

New starfish (Echinodermata, Asteroidea) from the Cenomanian and Turonian (Upper Cretaceous) of Seine-Maritime (France) and a revision of Cretaceous stauranderasterid genera

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ABSTRACT:

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Exceptionally well-preserved asteroid specimens from the Cenomanian and Turonian coastal exposures in Seine-Maritime (north-west France) are described. These include a new genus, *Crielaster* (type species: *C. annae* sp. nov.), which is provisionally assigned to the family Chaetasteridae, a new species of the astropectinid genus *Coulonia* de Loriol, 1873 (*C.ournoui* sp. nov.), and a new species of stauranderasterid (*Stauranderaster pustulosus* sp. nov.). A superbly preserved specimen of *Oreaster coronatus* Forbes, 1848, showing the construction of the abactinal surface, provides evidence supporting subdivision of the genus *Stauranderaster* Spencer, 1907. *Stauranderaster coronatus* is here made the type species of *Coronataster* gen. nov., and *Squamataster* gen. nov. is erected, with *Oreaster squamatus* Forbes, 1848 as type species.

Key words: Paxillosida; Valvatida; North-west Europe; White chalk facies.

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INTRODUCTION

Like ophiuroids and crinoids, articulated asteroids are amongst the rarest invertebrate fossils, as rapid decomposition after death usually results in fast disintegration and subsequent dispersal of the constituent ossicles. The Upper Cretaceous chalks of the Anglo-Paris Basin have yielded numerous (semi-)articulated starfish, the bulk of which were collected by quarry workers in the 19th and early 20th centuries, when hand working of chalk pits pro-

vided specimens which were readily saleable. This material formed the basis of the descriptive monographs of British Cretaceous asteroids by Forbes (1848, 1850), Sladen (1891, 1893) and Spencer (1905, 1907). Many of the specimens were obtained from the upper Coniacian to lower Santonian chalks of north-west Kent, referred to as the dealer's locality of 'Bromley'.

In northern France, the situation was rather different. Valette (1914) described chalk asteroids mostly from the Yonne, but much of the material

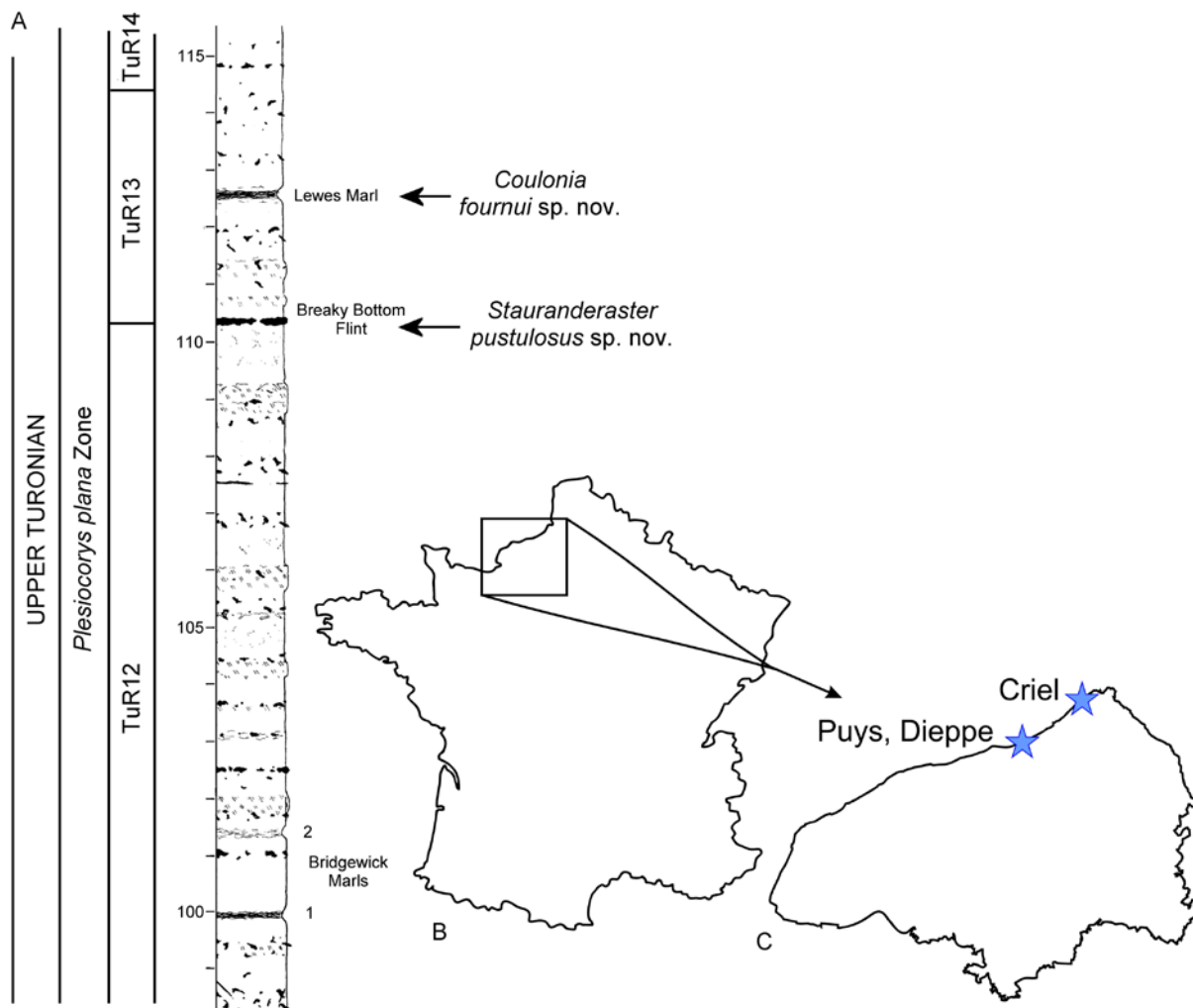


consisted of isolated ossicles, associated ossicles and articulated fragments. Articulated asteroids from the underground workings of upper Campanian chalks of Meudon (Hauts de Seine), near Paris, were described by Cottreau (1937). Mercier (1935, 1936) described asteroids from the Cretaceous of Haute Normandie. Later, Breton (1979, 1981, 1984, 1985, 1986, 1987, 1988, 1992) undertook description of French Cretaceous asteroids, based partly on older museum collections, but largely on newer material obtained by amateur collectors, much of which came from Seine-Maritime. This tradition continues, and one of us (NC) in particular has made spectacular finds of Late Cretaceous asteroids from the coastal exposures of this region. Some specimens from the Cenomanian have recently been illustrated in Hoyez *et al.* (2020). The present paper outlines and discusses the taxonomy some of important finds

which one of us (NC) has made recently, and also includes a generic revision of taxa based partly on these finds.

