SPIXIANA	31	2	233–239	München, November 2008	ISSN 0341–8391

Notes on ophiuroids from the Great Meteor Seamount (Northeastern Atlantic)

(Echinodermata, Ophiuroidea)

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Bartsch, I. (2008): Notes on ophiuroids from the Great Meteor Seamount (Northeastern Atlantic) (Echinodermata, Ophiuroidea). – Spixiana **31/2**: 233-239

The Great Meteor Seamount is a table mountain in the northeastern Atlantic, 1,700 km off Africa. Data on ophiuroids, collected with the RV Meteor during the cruises 9c (1967), 19 (1970) and 42/3 (1998), are summarized. The ophiuroid fauna is poor in number of species and abundance. Eight species were present in the samples dredged on the plateau and the adjacent slope, in depths of about 290-660 m, *Amphiura grandisquama* Lyman, 1869, *Amphipholis bananensis* Koehler, 1911, *Amphipholis squamata* (Delle Chiaje, 1829), *Ophiomyces grandis* Lyman, 1878, *Ophiambix meteoris* Bartsch, 1983, and fragments of *Amphilepis* sp., *Ophiosphalma* sp. and *Ophiothrix* sp. The five species are wide-spread in the Atlantic Ocean, with records from shallow shelf areas as well as the deep-sea. Two of the species, *Amphiura grandisquama* and *Amphipholis squamata*, are bursa brooders.

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Introduction

Seamounts are shallow water peaks arising from a deep-sea floor, often with steep slopes and a conical or flat summit, many of them far from the next continental coast, surrounded by water masses and with a local current regime around and above the seamount. Accordingly, the number, composition and relationship of the species on the seamounts, their life history and life style attracted the interest. Cruises with the German RV Meteor were initiated to study and analyze the biology and geology of the Great Meteor Seamount and the hydrography and chemistry of the water column above the seamount (Hempel 1968, Hempel & Nellen 1972, 1998).

Area investigated and Material

The Great Meteor Seamount, at about 30°N and 28-29°W, lies south of the Azores, west of Madeira and the Canary Islands, and almost 1,700 km off the coast of Morocco. The rather flat summit, in depths of 290-400 m, covers an area of approximately 1,200 km^2 (Ulrich 1971). The top is made up by porose limestone and pyroplastic rocks, and large areas with biogenic calcareous sediment (Schott et al. 1969, Rad 1974). These sediments are rich in remnants of planktontic but also benthic forms, amongst others ophiuroids (Rad 1974). The irregular pattern of the sediment reflects the strong winnowing and reworking bottom currents (Rad 1974).

The benthos on the Great Meteor Seamount was collected in the course of cruises of the German RV Meteor, Cruise 9c from July, 15th to 27th, 1967, Cruise 19, 17th to 27th February 1970, and recently Cruise 42/3 in September 1998. In 1967 and 1970 samples were taken with an Agassiz Trawl (AT), mesh size 15 mm, Beyer's epibenthic closing net (BSN), mesh size 0.5 mm, cuttertrawl (KT), mesh size 30 mm, chain dredge (KD), mesh size 15 mm, triangle dredge (DD), mesh size 15 mm, barrel dredge (TD), Van Veen Grab (BG), 0.1 m^2 sampling size, and box corer (KG) (Hesthagen 1970, Thiel 1970, 1972). In addition to

these gears, the bottom was surveyed by seabed photographs taken with photo grab and photo sledge (Thiel 1970). In 1998, the epibenthic megafauna on the top of the seamount was quantitatively analyzed by means of seabed photographs (Piepenburg & Müller 2004). Box corer and epibenthos sledges were used to collect the macro- and meiofauna (Brenke et al. 1998, Martinez & Schminke 1998).

In July 1967 (Cruise 9c) 103 samples in 31 stations were taken on the Great Meteor Seamount, in February 1970 (Cruise 19) 52 samples. Most of them are from the summit of the seamount, a few samples are from the slope (400-850 m) (Thiel 1970, 1972).

The ophiuroid material is deposited in Zoologische Staatssammlung, München (ZSM 20043262, 20043271-74, 20070513-43). The given number of individuals includes fragments. The abbreviation dd means disk diameter.

