroid 5 to 10 cm diameter with a fleshy membrane can be distinguished. This species is sometimes violet in photographs taken by the "Nautile".

According to the literature (Ludwig, 1905; Clark, 1920; Madsen, 1956) and in agreement with the specialists, the proposed identification for this taxon is *Hymenaster violaceus* (Ludwig, 1905). The distinctive features of the genus *Hymenaster* given by Sladen (1889) and Mortensen (1927) are a supradorsal membrane composed of numerous muscular fibres, well developed actinal prickles covered by a membrane, and adambulacral prickles that are free and not palmate.

This species has been reported from the DOMES C site (Pawson & Foell, 1983) and in the Peruvian Basin (Bluhm, 1994), as well as on rocky facies explored during the Cymor cruise (North Atlantic).

This asteroid might be expected to have omnivorous feeding habits, both detritivorous and carnivorous, based on the examination of the gastric contents of *Hymenaster sp.* and *Hymenaster quadrispinosus* (Fisher, 1905) collected at 1 600 m and 2 926 m (Carey, 1972). However, it may instead be a predominantly detritivorous opportunist, as many abyssal organisms are (Sokolova, 1959). This asteroid colonizes sediments as well as rocky substrata (Fisher, 1911; Clark, 1920; Madsen, 1951) and in photographs of the study zone, it was only found on substrata with polymetallic nodules.

Hymenaster quadrispinosus (Fisher, 1905), *Hymenaster gracilis* (Ludwig, 1905) and *Hymenaster violaceus* (Ludwig, 1905) have been collected at depths between 1 935 m and 3 436 m in the north, central and south-eastern Pacific Ocean (Appendix 3).

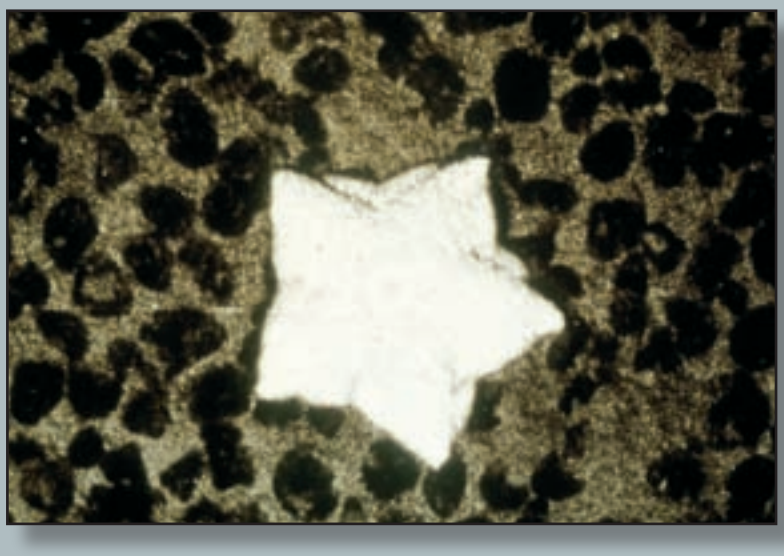

Fig. 13. Photographie prise par le «Deep Tow» sur le site d'Echo I : Faciès-nodules B, astéride *Hymenaster violaceus* (AST 5)

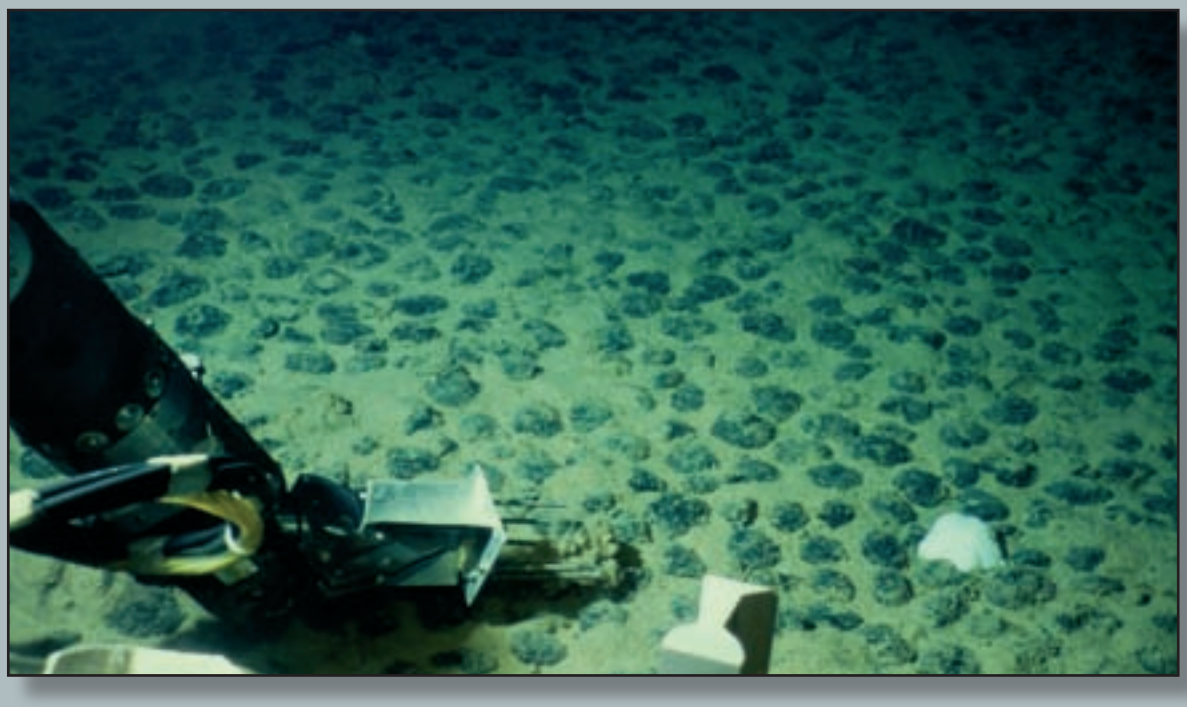

Fig.14. Photograph taken by the 'Nautile' during the NIXONAUT cruise: nodule-facies C, asteroid *Hymenaster violaceus* (AST 5)
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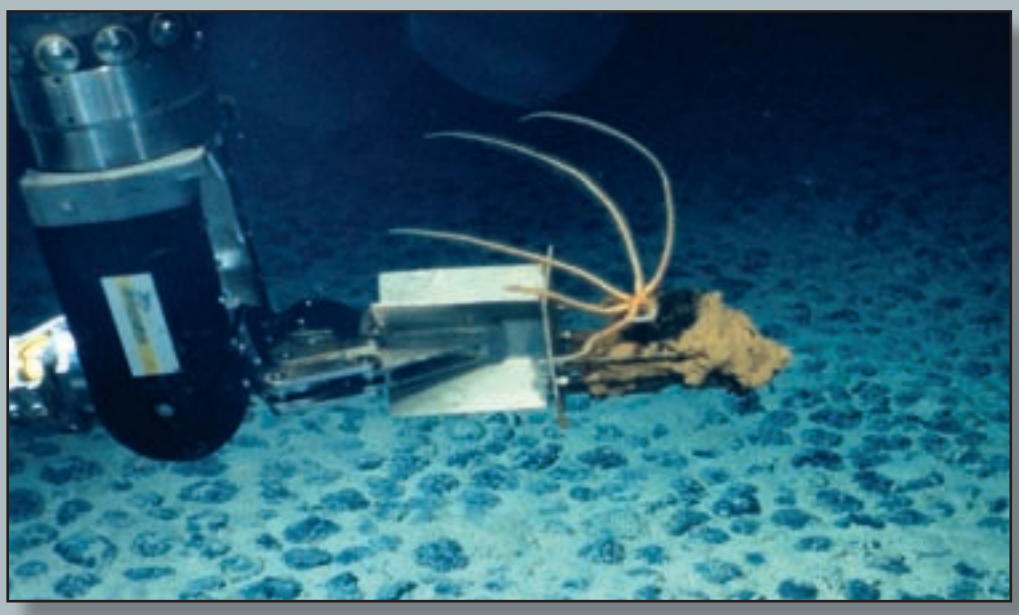

Fig. 15. Photograph taken by the 'Nautile' during the NIXONAUT cruise: nodule-facies C, brisingid asteroid with 6 arms captured by the 'Nautile', *Freyella benthophila* (AST 6)
© Ifremer

AST 6

These asteroids have six arms, each measuring 5 to 20 cm in length (figures 15, 16, 17). The arms are very thin and clearly distinct from a small central disc, which gives this taxon the appearance of a brittle star. White or yellow-orange in colour, *Freyella spp.* are generally quite abundant and attached to nodules.

Similar Brisingidae have been reported in the Clarion-Clipperton fracture zone ((Pawson & Foell, 1983) and in the Peruvian Basin (Bluhm, 1994).

Based on information from the literature (Sladen, 1889; Clark, 1920; Fisher 1928, 1930; Madsen, 1951, 1956) and the advice of specialists, the proposed identification for this asteroid is a member of the genus *Freyella*, family Brisingidae, Order Euclasterida (Downey, 1986). Freyella is cosmopolitan in abyssal environments and can have six or more arms. Some specialists have suggested this taxon might be *Freyella benthophila* (Sladen, 1889; Clark, 1920a) whose distribution extends across the eastern Pacific Ocean to the Indian Ocean in abyssal environments (Madsen, 1951, 1956; Fisher, 1928, 1930). Cherbonnier & Sibuet (1972) have also collected and identified *Freyella benthophila* in the Atlantic (45°13'N-5°30'W) at 4 700 m depth.

The majority of *Freyella* observed in the study zone had six arms but other Brisingidae had five, seven or eight arms (*Freyella octoradiata*, Clark, 1920), nine arms (*Freyella heroina*, Sladen, 1889) or 10 arms. The problem of number of arms as a means of determination in *Freyella* is tricky when one considers the frequency of autotomies and the regenerative power of a variable number of brachial buds, as in all the non-pentagonal asteroids which do not have arms largely united to the disc (Cuénot, 1948). Some specialists suggested that AST 6 could be a *Freyastera* (Downey, 1986). A Freyella with five arms has been observed in a single photograph from the Clarion-Clipperton fracture zone and could be an accidental case.

Some behavioural observations could be made on the feeding posture of this brisingid asteroid. *Freyella* generally has its arms slightly upturned in order to present the natural filter of their adherent podia to the current, thus trapping particles in suspension. This posture is similar to that of the comatulids. The position of the arms also indicates the direction of the current.

AST 7

Figure 18 represents a Brisingidae with seven arms, each measuring about 20 cm. *Freyella* species with seven arms have also observed in the Peruvian Basin (Bluhm, 1994).

The *Freyella sp.* in figure 18 has a less typical posture, with its arms stretched out and their extremities sometimes raised. The arms are fringed with long thin podia that comb the water-sediment interface. This difference in posture could indicate a new species of *Freyella* (Pawson, 1982) or another, more detrititus feeding behaviour. Note also that this posture demonstrates maximum efficiency in the pursuit of food by dividing up equally the area to be searched.

According to Downey (1986), the Brisingidae can be separated from the Freyellidae by their feeding behaviour, the Brinsingidae having their arms upturned in the current while the Freyellidae have theirs extended over the substratum. However, this statement does not seem justified as photographs from the Clarion-Clipperton fracture zone show that both taxa can have their arms in either position.

AST 8

Figure 19 shows a Brisingidae of the same diameter as AST 7 with 10 arms. As in all the other *Freyella* species observed in the Clarion-Clipperton fracture zone, they are found preferentially on nodules. *Freyella* with 11 arms were seen in photographs from the Bay of Biscay (Sibuet et al., 1980).

By common agreement of the specialists and with reference to the literature (Sladen, 1889; Clark, 1920; Fisher 1928, 1930; Madsen, 1951, 1956), the proposed identification is *Freyella sp.* because neither *Freyella brevispina* (Clark, 1920) nor *Freyella insignis* (Ludwig, 1910), collected in the eastrn Pacific Ocean, ever have 10 arms, but 11 and 13 respectively (A. Clark, pers. comm.).

The collected asteroids, which in the opinion of the specialists appear similar to the taxa identified in the Clarion-Clipperton fracture zone, are listed in Appendix 3 with their geographic and bathymetric distribution.

Fig.16. Photograph taken by the 'Epaulard' at the NIXO 45 site: mixed nodule-facies B and rock outcrop, brisingid asteroid with 6 arms, *Freyella benthophila* (AST 6) © Ifremer

Fig. 17. Photograph taken by the 'Epaulard' at the NIXO 45 site: nodule-facies O, brisingid asteroid with 6 arms, *Freyella benthophila* (AST 6) © Ifremer

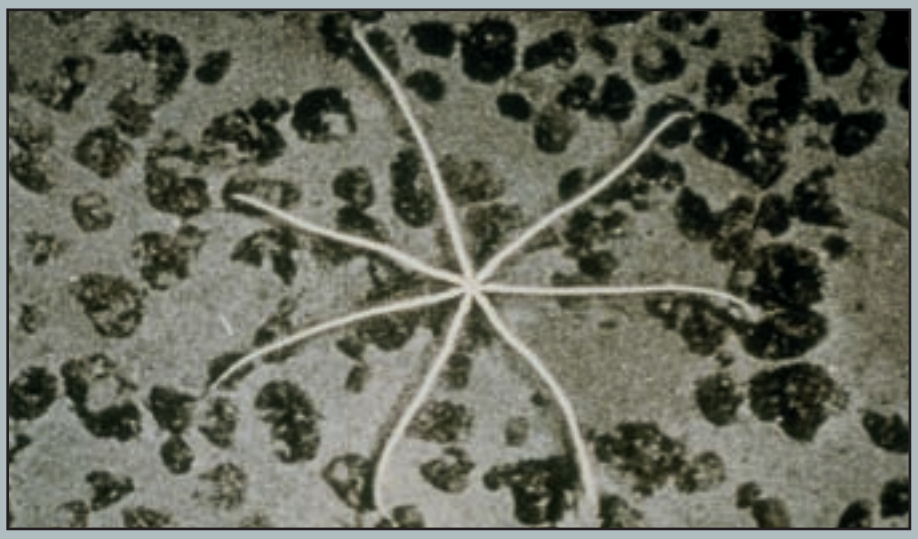

Fig. 18. Photograph taken by 'Deep Tow' at the Echo I site: nodule-facies C, asteroid with 7 arms *Freyella sp.* (AST 7) © Ifremer

Fig. 19. Photograph taken by the 'Epaulard' at the NIXO 43 site: mixed nodule-facies (A and C), asteroid with 10 arms *Freyella sp.* (AST 8) © Ifremer

Holothurians

HOL 1

This whitish holothurian measures 10 to 20 cm in length by 2 to 3 cm wide (figures 20, 21, 22). Its narrow body with attenuated extremities appears cylindrical with one ventral, plantar surface. Its rigid appearance suggests a thick cuticle, which is scarcely bristly with at least two rows of short, rudimentary dorsal papillae, sometimes irregularly arranged. In the study zone, this taxon was always relatively abundant, never seen in the water column and apparently indifferent to the type of substratum and sediments on which it feeds, and whether or not they are covered with nodules.

Similar *Synallactes* species were recorded by Pawson & Foell (1983) and Lauerman et al. (1996), as well as by Kaufman & Smith (1997) at a site in the north-eastern Pacific Ocean near the central section of the Californian coast at 4 100 m depth. This orange to brown taxon has also been found at great depths in the Peruvian Basin where they were identified as *Synallactes sp.* type 2 (Bluhm, 1994; Bluhm & Gebruk, 1999).

On the advice of specialists (Pawson, Sibuet, pers. comm.) and after referring to the literature (Ludwig, 1894; Clark, 1920; Madsen, 1953; Hansen, 1975), the identification proposed is a taxon belonging to the family Synallactidae, Order Aspidochirotida. The quality of the photographs did not allow further analysis and the recognition of *Synallactes aenigma* (Ludwig, 1894), which has been collected in the north-central Pacific Ocean (appendix 3). Bluhm & Gebruk (1999) suggested *Synallactes reticulatus* (Sluiter, 1901) as a second possible name for this taxon observed in the Peruvian Basin.

HOL 2

This whitish holothurian has a narrow, cylindrical body (figures 23, 24). Its dorsal surface is covered by at least two rows of numerous slender papillae of variable size but not however exceeding the width of the body. This species measures 12 to 20 cm long and 2 to 4 cm wide. Just as with the preceding taxon, this holothurian is found on all types of substratum, whether covered or not by nodules. It is not known to be mesopelagic (cf. appendix 3).

This holothurian is fairly cosmopolitan having been reported at depths between 2 700 m and 4 300 m in the Indian, Pacific and Atlantic Oceans on a great variety of substrata. Pawson & Foell (1983) identified it at the DOMES C site, and Kaufman & Smith (1997) also identified it. It has also been found with a pink tinge in the abyssal depths of the Peruvian Basin (Bluhm & Gebruk, 1999), who referred to it as *Synallactes sp.* type 1. This taxon has also been reported in the Atlantic Ocean, notably in the Bay of Biscay (Sibuet et al., 1980).

The identification proposed in accordance with the literature (Koehler & Vaney, 1905; Clark, 1920; Madsen, 1953; Hansen, 1975) and specialists (Pawson, Massin, pers. comm.) is *Synallactes profundi* (Koehler & Vaney, 1905) in the family Synallactidae and Order Aspidochirotida. This taxon has been collected in the Indian, central and south Pacific and north Atlantic Oceans (appendix 3).