STRATIGRAPHY AND LOCALITIES

One of the starfish specimens described below comes from the middle Cenomanian *Acanthoceras jukesbrownei* ammonite Zone of Heuqueville (Hoyez *et al.* 2020, p. 88, fig. 51). All others originate in the upper Turonian chalks of the Seine-Maritime coast between Dieppe and Le Tréport (Text-fig. 1), where the standard marker beds, widely recognisable across the Anglo-Paris Basin, can be identified (Mortimore and Pomerol 1987; Gale 2019a). These include the bentonitic Bridgewick and Lewes Marls, and the distinctive Breaky Bottom Flint. Specimens



Text-fig. 1. The study area. A – Succession exposed on the coast at Puys, Seine-Maritime, France (after Gale 2019a, fig. 4) to show horizons where asteroid specimens were collected. B – Map of France to show location of Seine-Maritime (C). Scale on left of column in metres.

were collected at Puys, immediately northeast of Dieppe, and at Criel, south-west of Le Tréport.

Institutional abbreviations

BMNH – Booth Museum of Natural History, Brighton, West Sussex, UK.

MHNH – Musée d'Histoire naturelle du Havre, Le Havre, Seine-Maritime, France.

NHMUK – The Natural History Museum, London, UK.

SYSTEMATIC PALAEONTOLOGY

Class Asteroidea de Blainville, 1830

Subclass Neoasteroidea Gale, 1987

Order Paxillosida Perrier, 1884

Family Astropectinidae Gray, 1840

DIAGNOSIS: Five-armed, flattened paxillosids, possessing a broad marginal frame made up of paired, opposing, supero- and inferomarginals; fascioles run abactinally-actinally between individual supero- and inferomarginal pairs in majority of genera; abactinal surface composed of small paxillae; actinals, when present, in well-defined rows of imbricating plates.

Genus *Coulonia* de Loriol, 1873

SYNONYMS: *Cuneaster* Hess, 1955 and *Betelgeusia* Blake and Reid, 1998.

TYPE SPECIES: *Coulonia neocomiensis* de Loriol, 1873, by monotypy.

DIAGNOSIS: Astropectinids with relatively short arms; actinal interareas very broad, interradian margin evenly curved. Marginals short and very broad (ratio of 3.5:1), tapering gently towards lateral margin with very deep intermarginal fasciolar grooves. Inferomarginals bearing coarse, irregularly sized spine pits arranged transversely, and with short abactinal surfaces. Superomarginals 30% narrower than inferomarginals, wedging laterally, external face flat, bearing evenly distributed pits for short, blunt spines (Ewin and Gale 2020, p. 4).

REMARKS: Large-sized, flattened, spinose astropectinids that possess broad actinal interareas and deep fascioles between the marginal plates are common and widespread in the Cretaceous. Distinctive, isolated marginals with deeply embayed fasciolar

regions of this type were described by Hess (1955) as a new genus, *Cuneaster*, but later referred by the same author to *Coulonia* de Loriol, 1873, leaving *Cuneaster* as an objective junior synonym.

Coulonia is well known from the type species, *C. neocomiensis*, material of which was figured by Hess (1970, text-fig. 7; pl. 3, figs 1, 2; pl. 4, figs 1, 2). The species is characterised by broad, evenly curved interradian arcs, broad inferomarginals that possess a short abactinal surface, and particularly by the narrower superomarginals that do not reach the ambitus. Isolated marginals figured by Hess (1955, figs 16–22) show broad, short inferomarginals with deep intermarginal fasciolar grooves, irregularly sized spine pits, and short, narrow superomarginals that wedge towards the margin. Hess and Blake (1995) described *C. platyspina* from the Barremian of Tamanar, north of Agadir, Morocco, based on an individual with an exceptionally well-preserved actinal surface. Ewin and Gale (2020, figs 3, 5) illustrated further material of this species from the Barremian of Taba, Morocco.

Couloniaournouii sp. nov.

(Text-fig. 2)

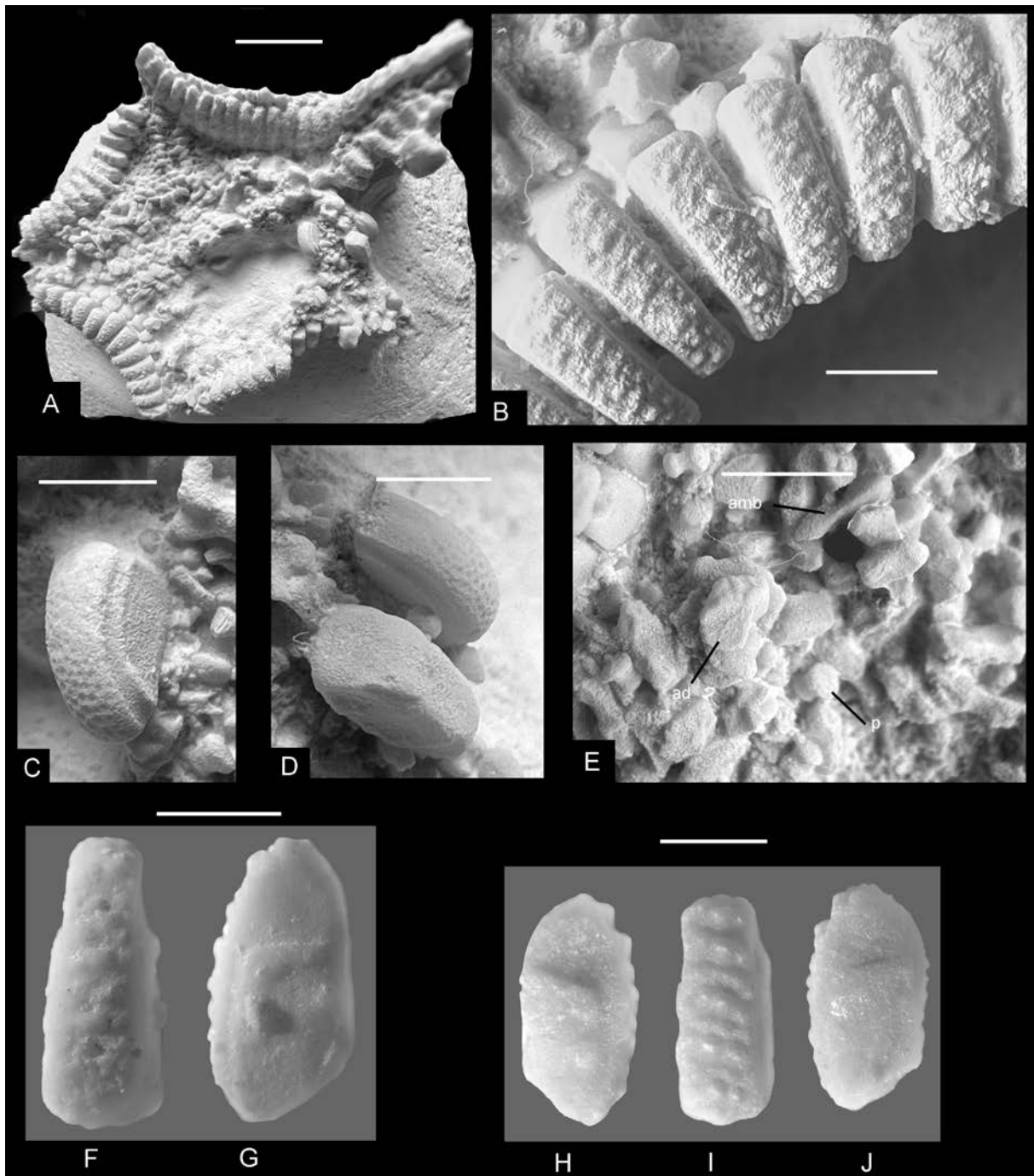
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DIAGNOSIS: Disc broad, interradian gently concave. Interradian inferomarginals broad, short, slightly wedged towards lateral margin. Inferomarginals bear coarse spine bases, arranged into poorly defined transverse rows. Superomarginals with even cover of closely spaced crater-like spine pits.