Results

In the material collected during the cruises 9c (1967) and 19 (1970), ophiuroids were present in samples taken with a dredge (AT, DD, KD, KT, TD, BSN), but not in samples taken with a grab or corer, and no ophiuroids were identified on photographs. Nineteen and 17 out of 37 and 34 dredged samples held ophiuroids.

Eight species were present in the samples, *Amphiura grandisquama* Lyman, 1869, *Amphipholis bananensis* Koehler, 1911, *Amphipholis squamata* (Delle Chiaje, 1829), *Ophiomyces grandis* Lyman, 1878, *Ophiambix meteoris* Bartsch, 1983, and fragments of *Amphilepis* sp., *Ophiosphalma* sp. and *Ophiothrix* sp. In samples taken during cruise 42/3 (1998) no ophiuroids were observed, neither in the benthos samples nor on the photographs (N. Brenke personal communication, Piepenburg & Müller 2004).

Amphiuridae

Amphiura grandisquama Lyman, 1869

Amphiura grandisquama Lyman, 1869: 334.
Amphiura josephinae Ljungman, 1871: 631.
Amphiura longispina Koehler, 1898: 52, pl. 9, figs 45-46.
Amphiura grandisquama guineensis Mortensen, 1936: 269, fig. 10.
Amphiura apicula Cherbonnier, 1957: 200, figs 1-3.

Material examined. Cruise 9c, July 1967: 4 specimens, 30°08.3'N, 28°20.2'W, 520-630 m, Station 147a, gear TD54, 15.7.1967; 1 specimen, 29°57.7'N, 28°35.1'W, 305-316 m, Station 151a, gear AT56, 16.7.1967; 7 specimens, 29°58.5'N, 28°39.2'W, 335-343 m, Station 152a, gear KD57, 16.7.1967; 6 specimens, 29°52.7'N, 28°31.8'W, 295 m, Station 160a, gear BSN21, 18.7.1967; 1 specimen, 30°04.2'N, 28°40.0'W, 480-660 m, Station 163a, gear TD65, 19.7.1967; 199 specimens, 30°07.0'N, 28°36.6'W, 318-321 m, Station 169a, gear DD66, 21.7.1967; 45 specimens, 30°06.3'N, 28°35.5'W, 301-310 m, Station 169a, gear AT67, 21.7.1967; 97 specimens, 30°03.9'N, 28°34.2'W, 290 m, Station 169a, gear BSN22, 21.7.1967; 84 specimens, 30°05.5'N, 28°35.0'W, 306-313 m, Station 170, gear DD68, 21.7.1967; 2 specimens, 30°03.0'N, 28°40.0'W, 450-505 m, Station 184, gear AT80, 25.7.1967; 6 specimens, 30°05.1'N, 28°38.4'W, 305-340 m, Station 189, gear KT84, 26.7.1967.

Cruise 19, February 1970: 10 specimens, 30°04.0'N, 28°24.5'W, 327-332 m, Station 128, gear KD93, 17.2.1970; 1 specimen, 29°59.0'N, 28°33.0'W, 293-296 m, Station 129, gear DD94, 17.2.1970; 5 specimens, 30°00.0'N, 28°31.5'W, 293 m, Station 129, gear DD95, 17.2.1970; 3 specimens, 30°01.5'N, 28°30.0'W, 292 m, Station 129, gear AT96, 17.2.1970; 3 specimens, 30°08.0'N, 28°38.5'W, 330-473 m, Station 131, gear AT97, 17.2.1970; 2 specimens, 30°06.0'N, 28°33.0'W, 303 m, Station 131, gear DD98, 17.2.1970; 3 specimens, 29°48.0'N, 28°21.5'W, 302-312 m, Station 133, gear DD99, 18.2.1970; 3 specimens, 29°48.0'N, 28°21.5'W, 302-312 m, Station 133, gear AT101, 18.2.1970; 1 specimen, 30°03.0'N, 28°23.0'W, 307-337 m, Station 137, gear KT107, 19.2.1970; 1 specimen, 29°58.5'N, 28°39.0'W, 352-407 m, Station 137, gear DD108, 19.2.1970; 10 specimens, 30°03.0'N, 28°33.5'W, 295-310 m, Station 140, gear AT109, 20.2.1970; 3 specimens, 30°07.0'N, 28°27.0'W, 317-327 m, Station 140, gear KT110, 20.2.1970; 16 specimens, 30°04.5'N, 28°38.0'W, 302-322 m, Station 146, gear KT114, 21.2.1970; 43 specimens, 29°55.5'N, 28°30.0'W, 292-297 m, Station 157, gear KT115, 25.2.1970; 2 specimens, 29°58.0'N, 28°20.0'W, 322-422 m, Station 157, gear KT116, 25.2.1970; 1 specimen, 29°53.0'N, 28°23.5'W, 307-322 m, Station 159, gear KT118, 26.2.1970; 6 specimens, 30°09.5'N, 28°32.2'W, 307-337 m, Station 163, gear KT123, 27.2.1970.