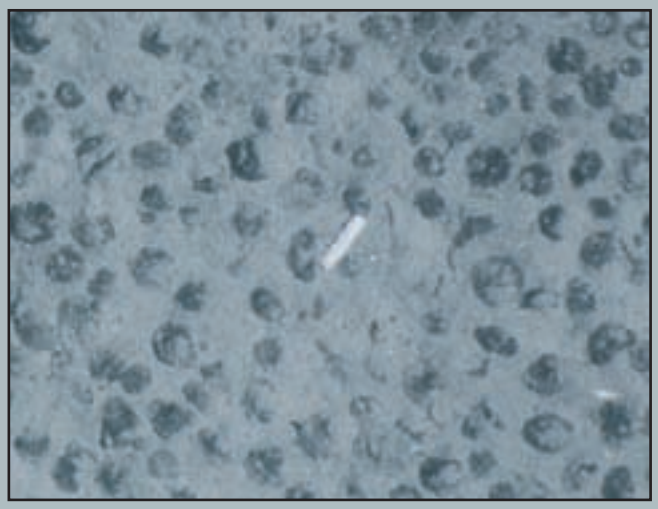

Fig. 20. Photograph taken by the 'Epaulard' at the NIXO 45 site: nodule-facies C, holothurian *Synallactes aenigma* (HOL 1)
© Ifremer

Fig. 21. Photograph taken by a "Troika" during the Copano 1 cruise: nodule-facies C, holothurian *Synallactes aenigma* (HOL 1)
© Ifremer

Fig. 22. Photograph taken by the 'R.A.I.E.' at the NIXO 45 site: nodule-facies C, holothurian *Synallactes aenigma* (HOL 1)
© Ifremer

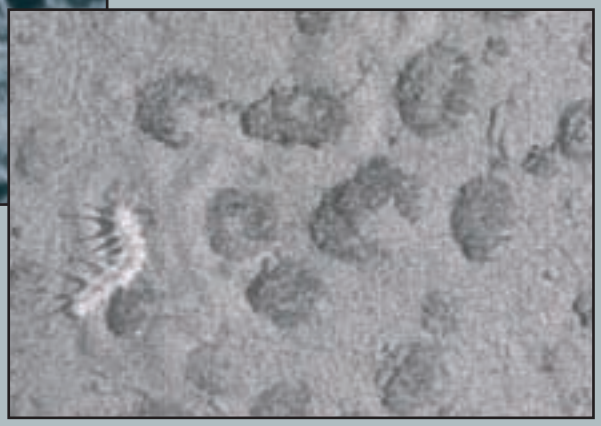

Fig. 23. Photograph taken by the 'Epaulard' at the NIXO 45 site: nodule-facies C, holothurian *Synallactes profundi* (HOL 2)
© Ifremer

Fig. 24. Photograph taken by the 'Epaulard' at the NIXO 45 site: mixed nodule-facies (C and B), holothurian *Synallactes profundi* (HOL 2)
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HOL 3

This white-coloured taxon can reach 25 cm long and 6 cm wide (figures 25, 26). It is remarkable in its elongated semi-cylindrical form with rounded extremities. The dorsal papillae are relatively long, thin and aligned in one row per radius, at the interior of which they are uniformly distributed. These papillae are rigid at the base and more flexible at the ends. This holothurian is is not mesopelagic, it is generally found on substrata with a dense covering of nodules and it. It leaves characteristic tracks on the sediment which consist of a double row of small depressions that infer the existence of a double row of ventral podia and the absence of medio-ventral podia.

Pawson & Foell (1983) identified this holothurian from the DOMES C site, however, it does not appear in the identifications of Lauerman et al. (1996) nor of Kaufmann & Smith (1997). It was not reported from photographs of the depths of the Peruvian Basin (Bluhm, 1994). It is poorly represented in the Bay of Biscay (Sibuet et al., 1980).

By reference to the literature (Théel, 1879; Ludwig, 1893, 1894; Clark, 1920; Madsen, 1953; Hansen, 1975) and in agreement with the specialists, we suggest that this taxon belongs to the genus *Orphnurgus* (Théel, 1879) in the family Deimatidae and Order Elasipodida. This holothurian demonstrates the visible characters of a member of the family Deimatidae by the presence of numerous long papillae, the mouth situated in the anterior part of the ventral sole and podia only on the external radius of the trivium. The genus *Orphnurgus*, previously known as *Scotodeima* (Ludwig, 1894), is characterised by the presence of 15 to 20 non-retractable tentacles and by the absence of peribuccal papillae.

HOL 4

This holothurian measures a maximum of 20 cm long and 4 cm wide, and is white with a rigid, cylindrical body (figures 27, 28). It closely resembles HOL 3 but is more thickset. Its dorsal surface has more numerous, long, delicate, rigid papillae distributed in several rows, with 4 to 35 pairs per dorsal row and 4 to 17 pairs per lateral row. The trail it creates makes a double row of small holes, indicating the absence of medio-ventral podia. This taxon has been observed on all types of substrata. It appears to ingest detritus and sediments in a non-selective manner, and is not known to be able to move in the water column.

Pawson & Foell (1983) identified this holothurian from the DOMES C site, and Lauerman et al. (1996) and Kaufman & Smith (1997) have also identified it from 4100 m at a site further north. It has been recorded from the Peruvian Basin (Bluhm, 1994; Bluhm & Gebruk, 1999) but appears somewhat different in their photographs, being narrower with two longer papillae on the anterior part of the body and two other perpendicular papillae on the dorsal posterior part. This taxon has been found also in the Bay of Biscay (Sibuet et al., 1980).

The proposed identification, after consulting the literature (Théel, 1879; Ludwig, 1894; Clark, 1901, 1913, 1920; Perrier, 1902; Grieg, 1921; Hansen, 1967, 1975) and specialists (Pawson, Sibuet, Gebruk, Massin, pers. comm.) is *Oneirophanta mutabilis* (Théel, 1879), family Deimatidae and Order Elasipodida. This cosmopolitan holothurian is characteristic of the abyssal region, having been recorded at depths between 1 800 m and 6 000 m in all explored parts of ocean depths. This taxon could be *Oneirophanta mutabilis affinis* (Ludwig, 1894), since that is peculiar to the region studied, in the tropical eastern Pacific Ocean, where it replaces the cosmopolitan *Oneirophanta mutabilis mutabilis* (Théel, 1879). However, HOL 4 is larger than *O. mutabilis affinis*, and from the description, it appears closer to *O. mutabilis mutabilis*. Less similar, *Oneirophanta setigera* (Ludwig, 1893) has been collected in the south-western Pacific Ocean (appendix 3).

Fig. 25. Photograph taken by the 'Epaulard' at the NIXO 45 site: mixed nodule-facies (C and B), holothurian *Orphnurgus sp.* (HOL 3)
© Ifremer

Fig. 26. Photograph taken by the 'Epaulard' at the NIXO 45 site: nodule-facies C, holothurian *Orphnurgus sp.* (HOL 3) © Ifremer

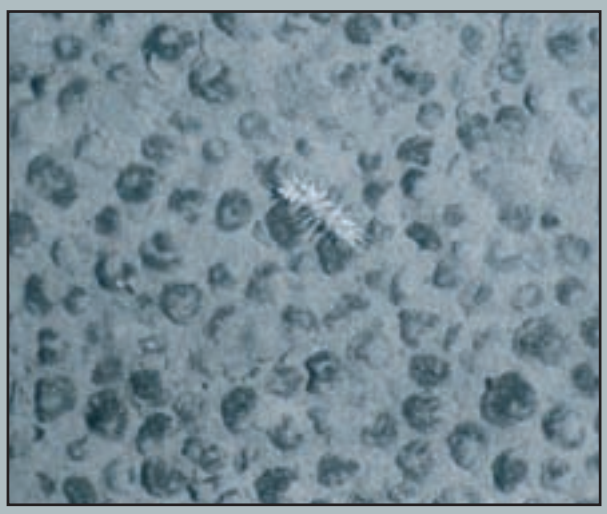


Fig. 27. Photograph taken by the 'Epaulard' at the NIXO 45 site: nodule-facies C, holothurian *Oneirophanta mutabilis* (HOL 4)
© Ifremer

Fig. 28. Photograph taken by the 'Nautile' at the NIXO 45 site: rock outcrop, holothurian *Oneirophanta mutabilis* (HOL 4)
© Ifremer

HOL 5

This white holothurian is smaller, thickset and ovoid (figure 29), measuring a maximum of 15 cm long by 5 cm wide. Its papillae are less numerous, thicker and rigid. There are 5 to 16 pairs of dorsal papillae arranged in a double row and 3 to 7 pairs of lateral papillae. From observations in the study area, they are always found on the ocean bed, in areas with or without nodules, and consequently they may adopt a non-selective detritivorous feeding behaviour. The trail left by their passage does not indicate that medio-ventral podia are absent.

Pawson & Foell (1983) identified this holothurian from the DOMES C site, and it also appears in photographs from the Peruvian Basin (Bluhm, 1994; Bluhm & Gebruk, 1999) and the Bay of Biscay (Sibuet et al., 1980).

The identification proposed in accordance with the literature (Théel, 1879, 1882; Ludwig, 1894; Sluiter, 1901; Koehler et Vaney, 1905; Hérouard, 1923; Deichmann 1930; Hansen, 1967, 1975) and in agreement with specialists is *Deima validum* (Théel, 1879), family Deimatidae, Order Elasipodida. However, one would infer from the tracks created by HOL 5 that *Deima validum* is not characterised by an absence of medio-ventral podia, which contradicts the description of the podial sole made by Hansen (1975). According to him, *Deima validum* does not have medio-ventral podia, or at the very most, has one pair reduced to pre-anal podia. More precisely, HOL 5 may be the cosmopolitan *D. validum pacificum* (Ludwig, 1894) collected in the tropical north-easern Pacific Ocean between 1 618 m and 2 487 m on various substrata (appendix 3). According to Sibuet et al. (1984), *Deima validum* is not a selective detritus feeder.

HOL 6

This holothurian measures 12 to 25 cm in length and 3 to 5 cm in width (figures 30 & 31). It appears semicircular and flattened, with the two extremities rounded. One can see on the dorsal surface a median groove and two rows of regularly distributed dorso-lateral papillae. The tegument appears soft and thick, and bluish or pale mauve in colour in photographs taken by the "Nautile" (figure 27). This taxon is found on all types of substratum, with or without nodules, as well as on rocky surfaces, but never in the water column.

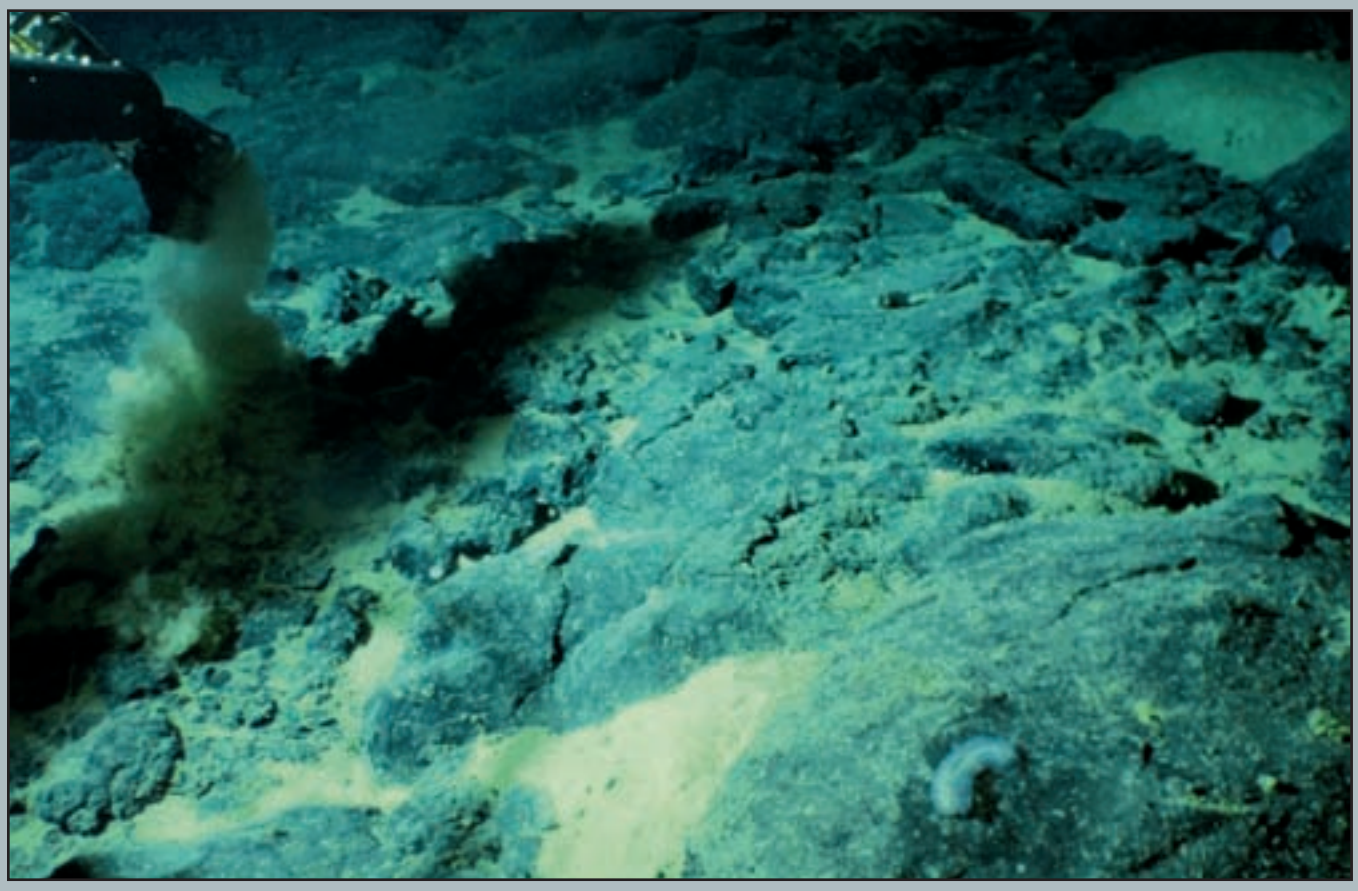
The proposed identification, with reference to the literature (Théel, 1882, 1886; Ludwig, 1894; Perrier, 1896; Clark, 1920; Hansen, 1956, 1975) and to specialists, is a holothurian of the genus *Benthodytes*, family Psychropotidae and Order Elasipodida, referred to here as *Benthodytes sp.* type 1. Visible characteristics of the family are the medio-ventral podia and a body laterally fringed by anastomosing podia. Some members of the genus *Benthodytes* have been observed swimming (Pérès, 1965; Heezen & Hollister, 1971). Pawson & Foell (1983) identified several types of *Benthodytes* at the DOMES C site. In photographs from the Peruvian Basin, Bluhm & Gebruk (1999) identified a holothurian that was similar but very dark in colour and with some perpendicular dorsal papillae as *Benthodytes sp.* type 2.

Data on *Benthodytes* species collected near to or in the Clarion-Clipperton fracture zone are shown in appendix 3.

Fig. 29. Photograph taken by the 'Epaulard' at the NIXO 45 site: nodule-facies C, holothurian *Deima validum* (HOL 5) © Ifremer

Fig. 30. Photograph taken by the 'Nautile' during the NIXONAUT cruise: holothurian (collected) *Benthodytes sp.* type 1 (HOL 6) © Ifremer

Fig. 31. Photograph taken by the 'Nautile' during the NIXONAUT cruise: rocky facies, holothurian *Benthodytes sp.* type 1 (HOL 6) © Ifremer



HOL 7

This taxon has a cylindrical body with rounded extremities (figures 32, 33). It measures about 20 cm long and 6 cm wide. The whitish tegument is often covered by sediment or detritus, giving the appearance of a smooth surface. The mouth is ventral but the podia are not visible in the photographs. The distinctive feature of this taxon is the vertical notch situated at the posterior end of the body. This holothurian is invariably found on all facies with nodules and sediments but never in the water column.

The proposed identification, in agreement with specialists and the literature (Ludwig, 1894; Madsen, 1953) is *Pseudostichopus mollis* (Théel, 1886), family Synallactidae, Order Aspidochirotida.

This cosmopolitan holothurian has already been recorded from the Clarion-Clipperton fracture zone (Pawson & Foell, 1983), as well as elsewhere in the north-eastern and south-eastern Pacific, the south-eastern Atlantic and the Indian Oceans, at depths varying between 100 m and 5 203 m on a great diversity of substrata (appendix 3). This taxon does not appear in photographs from the Peruvian Basin (Bluhm, 1994; Bluhm & Gebruk, 1999).

As indicated by its spade-like tentacles, *Pseudostichopus mollis* adopts a distinctive feeding behaviour, raking up a thin film of superficial sediments (Massin, 1982).

HOL 8

This holothurian is 10 to 20 cm long and up to 5 cm wide (figure 24). It has a sub cylindrical or flattened and elongated form, wider than high, and with a marginal fringe. The dorsal surface of the tegument bears numerous small irregular papillae that trap epibenthic detritus (e.g. debris from nodules, Foraminifera, shells of pteropods etc.), and in consequence, its colour is similar to that of this soft substratum. Its trail is more accentuated on purely sedimentary facies where it appears half buried. It does not appear to be mesopelagic, always being found at the surface of sediments.

This holothurian has also been reported at the DOMES C site (Pawson & Foell, 1983), in the Peruvian Basin (Bluhm, 1994; Bluhm et Gebruk, 1999) and in the Atlantic Ocean, in the Bay of Biscay (Sibuet et al., 1980).

The proposed identification, after reference to the literature (Lemche et al., 1976) and in the opinion of the specialists, is a species of *Meseres* (Ludwig, 1894), family Synallactidae and Order Aspidochirotida. It could be *Meseres macdonaldi* (Ludwig, 1894; Sluiter, 1901), as were those reported from the central eastern Pacific Ocean between 1 644 m and 2 149 m (appendix 3).

HOL 9

This holothurian measures up to 25 cm long and 5-6 cm wide and has a pointed structure at one end of the body (figure 25). Its body is bulging and cylindrical and has podia scattered all over. Those situated on the ventro-lateral surfaces are larger and could be seen in some photographs. This holothurian has a whitish tinge, and is brown to mauve in photographs in the rare instances when not covered by sediment. It is only seen on nodular substrata where it leaves a track that is clearly less deep than that of HOL 8. It is known to be a non-selective detritus feeder, and does not appear to be mesopelagic, never having been seen in the water column.

This holothurian has also been reported from the DOMES C site (Pawson & Foell, 1983), in the Peruvian Basin (Bluhm, 1994; Bluhm & Gebruk, 1999) and in the Atlantic, in the Bay of Biscay (Sibuet et al., 1980).

Literature references (Fisher, 1907) and the advice of specialists put this holothurian in the cosmopolitan species *Mesothuria murrayi* (Théel, 1886), family Synallactidae, Order Aspidochirotida. This taxon has been recorded from the western and eastern Pacific Ocean, as well as in the Indian Ocean at depths varying between 725 m and 4 064 m. It was not cited in the inventories of Kaufmann & Smith (1997) and Lauerman et al. (1996).

According to Heezen & Hollister (1971), Lemche et al. (1976) and Billet (1991) some *Mesothuria* and *Pseudostichopus* hollow out tracks about 1 cm deep by alternately extending and contracting the whole body, since the ventral podia are scarcely developed. These tracks are the most abundant form of bioturbation that disturbs the sedimentary surface to a significant degree in the depths of the Venezuelan Basin (Young et al., 1985), the Bay of Biscay (Mauviel & Sibuet, 1985) and the abyssal plain of Madeira (Hugget, 1987).