TYPES: The holotype is a well-preserved disc and proximal arms from the level of the Lewes Marl at Puys, near Dieppe, Seine-Maritime, France (MHNH 2025.1.4). The paratype inferomarginal ossicles (MHNH 2026.1.2, 2026.1.3) come from the Bridgwick Marls, Zone of *Gyrosoria lata*, upper Turonian at Criel.

DERIVATION OF NAME: For Jean Philippe Four-nou, friend of one of us (NC), in mark of respect.

DESCRIPTION: The type specimen, exposed in actinal aspect, comprises a well-preserved disc and the proximal part of one arm. The disc is broad, and the interradian are gently convex; approximately twelve inferomarginals are present on each side. The inferomarginals are broadest at the interradian and become narrower towards the base of the arms. They wedge



Text-fig. 2. *Couloniaournou* sp. nov. A–E – MHNH 2025.1.4, holotype, upper Turonian, level of Lewes Marl at Puits (Text-fig. 1), near Dieppe, Seine-Maritime, France; A – actinal view; B – enlarged actinal view; C, D – enlargements of superomarginal ossicles; E – enlargement of actinal surface to show adambulacral (ad) and ambulacral (amb) ossicles and paxillae (p). F–J – isolated inferomarginals, MHNH 2026.1.2 and 2026.1.3, Bridgewick Marls, *Gyrosoria lata* Zone, upper Turonian at Criel, in actinal (F, I) and proximal/distal views (G, H, J). Scale bars equal 10 mm (A), 5 mm (B) and 2 mm (all others).

towards the lateral margin, and the breadth exceeds the length by 2–2.5 times. The actinal surfaces of the inferomarginals are gently convex (Text-fig. 2F–J)

and carry seven to eight obliquely set rows of three to four rugosities, which acted as spine attachment bases. In proximal/distal profiles (Text-fig. 2G, H,

J) the articular facets for contact with adjacent inferomarginals are abruptly truncated, leaving spaces for deep intermarginal fascioles between adjacent plates.

Detached superomarginals are present on the actinal surface (Text-fig. 2C, D). These have strongly convex external surfaces which bear rather coarse, evenly spaced spine pits. The articular surfaces for the adjacent superomarginals are broad, leaving only a narrow, depressed rim to accommodate intermarginal fascioles. Disarticulated adambulacrals, ambulacrals and paxillae are visible within the disc (Text-fig. 2E).

REMARKS: This specimen is a typical *Coulonia*, in its possession of a broad disc, short, broad inferomarginals which bear coarse, obliquely arranged spine bases and with deep intermarginal fascioles. The superomarginals, with rather deeply depressed, evenly spaced spine pits are also typical. *Couloniaournoui* sp. nov. differs from *Coulonia platyspina* (Barremian of Morocco) and *C. reidi* (Blake and Reid, 1998) (Albian of Texas) in its longer inferomarginals, much smaller intermarginal fascioles, and strongly convex superomarginals. It differs from the Aptian *C. caseyi* Gale, 2019b in the very regular arrangement of spine bases on the inferomarginals, and from the Hauterivian *C. neocomiensis* in the less concave interradial arcs and broader inferomarginals (see Hess 1970, pl. 3, fig. 1; pl. 4, fig. 1). It differs from *C. hokahira* Gale, Ishida, Jagt, Thuy, Komatsu and Fujita, 2024 from the Albian of Japan in its much broader inferomarginals. Comparisons with *Coulonia parva* Neumann and Hess, 2001, from the Santonian of the Pyrenees are difficult, because the unique holotype (Neumann and Hess 2001, figs 2–4) is not fully grown and shows only the interior (abactinal) surface of the inferomarginals.

Order Valvatida Perrier, 1884
Family Chaetasteridae Sladen, 1889

AMENDED DIAGNOSIS: Arms subcylindrical, disc small, interradii acutely angled. Arms constructed of 7 to 13 well-defined rows of extra-axial ossicles; abactinal, marginal and actinal ossicles of the arm of similar size, all carrying raised central ridge. Abactinal ossicles of disc small, round to oval (modified from Clark and Downey 1992).

INCLUDED GENERA: *Chaetaster* Müller and Troschel, 1842, *Arthraster* Forbes, 1848 and *Crielaster* gen. nov.

REMARKS: In the molecular-based study of the Valvatida, Mah and Foltz (2011) placed the Chaetasteridae as sister taxon to the Odontasteridae.

Genus *Crielaster* nov.

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DIAGNOSIS: Small chaetasterids with a stellate outline, acute interradii, a small disc and short, rapidly tapering arms. Superomarginals robust, meeting over mid-radial line, bearing central abactinal-actinal ridge, sides of which carry rows of fine rugosities for spine attachment. Abactinal ossicles small, polygonal to square, with raised central boss. Inferomarginals low, square.

TYPE SPECIES: *Crielaster annae* gen. et sp. nov.

DERIVATION OF NAME: After Criel (Seine-Maritime), where the complete specimen of *Crielaster annae* gen. et sp. nov. was collected.

REMARKS: The affinities of this tiny asteroid were initially obscure, but the superomarginals are similar to those of the Cretaceous genus *Arthraster* in that they possess a tall, central ridge, the proximal and distal surfaces of which bear rows of fine rugosities. Additionally, the small polygonal to square abactinal ossicles with a narrow central process are also like those of the disc of *Arthraster*. *Arthraster* differs most importantly from *Crielaster* gen. nov. in the presence of a single row of broad, short radial ossicles set between the superomarginals; in *Crielaster* gen. nov. these are absent and the superomarginals meet over the mid-radial line along the arms. Although no juvenile *Arthraster* are known, the major differences in construction make it improbable that *Crielaster* gen. nov. is a juvenile of *Arthraster*.

Arthraster was assigned to the Chaetasteridae by Gale (2020), based partly on similarities in the morphology and arrangement of the abactinal ossicles and the ridged, wedge-shaped superomarginals (Gale 2020, fig. 1B, D). However, extant chaetasterids are characterised by elongated arms made up of seven to thirteen well-defined rows of extra-axial ossicles. In contrast, *Arthraster* possesses elongated arms made up of short, broad, transversely arranged marginals and a single row of radials. The placement of both *Arthraster* and *Crielaster* gen. nov. is uncertain.

Crielaster annae gen. et sp. nov.
(Text-fig. 3)

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DIAGNOSIS: As for genus.

TYPES: A single small, entire specimen (MHNH 2025.1.2) from the upper Turonian at Criel, Seine-Maritime, France is the holotype. The paratypes are isolated marginals (MHNH 2026.1.4, 2026.1.5) from the Bridgewick Marls, *Gyrosoria lata* Zone, upper Turonian at Criel.

DERIVATION OF NAME: After Anne Tison, the partner of NC.

