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Rapid evolution in Turonian microcrinoids (Crinoidea, Roveacrinidae) and its significance for Late Cretaceous stratigraphy

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ABSTRACT:

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Pelagic microcrinoids from the lower and middle Turonian chalks of the Anglo-Paris Basin (southern England, northern France) have distinctive morphologies that demonstrate rapid evolution among three genera, *Dentatocrinus* Gale, 2019a, *Drepanocrinus* Jækel, 1918 and *Striacrinus* gen. nov., and their constituent species and subspecific formae. These form the basis for a refined biostratigraphic zonation that can be applied across the basin. The genus *Striacrinus* is described as new (type species *Drepanocrinus striatulus* Gale, 2019a), with a new species *S. ornatus* described from the middle Turonian. A succession of stratigraphically restricted formae are recognised within *Dentatocrinus dentatus* Gale, 2019a, described herein as *D. dentatus* forma *inflatus* nov., *D. dentatus* forma *subspinosus* nov., *D. dentatus* forma *spinosus* nov., and *D. dentatus* forma *conicus* nov. These formae had ranges with a mean duration of 100–200 kyr as determined from orbital precession cycles.

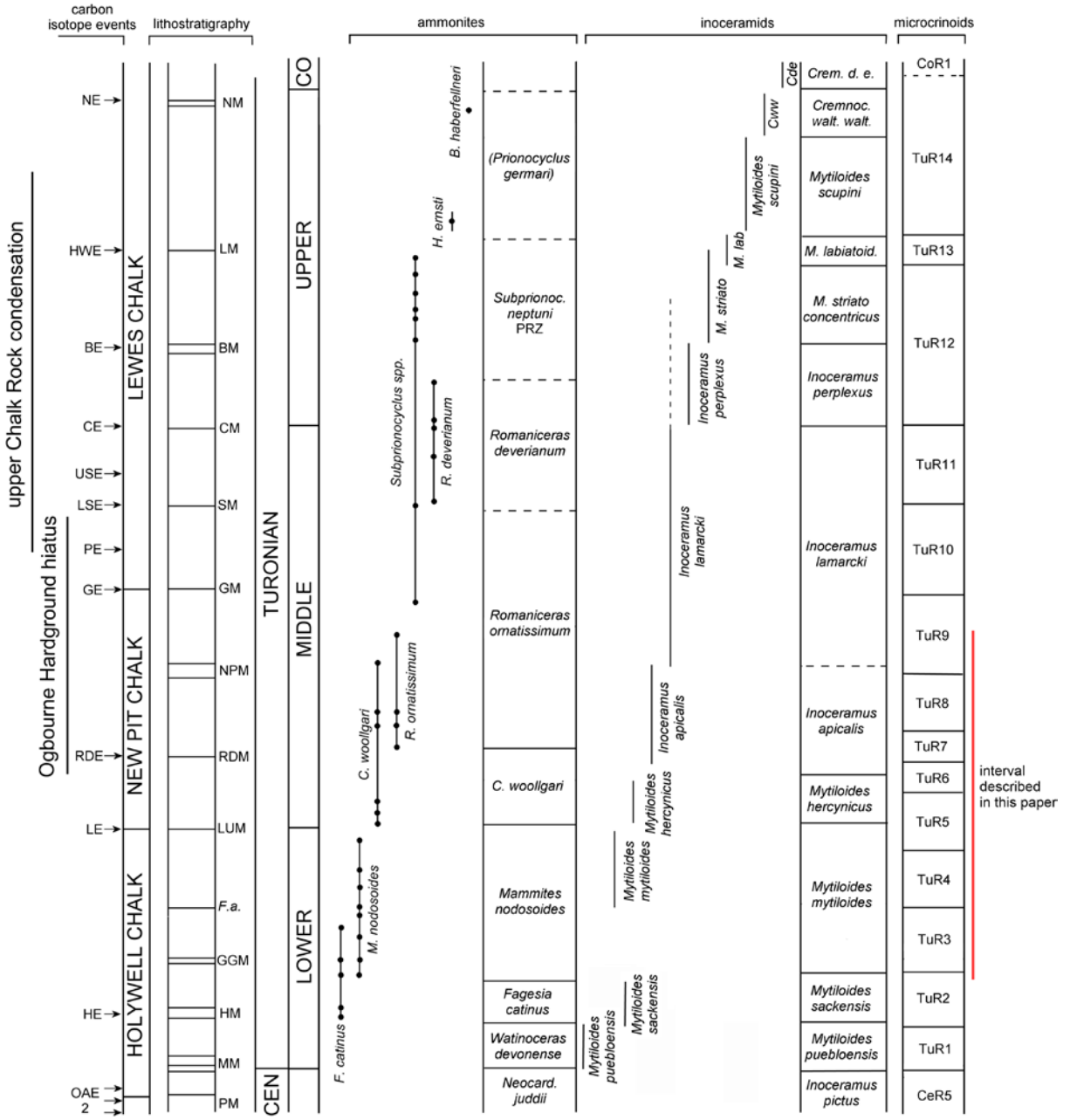
Key words: Pelagic crinoids; Middle Turonian; Anglo-Paris Basin.