Remarks. In the material from the Great Meteor Seamount, the largest specimens had a disk diameter of 5.0 mm. Diameters of up to 7 mm have been found (Paterson, 1985). Juveniles in the bursae had a diameter of 0.6-0.9 mm.

Characters of the species are: radial shields slender, about three times longer than wide and about as long as half the radius; shields in general separated, though in small specimens still contiguous; distal oral papillae large, generally blunt, sometimes scale-like, rarely pointed, in a few specimens two papillae present, in young specimens oral papilla lacking; in general with five, rarely with four arms; tentacle pores with one round scale; in specimens less than 1 mm dd tentacle scale absent; arm spines stout, ventralmost of four to five spines longer than the others and equalling 1.5-2.0 times length of an arm segment; in the material at hand that spine rarely sabre-shaped. Young specimens have three arm spines, these are almost equal in length.

In some specimens the length of the radial shields was slightly more than two-third of the disk radius and the disk was covered with few coarse scales. Obviously the disk of these individuals recently regenerated.

Several of the animals collected on the Great Meteor Seamount had well developed offsprings in their bursae, one or two juveniles per bursa. The brooding ophiuroids had a disk diameter of 3.1-4.0 mm, the smallest free-living instars reached one of 0.9-1.0 mm and had 13 arm segments. The arms of the embryos are directed upward, the ventral disk turned towards the inner bursal wall, the dorsal disk to the bursal slit. In populations collected during Cruise 9c, Stations 169a (DD66 and BSN22) and 170 (DD68), 37 out of 191 specimens, 19 out of 84 and 10 out of 97 specimens carried juveniles, i.e. 19.4, 10.3 and 22.6 % of the populations, respectively.

Distribution and Ecology. Very common and widespread. Records are from the Atlantic, Indian and Pacific Oceans; in the northeastern Atlantic from Iceland to the Cape Verde Islands and Gulf of Guinea (Madsen 1970, Paterson 1985). Unpublished material collected with the RV Meteor is from the adjacent northwestern Africa (Cruise 26, 1972 and Cruise 36, 1975), the Josephine Seamount (Cruise 9c, 1967), and off Portugal (Cruise 8, 1967). The depth range is from shallow water to 2870 m (Cherbonnier & Sibuet 1972). In the samples from the Great Meteor Seamount this was the dominant ophiuroid species. In the material from Cruise 9c, *A. grandisquama* was present in 11 out of the 19 samples which contained ophiuroids, in that of Cruise 19 in all of the 17 samples, with 1-199 individuals per sample.

Amphipholis bananensis Koehler, 1911

Amphipholis bananensis Koehler, 1911: 14, pl. 2, figs 3-4.
Amphipholis clypeata Koehler, 1914: 191, pl. 7, figs 16-17.

Material examined. 1 specimen, Great Meteor Seamount, 29°55.5'N, 28°30.0'W, 292-297 m, Cruise 19, Station 157, gear KT115, 25.2.1970.

Remarks. Disk in specimen available 1.5 mm in diameter, else up to 4 mm. Dorsal disk with distinct rosette of primary plates. Oral shields long, centrally pointed. Outermost oral papilla long and narrow. Basal arm segments with three to four spines. Adoral plates narrow, in specimen of 1.5 mm dd contiguous in their proximal portion, in larger specimens separated by oral shields, as illustrated in Koehler (1911: pl. 2, fig. 4), A. M. Clark (1955: fig. 14, *A. clypeata* Koehler, 1914) and Madsen (1970: fig. 32c).