DESCRIPTION: Form stellate, interradii acutely angled, arms short and rapidly tapering (R 12 mm; r 4 mm). Marginal frame stout, 8 paired marginals present in each half radius. Superomarginals 2–8 meet over mid-radial line, either opposing or alternating with the adjacent row. The interradii superomarginals (two in each interradius) wedge towards the lateral border, and possess a narrow, raised ridge which runs from the abactinal to the lateral margins. Distally, the ridge elongates, the depressed margins shorten and a short, rounded abactinal process develops and increases in size distally. The external surface of the ridge bears fine rugosities. Inferomarginals are poorly preserved but oppose the overlying superomarginals; they are small and square, becoming elongated in the distal arm. The central portion of the abactinal disc carries approximately fifteen small, polygonal to square abactinal ossicles which bear a rounded, centrally placed abactinal process. The most distal, placed between superomarginals 1 and 2, is triangular. Details of the superomarginals are best observed on isolated ossicles (Text-fig. 3F–K). The lateral surfaces of the raised ridges bear tiny rugosities aligned with the lateral margins of the ossicles.

REMARKS: Two undescribed species of *Crielaster* gen. nov. are present in the English chalk, one from the lower Turonian of Branscombe, Devon, the other from the Campanian of Hampshire. These will be described in due course.

Family Stauranderasteridae Spencer, 1913

DIAGNOSIS: Disc domed, including enlarged pri-

mary interradials and centrale. Supero- and infero-marginals alternate and imbricate proximally in part of the radius.

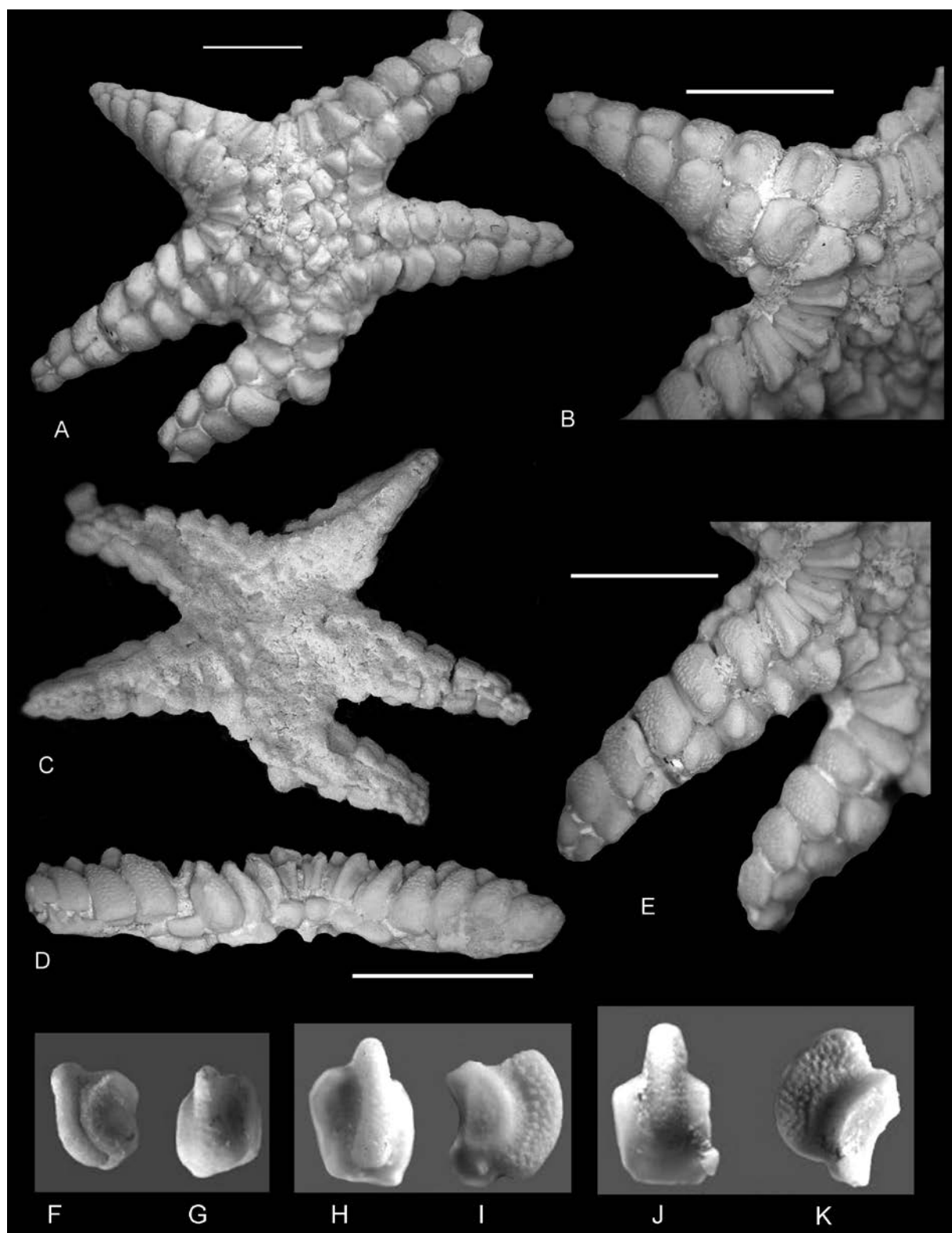
INCLUDED GENERA: *Stauranderaster* Spencer, 1907, *Aspidaster* de Loriol, 1884, *Manfredaster* Villier, Breton, Margerie and Néraudeau, 2003, *Hadranderaster* Spencer, 1907, *Stauraster* Valette, 1929, *Coronataster* gen. nov. and *Squamataster* gen. nov.

REMARKS: Stauranderasterids include a heterogeneous assortment of Jurassic–Paleocene asteroids which were abundant and diverse mostly in the Upper Cretaceous. They have received relatively little attention, although Villier *et al.* (2003) performed a cladistic analysis on a number of taxa and concluded that the group was monophyletic and that *Stauranderaster* and *Manfredaster* were the most derived genera. The relationship between stauranderasterids and the broadly similar Paleogene to present-day oreasterids has not been resolved.