Fig. 32. Photograph taken by the 'Epaulard' at the NIXO 45 site: mixed nodule-facies (C and B), holothurian *Pseudostichopus mollis* (HOL 7) © Ifremer

Fig. 33. Photograph taken by the 'Epaulard' at the NIXO 45 site: nodule-facies C, holothurian *Pseudostichopus mollis* (HOL 7) © Ifremer

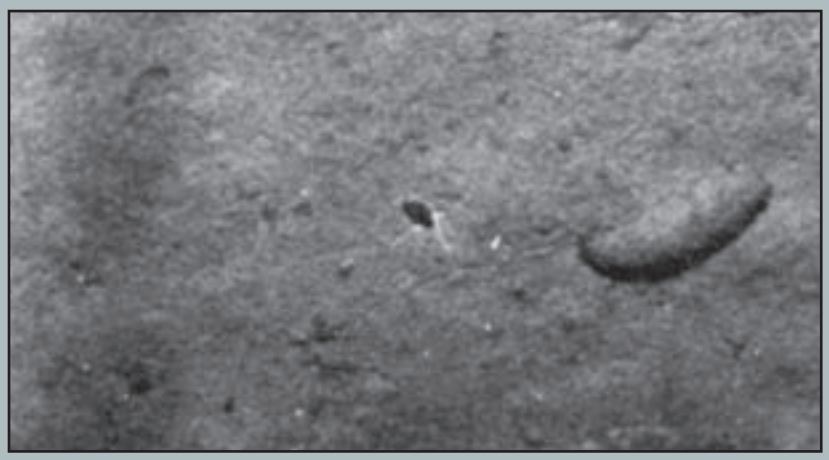


Fig. 34. Photograph taken by the 'Epaulard' at the NIXO 45 site: nodule-facies O, holothurian *Meseres macdonaldi* (HOL 8) © Ifremer

Fig. 35. Photograph taken by the 'Nautile' during the NIXONAUT cruise: mixed nodule-facies (C and B), tumulus with holothurian *Mesothuria murrayi* (HOL 9) © Ifremer

HOL 10

This taxon measures 20 to 25 cm long and 5 to 7 cm wide (figures 36, 37). It appears translucid and bears a long tapering projection on top of its anterior end. Its ventro-lateral podia are easily distinguished, few in number, relatively well spaced and independent, giving the impression of raising the body. The loop formed by the intestinal tract can be distinguished through the dorsal translucid septum, and at the anterior end of the animal is a region that reflects light. This is situated exactly at the level of the peripharyngeal cavity where the radiating conjuncto-muscular flanges are encrusted with calcareous bodies capable of reflecting light.

The holothurian HOL 10 has been found on all types of substratum, including sedimentary rocky, and with polymetallic nodules. It does not appear to be mesopelagic, never having been seen in the water column. It has not been observed in the Peruvian Basin nor the Bay of Biscay though forms morphologically similar to *Peniagone sp.* have been identified (Sibuet et al., 1980; Bluhm, 1994; Kaufman & Smith, 1997; Bluhm & Gebruk, 1999).

The proposed identification after referring to the literature (Hansen, 1975) and based on the opinion of specialists is *Peniagone papillata* (Hansen, 1975), family Elpidiidae, Order Elasipodida. This taxon has been collected particularly in the Clarion-Clipperton fracture zone at 3570 m. Its external characteristics are an elongated body, a soft, whitish tegument, eight to nine pairs of podia decreasing in size towards the posterior and situated in the posterior 2/3 of the ventral sole. It possesses four or five pairs of dorsal papillae of which the first and sometimes the second pair are independent, long and slender.

This taxon resembles a pink-tinted translucent species from the abyssal depths of the Peruvian Basin, identified as *Peniagone gracilis* (Bluhm & Gebruk, 1999). However, it was characterised by having podia only in the posterior half or 2/3rds of the body.

The independent movement of the ventro-lateral podia of HOL 10 is remarkable and recalls the model of locomotion proposed by Hansen (1972) for *Scotoplanes globosa* (Théel, 1879), another member of the Elpidiidae. Its podia communicate with wide water-filled cavities in the tegument, and local constriction of the latter, by peristaltic movements of the epidermal muscles, allows the independent movement of the podia. This suggests an adaptation to locomotion on soft substrata in abyssal environments (Hansen, 1975).

HOL 11

This holothurian, 17 to 20 cm long and 5 to 8 cm wide, resembles the previous taxon in its translucent texture through which one can see the loop of the intestinal tract, and a white mark, which reflects the light, situated at the peripharyngeal level (figure 38). Nevertheless, it appears flatter and bears marginal fringes that hide the ventro-lateral podia. A short velum in the nuchal part is formed by the fusion of the dorsal anterior papillae, and seems to unite four or five short projections. HOL 11 has been observed on all types of substrata but never in the water column.

Lauerman et al. (1996) and Kaufman & Smith (1997) recorded this taxon at their station further north at 4100 m, but it has not been found in the Peruvian Basin (Bluhm & Gebruk, 1999), nor does it appear to be present in the Bay of Biscay (Sibuet et al., 1980).

We propose as a hypothesis of identification a member of either the genus *Amperima* (Pawson, 1965) or *Peniagone* (Théel, 1882), family Elpidiidae and Order Elasipodida. HOL 11 and the following taxa (HOL 12 to HOL 15) share the characteristics of the groups *Peniagone* and *Amperima* (and part of the group Ellipinion), that is, an ovoid body, a wide velum consisting of two pairs of papillae, of which the median ones are generally longer than the laterals, podia bordering the posterior half or third of the body or distributed uniformly along the two lateral parts of the body.

Identification can not be taken further without a detailed study of the spicules. However, based on the literature (Théel, 1882; Ludwig, 1894; Clark, 1920; Hansen, 1975), one could compare this taxon with *Peniagone vitrea* (Théel, 1882) which has been collected in the region (between 10°N-10°S, cf. appendix 3). The external characteristics of this holothurian are an elongated body, a wide velum that can be folded either towards the anterior or the posterior, and 6 to 9 pairs of podia that decrease in size towards the posterior and border the posterior third of the ventral sole. As in most of the Elasipods, members of the genera *Amperima* and *Peniagone* comb a superficial film of sediments leaving few traces of their passage (Massin, 1982).

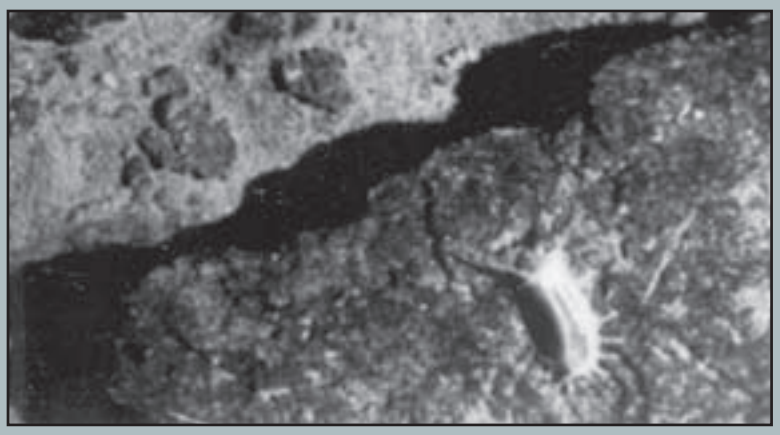


Fig. 36. Photograph taken by the 'Nautile' at the NIXO 45 site: cliff, holothurian *Peniagone papillata* (HOL 10)
© Ifremer

Fig. 37. Photograph taken by the 'Epaulard' at the NIXO 45 site: mixed nodule-facies B and plates: holothurian *Peniagone papillata* (HOL 10)
© Ifremer

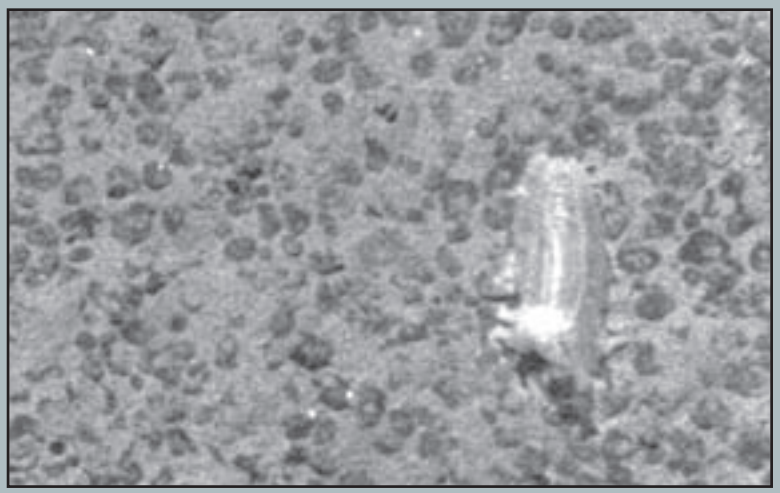


Fig. 38. Photograph taken by 'E.D.1' during the Copano cruise: nodule-facies B, holothurian *Peniagone vitrea* (HOL 11)
© Ifremer

HOL 12

This taxon only differs from the preceding one by its velum, which is formed by two small anterio-dorsal projections (figure 39). It can reach 20 cm in length and 8 cm width, and is found on all substrata but never in the water column.

Pawson & Foell (1983) found this holothurian at the DOMES C site in the Clarion-Clipperton fracture zone. Lauerman et al. (1996) and Kaufman & Smith (1997) have also identified it at 4100 m at a station further north and close to the central part of the Californian coast. This taxon has also been found in the abyssal depths of the Peruvian Basin (Bluhm & Gebruk, 1999) where it appears translucid brown. In contrast, no similar holothurian has been found in the Bay of Biscay (Sibuet et al., 1980).

Based on the literature (Ludwig, 1894; Hansen, 1975), the proposed identification is a member of the genus *Amperima* (Pawson, 1965) or *Peniagone* (Théel, 1882), family Elpidiidae and Order Elasipodida, or *Achlyonice sp.* (Théel, 1879). *Achlyonice ecalcarea* has been collected between 2 780 m and 4 924 m in the Pacific Ocean (appendix 3), and therefore we suggest this latter identification.

HOL 13

This holothurian is distinguished from the preceding ones by the velum, which is formed of two pairs of dorsal papillae divided into two long projections, two other shorter ones arranged laterally, and a buccal orifice situated on a retractable tube (figures 40, 41). Its body is broader, ovoid and measures up to 30 cm long and 10 cm wide. Its ventral face is bordered by nine or ten pairs of podia decreasing in size towards the posterior.

This taxon has been observed on all types of substrata but never in the water column. It has been identified in photographs from the Peruvian Basin and Bay of Biscay. Pawson & Foell (1983) identified it from the DOMES C site, and Kaufman & Smith (1997) have also identified it from their site further north. However, it has not been seen in the Bay of Biscay (Sibuet et al., 1980).

As in the case of HOL 10, this taxon is similar to a translucent, pink holothurian from the abyssal depths of the Peruvian Basin (Bluhm & Gebruk, 1999). However, this latter taxon, which has been identified as *Peniagone gracilis*, is narrower and its podia are not restricted to the posterior half or 2/3 of the body.

The proposed identification, based on the literature (Théel, 1882; Perrier, 1896, 1902; Hérouard, 1923; Agatep, 1967; Hansen, 1975) and the advice of specialists, is *Amperima rosea* (Perrier, 1896), family Elpidiidae and Order Elasipodida. However, this taxon has never been collected in the Pacific Ocean and has only been found between the Azores and Portugal at depths between 4 060 m and 5 000 m (cf. appendix 3).

HOL 14

This holothurian reaches a maximum of 25 cm long and 5 cm wide (figure 42). It only differs from the preceding ones by being more massive and by its velum, which is formed of four wide, equal-sized, anterio-dorsal projections that can be folded either backwards over the body or forwards towards the substratum. It has been observed on all types of substratum but never in the water column, and thus it does not appear to be mesopelagic.

This taxon has perhaps been found in photographs from the region of the DOMES sites, recorded as a *Peniagone sp.*, either type 1 or type 2 (Pawson & Foell, 1983). Lauerman et al. (1996) and Kaufman & Smith (1997) did not cite it in their faunistic inventories, nor has it been reported from the Bay of Biscay (Sibuet et al., 1980).

The proposed identification, based on the literature (Ludwig, 1894; Clark, 1920b; Hansen, 1975; Madsen, 1953) and in agreement with the specialists, is *Peniagone purpurea* (Théel, 1882), as in the case of specimens collected in the Indo-Pacific region (cf. appendix 3). *Peniagone purpurea* has the following external characteristics: a thickset body with seven to nine pairs of podia, the first two being independent and ventral while the other five to seven pairs are close together and partly fused. The velum consists of two pairs of very long, thin papillae joined together at the base. The edge of the velum is prolonged in a lateral fringe covering the podia.

In the figures, the velum sometimes appears folded towards the anterior with the extremities emerging on the substratum, or sometimes it is held high, almost perpendicularly. This could have various functions, sensorial and perhaps even respiratory, by increasing the surface area of the body and facilitating the exchange of fluids in the water-vascular system by its movements (Hansen, 1975).

Fig. 39. Photograph taken by the 'Epaulard' at the NIXO 45 site: mixed nodule-facies C, holothurian *Achlyonice ecalcarea* (HOL 12) © Ifremer

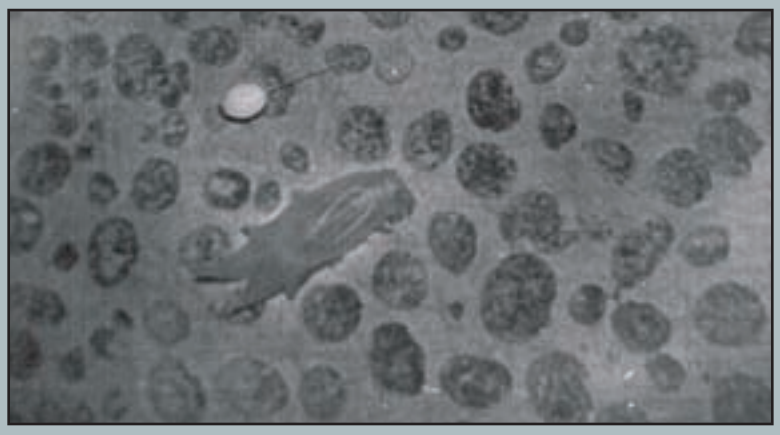


Fig. 40. Photograph taken by the 'E.D.1' device during the Copano cruise: nodule-facies C, holothurian *Amperima rosea* (HOL 13) © Ifremer

Fig. 41. Photograph taken by a 'Troïka' during the Copano 1 cruise: nodule-facies C, holothurian *Amperima rosea* (HOL 13) © Ifremer

Fig. 42. Photograph taken by the 'Nautile' during the NIXONAUT cruise: nodule-facies O, holothurian *Peniagone purpurea* (HOL 14) © Ifremer

HOL 15

This whitish taxon, maximum dimensions 20 cm long and 5 cm wide, seems to be quite rare in the study zone (figures 43, 44). It does not appear to have a preference in relation to substratum, occurring on nodules or sediments, and it does not appear to be mesopelagic.

This taxon has also been found in the Peruvian Basin (Bluhm & Gebruk, 1999) but was not recorded among the echinoderms in the Bay of Biscay (Sibuet et al., 1980).

Except for its two large characteristic anterio-dorsal projections, it differs little from the other holothurians of the genera *Amperima* (Pawson, 1965) or *Peniagone* (Théel, 1882), family Elpidiidae and Order Elasipodida. As a more precise hypothesis of identification, based on the literature (Théel, 1882; Clark, 1920b; Madsen, 1953; Hansen, 1956, 1975) and the specialists, one could propose *Amperima naresi* (Théel, 1882), which has been collected in the study zone and is very similar. Its external characters are a body more ovoid than in the other members of the group, and eight to ten pairs of broad ventro-lateral podia, which border the whole sole, decrease in size towards the posterior, and are distributed more or less uniformly along the sides of the body. These podia are slightly fused in the posterior part. The velum, composed of two pairs of papillae, is well developed and can take different forms (Hansen, 1956).

Appendix 3 presents possible identifications for taxa HOL 10 to HOL 15 by describing the holothurians recorded belonging to the genera *Amperima* (Pawson, 1965) or *Peniagone* (Théel, 1882). Specimens of *Amperima naresi* would have come from between 10°S and the central eastern Pacific Ocean, between 2 010 m and 7 130 m depth.

HOL 16

This quite remarkable holothurian measures at the very most 40 cm long and 12 cm wide, with a very large caudal extension held perpendicular to the substratum, and which is about the same length as the body and as wide as the latter in its most expanded part (figures 45, 46). The body is very flattened on the ventral surface and arched dorsally. The extremities are strongly rounded and the whole body is bordered by a wide dark podial fringe on the trivium. The caudal appendage is fleshy and more indented along a median grove. This appendage originates in an upper dorsal region, about 1/4 to 1/3 of the way from the posterior end. This holothurian can be very dark or almost translucent, and the colour photographs taken by the "Nautile" show a bluish tinge for the translucent specimens.

This taxon has been observed on all types of substratum and occasionally in the water column. Pawson & Foell (1983) identified it from the DOMES C site though Kaufman & Smith (1997) did not see it at their station further north-east, and neither did Bluhm (1994; Bluhm & Gebruk, 1999) in the Peruvian Basin. On the other hand, it is present in the Bay of Biscay (Sibuet et al., 1980).

The proposed identification, based on the literature (Théel, 1882; Hérouard, 1902, 1923; Deichmann, 1940; Madsen, 1953) and on the advice of specialists, is *Psychropotes semperiana* (Théel, 1882), family Psychropotidae, Order Elasipodida. This holothurian has not yet been collected in the study zone nor elsewhere in the Pacific, but only in the Indian and Atlantic Oceans at depths of 3 460 m to 5 600 m.

The translucent versions of this taxon could be either juveniles that become darker in the adult stage (Miller & Pawson, 1990), or they could belong to another species, *Psychropotes hyalinus*, collected in the Pacific north-east at 5 891 m (Pawson, 1985). This latter species is very close to *Psychropotes semperiana* but differs in its transparency and the characteristics of its spicules. In addition, it is known to be a facultative swimmer, using its large marginal fringe as fins. Elsewhere it has been collected at 5 m above the substratum at a depth of 5890 m in the tropical north-easern Pacific Ocean (Pawson, 1985). In films taken by the "Nautile", one can see it making swimming movements when it contacts the manipulator arm, by twisting then gliding. This could be an avoidance behaviour in case of predation.

The tracks left by this taxon are difficult to see in the numerous photographs from the study zone. That might suggest *Psychropotes semperiana*, which has relatively small podia on the medio-ventral part of the plantar sole, distributed in two rows of 7 to 25. The nodules appear darker, as if cleaned by the animal's passage.