https://zoobank.org/References/baeba481-9b85-41fd-a727-10a114af0d63

INTRODUCTION

Pelagic microcrinoids belonging to the families Roveacrinidae Peck, 1943 and Saccocomidae d'Orbigny, 1852a have proven of considerable value in the correlation of Cretaceous (Albian–Campanian) successions, including those in North America (Gale *et al.* 2020a, 2021a), North Africa (Gale 2020; Gale *et al.* 2021b) and northwest Europe (Gale 2016, 2018, 2019a, b, 2023a, b). They are small, often abundant, geographically widespread, facies independent, morphologically distinctive, and evolved rapidly – hence they are ideal zone fossils for the Cretaceous. Refined zonations for the Cenomanian to Campanian interval afford useful means of correlating regional successions, and also allow trans-Atlantic correlations for the Albian–Cenomanian (North Africa-Texas, USA; Gale 2020) and Campanian intervals (UK-Texas, USA; Gale *et al.* 2020a).

In the Turonian chalk facies of the Anglo-Paris Basin, microcrinoids belonging to the Roveacrinidae underwent rapid evolution. Integration of roveacrinid data with ammonite, inoceramid and microfossil zonal schemes, plus carbon isotope stratigraphies (Gale 2019a, b, 2023a) considerably enhances the resolution of correlation that can be achieved (Text-fig. 1). A Turonian microcrinoid zonation can be constructed that includes 14 zones (TuR1–14), based on total and partial ranges of species and formae. This allows a detailed appraisal of the condensation associ-