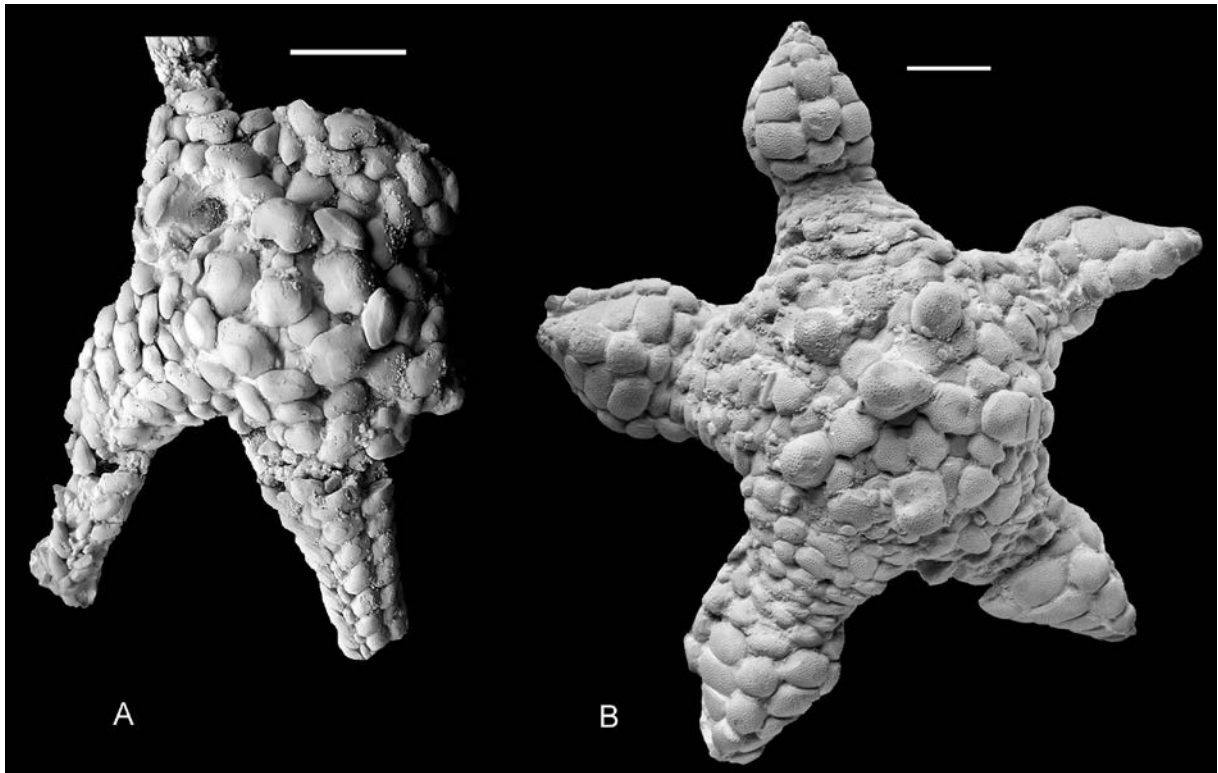
A superbly preserved stauranderasterid was found by NC in the middle Cenomanian of Seine-Maritime (Hoyez *et al.* 2020, pl. 28, fig. 1) and identified as *Stauranderaster coronatus* (Forbes, 1848). The almost perfect preservation of the articulated abactinal ossicles of the disc permits detailed comparison with other similarly well-preserved stauranderasterids, including *Stauranderaster squamatus* (Forbes, 1848) (Text-figs 4A, 5B), *Manfredaster bulbiferus* (Forbes, 1848) (Text-figs 4B, 5A) and *Stauranderaster boysii* (Forbes, 1848) (Text-fig. 5D). Detailed analysis of the abactinal plating of these taxa (Text-fig. 5) has demonstrated the existence of significant differences, which are used here as a basis to erect two new genera of stauranderasterids, *Coronataster* gen. nov. and *Squamataster* gen. nov.

Genus *Stauranderaster* Spencer, 1907

DIAGNOSIS: Disc tumid, arms long and tapering gradually. Primary ring occupying most of the abactinal disc, primary radials and interradials tumid, evenly convex, rounded, oval or pentagonal in shape, separated by a pair of large abactinal ossicles. Inner calycinal ossicles forming distinctive pattern, with three rectangular plates set between the proximal margin of the primary radials, intervening spaces with three oval plates in each interradius. Radials extend approximately half-way along arms. Intermarginals and adradials absent. Well-defined raised central area present on extra-axial ossicles,



Text-fig. 3. *Crielaster annae* gen. et sp. nov. A–E – MHNH 2025.1.2, holotype, upper Turonian at Criel, Seine-Maritime, France; A – abactinal view; C – actinal view; D – lateral view; B, E – enlargements of arms in actinal view; F–K – isolated paratype superomarginal ossicles, MHNH 2026.1.4 and 2026.1.5, Bridgewick Marls, *Gyrosoria lata* Zone, upper Turonian at Criel in proximal/distal (F, I, K) and lateral (G, H, J) views. Scale bars equal 5 mm.



Text-fig. 4. Photographs of stauranderasterid asteroids in abactinal view. A – *Squamataster squamatus* (Forbes, 1848), BMNH 007806, holotype, the original of Forbes in Dixon (1850, pl. 23, fig. 7) and Spencer (1905, pl. 25 figs 3, 3a–c), “Upper Chalk, Woolwich, Kent”, UK. B – *Manfredaster bulbiferus* (Forbes, 1848), NHMUK E 4344, Bromley, Kent, UK. Scale bars equal 10 mm.

which bears fine spine pits and sugar tong pedicellariae.

TYPE SPECIES: *Oreaster boysii* Forbes, 1848, by original designation.

INCLUDED SPECIES: *Stauranderaster bispinosus* Spencer, 1908; *Stauranderaster gibbosus* Spencer, 1913 and *Stauranderaster pustulosus* sp. nov.

REMARKS: An articulated abactinal disc of the type species, *Stauranderaster boysii* (Text-fig. 5D), shows the plating of the disc for the first time and permits the genus to be distinguished from the new genera *Coronataster* nov. and *Squamataster* nov. The generic, and familial affinities of *Oreaster pistilliferus* Forbes, 1848, commonly placed in *Stauranderaster*, remain uncertain.

Stauranderaster pustulosus sp. nov.
(Text-fig. 6A–F)