Distribution. Western African coast, from Côte d'Ivoire to Angola (Koehler 1914, Tommasi 1967), from shallow water.

Amphipholis squamata (Delle Chiaje, 1829)

Asterias squamata Delle Chiaje, 1829: 77, pl. 34, fig. 1.
Amphipholis squamata, Mortensen, 1927: 221, fig. 125.
Axiognathus squamata, Thomas 1966: 831.

Material examined. 2 specimens, 29°47.9'N, 28°23.3'W, 300-310 m, Cruise M9c, Station 172, gear BSN24, 22.7. 1967; 1 specimen, 30°07.0'N, 8°27.0'W, 317-327 m, Cruise M19, Station 140, gear KT110, 20.2.1970.

Remarks. Disk diameter of material at hand 0.7-3.0 mm; records of disk size up to 5 mm dd are documented (Mortensen 1927). Radial shields small, contiguous. Large specimen with two tentacle scales in proximal part of arm, small specimens with single tentacle scale.

Thomas (1966) re-examined tropical *Amphipholis* species, found three species groups and proposed to split the genus into *Amphipholis*, with the type species *A. januarii* Ljungman, 1867, and the new genera *Axiognathus* and *Micropholis* with the type species *Asterias squamata* Delle Chiaje, 1829, and *Ohiolepis atra* Stimpson, 1852, respectively. In a revision of the Amphiuridae, A. M. Clark (1970) anew discussed the position of *Amphipholis squamata*.

Distribution and Ecology. This small brittle star is said to have an almost cosmopolitan distribution, though, obviously, its records belong to a species complex with allopatric clades (Le Gac et al. 2004, Spooner & Roy 2002). Records of *Amphipholis squamata* are from cold temperate to tropical regions, but not from polar waters, mostly from shallow water areas. The known depth range extends from 0 to 1200 m (Paterson 1985). It is a hermaphrodite and brooding species that lives, hidden, in different habitat structures, in gravel, under stones, amongst algal hapteres, and a variety of algal turf. The species is polychromatic and luminescent.

Ophiacanthidae

Ophiomyces grandis Lyman, 1878

Ophiomyces grandis Lyman, 1879: 46, figs 383-385.
Ophiomyces peresi Reys, 1961: 154, fig. 3-5, photo a, b.

Material examined. 1 specimen, 5 mm dd, 30°05.5'N, 28°35.0'W, 306-313 m, Cruise M9c, Station 170, gear DD68, 21.7.1967; remnants of disk, 29°49.1'N, 28°23.5'W, 296-297 m, Cruise M9c, Station 172, gear DD72, 22.7. 1967; 1 specimen, 29°59.5'N, 28°22.5'W, 323-314 m,

Cruise M9c, Station 180b, gear KD78, 24.7.1967; 1 specimen, 29°59.0'N, 28°33.0'W, 293-296 m, Cruise M19, Station 129, gear DD94, 17.2.1970.

Remarks. Disk diameter of specimens studied 4.5-5.0 mm. Largest size record about 9 mm dd (Paterson, 1985). Disk conspicuously sack-like, scaled, with spines. Ventral disk plates with numerous, often wide scales, obscuring outline of plates. Arms twisted upward (as shown by Reys 1961: photo a).

Distribution and Ecology. An Atlantic species with a longitudinal range from Tristan da Cunha to the Rockall Trough and a bathymetric range from 150-1800 m (Paterson 1985, Bartsch 1987). Expected to live in a system of microcavernes.

Ophiurinae

Ophiambix meteoris Bartsch, 1983

Ophiambix meteoris Bartsch, 1983: 97, figs 1-7.

Material examined. 1 specimen, 30°05.5'N, 28°35.0'W, 306-313 m, Cruise M9c, Station 17, gear DD68, 21.7. 1967.