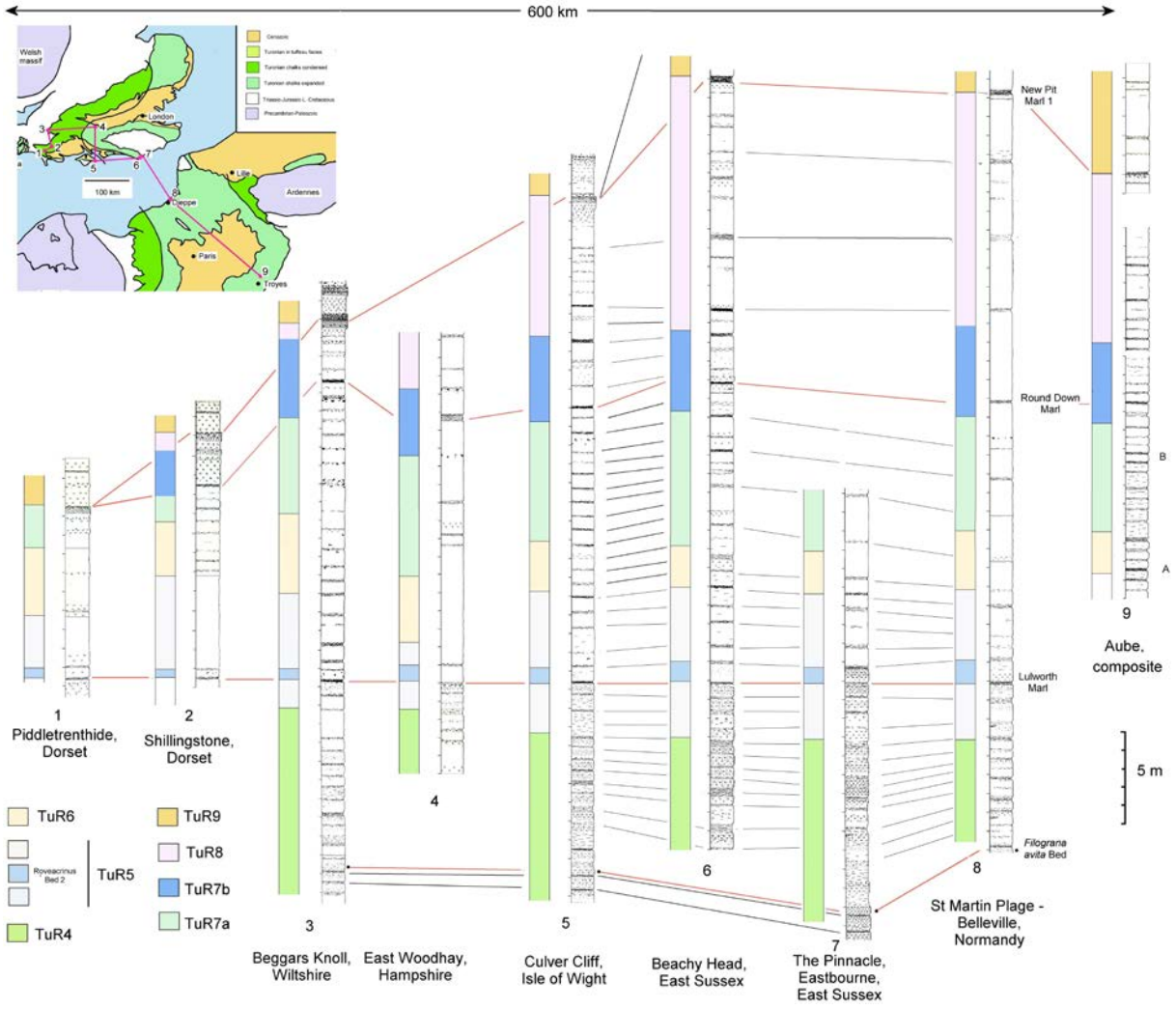
Text-fig. 1. Turonian stratigraphy in the Anglo-Paris Basin, modified after Gale (2019b, fig. 2), to show the interval studied in this paper. Carbon isotope excursions: HE – Holywell Event; LE – Lulworth Event; RDE – Round Down Event; GE – Glynde Event; PE – Pewsey Event; LSE, USE – lower and upper Southerham Events; CE – Caburn Event; BE – Bridgewick Event; HWE – Hitch Wood Event; NE – Navigation Event. Lithostratigraphy, marker beds: PM – Plenus Marls; MM – Meads Marls; HM – Holywell Marls; GGM – Gun Gardens Marls; *Fa* – *Filograna avita* Bed; LUM – Lulworth Marl; RDM – Round Down Marl; NPM – New Pit Marls; GM – Glynde Marls; SM – Southerham Marls; CM – Caburn Marl; BM – Bridgewick Marls; LM – Lewes Marl; NM – Navigation Marls. Ammonite zones after Gale (1996) with modifications. Inoceramid zones after Walaszczyk (pers. comm. 2022). Microcrinoid zones after Gale (2019a). This figure is not to scale.