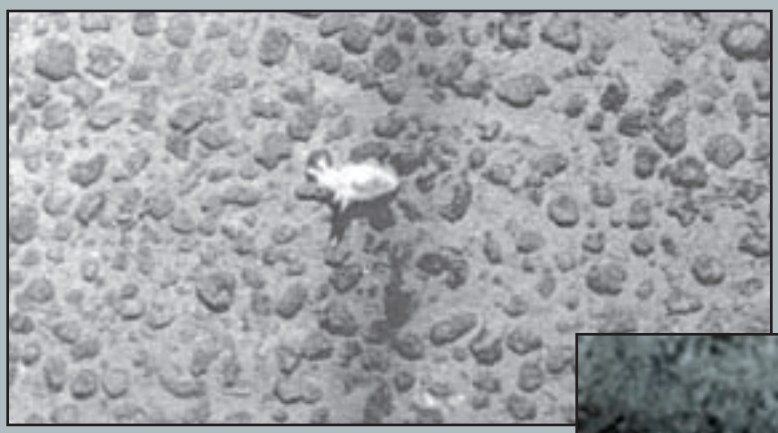


Fig. 43. Photograph taken by the 'Epaulard' at the NIXO 45 site: nodule-facies C, holothurian, *Amperima naresi* (HOL 15) © Ifremer

Fig. 44. Photograph taken by the 'Epaulard' at the NIXO 45 site: nodule-facies O, holothurian, *Amperima naresi* (HOL 15) © Ifremer

Fig. 45. Photograph taken by the 'Epaulard' at the NIXO 45 site: mixed nodule-facies (C and B), holothurian *Psychropotes semperiana* (HOL) © Ifremer

Fig. 46. Photograph taken by the 'Epaulard' at the Nixo 45 site: nodule-facies C, holothurian *Psychropotes semperiana* (HOL 16) © Ifremer

HOL 17

This holothurian differs from the preceding one particularly in the location of the caudal appendage, which is in the extension of the posterior part of the body, behind the bivium (figures 47, 48, 49, 50). This taxon reaches a maximum of 50 cm in length and 15 cm width with a caudal appendage up to 30 cm long. The latter appears more fleshy and rigid in its first third, and more supple at its extremity, which can be flexed during swimming. The marginal fringe is much less developed than in the preceding species and demarcated from a well-developed peristomal membrane. In some photographs, the tail appears shorter, the peristomal membrane less spreading and the ventro-lateral podia more free and prominent.

This taxon appears very dark in black and white photographs but pale yellow to orange in the colour ones taken by the "Nautile". In film from the NIXONAUT cruise, it performs a swimming motion, rhythmically arching the axis of its body after inducing a pulsation in its peristomal membrane, in opposition to movement in its caudal appendage. This taxon was only observed on ocean floor with a dense covering of nodules.

Pawson & Foell (1983) have identified this holothurian at the DOMES C site, while Kaufman & Smith (1997) did not see it at 4 100 m. Bluhm (1994) and Bluhm & Gebruk (1999) recorded it in the Peruvian Basin and it is also present in the Bay of Biscay (Sibuet et al., 1980).

Based on the literature (Théel, 1882; Ludwig, 1894; Clark, 1920; Madsen, 1953; Parker, 1963; Bayer, 1970; Hansen, 1975; Luke, 1982) and the advice of specialists, we propose as a hypothesis of identification, *Psychropotes longicauda* (Théel, 1882), family Psychropotidae, Order Elasipodida. This cosmopolitan holothurian has been reported between 2 210 m and 5 203 m (appendix 3). It bears between 7 and 25 pairs of independent podia, 18 peribuccal tentacles, a marginal fringe composed of two to nine pairs of podia and two to eight pairs of very small dorsal papillae. It can take on yellow to deep violet tones, always with the plantar sole darker.

According to Khripounoff & Sibuet (1980), *Psychropotes longicauda* is a detritus feeder, which selects the particles richest in assimilable compounds, and occasionally a scavenger. It has been recorded in all the oceans at depths between 2 210 m and 5 203 m on a great variety of substrata. According to Mortensen (1927), the caudal appendage is used in swimming, though Miller & Pawson (1990) stated that only the juveniles are mesopelagic and some of these have been collected 500 m above the benthos (Billet et al., 1985).

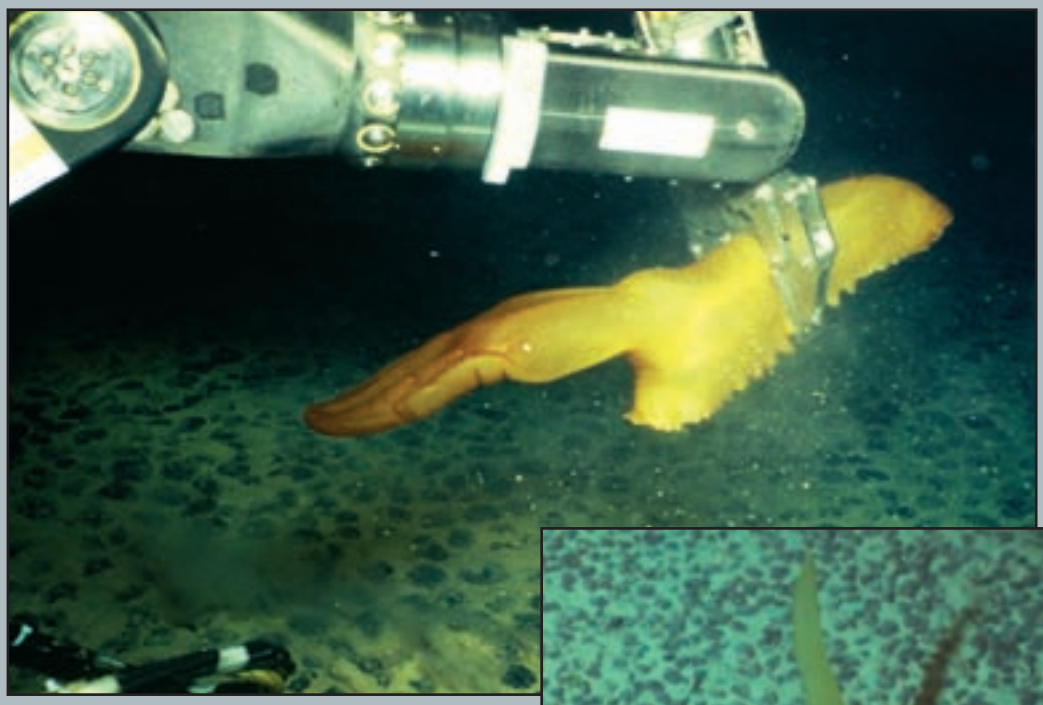


Fig. 47. Photograph taken by the 'Nautile' during the NIXONAUT cruise: nodule-facies C, holothurian (collected) *Psychropotes longicauda* (HOL 17)
© Ifremer

Fig. 48. Photograph taken by the 'Nautile' during the NIXONAUT cruise: nodule-facies C, holothurian *Psychropotes longicauda* (HOL 17)
© Ifremer

Fig. 49. Photograph taken by the 'Nautile' during the NIXONAUT cruise: nodule-facies O, holothurian *Psychropotes longicauda* (HOL 17)
© Ifremer

Fig. 50. Photograph taken by the 'Epaulard' at the NIXO 45 site: nodule-facies C, holothurian *Psychropotes longicauda* (HOL 17)
© Ifremer

HOL 18

This swimming holothurian is dark in colour and brown-violet in films taken by the "Nautile" (figures 51, 52, 53, 54). Its fleshy body (maximum dimensions 25 cm long and 10 cm wide), is slightly dorso-ventrally flattened. The anterior part bears a velum combining 12 to 14 broad dorso-ventral papillae into a membrane encircling 3/4 of the body. The anterio-ventral branch is encircled by 20 small tentacles whose extremities are divided in dendritic ramifications. The ventro-lateral podia are divided into two groups, one forming two fans each with six to nine pairs of long podia joined together posteriorily, and the other with three to six pairs of anterior, more rudimentary, podia.

Most of the time this holothurian is seen swimming over a great variety of facies of nodules and sediments. The tracks it leaves on the substratum are formed by the weight of the body resting on the ends of the three or four pairs membranous posterior podia and by the terminal parts of the folded tentacles. When following the swimming movements in film taken by the "Nautile", the interval for each propulsion was estimated at 5 seconds. Miller & Pawson (1990) recorded a cycle of 7.5 seconds, during which the animal stayed vertical and beat the water by negative rheotropism with an undulating movement of its velum.

Pawson & Foell (1983) identified this holothurian at the DOMES C site although Kaufman & Smith (1997) did not find it at 4100 m at their station further northeast in the Pacific Ocean, perhaps because it has a more mesopelagic lifestyle. Bluhm (1994) and Bluhm & Gebruk (1999) definitely identified it in the Peruvian Basin, and it is also present in the Bay of Biscay (Sibuet et al., 1980).

The hypothesis of identification, based on the literature (Pawson, 1976, 1982; Ohta, 1985; Miller & Pawson, 1990) and the advice of specialists, is *Enypniastes eximia* (Théel, 1882), family Pelagothuriidae and Order Elasipodida. This holothurian has been observed swimming between 2.5 m and 5 m above the substratum, except for young specimens, which have been collected more than 3 000 m above the bottom by Billett et al. (1985), or even at the ocean surface (Herouard, 1923). Details of its swimming were described by Ohta (1985) and Miller & Pawson (1990). However, in photographs and films from the Clarion-Clipperton fracture zone, *Enypniastes eximia* adopts a swimming posture typical of currents, and uses its velum as a sail, opposed to the direction of the current, and its ventro-lateral podia as brakes. According to in situ observations, young *E. eximia* are smaller and translucent pink in colour (Billett et al., 1985; Miller & Pawson, 1990).

Enypniastes eximia is known to be cosmopolitan and has been recorded at depths between 516 m and 5 689 m (appendix 3). This holothurian spends 10% of its time on the substratum in order to ingest sediment in a non-selective manner (Miller & Pawson, 1990). Thus it is not a suspension feeder and does not feed in the water column (Ohta, 1985). However, it could be at an intermediate stage of evolutionary adaptation to an essentially mesopelagic life, as seen in *Pelagothuria natatrix* (Ludwig, 1894; Chun, 1900; Etman, 1926). The latter is presumed to be a suspension feeder since it has only been collected in the water column (Ohta, 1985).

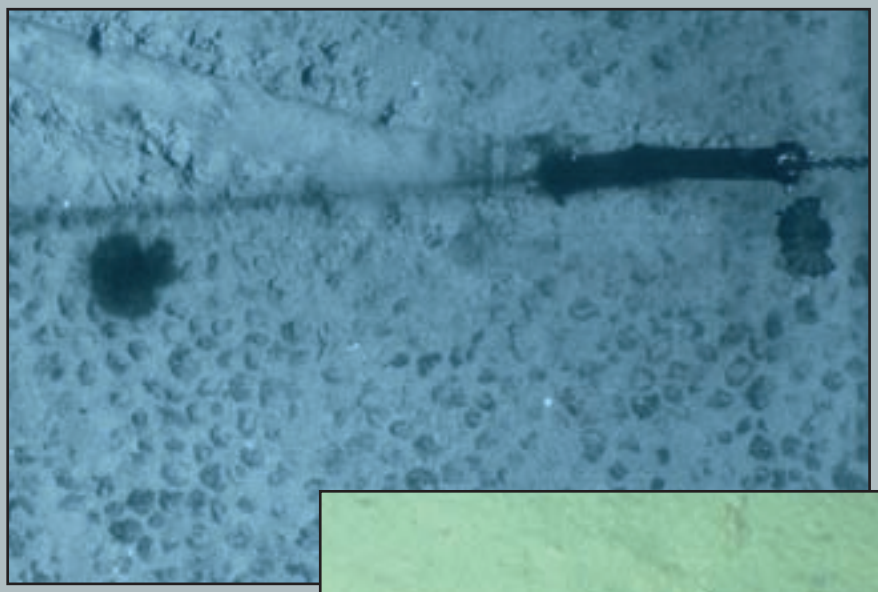


Fig. 51. Photograph taken by the 'Epaulard' at the NIXO 45 site: nodule-facies C, holothurian (swimming) *Enypniastes eximia* (HOL 18)
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Fig. 52. Photograph taken by the 'Nautile' during the NIXONAUT cruise: nodule-facies C, holothurian (swimming) *Enypniastes eximia* (HOL 18)
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Fig. 53. Photograph taken by the 'Epaulard' at the NIXO 45 site: nodule-facies C, holothurian *Enypniastes eximia* (HOL 18)
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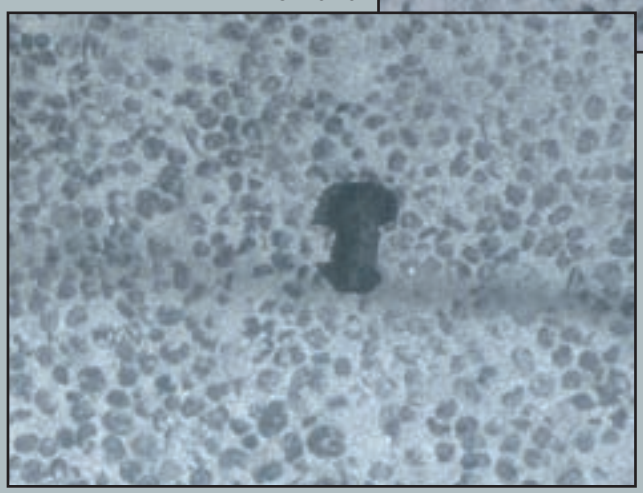

Fig. 54. Photograph taken by the 'Epaulard' at the NIXO 45 site: nodule-facies C, holothurian *Enypniastes eximia* (HOL 18)
© Ifremer

HOL 19

This taxon with an ovoid body can measure up to 32 cm long by 10 cm wide (figures 55, 56, 57, 58, 59, 60), and in situ, it is bright pink. The velum is formed by four dorsal papillae of which the central pair is longer than the laterals. At the posterior of the body are four pairs of ventral, membranous podia, laterally arranged. The mouth is in a retractable tube oriented towards the posterior. About ten tentacles, branched at their ends, surround the mouth and folds mark the dorsal surface of the body. A membranous fringe joins the velum to the ventro-posterior podia laterally.

In photographs and film from the "Nautile", this holothurian is mostly seen swimming. Whether suspended vertically and maintaining its flotation by beating its buccal tentacles, or with its body-axis parallel to the substratum, it propels itself by flexing its body, which is bent at the level of the velum, in rhythmic opposition to the pulsation of its ventro-posterior podia. When on the substratum, it feeds from the superficial film covering the nodules and sediments with the aid of its tentacles, which are forked at their ends (figure 60). The axis of the mouth and tentacles form a right angle in relation to the axis of the squat body, held up by the two series of ventro-posterior podia.

Pawson & Foell (1983) identified this holothurian at the DOMES C site although Kaufman & Smith (1997) did not find it, perhaps because it lives mostly in the water column. Bluhm (1994) and Bluhm & Gebruk (1999) did not record it in the Peruvian Basin, though it is present in the Bay of Biscay at a depth of 3000 m (Sibuet et al., 1980).

The hypothesis of identification based on the advice of specialists is *Peniagone leander* (Pawson & Foell, 1986), family Elpidiidae, Order Elasipodida. However, the authors described this taxon on the basis of photographs, which were taken between 14°33'N-127°39'W and at around 4 500-5 000 m depth. They referred to the quality of photographic detail that enabled them to see all the taxonomic parts required for its identification, and the considerable difficulty in collecting an organism that is so fragile and for the most part, is mesopelagic.

HOL 20

This holothurian closely resembles the preceding one in its body shape and its mesopelagic life (figure 61). However, it presents the following characters: a flattened body, 15 cm long and 7 cm wide, a translucid tegument, through which the pigmented loop of the digestive tract is visible, a broad velum, formed of four dorsal papillae and directed forwards and prolonging the dorsal surface, four to five pairs of fused podia arranged in two posterior winglike projections Since it has never been seen on substratum, only its position in the water column can be described, and here it swims by maintaining its body axis vertically and beating the water simultaneously with its posterior paired projections and its 10 peribuccal, branched tentacles.

Pawson & Foell (1983) identified this holothurian at the DOMES C site although Kaufman & Smith (1997) did not record it at 4100 m at the station further north-east, perhaps because it lives more in the water column. Bluhm (1994; Bluhm & Gebruk, 1999) recorded it in the Peruvian Basin, and it is known from photographs from the deep north Atlantic Ocean, in the Bay of Biscay (Sibuet et al., 1980).

The hypothesis of identification proposed on the basis of literature (Théel, 1882; Herouard, 1899, 1902, 1923; Madsen, 1953; Barnes et al., 1976) and the advice of specialists is *Peniagone diaphana* (Théel, 1882), family Elpidiidae, Order Elasipodida. This species has been collected in the Pacific, Atlantic and Indian Oceans at depths between 1 520 m and 5 600 m (appendix 3). *Peniagone diaphana* has been observed from a submersible (Barnes et al., 1976) in such a way that its rhythmic swimming pulsations could be determined as 10 to 20 cycles per minute. It is known that it can maintain itself vertically in the water column for more than 12 hours and it was once found at more than 70 m above the bottom surface. According to Hansen (1975), the specific weight of this pelagic species is close to that of water, and it utilises currents as a means of displacement.

An interesting hypothesis for the function of its swimming movements has been proposed by Barnes et al. (1976). They suggest that they facilitate respiration and cause a current that puts particles of detritus from the water-sediment boundary into suspension, and which thus feed the animal. The hypothesis was proposed because *Peniagone diaphana* seems to be essentially mesopelagic, having been observed from a submersible to spend more than 12 hours continuously in the water column. It seems to be a suprabenthic detritus feeder on the basis of the contents of its digestive tract, which include the tests of Foraminifera, spicules of sponges and holothurians, as well as other detritus of benthic origin. Barnes et al. (1976) attributed a special feeding behaviour to it, that of a detritus feeder with the lifestyle almost of an agile suspension feeder. However, just as in *Peniagone leander*, this taxon may perhaps sometimes settle on the substratum in order to feed itself, like all detritus feeders, and the long time spent in the water column could perhaps be an artefact caused by the presence of the submersible disturbing its usual way of life.