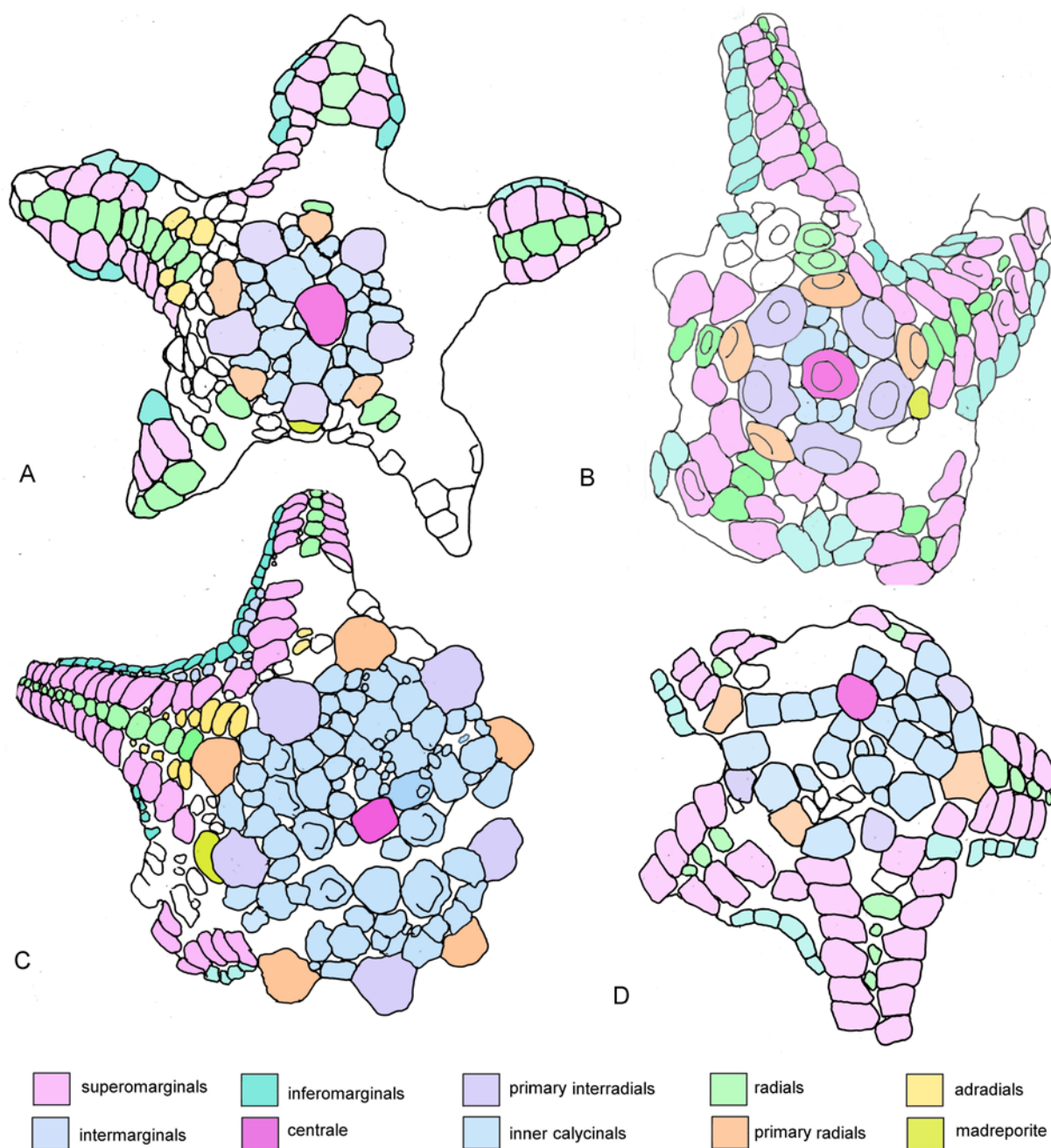
urn:lsid:zoobank.org:act:2C44E58F-7757-4CAD-9135-5431028EAE38

DIAGNOSIS: *Stauranderaster* with long, narrow arms made up of paired super- and inferomarginals; radial ossicles absent in distal arm. Superomarginals with a sharply defined central area which broadens distally, carrying few pustule-like spine pits with crater rims, and sugar-tong pedicellariae. Inferomarginals with larger raised central area, bearing granule pits flush with the surface and no pedicellariae.

TYPE: Two arms originating in the same individual (MHNH 2025.1.3) from the level of the Breaky Bottom Flint (Text-fig. 1), upper Turonian of Criel, Seine-Maritime, France.

DERIVATION OF NAME: Latin *pustulosus*, after the pustule-like spine pits on the superomarginals.

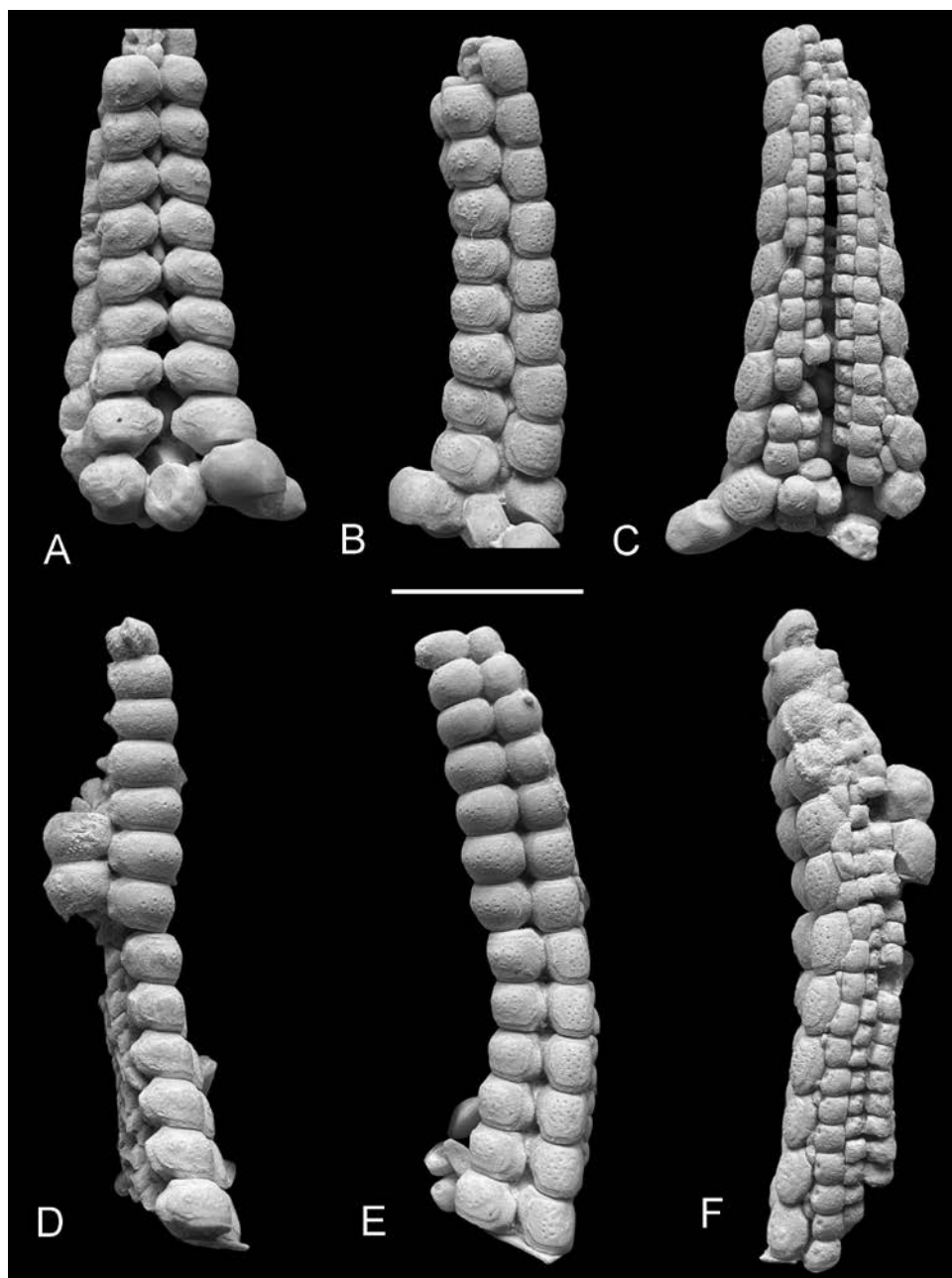
DESCRIPTION: Arms narrow, elongated, slightly recurved abactinally, made up of two rows of superomarginals and two rows of inferomarginals. Radials absent, superomarginals meet over mid-radial line, leaving a space between successive pairs. Marginals block-like, approximately equidimensional, infero- and superomarginals alternate. Superomarginals



Text-fig. 5. Drawings of abactinal plating of stauranderasterid asteroids. A – *Manfredaster bulbiferus* (Forbes, 1848), NHMUK E 4344, Bromley, Kent, UK. B – *Squamataster squamatus* (Forbes, 1848), BMNH 007806, holotype, “Upper Chalk, Woolwich, Kent”, UK. C – *Coronataster coronatus* (Forbes, 1848), MHNH 2026.1.1, the original of Hoyez *et al.* (2020, pl. 28, fig. 1), middle Cenomanian *Acanthoceras jukesbrownei* ammonite Zone, Seine- Maritime. D – *Stauranderaster boysii* (Forbes, 1848), *Micraster coranguinum* Zone, Thanet, Kent, UK.

slightly higher than inferomarginals, outer face re-
flexed abactinally; outer face of inferomarginals
evenly convex. All marginals possess a sharply de-
fined, narrow depressed border. The superomargin-
als carry a cluster of rimmed, crater-like spine pits

concentrated on the abactinolateral faces, and close
to the inferomarginal contact, one or two sugar tong
pedicellariae. Distally, the supero- and inferomar-
ginals lose the spine pits, and the superomarginals
increase in height.