ated with hardgrounds of the middle–upper Turonian Chalk Rock Member and its equivalents in France (Gale 1996, 2019b, 2023a). Subsequent detailed sampling of the interval that includes the lower–middle Turonian boundary (Text-fig. 1, bottom right) has yielded further material that demonstrates rapid phyletic evolution in the genera *Striacrinus* gen. nov. and *Dentatocrinus* Gale, 2019a through this interval. This, in turn, enables significant stratigraphical refinement to be made.

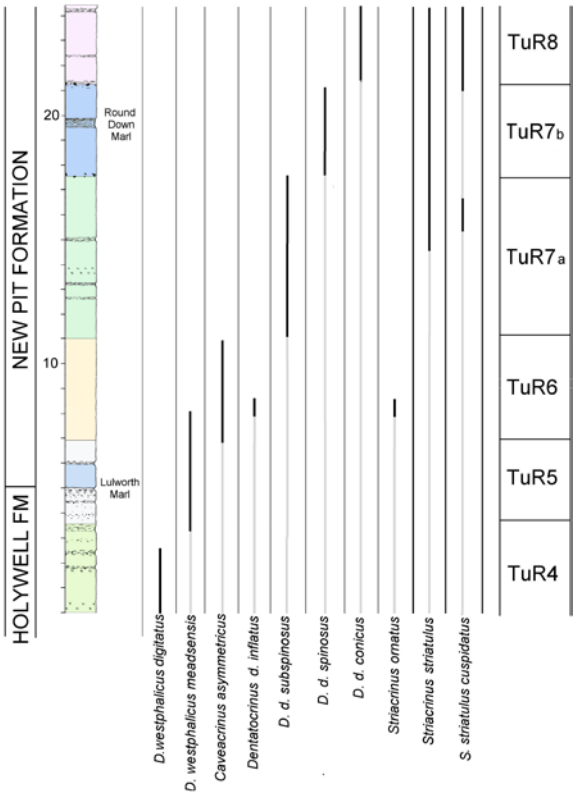
STRATIGRAPHY AND LOCALITIES

The litho-, bio- and chemostratigraphical subdivisions of the Turonian in the northern Anglo-Paris Basin are given in Text-fig. 1, plotted against the timescale from GTS2020 (Gale *et al.* 2020a). Ammonites are rare, but inoceramid bivalves, used in conjunction with marker marl beds, provide an important means of correlation, augmented by the identification of carbon isotope events and microcrinoid stratigraphy. The stratigraphy and correlation of selected sections is given in Text-fig. 2 (for locality details, see Gale 2023a, table 1). For the present study, sections in the Aube (Champagne-Ardenne), eastern France (Text-fig. 2, column 9), the Pinnacle, Eastbourne, East Sussex, UK (Text-fig. 2, column 7), and East Woodhay, Hampshire, UK (Text-fig. 2, column 4; Text-fig. 3) have yielded important new microcrinoid faunas.

In view of the fact that the middle Turonian is rhythmically bedded in sections along the south coast of England, it is possible to provisionally identify orbital cycles (Gale 1996, 2023a, fig. 7). The bedding couplets, consisting of decametric alternations of thin marly chalk and massive cleaner chalk, can be ascribed to precession (mode at 20 kyr). In turn these are bundled into sets of 4–5, each defined by darker marl pairs and generated by short eccentricity (100 kyr). Using this lithostratigraphic cyclicity it is thus possible to estimate the duration of the ranges



Text-fig. 2. Correlation of the upper part of the lower Turonian and the lower part of the middle Turonian across the Anglo-Paris Basin, with marker beds and microcrinoid zones marked. Note the progressive western erosion beneath the Ogbourne Hardground across southern England (sections 1–5) which cuts out, successively, TuR8 and TuR7b to the west. On the Aube composite section, A shows the level which has yielded *Striacrinus ornatus* gen. et sp. nov. and *Dentatocrinus dentatus* forma *inflatus* nov. and B indicates the level with the lowest occurrence of *Striacrinus striatulus* forma *cuspidata*.