Fig. 55. Photograph taken by the 'Nautile' during the NIXONAUT cruise: nodule-facies C, holothurian (swimming) *Peniagone leander* (HOL 19) © Ifremer

Fig. 56. Photograph taken by the 'Epaulard' at the NIXO 45 site: nodule-facies C, holothurian (swimming) *Peniagone leander* (HOL 19) © Ifremer

Fig. 57. Photograph taken by the 'Epaulard' at the NIXO 45 site: nodule-facies C, holothurian (swimming) *Peniagone leander* (HOL 19) © Ifremer

Fig. 58. Photograph taken by a 'Troïka' during the Copano 1 cruise: nodule-facies C, holothurian (swimming) *Peniagone leander* (HOL 19) © Ifremer

Fig. 59. Photograph taken by the 'Nautile' during the NIXONAUT cruise: nodule-facies C, holothurian on the ocean floor *Peniagone leander* (HOL 19) © Ifremer

Fig. 60. Photograph taken by the 'Nautile' during the NIXONAUT cruise: nodule-facies C, holothurian (swimming) *Peniagone diaphana* (HOL 20) © Ifremer

HOL 21

This holothurian measures up to 55 cm long and 5 cm wide and its body is cylindrical to fusiform (figures 61, 62, 63, 64, 65, 66). In colour it is dark purple or violet with paler patches. The dorsal papillae form an irregular fringe around the anterior dorsal extremity. The oral region bears tentacles and is directed ventrally. Two rows of small more or less protruding papillae are aligned on the dorsal surface. The posterior ends in a blunt point, sometimes with some short tapering projections. The non-gelatinous tegument resembles leather. This holothurian appears entirely benthic since it has never been reported from the water column. It has been found on different types of nodule substrata and purely sedimentary ones. Its tracks on sediments are characterised by a double row of relatively large and well-spaced ventro-lateral podia, and by an absence of medio-ventral podia.

Pawson & Foell (1983) identified this holothurian from the DOMES C site although it was not recorded in the inventories of Kaufman & Smith (1997) or Lauerman et al. (1996). Bluhm (1994) and Bluhm & Gebruk (1999) found it in the Peruvian Basin and it has been recognised in photographs from the Bay of Biscay in the north Atlantic Ocean (Sibuet et al., 1980).

The hypothesis of identification in agreement with Pawson (pers. comm.) is *Psychronaetes hanseni* (Pawson, 1983), family Laetmogonidae, Order Elasipodida, which has been collected in the central Pacific Ocean and especially in the study zone, between 4 800 m and 5 200 m (appendix 3). Externally, the holotype does not have peribuccal papillae but has 15 tentacles with broad oral discs and small short stalks. The 15 ventro-lateral podia per row are approximately 10 mm long and 8 mm wide, triangular in shape and evenly distributed. The dorsal papillae are arranged in two rows with 30 in each row. At the anterior end, about 15 papillae, measuring 15 mm long by 9 mm wide for the largest, form an irregular fringe.

Fig. 61. Photograph taken by the 'Nautile' during the NIXONAUT cruise: capture of a holothurian *Psychronaetes hanseni* (HOL 21)
© Ifremer

Fig. 62. Photograph taken by 'Deep Tow' at the Echo I site: nodule-facies C, holothurian *Psychronaetes hanseni* (HOL 21)
© Ifremer

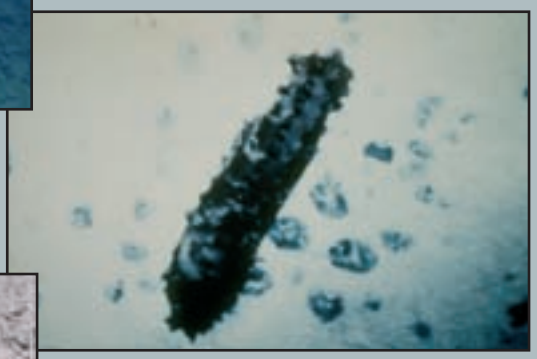

Fig. 63. Photograph taken by the 'Epaulard' at the NIXO 45 site: nodule-facies C, holothurians *Psychronaetes hanseni* (HOL 21) and *Oneirophanta mutabilis* (HOL 4)
© Ifremer

Fig. 64. Photograph taken by the 'Nautile' during the NIXONAUT cruise: nodule-facies O, holothurian *Psychronaetes hanseni* (HOL 21) © Ifremer

Fig. 66. Photograph taken by the 'Nautile' during the NIXONAUT cruise: on ancient dredge tracks, two holothurians *Psychronaetes hanseni* (HOL 21) and *Mesothuria murrayi* (HOL 9)
© Ifremer

Fig. 65. Photograph taken by the 'Nautile' during the NIXONAUT cruise: nodule-facies C, holothurian *Psychronaetes hanseni* (HOL 21) © Ifremer

HOL 22

This holothurian can reach up to 35 cm in length and 12 cm width (figure 67). It has a very dark tegument and in consequence, the detail of the dorsal surface is very difficult to discern. In some photographs, however, a double row or bands of dorsal papillae can be seen, as well as a marginal fringe bordering the sides of the body. In addition, it is characterised by the absence of a distinct anterior region, as was the case for the preceding taxon. HOL 22 is the only holothurian observed in the study zone that leaves a trail free of nodules on substrata with a dense covering of nodules. This gives an idea of its mass and power and the perturbation caused in the edaphic environment by its passage. It has never been seen in the water column.

Pawson & Foell (1983) identified similar holothurians from the DOMES C site, though Kaufman & Smith (1997) and Lauerman et al. (1996) did not record it. Bluhm (1994) and Bluhm & Gebruk (1999) reported comparable taxa in the Peruvian Basin, and it is also present in photographs from the Bay of Biscay in the northern Atlantic Ocean (Sibuet et al., 1980).

The hypothesis of identification proposed by reference to the literature (Théel, 1879, 1882, 1886a, 1886b; Ludwig, 1894; Madsen, 1953; Hansen, 1975; Luke, 1982) and specialists is a member of the Order Elasipodida and family Laetmogonidae, *Laetmogone sp.* Holothurians identified as *Laetmogone wyville thomsoni* (Theel, 1879; Madsen, 1953) have been collected in the north-east and south-east Pacific Ocean (cf. appendix 3).

HOL 23

This holothurian measures up to 30 cm long and 6 cm wide (figures 68, 69, 70, 71). Its dark body is semi-cylindrical, flattened on the ventral surface and supported by a broad podial fringe. In black and white photographs it appears dark, and in colour photographs, pale violet-brown on the dorsal surface with much darker shades on the ventral plantar surface. In figure 69, one can distinguish two dorsal tapering papillae perpendicular to the axis of the body. One small dorsal apophysis is situated approximately 1/4 of the way from the posterior end. The broad podial fringe is used in swimming, putting the holothurian in a medio-transverse plane while keeping the dorsal apophysis upright (figure 71). This holothurian has been observed on all types of ocean floor and its tracks are easily discernible (figure 70).

Pawson & Foell (1983) identified it from the DOMES C site though it has not been recorded by Kaufman & Smith (1997) or Lauerman et al. (1996) at the station further north-east at 4 100 m. Bluhm (1994) and Bluhm & Gebruk (1999) also found it in the Peruvian Basin, but it has not been seen in the Bay of Biscay in the north Atlantic Ocean (Sibuet et al., 1980).

The proposed identification, based on the literature (Ludwig, 1894; Koehler et Vaney, 1905; Clark, 1920; Madsen, 1953; Hansen, 1956, 1975) and the opinion of specialists, is *Psychropotes verrucosa* (Ludwig, 1894), family Psychropotidae and Order Elasipodida. This holothurian exhibits the external characters that can be seen in some photographs, such as 15 or 16 peribuccal tentacles, one to four pairs of small dorsal papillae, a conical and retractable dorsal appendage, a marginal fringe composed of ventro-lateral podia and their water-vascular system, and a tegument covered with excrescences that each contain a giant spicule in the form of a cross; in older individuals, the tegument has longitudinal bands of transverse ridges. One can explain the absence of definite tracks on the substratum by the fact that this taxon only has medio-ventral podia (56 pairs).

This species has been reported from many localities from the Indian to the eastern Pacific Ocean at depths varying between 2 417 m and 7 250 m (appendix 3), but never in the water column.

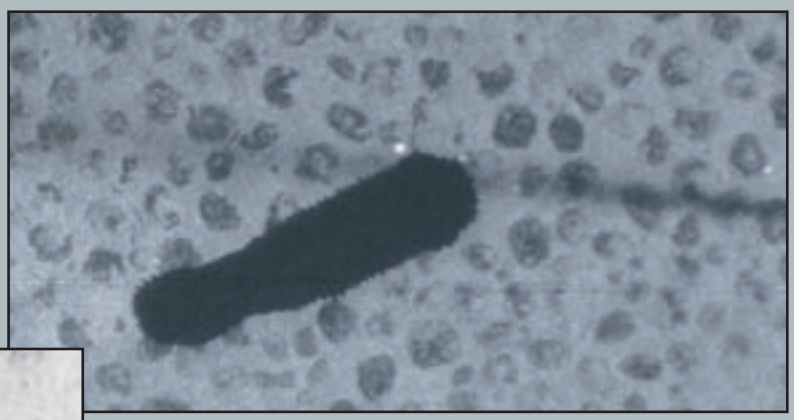

Fig. 67. Photograph taken by the 'Epaulard' at the NIXO 45 site: nodule-facies C: holothurian *Laetmogone sp.* (HOL 22) © Ifremer

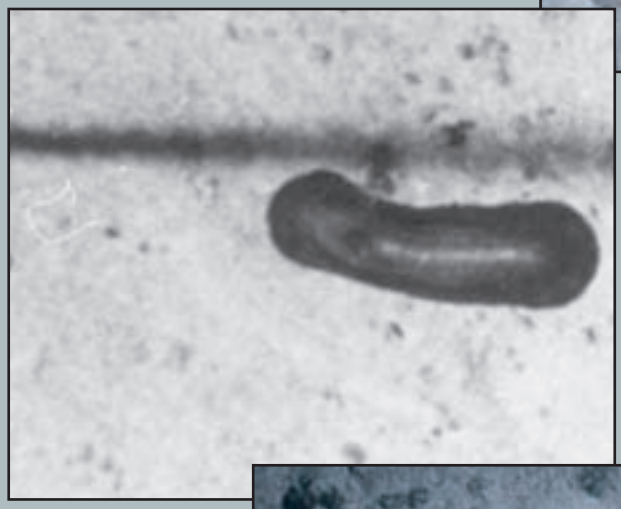

Fig.68. Photograph taken by the 'Epaulard' at the NIXO 45 site: nodule-facies O, holothurian *Psychropotes verrucosa* (HOL 23) © Ifremer

Fig. 69. Photograph taken by the 'Epaulard' at the NIXO 45 site: mixed nodule-facies (C and B), holothurian *Psychropotes verrucosa* (HOL 23) © Ifremer

Fig. 70. Photograph taken by the 'Epaulard' at the NIXO 45 site: nodule-facies C sparse, holothurian *Psychropotes verrucosa* (HOL 23) © Ifremer

Fig. 71. Photograph taken by the 'Nautile' at the NIXO 45 site: nodule-facies O, holothurian (swimming) *Psychropotes verrucosa* (HOL 23) © Ifremer

HOL 24

This holothurian measures 20 to 30 cm long and 5 to 7 cm wide (figure 72). Its very dark, smooth tegument reflects light, as though armoured and marked by transverse folds. A relatively thin podial fringe encircles the body. The anterior region is very distinct and almost hexahedral in shape. It occurs on sedimentary facies and rock outcrops but has never been observed in the water column, and its tracks can not be discerned. Outside the study zone, it has not been seen in photographs from the Peruvian Basin nor those from the Bay of Biscay.

The proposed identification is a member of the family Psychropotidae, Order Elasipodida. The identification can not be taken further, either by reference to the literature (Sluiter, 1901; Heding, 1940; Hansen, 1975) or to specialists, because this species was previously unknown to science. It has certain characteristics in common with *Benthodytes sibogae* (Sluiter, 1901; Hansen, 1975) that has been collected around Indonesia between 694 m and 2 798 m.

HOL 25

This taxon is about 30 cm long and 10 cm wide, very flattened and dark, and is found on all types of sedimentary facies and with nodules (figures 73, 74). The podial margin is developed and continuous with the widely spreading peribuccal tentacles. Unfortunately the dark dull colour of the tegument prevents any morphological detail from being distinguished, and the tracks left by its passage could not be seen either. One individual of HOL 25 was filmed on a voyage during the NIXONAUT cruise, raising itself half way up the side of a cliff and then diving, flattened, with the aid of its broadly spread fringe in order to alight several metres lower. This was perhaps a reaction to the approach of the "Nautile" or done under the influence of its hydrodynamic turbulence.

The hypothesis of identification based on the literature (Théel, 1879, 1882, 1886a, 1886b; Ludwig, 1894; Madsen, 1953; Hansen, 1975; Luke, 1982) and specialists is a member of the Order Aspidochirotida, family Synallactidae, *Paelopatides sp.* (Théel, 1886). *Paleopatides confundens* (Théel, 1886) has been recorded in the north and south-east Pacific Ocean, especially in the study zone between 450 m and 4 070 m and *P. suspecta* at 2 323 m at 8°N in the Pacific (appendix 3).

Pawson & Foell (1983) identified *Paleopatides* species of similar appearance at the DOMES C site. Kaufman & Smith (1997) and Lauerman et al. (1996) did not find this genus at their station. Bluhm (1994) and Bluhm & Gebruk (1999) have also recorded *Paleopatides* in the Peruvian Basin that were brown-orange in colour and had a somewhat convex dorsal surface and two rows of short papillae. Similar taxa have been reported from the Bay of Biscay in the northern Atlantic Ocean (Sibuet et al., 1980).

According to Gage et al. (1985), holothurians identified as *Paelopatides sp.* have been photographed in the north-east Atlantic Ocean at 1942-1949 m and at 1100 m in the north-east Pacific Ocean. They appeared to flee with a sinusoidal motion at the approach of the trawl.

Fig. 72. Photograph taken by the 'R.A.I.E.' at the NIXO 42 site: mixed nodule-facies O and rock, holothurian *Benthodytes sibogae* (HOL 24)
© Ifremer

Fig. 73. Photograph taken by the 'Epaulard' at the NIXO 45 site: nodule-facies O, holothurian *Paelopatides confundens* (HOL 25)
© Ifremer

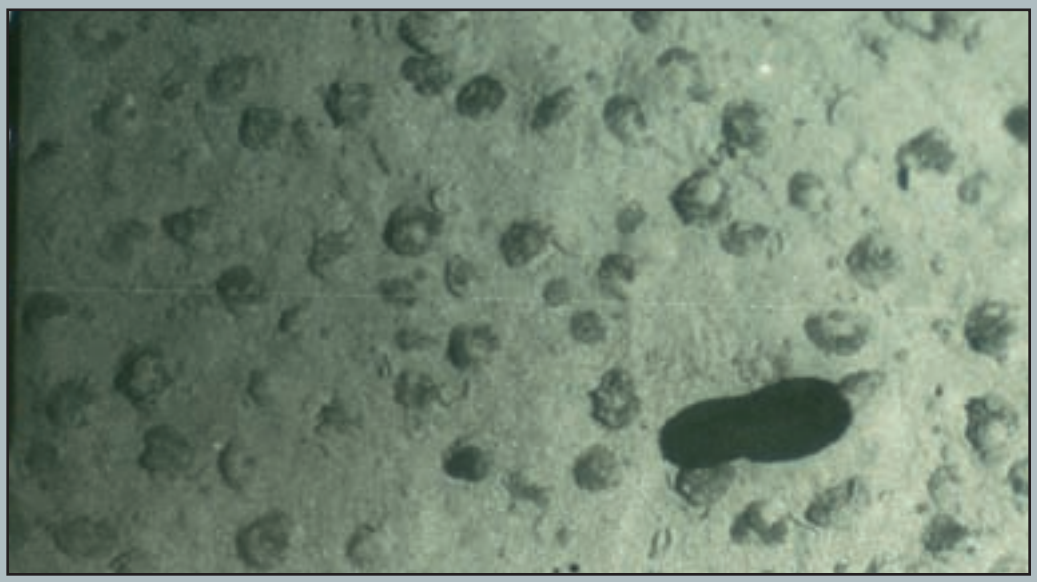

Fig. 74. Photograph taken by the 'Epaulard' at the NIXO 45 site: nodule-facies O, holothurian *Paelopatides sp.* (HOL 25)
© Ifremer

HOL 26

This holothurian measures 16 to 20 cm in length and 7 cm width (figure 75). It is very flattened, paler in colour than HOL 25 and with the edges and the dorsal median groove darker. The extremities of the body are rounded. One distinctive external character is the presence of some long tapering dorsal papillae. This holothurian has only been observed on surfaces with nodules, where its tracks are indistinct, and never in the water column, although it has a morphology suitable for vertical movement due to the presence of a broad podial fringe (Hansen, 1975).

Pawson & Foell (1983) identified similar taxa from the DOMES C site. Kaufman & Smith (1997) and Lauerman et al. (1996) did not find this genus at their station, and neither did Bluhm (1994; Bluhm & Gebruk, 1999) in inventories from the Peruvian Basin. This taxon also seems to be absent from the Bay of Biscay in the north Atlantic Ocean (Sibuet et al., 1980).

The identification proposed, based on the literature (Théel, 1882; Ludwig, 1894; Sluiter, 1901; Edwards, 1907; Fisher, 1907; Mitsukuri, 1912; Clark, 1913, 1920; Oshima, 1915, 1916, 1919; Parker, 1963; Hansen, 1975) and the advice of specialists, is *Pannychia moseleyi* (Théel, 1882), family Laetmogonidae. It has been recorded in the north, south-east and south-west Pacific Ocean at depths varying between 212 m and 2 599 m (appendix 3). External characters of this taxon are 20 tentacles, ventro-lateral podia in a double row to the extremities (34 to 45 podia per row), which terminate in discs in the form of suckers, 40 smaller medio-ventral podia, numerous small papillae distributed over all the body, and 10-20 longer papillae arranged bilaterally on the dorsal radii.

HOL 27

This taxon is characterised by a flattened, elongated body with a well developed lateral fringe (figure 76). It measures a maximum of 20 cm long and 7 cm wide. The lateral fringe has a dark tinge contrasting with the pale or sometimes off-white dorsal surface that has a speckled appearance. It has never been seen swimming although its morphology would be suitable. Östergren (1938) suggested that this bicoloured pattern could be an aid to escaping predation by swimming, as in numerous Elasipods. This taxon has only been observed on facies with nodules and it does not leave any visible trail in photographs. A similar taxon appears in the photographs from the Bay of Biscay but it does not show the bicoloured pattern seen in the holotype HOL 27.