Remarks. Single specimen 3.9 mm dd; known size range 3.5-5.0 mm dd. Dorsal disk and arms covered with imbricating plates which are partly obscured by small, pointed spinelets. Proximal part of interradial area naked. Arm spines conspicuously flattened, oar-shaped, with four to five spines proximally. In distal end of arm ventral arm spines cylindrical and slightly hooked.

The genus includes the species *O. aculeatus* Lyman, 1880, *O. devaneyi* Paterson, 1985, *O. epicopus* Paterson & Baker, 1988, and *O. meteoris*. These species can be discriminated by the shape of the disk spinelets and arm spines.

Distribution and Ecology. This is a shallow water record of a species which first was recorded from the Iberian deep-sea basin, from 5315 m (Bartsch 1983). Records of congeners are within a range of 150-1100 m (Paterson & Baker 1988). Two of the *Ophiambix* species, *O. meteoris* and *O. aculeatus*, had fragments of wood in their guts (Bartsch 1983, Paterson & Baker 1988). *Ophiambix* species show a tendency to live within mollusc borings in waterlogged wood and in vesicles of pumice (Paterson & Baker 1988).

Discussion

Ophiuroids are part of the benthos fauna on the Great Meteor Seamount, as documented by fragments in the sediment (Rad 1974), but the ophiuroid fauna of the Great Meteor Seamount is remarkably poor in species and numbers. No ophiuroids were present in the grab samples with their small-scale sampling area, in neither the cruises M9c and 19 (see above) nor in cruise 42/3 (RV Meteor in 1998). Ophiuroids were only present in sediment collections taken with a dredge, a gear catching the fauna of a large area. The diversity of the ophiuroid fauna of the Great Meteor Seamount is less than that of the adjacent continental shelf and slope (Bartsch 1991). A single species, *Amphiura grandisquama*, seems to be a regular inhabitant of the Great Meteor Seamount. This species, as also *Amphipholis squamata*, is a bursal brooder, the embryos remain in the bursae, the juveniles leave the bursae in an advanced stage of development, with a disk diameter of almost 1 mm. The patchy coarse-grained deposits on the Great Meteor Seamount reflect a strong sorting process and reworking of the sediment due to bottom currents (Rad 1974). Brood protection is likely to eliminate loss of offsprings and hence help to build up and maintain a stable population. Amongst ophiuroids, approximately 70 species are internal brooders (Hendler 1991, Hendler & Tan 2001). Brooding ophiuroid species are known from both tropical, temperate and polar waters, from shallow water and the deep-sea (Hendler 1991).

The scarcity of ophiuroids agrees with information on other macro- and megafaunal taxa. Hempel (1968) in a report after Cruise 9c stated that the fauna on the Great Meteor Seamount is poor, both in species and abundance, distinctly poorer than on the continental shelf. A poor epifauna was also found in the course of a photographic documentation of the seabed during Cruise 42/3 (RV Meteor) (Piepenburg & Müller 2004). In the high resolution pictures epibenthic organisms as small as 1 mm were visible. The analyses of the 622 pictures taken at 15 stations (transects), each photograph representing an area of about 0.83 m^2, showed rather uniform sandy deposits with sparse or almost no epibenthos, in average 2.5-71.3 individuals per m^2 and 11-22 species per transect, in all a total of 53 putative species (Piepenburg 1998, Piepenburg & Müller 2004). Ophiuroids were not detected. The number of polychaete species collected from the Great Meteor Seamount proved to be somewhat larger or similar to that from nearby seamounts (Gillet & Dauvin 2000, 2003), but distinctly less than that from the northern African continental shelf (Hartmann-Schröder 1979, 1981, 1982). In contrast,