Text-fig. 3. Succession of microcrinoid species in the upper Holywell Nodular Chalk Formation and lower New Pit Formation, East Woodhay, Hampshire, UK. Scale bar on left in metres.

of species and formae, infer migration patterns and determine evolutionary rates.

MICROCRINOID EVOLUTION

A proposed phylogeny of Cenomanian–Turonian microcrinoid lineages is illustrated in Text-fig. 4. A clade based on the genus *Drepanocrinus* Jækel, 1918 originated in the middle Cenomanian, gave rise to a *Striacrinus* gen. nov. lineage in the lower Turonian, and possibly to *Caveacrinus* Gale, 2019a in the middle Turonian. *Dentatocrinus* and *Roveacrinus* Douglas, 1908 also continued from the Cenomanian onwards and evolved a succession of short-ranged species and formae in the Turonian. *Lebenharticrinus* Žítt, Löser, Nekvasilová, Hradecká and Švábenická, 2020 is represented by the long-ranging *L. canaliculatus* Žítt, Löser, Nekvasilová, Hradecká and Švábenická, 2020. The saccocomid *Costatocrinus* Gale, 2016 also appears in the middle Turonian.

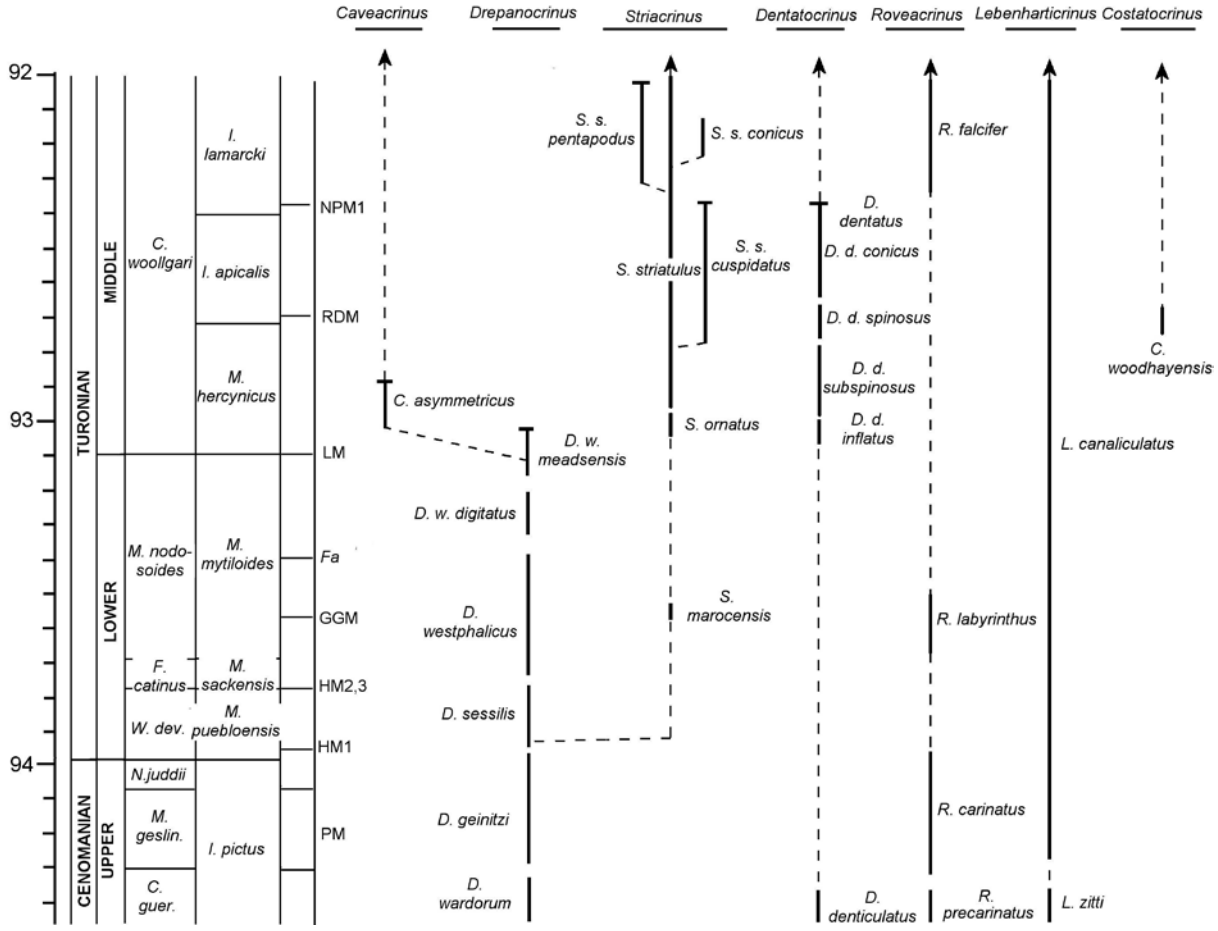
The *Dentatocrinus dentatus* lineage

This lineage provides a remarkable example of rapid evolutionary change (Text-figs 4–6). The earliest forma, *D. dentatus* forma *inflatus* nov. is found rarely in the upper part of TuR5, both in the east of the Paris Basin and in southern England and represents a brief incursion into the region. The succeeding forma, *D. dentatus* forma *subspinosus* nov., has a continuous range in the Anglo-Paris Basin (occurring in almost every sample) over an interval of 5–7 m, equivalent to about 200 kyr. Change to the succeeding forma, *D. dentatus* forma *spinosus* nov. took place over about 1 m, with intermediate forms present. This latter forma has a range of 4–5 m (approximately 80 kyr) and passes, with intermediates, to *D. dentatus* forma *conicus* nov. over less than 1 m. This latter species has a range of about 12–13 m and hence probably existed in the Anglo-Paris Basin for about 250 kyr. The changes in this lineage appear to represent *in situ* evolution, although without knowledge of distribution in other regions, it is not possible to say whether these were geographically more widespread and they might just represent adaptations to local conditions. The termination of the range of the lineage, at the level of New Pit Marl 1, is an extinction event, which also saw the demise of *Striacrinus striatulus* forma *cuspidatus* (Gale, 2019a) (see Gale 2019a, b, 2023a).

The *Drepanocrinus–Striacrinus–Caveacrinus* lineage

Drepanocrinus appeared in the middle Cenomanian, with a succession of short-ranged species extending through the upper Cenomanian, lower Turonian and basal middle Turonian [*D. wardorum* Gale, 2020 – *D. geinitzi* (Schneider, 1989) – *D. sessilis* Jækel, 1918 – *D. westphalicus* (Sieverts, 1933)]. In the lower Turonian, *D. sessilis* (Text-fig. 7M–P) gave rise to a suite of formae of *D. westphalicus* which characterise successive discrete levels; *D. westphalicus* forma *digitatus* Gale, 2019a (Text-fig. 7I–L, defining zone TuR4) and *D. westphalicus* forma *meadsensis* Gale, 2019a (Text-fig. 7E–H, characterising zone TuR5). The range of *Caveacrinus asymmetricus* Gale, 2019a (Text-fig. 7A–D, zone TuR6) overlaps with that of *D. westphalicus* forma *meadsensis,* its probable ancestor (Text-fig. 4).