The identification proposed by reference to the literature (Théel, 1882, 1886; von Marenzeller, 1893; Ludwig, 1894; Perrier, 1896, 1902; Koehler et Vaney, 1905; Clark, 1913, 1920, 1923a, 1923b; Oshima, 1915, 1916, 1919; Grieg, 1921; Hérouard, 1923; Deichmann, 1930, 1940, 1954; Heding, 1940; Madsen, 1953; Hansen, 1975) and on the advice of specialists is a holothurian of the genus *Benthodytes*, family Psychropotidae, Order Elasipodida. It most closely resembles *Benthodytes typica* (Théel, 1882) which has been reported between 315 m and 4 700 m between 8°N and 6°S in the Pacific Ocean (appendix 3). The external characters of *Benthodytes typica* are, among others, 15 to 20 peribuccal tentacles, circum-oral papillae and well pigmented water-vascular system on the ventro-lateral podia that is equally visible from the dorsal and ventral surfaces. The dorsal papillae are few (three or four pairs), small and aligned in two rows along the anterior part of the dorsal radii. The tegument is soft and mucosal for most of the time. The speckled appearance of the dorsal tegument comes from the fact that it is covered with small mauve swellings on a dark back ground. The ventral surface is uniformly dark violet.

This taxon is fairly cosmopolitan having been reported at depths varying between 315 m and 4 700 m. According to Miller & Pawson (1990), specimens have been collected in the Atlantic Ocean up to an altitude of 3 400 m above the bottom, indicating that only the juvenile forms are bentho-pelagic (Grieg, 1921; Billett et al., 1985).

A similar form, *Benthodytes sanguinolenta* (Théel, 1882), from in the north-east Pacific Ocean, has also been found in the Peruvian Basin, where it is relatively abundant. It is an active swimmer and moves by rhythmic flexing.

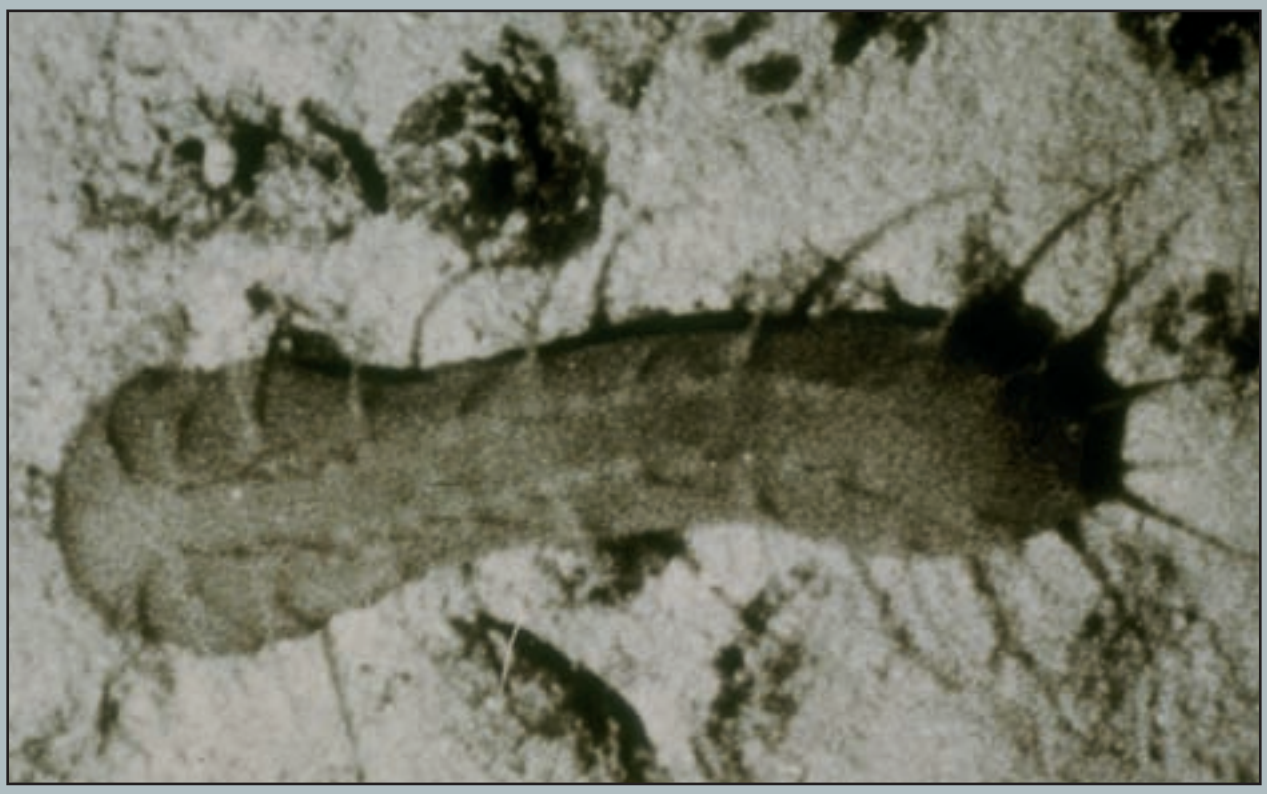

Fig. 75. Photograph taken by 'Deep Tow' at the Echo 1 site: nodule-facies C, holothurian *Pannychia moseleyi* (HOL 26) © Ifremer

Fig. 76. Photograph taken by the 'Epaulard' at the NIXO 45 site: nodule-facies B, holothurian *Benthodytes typica* (HOL 27) © Ifremer

HOL 28

This holothurian measures 17 to 25 cm long by 2 to 4 cm wide (figures 77, 78). It appears flattened with the extremities rounded. In photographs taken by the "Nautile", it is pale violet with clearly darker shades along the podial fringe and at the anterior extremity, which is slightly more developed. On the dorsal surface, two rows of long dispersed papillae can be distinguished, turned down towards the substratum. Just as in the preceding taxa, no trail could be detected after its passage over ocean floor covered in nodules. This taxon appears to prefer a habitat with a relatively dense covering of nodules and does not appear to be mesopelagic, never having been seen in the water column.

Pawson & Foell (1983) identified *Benthodytes incerta* at the DOMES C site. Kaufman & Smith (1997) and Lauerman et al. (1996) did not find it at their station further to the north-east, and neither did Bluhm (1994; Bluhm & Gebruk, 1999) in inventories of the Peruvian Basin. It also appears to be absent from the Bay of Biscay in the northern Atlantic Ocean (Sibuet et al., 1980).

The proposed identification, based on the literature (Ludwig, 1894; Oshima, 1915, 1915-1919; Clark, 1920; Madsen, 1953; Hansen, 1975) and on the advice of specialists, is *Benthodytes incerta* (Ludwig, 1894), family Psychropotidae, Order Elasipodida. *Benthodytes incerta* has been collected in the tropical east Pacific Ocean and around Japan at depths varying from 2 417 m to 4 087 m (appendix 3). It has as external characters a semi-cylindrical body, a firm tegument finely covered with swellings, 9 to 15 tentacles, a narrow podial fringe delimiting the well defined ventral sole, six to nine filiform or conical dorsal papillae in two rows, 9-15 tentacles, circum-oral papillae, a contractile peribuccal membrane, often turned down over the tentacles, and medio-ventral podia arranged irregularly in a double row.

HOL 29

This dark taxon measures between 15 and 20 cm long and 2-3 cm wide (figure 79). It has some long scattered dorsal papillae extending over the dorsal radii. The peribuccal region is clearly distinct from the rest of the body. It is never found in the water column but is present on all types of facies with nodules and it leaves no visible trail.

Pawson & Foell (1983) have identified three sorts of *Benthodytes* from the DOMES C site, *Benthodytes sp.*, *B. incerta* and *B. typica*, one of which is similar to HOL 29. Kaufman & Smith (1997) and Lauerman et al. (1996) did not record *Benthodytes sp.* at their station. Bluhm (1994) and Bluhm & Gebruk (1999) reported two types of *Benthodytes* in their inventories from the Peruvian Basin, as well as *Benthodytes sanguinolenta*, which is very characteristic of this zone. This taxon was not recognised in photographs from the Bay of Biscay (Sibuet et al., 1980).

We propose as a hypothesis of identification, based on the literature (von Marenzeller, 1893; Ludwig, 1894; Perrier, 1896; Clark, 1920; Deichmann, 1930, 1940, 1954; Heding, 1940, 1942; Hansen, 1956, 1975) and the advice of specialists, a holothurian that is probably new to science and related to the genus *Benthodytes, B. sp.* type 2 (Théel, 1882), family Psychropotidae and Order Elasipodida. One possibility would be *Benthodytes lingua* (Perrier, 1896), which is characterised by a podial sole scarcely differentiated from the rest of the body, filiform and conical dorsal papillae in up to 12 pairs, and rounded ends to the body. *Benthodytes lingua* has been collected in the Atlantic Ocean (04°05'N, 02°13'O) at 2 100 m depth.

HOL 30

This holothurian measures about 30 cm long by 5 cm wide (figures 77, 78). The tegument is off-white seems randomly speckled by numerous small papillae. The body appears cylindrical and rounded at the extremities. This taxon only appears on nodular ocean floor and does not seem to be mesopelagic.

In referring to the literatures (Ludwig, 1893, 1894; Clark, 1920; Hansen, 1956) and on the advice of specialists, we propose as a hypothesis of identification a species of the genus *Mesothuria* (Théel, 1886), family Synallactidae, Order Aspidochirotida. Three members of this genus have been collected not far from the study zone: *Mesothuria megapoda* (Clark, 1920) at 4 245 m in the central east Pacific Ocean, *Mesothuria murrayi* (Théel, 1886) which corresponds to HOL 9 described previously, and *Mesothuria multipes* (Ludwig, 1893) from the Indian Ocean and the central east Pacific Ocean between 725 m and 4 064 m depth (appendix 3).

Pawson & Foell (1983) did not identify any *Mesothuria* species from the DOMES C area except for *M. murrayi*, and the same is true for Bluhm & Gebruk (1999) in the Peruvian Basin.

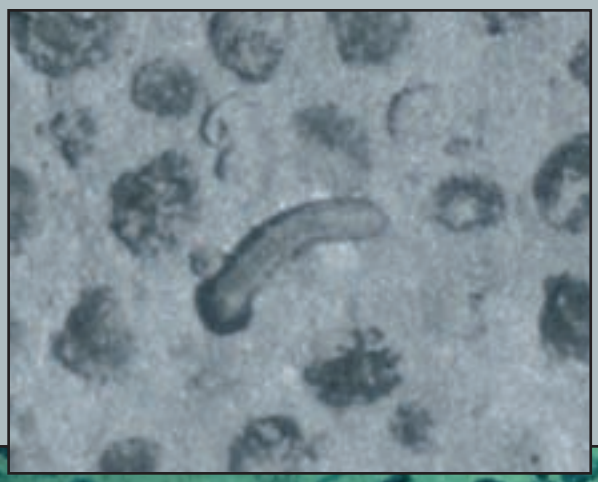

Fig.77. Photograph taken by the 'Epaulard' at the NIXO 45 site: nodule-facies C, holothurian *Benthodytes incerta* (HOL 28) © Ifremer

Fig.78. Photograph taken by the 'Nautile' during the NIXONAUT cruise: facies of plates, holothurian *Benthodytes sp.* type 1 (HOL 6) © Ifremer

Fig. 79. Photograph taken by 'Deep Tow' at the Echo I site: mixed nodule-facies with plates (B and C), holothurian *Benthodytes sp.* type 2 (HOL 29) © Ifremer

Fig.80. Photograph taken by the 'Epaulard' at the NIXO 45 site: nodule-facies C, holothurian *Mesothuria sp.* (HOL 30) © Ifremer

Fig.81. Photograph taken by the 'Epaulard' at the NIXO 45 site: nodule-facies C, holothurian *Mesothuria sp.* (HOL 30) © Ifremer

HOL 31

These small holothurians 3-5 cm long and 1-2 cm wide are difficult to see and can be found on all types of ocean floor. They can sometimes be confused with other organisms such as sponges, molluscs or crustaceans. The body is almost globular and bears some long dorsal papillae and long, widely spaced, latero-ventral podia. This taxon is only seen on sedimentary surfaces. The small size of these holothurians is perhaps the reason why they were not distinguished in photographs from the Peruvian Basin.

Based on the literature (Clark, 1920; Hansen, 1956, 1967, 1975; Belyaev 1971; Lemche et al., 1976) and specialist advice, identification proposed is a member of the family Elpidiidae, Order Elasipodida. *Scotoplanes globosa* (Théel, 1879), a cosmopolitan holothurian which has been recorded in the study zone, is a possibility, or *Scotoplanes clarki* (Hansen, 1975), which has only been collected in the central eastern Pacific Ocean (10°N, 10°S) at depths between 3 570 m and 5 107 m (appendix 3). These holothurians both have two or three pairs of long dorsal papillae, five to seven pairs of ventral podia and 10 peribuccal tentacles. A smooth tegument and rigid dorsal papillae would correspond to the external characters of *Scotoplanes globosa*, while a tegument covered with swellings and long, thin dorsal papillae are characteristic of *Scotoplanes clarki*. These holothurians can measure up to 9 cm. They have a very special mode of locomotion, as mentioned previously for HOL 10, using their long latero-ventral podia activated independently by the constriction of cavities of the water-vascular system contained in the dermis (Hansen, 1972). Some *Scotoplanes* species are known to be occasional scavengers, feeding in fish carcasses (Pawson, 1976).

The collected holothurians, which on the advice of specialists appear similar to the taxa identified in the Clarion-Clipperton fracture zone, are presented in appendix 3 with their geographic and bathymetric distribution.

Appendix 1

List of codes

based on the classification of Parker (1982) (1982)

XEN	Xenophyophora, Cl. Xenophyophorea, Supercl. Rhizopoda, Phyl. Protozoa
SPO	Sponges, Phyl. Porifera
HYD	Hydroids, O. Hydroidea, Cl. Hydrozoa, Phyl. Cnidaria
MED	Jellyfish, O. Coronatae and O. Semaeostoniae, Cl. Scyphozoa, Phyl. Cnidaria
SIF	Siphonophores, O. Siphonophora, Cl. Hydrozoa, Phyl. Cnidaria
OCT	Octocoralliarians, O. Gorgonacea and O. Pennatulacea, Cl. Anthozoa, Phyl. Cnidaria
CER	Ceriantharians, O. Ceriantharia, Cl. Anthozoa, Phyl. Cnidaria
CTEN	Ctenophorans, Phyl. Ctenophora
ANT	Antipatharians, O. Antipatharia, Cl. Anthozoa, Phyl. Cnidaria
ACT	Sea-anemones, O. Actinaria, Cl. Anthozoa, Phyl. Cnidaria
CEP	Cephalopods, Cl. Cephalopoda, Phyl. Mollusca
NUD	Nudibranchs, O. Nudibranchia, Cl. Gastropoda, Phyl. Mollusca
MOL	Molluscs, Phyl. Mollusca
POL	Polychaete worms, Cl. Polychaeta, Phyl. Annelida
SIP	Sipunculians, Phyl. Sipuncula
ECH	Echiurians, Phyl. Echiuria
PYC	Pycnogonids, Cl. Pycnogonida, Phyl. Arthropoda
PER	Peracarids, Super-O. Peracaridea, Cl. Crustacea, Phyl. Arthropoda
ISO	Isopods, O. Isopoda, Super-O. Peracaridea, Cl. Crustacea, Phyl. Arthropoda
DEC	Decapods, O. Decapoda, Super-O. Peracaridea, Cl. Crustacea, Phyl. Arthropoda
GAL	Galatheas, Fam. Galatheidea, Infra-O. Anomourea, O. Decapoda, Super-O. Peracaridea, Cl. Crustacea, Phyl. Arthropoda
CRI	Crinoids, Cl. Crinoïdea, Phyl. Echinodermata
AST	Seastars, Subcl. Somasteroïdea, Cl. Asteridae, Phyl. Echinodermata
OPH	Brittle stars, Subcl. Ophiuroidea, Cl. Asteridae, Phyl. Echinodermata
OUR	Sea urchins, Cl. Echinoidea, Phyl. Echinodermata
HOL	Sea cucumbers, Cl. Holothuridea, Phyl. Echinodermata
ENT	Epibenthic hemichordates, Cl. Enteropneusta, Phyl. Hemichordata
ASC	Ascidians, Cl. Ascidiacea, Subphyl. Tunicata, Phyl. Chordata
SAL	Salps, O. Salpidae, Cl. Thaliacea, Subphyl. Tuniciata, Phyl. Chordata
POI	Fish, Cl. Osteichthya, Subphyl. Vertebrata, Phyl. Chordata

Appendix 2

List of international specialists consulted

Phylum PROTOZOA	Cl. Xenophyophorea	A. Gooday	U.K.
		O. Kamenskaya	Federation of Russia
		L. Levin	U.K.
		C. Maybury	U.K.
		O. Tendal	Denmark
Phylum PORIFERA	Cl. Demospongiae	N. Boury-Esnault	Fr., Endume
	Cl. Hexactinellida	W. Hartman	E.U.
		V. Koltun	Federation of Russia
		C. Levi	Fr., Muséum
		D. Pawson	E.U.
		O. Tendal	Denmark
		J. Vacelet	Fr., Endume
Phylum CNIDARIA	Cl. Hydrozoa	J. Bouillon	Belgium
		J. Goy	Fr., Muséum
		M. Van Praët	Fr., Muséum
		W. Vervoort	Netherlands
	O. Siphonophora	C. Carré	Fr., Villefranche s/mer
		F. Pagès	Spain
		P. Pugh	U.K.
	Cl. Scyphozoa	J. Bouillon	Belgium
	Cl. Anthozoa	F.M. Bayer	E.U.
	subcl. Alcyonaria	M. Grasshoff	Fed. Rep. of Germany
	O. Gorgonacea	M.J. d'Hondt	Fr., Muséum
	O. Pennatulacea	M. Opresko	E.U.
		H. Zibrowius	(Fr., Endume)
	subcl. Zoantharia	D. Doumenc	(Fr., Muséum)
	O. Actinaria	D. Fautin	E.U.
		K. Riemann-Zürneck	Fed. Rep. of Germany
		M. Sokolova	Federation of Russia
		O. Zezina	Federation of Russia
		H. Zibrowius	Fr., Endume
	O. Scleractinia	H. Zibrowius	Fr., Endume
	O. Antipatharia	M. Grasshoff	Fed. Rep. of Germany
		M.J. d'Hondt	Fr., Muséum
		M. Opresko	E.U.
		H. Zibrowius	Fr., Endume
	O. Ceriantharia	D. Doumenc	Fr., Muséum
		D. Fautin	E.U.
		K. Riemann-Zürneck	Fed. Rep. of Germany
		H. Zibrowius	Fr., Endume
Phylum CTENOPHORA		C. Carré	Fr., Villefranche s/mer

Phylum ANNELIDA	Cl. Polychaeta	C. Bussau	Fed. Rep. of Germany
		D. Desbruyères	Fr., Ifremer
		L. Laubier	Fr., Ifremer
		T. Miura	Japan
		F. Pleijel	Sweden
		E. Southward	U.K.
Phylum ECHIURA		S. Edmonds	Australia
		S. Ohta	Japan
		C. Smith	E.U.
Phylum SIPUNCULA		C. Bussau	Fed. Rep. of Germany
		E. Cutler and N. Cutler	E.U.
		P. Gibbs	U.K.
		M. Rice	E.U.
Phylum MOLLUSCA	Cl. Bivalvia	P. Bouchet	Fr., Muséum
		M. Rex	E.U.
		A. Waren	Sweden
	Cl. Gastropoda	P. Bouchet	Fr., Muséum
		M. Rex	E.U.
		A. Waren	Sweden
	O. Nudibranchia	C. Poizat	Fr., Marseille
		R. Turner	E.U.
	Cl. Cephalopoda	G. Aldred	U.K.
		S. von Boletzky	Fr., Banyuls
		M. Clarke	U.K.
		T. Kubodera	Japan
		M. NIXOn	U.K.
		T. Okutani	Japan
		C. Roper	E.U.
		N. Voss	E.U.
		R. Young	E.U.
Phylum ARTHROPODA			
Subph. CHELICERATA	Cl. Pycnogonida	C. Allan Child	E.U.
		M. de Saint Laurent	Fr., Muséum
		J. Stock	Netherlands
		M. Türkay	Fed. Rep. of Germany
Subph. CRUSTACEA	Super O. Peracarida	J. Svavarsson	Iceland
		M. Türkay	Fed. Rep. of Germany
	O. Mysidacea	J.P. Lagardère	Fr., Endume
	O. Cumacea	M. Ledoyer	Fr., Endume
	O. Tanaidacea	C. Allan Child	E.U.
		A.B. Williams	E.U.
	O. Isopoda	C. Allan Child	E.U.
		R. Hessler	E.U.
		J. Stromberg	Sweden
		J. Svavarsson	Iceland
		D. Thistle	E.U.