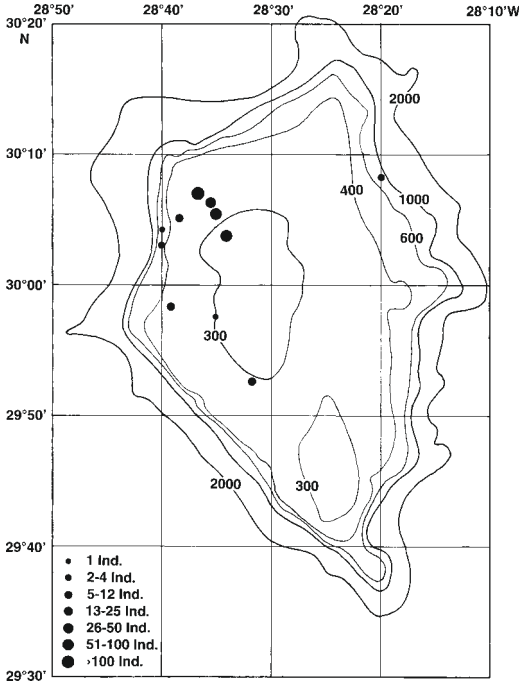

Fig. 1. Map of the Great Meteor Seamount with depth contour and distribution of *Amphiura grandisquama*; results of Cruise 9c.

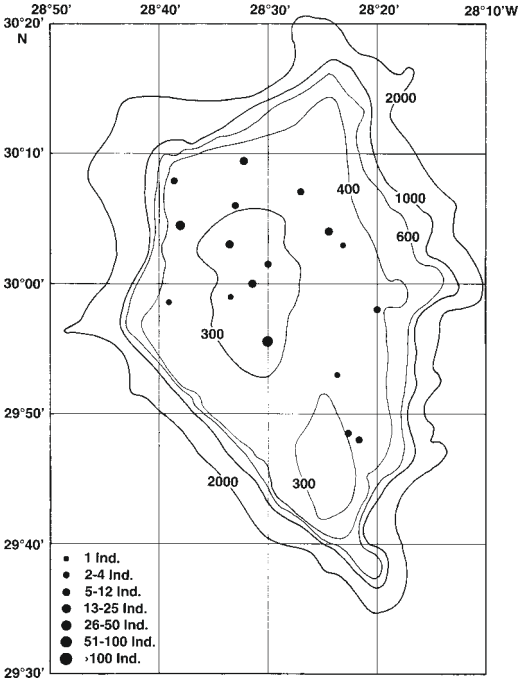

Fig. 2. Map of the Great Meteor Seamount with depth contour and distribution pattern of *Amphiura grandisquama*; results of Cruise 19.

gorgonarians and antipatharians were abundant on the Great Meteor Seamount and species diversity was similar to that of continental shelf areas (Grasshoff 1985). The Great Meteor Seamount lies in an oligotrophic province with a low primary production (Macedo et al. 2000, Kaufmann et al. 2002), and a restricted input of organic material from the water column often has been said to be a reason for the in general sparse endo- and epifauna. On the other hand, there are dense populations of filter feeding gorgonarians and antipatharians, as well as sponges (Piepenburg & Müller 2004), and hence food supply is not a seriously limiting parameter (Grasshoff 1985). The faunistic analysis of the benthos collected in 1998 (Cruise 42), showed that different feeders, filter- and suspension-feeders, carnivores and carrion eaters, are present in approximately equal ratios (Brenke 2002).

Though the Great Meteor Seamount is rather isolated, none of the ophiuroid species is endemic, all are wide-spread. The absence of endemism is consistent with the results gained by O'Hara (2007) who analyzed data of the ophiuroid faunas of southwestern Pacific seamounts and adjacent areas.

The macrofauna on the Great Meteor Seamount is often poor, an analysis of the meiofauna (George & Schminke 2002, Bartsch 2003, Gad & Schminke 2004, Gad 2004a,b) seems to demonstrate the opposite. The knowledge of the meiofauna of the Great Meteor Seamount is far from complete, still the presently known halacarid fauna is as diverse as that of many tropical and temperate littoral areas (Bartsch 2004). Other taxa reveal an astonishingly high diversity (George & Schminke 2002, Gad 2004a). The strong bottom currents obviously do not prevent but favour an interstially living fauna which can retreat into the well aerated sediment.

Amphiura grandisquama, the most abundant ophiuroid, was present within a range from about 290 m to 660 m depth. The highest density was found in the northwestern part of the Great Meteor Seamount (Figs 1 and 2). Similarly, photographs from the Northern Plateau showed a fauna slightly richer than that on the Southern Plateau and the slope (> 450 m) (Piepenburg & Müller 2004).

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