The *Drepanocrinus* lineage splits in the lower Turonian (Text-fig. 4), giving rise to the new genus *Striacrinus* (Text-figs 8, 9). The oldest species, *S. marocensis* (Gale, 2019a) has a long range in North Africa



Text-fig. 4. Proposed phylogeny of saccocomid and roveacrinid microcrinoids in the Cenomanian–middle Turonian of the Anglo-Paris Basin. The ancestry of *Caveacrinus* is uncertain. Abbreviations: Lithological markers: PM – Plenus Marl, HM1–3 – Holywell Marls, GGM – Gun Gardens Marls, *Fa* – *Filograna avita* Bed, LM – Lulworth Marl, RDM – Round Down Marl, NPM1 – New Pit Marl 1. Ammonite zones; *C. guer.* – *Calycoceras guerangeri* Zone, *M. geslin.* – *Metoicoceras geslinianum* Zone, *N. juddii* – *Neocardioceras juddii* Zone, *W. dev.* – *Watinoceras devonense* Zone, *F. catinus* – *Fagesia catinus* Zone, *M. nodosoides* – *Mammites nodosoides* Zone, *C. woollgari* – *Collignoniceras woollgari* Zone. Inoceramid zones: *I* – *Inoceramus*, *M* – *Mytiloides*.

(Gale 2020; Text-fig. 9M–P herein) but occurs only within one narrow level in the Anglo-Paris Basin, in the Gun Gardens Marl 1 (Gale 2019a). *Striacrinus ornatus* gen. et sp. nov. (Text-fig. 9I–L) is found in the Anglo-Paris Basin as a rarity in the lower part of TuR6 (Text-fig. 3). Above, *Striacrinus striatulus* (Gale, 2019a) appears in zone TuR7a (Text-fig. 3) and is abundant throughout the middle Turonian, including a suite of formae based on cup morphology which characterise successive levels. *Striacrinus striatulus* forma *cuspidatus* has aborally elongated radials, forming a spike (Text-fig. 8D–H) and is found only in TuR7a and TuR8 (Text-fig. 3). *Striacrinus striatulus* forma *pentapodus* (Gale, 2019a) has laterally divergent blades on the radials (Text-fig. 8I–O) and is restricted to TuR9. *Striacrinus striatulus* forma *conicus* (Gale, 2019a) is also found in TuR9 (Text-fig. 9P–S). In addition to the formae based on cup morphology, the sculpture of the primibrachial IBr2 changes through time. In the lower part of its range (TuR7A, B), the IBr2 of *Striacrinus striatulus* has strongly striated, robust buttresses (Text-fig. 9E–G), whereas in the higher part (TuR8,9) these are delicate, short, smooth structures (Text-fig. 9A–C).

Species and formae of the genera *Striacrinus* gen. nov. and *Caveacrinus* appear and disappear suddenly, without evidence of ancestors or descendants. *Caveacrinus asymmetricus* has a very short range in southern England and northern France (3 m), defining zone TuR6, but in the Aube (eastern Paris Basin) it

reappears in abundance at just a single level in the middle part of TuR7. Similarly, *Striacrinus striatulus* forma *cuspidatus* occurs only in TuR8 in the northern Anglo-Paris Basin where its range was used to define the zone (Gale 2019a, b, 2023a). However, in the Aube (eastern Paris Basin) this forma occurs at just a single lower level within TuR7A. It would appear that these taxa had significantly longer ranges outside the Anglo-Paris Basin, and their occurrences in this region represent brief migrations. The sporadic earlier and later records in the east of the Paris Basin might indicate a Tethyan source to the south and east.

The *Roveacrinus* lineage

Roveacrinus evolved from *Poecilocrinus* Peck, 1943 in the late Albian (Gale *et al.* 2021a) and a succession of species characterise levels in the Cenomanian and Turonian. In the Turonian of the Anglo-Paris Basin, the genus is represented only by *R. labyrinthus* Gale, 2019a (*Mytiloides mytiloides* inoceramid Zone) and *R. falcifer* Gale, 2019a (*Inoceramus lamarcki* inoceramid Zone). These represent relatively short migration events into the region.