		A.B. Williams	E.U.
		G. Wilson	Australia
	O. Amphipoda	Ph. Laval	Fr., Villefranche s/mer
	subo. Hyperiidea		
	O. Decapoda	C. Allan Child	E.U.
	Natantia	A. Crosnier	Fr., Museum
		J.P. Lagardère	Fr., Endume
		M. Türkay	Fed. Rep. of Germany
		A.B. Williams	E.U.
	Reptantia	C. Allan Child	E.U.
		A. Crosnier	Fr., Museum
		I. Gordon	U.K.
		J.P. Lagardère	Fr., Endume
	Reptantia (suite)	M. de Saint Laurent	Fr., Museum
		J. Stock	Netherlands
		M. Türkay	Fed. Rep. of Germany
		A.B. Williams	E.U.
Phylum ECHINODERMATA			
Subph. CRINOZOA	Cl. Crinoidea	A. Clark	U.K.
		J. Durham	E.U.
		D. Pawson	E.U.
		M. Roux	Fr., Reims
Subph. ASTEROZOA	Cl. Stelleroidea	D. Blake	E.U.
	subcl. Asteroidea	A. Clark	U.K.
		L. Maluf	E.U.
		D. Pawson	E.U.
		M. Sibuet	Fr., Ifremer
	subcl. Ophiuroidea	A. Clark	U.K.
	O. Ophiurida	G. Hendler	E.U.
		L. Maluf	E.U.
		D. Pawson	E.U.
		M. Sibuet	Fr., Ifremer
Subph. ECHINOZOA	Cl. Echinoidea	A. Gebruk	Federation of Russia
		G. Hendler	E.U.
		D. Pawson	E.U.
		M. Roux	Fr., Reims
		M. Sibuet	Fr., Ifremer
	Cl. Holothuroidea	D. Billett	U.K.
		R.S. Carney	E.U.
		A. Gebruk	Federation of Russia
		M. Jangoux	Belgium
		L. Maluf	E.U.
		C. Massin	Belgium
		D. Pawson	E.U.
		M. Sibuet	Fr., Ifremer
Phylum HEMICHORDATA	Cl. Enteropneusta	M. Romero-Wetzel	Federation of Russia
		E. Southward	U.K.

Phylum CHORDATA			
Subph. TUNICATA	Cl. Ascidiacea	L. Cole	E.U.
		C. Monniot	Fr., Museum
		F. Monniot	Fr., Museum
	Cl. Thaliacea	J.C. Braconnot	Fr., Villefranche s/mer
Subph. VERTEBRATA	Cl. Osteichthyes	E. Anderson	South Africa
		P. Castle	New Zealand
		D. Cohen	E.U.
		P. Geistdoerfer	Fr., Museum
		T. Iwamoto	E.U.
		N. Merrett	U.K.
		J. Nielsen	Denmark
		B. Seret	Fr., Museum
	Cl. Mammalia	G. Demuizan	Peru
		E. Hussenot	Fr., Brest
		D. Robineau	Fr., Museum

Appendix 3

Identification, geographic and bathymetric distribution of echinoderms collected in the Pacific Ocean

Identification, geographic and bathymetric distribution of crinoids collected in the Pacific Ocean

Taxinomic identification	Taxon	Authors + date of identification	Gegraphic distribution	Bathymetric distribution	Substratum	Codes of taxons on photographs and specialists consulted
O. Comatulida Fam. Antedonidae	*Fariometra parvula*	Hartlaub, 1895 Clark, 1923 ; 1967	Escarpement Patton à la Ride Cocos	589-1969 m	Boues vertes, Vases à globigérines	CRI 1 (M. Roux, A. Clark)
O. Bourgueticrinida Fam. Bathycrinidae	*Bathycrinus equatorialis*	Roux, 1980	Ride Est Pacifique	4246 m	-	CRI 2 (A. Clark, M. Roux)
O. Millericrinida Fam. Hyocrinidae	*Ptilocrinus sp.*	Macurda et Meyer, 1976 Roux, 1980	Ride Est Pacifique	2520-2689 m	Roche	CRI 3 (M. Roux, A. Clark)

Identification, geographic and bathymetric distribution of crinoids collected in the Pacific Ocean

Taxinomic identification	Taxon	Authors + date of identification	Gegraphic distribution	Bathymetric distribution	Substratum	Codes of taxons on photographs and specialists consulted
O. Cidaroida Fam. Cidaridae	*Aporocidaris milleri*	Agassiz, 1898	Alaska, Galapagos, O. Antarctique	300-3937 m	Boues vertes, Sables fins, Vases vertes à diatomées et globigérines	possible CCFZ*
O. Echinothurioida Fam. Echinoturiidae	*Tromikosoma hispidum*	Agassiz, 1898	Guadeloupe, ride Galapagos (30°N-4°S)	1820-2763 m	Boues vertes, Sables, Roche, Vases grises à globigérines	possible CCFZ
O. Echinothurioida Fam. Echinoturiidae	*Tromikosoma panamense*	Agassiz, 1898	Fosse Cedros, ride Malpelo	2054-3334 m	Vases vertes	possible CCFZ
O. Diadematoida Fam. Diadematidae	*Kamptosoma asterias*	Agassiz, 1881	Bassin Mazatlan, fosse du Perou	2988-4950 m	Boues grises	possible CCFZ
O. Diadematoida Fam. Aspidodiadematidae	*Pleisiodiadema globulosum*	Agassiz, 1898	Ride Malpelo, Valparaiso	2830-3900 m	Boues vertes, Vases vertes	OUR 1 (D. Pawson)
O. Diadematoida Fam. Aspidodiade-matidae	*Pleisiodiadema horridum*	Agassiz, 1898	Ride Cocos/Malpelo/ Galapagos	1625-3241 m	Vases vertes à globigérines, Boues vertes, sables, roche	possible CCFZ
O. Spatangoida sub O. Aphisternata Fam. Aeropsidae	*Aceste ovata*	Agassiz et Clark, 1907	Bassin du Pérou, Hawaii, Japon, O. Indien	450-4800 m	Echinides enfouis dans les sédiments	OUR2 (D. Pawson)
O. Spatangoida sub O. Aphisternata Fam. Hemiasteridae	*Hemiaster tenuis*	Agassiz, 1898	Golfe de Panama	980-4027 m	Boues volcaniques fines, Boues vertes, Vases vertes	possible CCFZ
O. Spatangoida sub O. Aphisternata Fam. Schizasteridae	*Brisaster latifrons*	Agassiz, 1881,1898, 1901	Mer de Bering, Galapagos	1900-2817 m	Boues vertes, Sable, Vases à globigérines, Siltes	possible CCFZ
O. Spatangoida sub O. Aphisternata Fam. Aeropsidae	*Aeropsis fulva*	Agassiz, 1898	Mer de Bering, O. Pacifique O	1455-5200 m	Boues vertes fines, Vases vertes	possible CCFZ

Identification and geographic and bathymetric distributions of echinoids collected in the Pacific Ocean

Taxinomic identification	Taxon	Authors + date of identification	Gegraphic distribution	Bathymetric distribution	Substratum	Codes of taxons on photographs and specialists consulted
O. Spatangoida sub O. Aphisternata Fam. Brissidae	*Brissopsis pacifica*	Agassiz, 1898	Ile Manta, Hawaii, Indo-Pacifique O	3279 m	Boues bleues et vertes, Siltes, Sables, Argiles	possible CCFZ
O. Spatangoida sub O. Aphisternata Fam. Loveniidae	*Echinocardium cordata*	Pennant, 1777 Gray, 1851, 1855	Bassin Conception, O. Atlantique, O. Pacifique O , M. Mediterranée	0-4900 m	Boues, Sables, Vases grises, Schiste argileux	possible CCFZ
O. Spatangoida sub O. Aphisternata Fam. Loveniidae	*Homolampas fulva*	Agassiz, 1879	Fosse d'Amérique Centrale, O. Pacifique C	3665-4500 m	Vases grises à globigérines	possible CCFZ
O. Spatangoida sub O. Holasterina Fam. Urechinidae	*Urechinus loveni*	Agassiz, 1898 Agassiz et Clark, 1907	Mer de Bering, O. Pacifique N, Guatemala	1571-3710 m	Boues, Vases à globigérines, Argiles bleues	possible CCFZ
O. Spatangoida sub O. Holasterina Fam. Urechinidae	*Urechinus naresianus*	Agassiz, 1879	Bassin de Californie, Chili, O. Antarctique, O. Atlantique, O. Pacifique N	755-4400 m	Vases à globigérines, Boues	possible CCFZ
O. Spatangoida sub O. Holasterina Fam. Pourtalesiidae	*Cystocrepis setigera*	Agassiz, 1898	Fosse d'Amérique Centrale	2875-3436 m	Vases vertes à globigérines, Boues	possible CCFZ
O. Spatangoida sub O. Holasterina Fam. Pourtalesiidae	*Pourtalesia tanneri*	Agassiz, 1898	Bassin de Guayamas, O. Atlantique N	1450-2454 m	Boues,bleues, Vases à globigérines	possible CCFZ

Identification, geographic and bathymetric distribution of ophiuroids collected in the Pacific Ocean

Taxinomic identification	Taxon	Authors + date of identification	Gegraphic distribution	Bathymetric distribution	Substratum	Codes of taxons on photographs and specialists consulted
O. Ophiurida Fam. Ophiacanthidae	*Ophiacantha cosmica*	Lyman, 1878 Djakonov, 1954 Zenkevitch, 1969	O. Pacifique (32°N-10°S), O. Indien, O. Atlantique N, O. Antarctique	415-4840 m	Sables fins et gris, Boues vertes	possible CCFZ*
O. Ophiurida Fam. Ophiacanthidae	*Ophiacantha pacifica*	Djakonov, 1954 Zenkevitch, 1969 Lütken et Mortensen, 1899	O. Pacifique (32°N- 0°)	362-2877 m	Vases vertes, Boues, Sables	possible CCFZ
O. Ophiurida Fam. Ophiacanthidae	*Ophiacantha sentosa*	Djakonov, 1954 Zenkevitch, 1969 Lyman, 1978 Parker, 1964	O. Pacifique (32°N-60°S)	2067-5203 m	Boues fines et noires, Argiles, Vases à radiolaires	possible CCFZ
O. Ophiurida Fam. Ophiacanthidae	*Ophiolima bairdi*	Djakonov, 1954 Zenkevitch, 1969 Lyman, 1883	O. Pacifique (60°N-14°N)	578-2549 m	Boues vertes, Sables fins et gris, Vases à globigérines, Roches	possible CCFZ
O. Ophiurida Fam. Ophiacanthidae	*Ophiotoma paucispina*	Djakonov, 1954 Zenkevitch, 1969 Lütken et Mortensen, 1899	O. Pacifique (14°N-0°)	2149-4082 m	Vases vertes à globigérines, Boues vertes, Sables, Roches	possible CCFZ
O. Ophiurida Fam. Amphiuridae	*Amphilepis patens*	Djakonov, 1954 Zenkevitch, 1969 Lyman, 1879 Clark, 1911	Alaska, O. Pacifique (60°N-60°S)	385-4087 m	Boues grises, Boues vertes	possible CCFZ
O. Ophiurida Fam. Amphiuridae	*Amphioplus daleus*	Djakonov, 1954 Zenkevitch, 1969 Lyman, 1879	O. Pacifique (32°N-10°S), O. Atlantique O	1170-5869 m	Boues fines et vertes, Boues grises, Vases vertes	possible CCFZ
O. Ophiurida Fam. Amphiuridae	*Amphiura assimilis*	Djakonov, 1954 Zenkevitch, 1969 Lütken et Mortensen, 1899	O. Pacifique (26°N-2°N)	2996-5482 m	Vases vertes	possible CCFZ
O. Ophiurida Fam. Amphiuridae	*Amphiura diomedeae*	Djakonov, 1954 Zenkevitch, 1969 Lütken et Mortensen, 1899 McClendon, 1909	O. Pacifique (60°N-4°S), Japon	44-3017 m	Boues vertes, Sable, Vases vertes à globigérines, Rhabdammina	possible CCFZ
O. Ophiurida Fam. Amphiuridae	*Amphiodia seminuda*	Djakonov, 1954 Zenkevitch, 1969 Lütken et Mortensen, 1899	O. Pacifique (60°N-10°N)	9-4096 m	Sables noirs, Boues vertes, Manganèse, Cailloutis	possible CCFZ

Identification, geographic and bathymetric distribution of ophiuroids collected in the Pacific Ocean

Taxinomic identification	Taxon	Authors + date of identification	Gegraphic distribution	Bathymetric distribution	Substratum	Codes of taxons on photographs and specialists consulted
O. Ophiurida Fam. Ophiuridae	*Ophiocten hastatum*	Djakonov, 1954 Zenkevitch, 1969 Lyman, 1878 Lütken et Mortensen, 1899	O. Pacifique (60°N-3°S), Japon, O. Atlantique E, Océans sud	824-4700 m	Vases à globigérines, Boues vertes, Rhabdammina	possible CCFZ
O. Ophiurida Fam. Ophiuridae	*Ophiomusium lymani*	Djakonov, 1954 Zenkevitch, 1969 Thomson, 1873	O. Pacifique (60°N-60°S), Indo-Ouest Pacifique, O. Atlantique N	51-2906 m	Vases jaunes à globigérines, Boues vertes, Sable, Rhabdammina	possible CCFZ
O. Ophiurida Fam. Ophiuridae	*Ophiosphalma glabrum*	Djakonov, 1954 Zenkevitch, 1969 Lütken et Mortensen, 1899	O. Pacifique (32°N-60°S)	878-5203 m	Manganèse, Vases à globigérines et radiolaires, Boues vertes, Sable, Rhabdammina	possible CCFZ
O. Ophiurida Fam. Ophiuridae	*Ophiotypa simplex*	Djakonov, 1954 Zenkevitch, 1969 Koehler, 1897	O. Pacifique E, O. Atlantique E, O. Indien	3652-3811 m	Vases à globigérines	possible CCFZ
O. Ophiurida Fam. Ophiuridae	*Ophiura irrorata*	Djakonov, 1954 Zenkevitch, 1969 Clark, 1911	O. Pacifique (32°N-60°S), Indo-Pacifique, O. Atlantique	405-5869 m	Vases vertes à globigérines, Boues vertes, Sable, Manganèse, Rhabdammina	possible CCFZ
O. Ophiurida Fam. Ophiuridae	*Homphiura nexila*	Djakonov, 1954 Zenkevitch, 1969	O. Pacifique (14°N-2°N)	1749-5690 m	-	possible CCFZ
O. Ophiurida Fam. Ophioleucidae	*Ophiernus seminudus*	Djakonov, 1954 Zenkevitch, 1969 Lütken et Mortensen,1899	O. Pacifique (14°N-60°S)	840-4082 m	Sables fins, Vases à globigérines, Argiles, boues vertes	possible CCFZ

Identification, geographic and bathymetric distribution of asteroids collected in the Pacific Ocean

Taxinomic identification	Taxon	Authors + date of identification	Gegraphic distribution	Bathymetric distribution	Substratum	Codes of taxons on photographs and specialists consulted
O. Paxillosida Fam. Astropectinidae	*Dipsacaster anoplus*	Fisher, 1910	Mer de Bering, O. Pacifique N	220-2200 m	Sables fins, Boues	possible CCFZ*
O. Paxillosida Fam. Astropectinidae	*Dytaster gilberti*	Fisher, 1905 ; Ludwig, 1905	Escarpement Patton, Trujillo	1573-4335 m	Boues grises et vertes, Vases à globigérines, Sables	possible CCFZ
O. Paxillosida Fam. Astropectinidae	*Psilaster pectinatus*	Fisher, 1905 ; Ludwig, 1905	De la Mer de Bering au Bassin de Panama	1600-3060 m	Boues et vases vertes, Sables	possible CCFZ
O. Paxillosida Fam. Porcellan-asteridae	*Eremicaster crassus gracilis*	Fisher, 1905 Sladen, 1883 Ludwig, 1905	Alaska à Valparaiso, O. Atlantique E	2420-5204 m	Vases à globigérines et diatomées, Boues bleues et grises, Sables verts, Argiles	possible CCFZ
O. Paxillosida Fam. Porcellan-asteridae	*Eremicaster pacificus*	Ludwig, 1905	Mer de Bering à Valparaiso, O. Atlantique E O. Pacifique N O	1463-5780 m	Vases à globigérine, Boues grises, Sables, Rhabdammina	possible CCFZ
O. Paxillosida Fam. Porcellan-asteridae	*Hyphalaster inermis*	Sladen, 1883 Luke, 1982	O. Pacifique, O. Indien, O. Atlantique	1271-5413 m	Boues grises, Vases à globigérines, Argiles	AST 2 (A. Clarke, M. Sibuet)
O. Paxillosida Fam. Porcellan-asteridae	*Thoracaster cylindratus*	Sladen, 1883 Ludwig, 1907	Indo-Pacifique, O. Atlantique W	2600-5303 m	Boues grises et vertes, Argiles, Vases, Manganèse	possible CCFZ (D. Pawson)
O. Paxillosida Fam. Bentho-pectinidae	*Benthopecten acanthonotus*	Fisher, 1905	Bassin de Californie, Galapagos, Bassin Guiones	1157-2726 m	Boues	possible CCFZ (A. Clarke, M. Sibuet)
O. Paxillosida Fam. Bentho-pectinidae	*Pectinaster agassizii*	Ludwig, 1905 Fisher, 1910	Bassin de Californie, Galapagos O. Indien O	790-2323 m	Vases à globigérines, Boues vertes et grises, Rhabdammina	AST 3
O. Spinulosida Fam. Pterasteridae	*Hymenaster gracilis*	Ludwig, 1905	Galapagos	2418-3241 m	Vases à globigérines, Boues vertes	possible CCFZ
O. Spinulosida Fam. Pterasteridae	*Hymenaster quadrispinosus*	Fisher, 1905	Mer de Bering, golfe de Panama	1935-3240 m	Vases grises à globigérines, Boues vertes	possible CCFZ
O. Spinulosida Fam. Pterasteridae	*Hymenaster violaceus*	Ludwig, 1905	O. Pacifique Central	3193-3436 m	Vases à globigérines, Boues	AST 5 (D. Pawson)
O. Forcipulatida Fam. Zoroasteridae	*Zoroaster hirsutus*	Ludwig, 1905	O. Pacifique Central	3436 m	Boues, Vases à globigérines	AST 1 (A. Clarke, M. Sibuet)