Text-fig. 6. *Stauranderaster pustulosus* sp. nov., MHNH 2025.1.3, holotype, two arms originating in the same individual, from the level of the Breaky Bottom Flint (Text-fig. 1), upper Turonian of Criel, Seine-Maritime, France, in abactinal (A, D), lateral (B, E) and actinal (C, F) views. Scale bar equals 10 mm.

Actinal and adambulacrals are preserved on the actinal surfaces of both arms. A single row of block-like, robust, square actinals articulate with the inferomarginals along the distal arm; each actinal carries a single, depressed spine pit close to the lateral border. Proximally, small oval actinals are irregularly intercalated between the inferomargin-

als and the larger actinals. The adambulacrals are square in actinal aspect and possess a depressed adradial border which bore subadambulacrals spines.

REMARKS: *Stauranderaster pustulosus* sp. nov. is closest to *S. boysii* in the shape of the marginals and the absence of radial ossicles in the distal arm.

However, in *S. boysii* the sculpture of the central areas of the marginals comprises evenly spaced, fine spine pits, similar on all ossicles.

Genus *Coronataster* nov.

urn:lsid:zoobank.org:act:0F4775AA-EA78-4841-B8F7-71E39D8314E9

DIAGNOSIS: Disc broad, weakly tumid, arms long, narrow, tapering slowly. Radials narrow, slightly inset, absent in distal arm; single column of adradials extending into proximal arm. Small oval intermarginals present in disc and proximal arm. Primary radials and interradials large, tumid, forming a broad circlet, centrale relatively small, not tumid. Central abactinal surface of disc flat, composed of weakly convex abactinals, the boundaries of which are occupied by small oval ossicles. Two columns of rectangular actinals present in distal arm. Extra-axial plates bearing sharply defined central area, lacking spine pits with narrow depressed rim. Sugar tongs bivalved pedicellariae common.

TYPE SPECIES: *Oreaster coronatus* Forbes, 1848.

DERIVATION OF NAME: In iterative reference to the name of the type species.

REMARKS: *Coronataster* gen. nov. is distinguished from all other stauranderasterid genera by the very broad calycinal ring, which occupies most of the abactinal disc, and is demarcated by the ten tumid primary radials and interradials. A single ossicle separates each of the primary ossicles, and the inner calycinal ossicles form a flat tessellation surrounding the inconspicuous centrale. The boundaries of the inner calycinal ossicles are occupied by small, oval plates. Intermarginal ossicles are present but absent in all other stauranderasterids. The primary circlet is differently structured in *Manfredaster* (Text-figs 4B, 5A), with primary abactinal ossicles separated by two to three smaller plates, and a circlet of larger inner calycinal ossicles surrounding the centrale. In *Squametaster* gen. nov. (see below) the primary abactinal ossicles are all in contact, and the radials overlap the interradials (Text-figs 4A, 5A).

Coronataster coronatus (Forbes, 1848)
(Text-figs 5C, 7)

1848. *Oreaster coronatus* Forbes, 1848, p. 467.

1850. *Oreaster coronatus* Forbes in Dixon, p. 327, pl. 21, fig. 7a–d.

1905. *Pentaceros coronatus* (Forbes); Spencer, p. 82, pl. 19, figs 1, 1a; pl. 24, fig. 2; pl. 25.

1907. *Stauranderaster coronatus* (Forbes); Spencer, p. 120, text-fig. 28.

1913. *Stauranderaster coronatus* (Forbes); Spencer, p. 135.

1988. *Stauranderaster coronatus* (Forbes); Gale in Smith *et al.*, p. 193, pl. 41, fig. 2.

2003. *Stauranderaster coronatus* (Forbes); Villier *et al.*, p. 39.

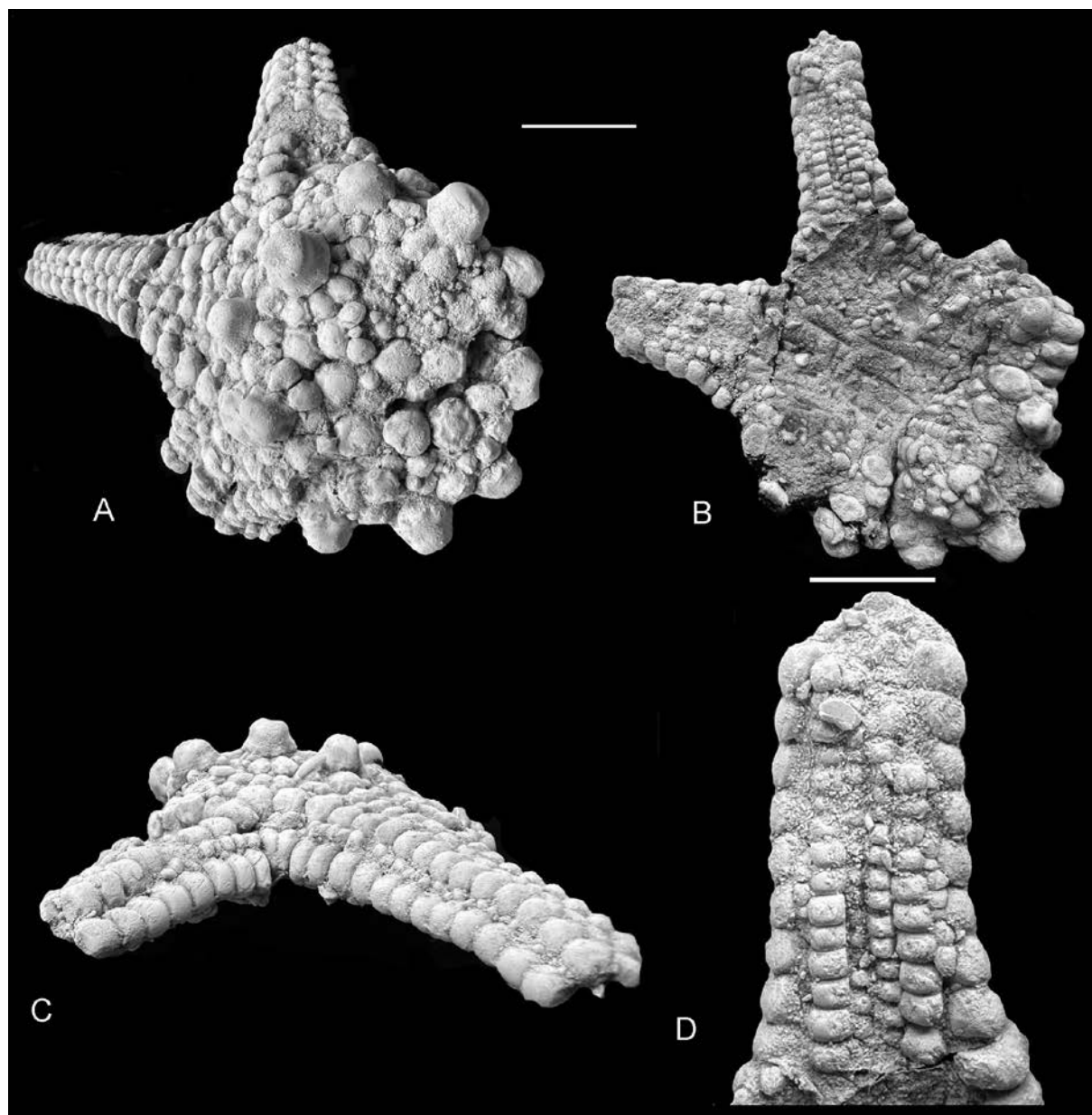
2020. *Stauranderaster coronatus* (Forbes); Hoyez *et al.*, p. 192, pl. 28, fig. 1.