Identification, geographic and bathymetric distribution of asteroids collected in the Pacific Ocean

Taxinomic identification	Taxon	Authors + date of identification	Gegraphic distribution	Bathymetric distribution	Substratum	Codes of taxons on photographs and specialists consulted
O. Forcipulatida Fam. Zoroasteridae	*Zoroaster ophiurus*	Fisher, 1905	Mer de Bering, O. Pacifique SE	695-2226 m	Sables fins, Boues	AST 1 (A. Clarke, M. Sibuet)
O. Brisingida Fam. Brisingidae	*Astrolirus panamensis*	Ludwig, 1905	Galapagos	48-2418 m	Vases vertes à globigérines, Boues, Sables, Rhabdammina	possible CCFZ
O. Euclasterida Fam. Brisingidae	*Freyella benthophila*	Sladen, 1889 Clark, 1920a	Ride Est Pacifique Pointe Aguja	4064-4667 m	Vases à globigérines, Argiles, Boues fines, Manganèse	AST 6 (A. Clarke, M. Sibuet)
O. Euclasterida Fam. Brisingidae	*Freyella insignis*	Ludwig, 1905	Bassin de Californie, Bassin de Panama	3180-4075 m	Boues, Vases vertes à globigérines	AST 8 (A. Clarke, M. Sibuet)
O. Euclasterida Fam. Brisingidae	*Freyella octoradiata*	Clark, 1920a	Ride Est Pacifique, Pointe Aguja	4085-4430 m	Boues grises, Vases à radiolaires et à globigérines	possible CCFZ (A. Clarke, M. Sibuet)
O. Euclasterida Fam. Brisingidae	*Freyella pacifica*	Ludwig, 1905	Golfe du Panama	3193-3200 m	-	possible CCFZ
O. Euclasterida Fam. Brisingidae	*Freyella tuberculata*	Sladen, 1889	Galapagos, O. Indien, O. Atlantique E	3365-5300 m	Vases à globigérines	possible CCFZ

Identification, geographic and bathymetric distribution of holothuroids collected in the Pacific Ocean

Taxinomic identification	Taxon	Authors + date of identification	Gegraphic distribution	Bathymetric distribution	Substratum	Codes of taxons on photographs and specialists consulted
O. Dendrochirotida Fam. Cucumariidae	*Abyssocucumis abyssorum*	Théel, 1886	O. Pacifique N et SE, O. Indien, O. Atlantique	385-4087 m	Boues vertes, sable, Boues à globigérines et Diatomées, Manganèse	possible dans CCFZ*
O. Dendrochirotida Fam. Cucumariidae	*Abyssocucumis albatrossi*	Cherbonnier, 1941	O. Pacifique N et SE	1585-569 m	Boues vertes, Sable, Boues à globigérines et diatomées, Manganèse	possible dans CCFZ
O. Dactylochirotida Fam. Ypsilothuriidae	*Ypsilothuria bitentaculata*	Ludwig 1893	O. Pacifique N, O et SE, O. Indien	225-4082 m	Boues à globigérines, Sable, Boues vertes	possible dans CCFZ
O. Aspidochirotida Fam. Synallactidae (Madsen, 1953; Hansen, 1975)	*Capheira sulcata*	Madsen, 1953 Hansen, 1975	8°N-10°S O. Pacifique Central Est	2877-4334 m	Boues à globigérines, Boues vertes, Manganèse	possible dans CCFZ
O. Aspidochirotida Fam. Synallactidae	*Meseres macdonaldi*	Ludwig, 1894 Sluiter, 1901	2°N-8°N O. Pacifique Central Est	1644-2149 m	Roche, Boues vertes, Sable	HOL 8 (D. Pawson)
O. Aspidochirotida Fam. Synallactidae	*Bathyplotes sp.*	Madsen, 1953 Hansen, 1975 Parker, 1964 Luke, 1982	20°N-26°N O. Pacifique Central Est	1500-2715 m	?	possible dans CCFZ
O. Aspidochirotida Fam. Synallactidae	*Galatheathuria aspera*	Théel, 1886	O. Atlantique	2500 m	-	possible dans CCFZ
O. Aspidochirotida Fam. Synallactidae	*Mesothuria megapoda*	Clark, 1920	2°N O. Pacifique Central Est	4245 m	?	possible dans CCFZ
O. Aspidochirotida Fam. Synallactidae	*Mesothuria murrayi*	Théel, 1886 Fisher, 1907	O. Pacifique E et O, O. Atlantique N	300-3000 m	Sediments	HOL 9 (D. Pawson)
O. Aspidochirotida Fam. Synallactidae	*Mesothuria multipes*	Ludwig, 1893	8°N-9°S O. Pacifique Central Est, O. Indien O	725-4064 m	Boues, Manganèse, Nodules, Rhabdammina	possible dans CCFZ
O. Aspidochirotida Fam. Synallactidae	*Paelopatides confundens*	Théel, 1886	O. Pacifique N et SE	450-4070 m	Boues vertes et noires, Vases à globigérines	possible dans CCFZ *Paelopatides sp.* (D. Pawson)
O. Aspidochirotida Fam. Synallactidae	*Paelopatides suspecta*	Ludwig, 1894	8°N O. Pacifique	2323 m	Rhabdammina	possible dans CCFZ (D. Pawson)
O. Aspidochirotida Fam. Synallactidae	*Pseudostichopus mollis*	Théel, 1886 Ludwig, 1894 Madsen, 1953	O. Pacifique NE et SE, O. Atlantique SE, O. Antarctique, O. Indien	100-5203 m	Boues vertes, Vases à globigérines, Manganèse, Sable	HOL 7 (D. Pawson)
O. Aspidochirotida Fam. Synallactidae	*Pseudostichopus villosus*	Théel, 1886	O. Pacifique SO	8000 m	-	possible dans CCFZ (Lemche et al., 1976)
O. Aspidochirotida Fam. Synallactidae	*Synallactes aenigma*	Ludwig, 1894	8°N-10°S O. Pacifique Central N	2404-4334 m	Sable, Vases à globigérines, Manganèse, Boues vertes	HOL 1 Fam. Synallactidae (D. Pawson, M. Sibuet)
O. Aspidochirotida Fam. Synallactidae	*Synallactes profundi*	Koehler et Vaney, 1905	O. Indien, O. Pacifique Central et S, O. Atlantique N	2700-4300 m	Sable, Vases à globigérines, Manganèse, Boues vertes	HOL 2 (D. Pawson; C. Massin)

Identification, geographic and bathymetric distribution of holothuroids collected in the Pacific Ocean

Taxinomic identification	Taxon	Authors + date of identification	Gegraphic distribution	Bathymetric distribution	Substratum	Codes of taxons on photographs and specialists consulted
O. Elasipodida Fam. Deimatidae	*Deima validum pacificum*	Théel, 1879 Ludwig, 1894 Koehler and Vaney 1905	1°N-8°N Cosmopolite	1618-2487 m	Boues vertes, Sable, Manganèse, Vases à globigérines, Roche	HOL 5 *Deima validum* (D. Pawson)
O. Elasipodida Fam. Deimatidae	*Orphnurgus parvispiculatum*	Clark, 1901	8°S-85°SO	4335 m	-	possible dans CCFZ
O. Elasipodida Fam. Deimatidae	*Oneirophanta mutabilis affinis*	Clark, 1901	14°N-10°S	3241-3670 m	Boues vertes, Vases vertes	HOL 4 *Oneirophanta mutabilis* (D. Pawson ; M.Sibuet ; A. Gebruk ; C. Massin)
O. Elasipodida Fam. Deimatidae	*Oneirophanta mutabilis mutabilis*	Théel, 1879	O. Pacifique NE, Cosmopolite	1805-6000 m	Vases à globigérines et à diatomées, Boues vertes, Argiles	HOL 4 possible dans CCFZ
O. Elasipodida Fam. Deimatidae	*Oneirophanta setigera*	Ludwig, 1893	8°N-3°S , O. Pacifique SO	2104-4540 m	Vases à globigérines, Sable, Boues vertes, Roche	possible dans CCFZ
O. Elasipodida Fam. Laetmogonidae	*Apodogaster sp.*	Hansen, 1975	Golf de Panama	2950-3190 m	Argiles, Roche	possible dans CCFZ Laetmogonidae (C. Massin)
O. Elasipodida Fam. Laetmogonidae	*Laetmogone wyville thomsoni*	Théel, 1879 Madsen, 1953	O. Pacifique NE et SE	631-4410 m	Vases à globigérines, boues, Sable	possible dans CCFZ
O. Elasipodida Fam. Laetmogonidae	*Pannychia moseleyi*	Théel, 1882	O. Pacifique NE, 32°N-6°S SE et SO	212-2599 m	Vases à globigérines, Boues vertes, Sable	HOL 26 *Pannychia sp.* (D. Pawson)
O. Elasipodida Fam. Laetmogonidae	*Psychronaetes hanseni*	Pawson, 1983	20°N-14°N O. Pacifique Central Est	4800-5200 m	Vases à diatomées, Manganèse, Argile	Dans CCFZ HOL 21 (D. Pawson)
O. Elasipodida Fam. Psychropotidae	*Benthodytes incerta*	Ludwig, 1894	O. Pacifique, 8°N-4°S Japon	2417-4087 m	Boues adhérentes grises, Vases à globigérines	HOL 28 (D. Pawson)
O. Elasipodida Fam. Psychropotidae	*Benthodytes sanguinolenta*	Hansen, 1956	O. Pacifique NE, SE et O, O. Indien	768-7250 m	Boues argileuses, Vases à globigérines, Rhabdammina	possible dans CCFZ
O. Elasipodida Fam. Psychropotidae	*Benthodytes typica*	Théel, 1882	8°N-6°S O. Pacifique, O. Atlantique N, O. Indien	315-4700 m	Vases grises à globigérines	HOL 27 (D. Pawson)
O. Elasipodida Fam. Psychropotidae	*Benthodytes lingua*	Perrier, 1896	O. Atlantique	2100 m	-	HOL 25 (D. Pawson)
O. Elasipodida Fam. Psychropotidae	*Psychropotes depressa*	Théel, 1882	2°N , O. Pacifique SE, O. Atlantique E	957-4060 m	Vases à globigérines, Boues	possible dans CCFZ
O. Elasipodida Fam. Psychropotidae	*Psychropotes longicauda*	Théel, 1882	Cosmopolite	2210-5203 m	Vases à diatomées, Boues grises fines, Manganèse	HOL 17 (D. Pawson)

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Taxinomic identification	Taxon	Authors + date of identification	Gegraphic distribution	Bathymetric distribution	Substratum	Codes of taxons on photographs and specialists consulted
O. Elasipodida Fam. Psychropotidae	*Psychropotes hyalinus*	Pawson, 1985	O. Pacifique NE	5891 m	Vases à diatomées, Boues grises fines, Manganèse	possible dans CCFZ
O. Elasipodida Fam. Psychropotidae	*Psychropotes semperiana*	Théel, 1882	O. Atlantique N et S, O. Indien	3465-5600 m	Vases à diatomées, Boues grises fines, Manganèse	Dans CCFZ, HOL 16 (D. Pawson)
O. Elasipodida Fam. Psychropotidae	*Psychropotes verrucosa*	Ludwig, 1894	O. Indien, O. Pacifique SE	2417-7250 m	Vases grises et jaunes à globigérines	HOL 23 (D. Pawson)
O. Elasipodida Fam. Elpidiidae	*Achlyonice ecalcarea*	Théel, 1879	Cosmopolite, O. Atlantique, O. Indien, O. Pacifique NO	2780-4924 m	Vases, Roche	HOL 32 (D. Pawson)
O. Elasipodida Fam. Elpidiidae	*Amperima naresi*	Théel, 1882	Indo-Pacifique, 10°S, O. Pacifique Central Est	2010-7130 m	Vases à globigérines, Boues fines et foncées	HOL 15
O. Elasipodida Fam. Elpidiidae	*Amperima rosea*	Perrier, 1896	O. Atlantique N	4060-5005 m	Vases	Hol 13 (D. Pawson)
O. Elasipodida Fam. Elpidiidae	*Peniagone gracilis*	Ludwig, 1894	2°N, O. Pacifique Central Est	2475 m	Vases à globigérines	HOL 12 possible dans CCFZ *Peniagone sp.* et *Amperima sp.*
O. Elasipodida Fam. Elpidiidae	*Peniagone purpurea*	Théel, 1882	Indo-Pacifique, O. Antarctique	3560-8000 m	Vases à globigérines	HOL 13
O. Elasipodida Fam. Elpidiidae	*Peniagone intermedia*	Ludwig, 1894	20°N-10°S, O. Pacifique Central Est	2418-5203 m	Vases à globigérines, Manganèse, Boues vertes et grises	HOL 14 (Hansen, 1975)
O. Elasipodida Fam. Elpidiidae	*Peniagone papillata*	Hansen, 1975	20°N-8°N, O. Pacifique Central Est	3570 m	Argiles sombres	HOL 10
O. Elasipodida Fam. Elpidiidae	*Peniagone vitrea*	Théel, 1882	10°N-10°S	1160-4507 m	Vases à globigérine, Boues grises, Sable, Roche	HOL 11 (Hansen, 1975)
O. Elasipodida Fam. Elpidiidae	*Peniagone elongata*	Théel, 1879	O. Pacifique SO	3947-4065 m	Vases à globigérine, Boues grises, Sable, Roche	possible dans CCFZ*
O. Elasipodida Fam. Elpidiidae	*Peniagone diaphana*	Théel, 1882	O. Pacifique, O. Atlantique, O. Indien	1520-5600 m	Manganèse, Vases, Sable	HOL 20 (D. Pawson)
O. Elasipodida Fam. Elpidiidae	*Scotoplanes clarki*	Hansen, 1975	10°N-10°S O. Pacifique Central Est	3570-5107 m	Argiles sombres	possible dans CCFZ
O. Elasipodida Fam. Elpidiidae	*Scotoplanes globosa*	Théel, 1879	32°N, O. Pacifique SE, Cosmopolite	545-6770 m	Vases meubles	possible dans CCFZ
O. Elasipodida Fam. Pelagothuriidae	*Pelagothuria natatrix*	Ludwig, 1894	8°N-3°S, O. Pacifique Central Est	4504 m	Vases, Boues, Sable	possible dans CCFZ
O. Elasipodida Fam. Pelagothuriidae	*Enypniastes eximia*	Théel, 1882	Cosmopolite	516-5689 m	Sable fin, Boues grises, Vases grises	HOL 18 (S. Ohta ; D. Pawson)

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O. Elasipodida Fam. Elpidiidae	*Scotoplanes clarki*	Hansen, 1975	10°N-10°S O. Pacifique Central Est	3570-5107 m	Argiles sombres	possible dans CCFZ
O. Elasipodida Fam. Elpidiidae	*Scotoplanes globosa*	Théel, 1879	32°N, O. Pacifique SE, Cosmopolite	545-6770 m	Vases meubles	possible dans CCFZ
O. Elasipodida Fam. Pelagothuriidae	*Pelagothuria natatrix*	Ludwig, 1894	8°N-3°S, O. Pacifique Central Est	4504 m	Vases, Boues, Sable	possible dans CCFZ
O. Elasipodida Fam. Pelagothuriidae	*Enypniastes eximia*	Théel, 1882	Cosmopolite	516-5689 m	Sable fin, Boues grises, Vases grises	HOL 18 (S. Ohta; D. Pawson)
O. Apodida Fam. Synaptidae	*Protankyra pacifica*	Ludwig, 1894	O. Pacifique N et SE	870-4990 m	Sable fin, Boues grises, Vases grises	Enfouis, non visibles sur photographies du benthos
O. Molpadiida Fam. Molpadiidae	*Ceraplectana trachyderma*	Clark, 1907	O. Pacifique N et O	3188-6580 m	Boues fines et sombres, Argiles vertes	Enfouis, non visibles sur photographies du benthos
O. Molpadiida Fam. Molpadiidae	*Molpadia granulata*	Ludwig 1894	24°N-15°S	2690-5869 m	Boues grises, Vases fines vertes	Enfouis, non visibles sur photographies du benthos
O. Molpadiida Fam. Molpadiidae	*Molpadia intermedia*	Ludwig, 1894	O. Pacifique NE et S	55-2014 m	Boues à globigérines, Boues, Roche	Enfouis, non visibles sur photographies du benthos
O. Molpadiida Fam. Molpadiidae	*Molpadia musculus*	Risso, 1826	O. Pacifique NE et S, M. Mediterranée, O. Indien, O. Atlantique N	4-5203 m	Boues grises, vertes et noires, Sable gris, Vases, Rhabdammina	possible dans CCFZ
Fam. Gephyrothuridae	*Hadalothuria*	Hansen, 1975	O. Pacifique O et S	7000-8000 m	-	HOL 9 (Lemche et al., 1976)
Fam. Gephyrothuridae	*Paroriza sp.*	Hansen, 1975	Cosmopolite, O. Pacifique S	6650-7280 m	-	possible dans CCFZ

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