TYPE: The specimen figured by Forbes in Dixon (1850, pl. 21, fig. 7), is the holotype (NHMUK EE 35480). This is from the ‘Lower Chalk’ (probably Zig Zag Chalk Formation, upper Cenomanian) of Washington, West Sussex, UK.

MATERIAL: A well-preserved disc with partial arms, figured by Hoyez *et al.* (2020, pl. 28, fig. 1), from the middle Cenomanian *Acanthoceras jukes-brownei* ammonite Zone, Seine-Maritime (MHNH 2026.1.1). This shows a well-preserved disc with the ossicles *in situ*, not known in the material from England and here described. The surfaces of the ossicles are not well preserved.

DESCRIPTION: The specimen comprises a complete articulated disc and the base of two arms. The central disc is broad and delimited by strongly tumid, flat-topped primary radials and interradials which stand proud of the disc in lateral view. The primary ossicles are conjoined by single, slightly elongated, narrow ossicles. The polygonal inner calycinal ossicles are flat to gently convex and form a flat tessellation, the border of which is delimited by the primary abactinal ossicles. The boundaries of the inner calycinal ossicles are marked by rows of small, oval, secondary abactinals, preserved *in situ* on part of the disc. A slightly larger, flat-topped ossicle is identified as the centrale.

The interradia are parabolically rounded and the margins are formed by the inferomarginals, seen in lateral view as slightly crescentic (proximal margin convex, distal margin concave) subrectangular and these imbricate weakly proximally. They possess a narrow, depressed margin. Supero- and inferomarginals alternate and are separated by a single column of small oval intermarginals, which decrease in size from the disc to the distal arm. The proximal pair of superomarginals are broad and relatively short and are separated from the primary interradials by a



Text-fig. 7. *Coronataster coronatus* (Forbes, 1848), MHNH 2026.1.1, articulated specimen in abactinal (A), actinal (B) and lateral (C) views, and enlargement of actinal surface of arm (D). Original of Hoyez *et al.* (2020, pl. 28, fig. 1), from the middle Cenomanian *Acanthoceras jukes-brownei* ammonite Zone, Seine-Maritime. Scale bars equal 10 mm (A–C) and 5 mm (D).

cluster of small ossicles. Distally, the superomarginals are transversely oval and the breadth is approximately 1.5 times the length. The radials extend from the distal margin of the primary radial and proximally are rectangular, but narrow to become square distally. They are flanked in each proximal arm by two columns of seven adradials, the most proximal of which articulate with the short abactinal ossicles

separating the primary radials and interradians. The adradials only extend into the proximal arm, separating the radials and superomarginals.

The ossicles of the actinal surface of the specimen are mostly lost but preserved *in situ* on one arm. This demonstrates the presence of two columns of actinal ossicles; the adradial row consists of relatively large square ossicles, while ossicles of the abradial row are

narrow and variable in size. Square adambulacral ossicles are visible, but too poorly preserved to provide details.

REMARKS: Unfortunately, the external surfaces of the ossicles are insufficiently well preserved to see detail, but on some larger plates a smooth, slightly raised central area is present. The species evidently had a broad palaeoenvironmental tolerance, being found in both nearshore sands (Gale in Smith *et al.* 1988) and deeper-water marly chalks.

Genus *Squamataster* nov.

urn:lsid:zoobank.org:act:DA8BA7DC-CB1F-4347-A536-BB909C8B7A94

DIAGNOSIS: Disc small, primary circlet approximately 50% of disc dimensions. Primary circlet comprising low, weakly convex pentagonal ossicles; primary radials overlapping primary interradials without intervening ossicles. Centrale equal in size and sculpture to primary radials. Inner calycinal ossicles few, of variable size. Arms tapering rapidly, made up of subrectangular, alternating supero- and inferomarginals. Intermarginals and adradials absent. Proximal radials transversely oval, distally decreasing rapidly in size and becoming narrow and elongate. Pedicellariae absent.

TYPE SPECIES: *Oreaster squamatus* Forbes, 1848.

INCLUDED SPECIES: *Stauranderaster? doreckae* Schulz and Weitschat, 1971 and *Stauranderaster speculum* Nielsen, 1943. An undescribed species is present in the upper Campanian of the Isle of Wight, southern England.

REMARKS: *Squamataster* gen. nov. differs from other stauranderasterids in the distinctive morphology and arrangement of the primary circlet. These are low, pentagonal, weakly convex, and the primary radials overlap the primary radials without intervening ossicles (Text-figs 4A, 5B). Ossicles of this morphology have been described from the Campanian of northern Germany as *Stauranderaster? doreckae* and from the Danian of Denmark as *Stauranderaster speculum*.

Squamataster squamatus (Forbes, 1848)
(Text-figs 4A, 5B)

1848. *Oreaster squamatus* Forbes, p. 468.

1850. *Oreaster squamatus* Forbes in Dixon, p. 328, pl. 23, fig. 3.

1905. *Pentaceros squamatus* Forbes; Spencer, p. 83, pl. 25, figs 3, 3a–c.

1907. *Stauranderaster squamatus* Forbes; Spencer, p. 125.

2003. *Stauranderaster squamatus* (Forbes); Villier *et al.*, p. 39.

DIAGNOSIS: A species of *Squamataster* gen. nov. in which all extra-axial ossicles bear a sharply defined, smooth, slightly raised central area completely lacking spine pits.

TYPE: The specimen figured by Forbes is the holotype, refigured here (Text-fig. 4A), and is from the 'Chalk of Woolwich, Kent', probably coming from the upper Coniacian to lower Santonian Seaford Chalk Formation. Booth Museum, Brighton, West Sussex, BMNH 007806.

MATERIAL: An additional, very well-preserved specimen from Kent is in the collection of the Western Australian Museum, Perth (Australia).

REMARKS. *Squamataster squamatus* differs from other species of the genus in the very sharply defined, relatively small central area on extra-axial ossicles.

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