STRATIGRAPHICAL IMPLICATIONS

In the past, the middle Turonian chalk of the Anglo-Paris has proven difficult to subdivide biostratigraphically. The base is marked by a sharp lithological change from nodular, intraclastic chalks containing abundant inoceramid debris to softer chalks lacking intraclasts and nodular levels (Text-figs 1, 2). This is reflected in the boundary placement between the Holywell Nodular Chalk Formation and the overlying New Pit Chalk Formation (UK – Hopson 2005), a lithological boundary coincident with that between the inoceramid zones of *Mytiloides mytiloides* and *M. hercynicus* (Mortimore *et al.* 2001), with other macrofossils mostly long-ranging taxa. Correlation of the New Pit Chalk, and its equivalent in France, has relied largely upon the identification of thin (<10 cm) marker marl beds named by Mortimore (1986) and Gale (1996). The most important of these are the New Pit Marls (1, 2) which have been widely identified in cores, outcrops and from geophysical logging (Woods *et al.* 2023). The clays in the New Pit Formation marls are of detrital origin, in contrast to the volcanogenic clays in the marls of the overlying Lewes Nodular Chalk Formation (Wray 1999) and hence cannot be individually characterised from geochemical data. Considerable disagreement surrounds the identification and correlation of individual marl beds, particularly in electrical resistivity profiles (Gale 2023a; Woods *et al.* 2023).

The microcrinoid biostratigraphy for the Turonian which I have presented previously (Gale 2019a, b, 2023a), coupled with new data in this paper, provides a high-resolution framework for correlating middle Turonian chalks. In particular, the evolutionary lineages represented by successive formae of *Dentatocrinus dentatus* and *Striacrinus striatulus* enable very precise zonal subdivision of the middle Turonian (Text-fig. 2). This is enhanced by brief incursions of longer-ranging taxa such as *Caveacrinus asymmetricus*. The successive zones established (TuR5, 6, 7A, 7B, 8, 9A, and 9B) span an interval of approximately 1 myr and have a mean duration of 150 kyr. Importantly for correlation of the chalk, it is now possible to identify key marker marl beds from their microcrinoid faunas. Thus, the Round Down Marl falls within the short range of *Dentatocrinus dentatus* forma *spinosus* nov., and its identity can therefore be confirmed across the Anglo-Paris Basin (Text-fig. 2). The New Pit Marls are marked by the disappearance of *Dentatocrinus dentatus* and *Striacrinus striatulus* forma *cuspidatus* within the 10 cm thick New Pit Marl 1, defining the base of the TuR9 (see below and Text-fig. 2). *Striacrinus striatulus* forma *cuspidatus* is found in the middle Turonian of Morocco (Gale 2020) and central Texas, USA (pers. obs.) but the occurrences there cannot yet be related to a detailed stratigraphy.

Revised zonation

The roveacrinid zonation of the lower–middle Turonian provided by Gale (2019a, b, 2023) is here revised in the light of new discoveries (Text-figs 2, 3).

- TuR4. Total range of *Drepanocrinus westphalicus* forma *digitatus*.
- TuR5. The lowest occurrence of *Drepanocrinus westphalicus* forma *meadsensis* to the lowest occurrence of *Caveacrinus asymmetricus*. This includes a single bed, immediately overlying the Lulworth Marl, that contains abundant debris of *D. w.* forma *meadsensis* (Text-fig. 2; R. c. 2 Bed of Gale 1996).
- TuR6. Lowest occurrence of *Caveacrinus asymmetricus* to the lowest occurrence of *Dentatocrinus dentatus*.
- TuR7a. Lowest occurrence of *Dentatocrinus dentatus* to lowest occurrence of *D. dentatus* forma *spinosus* nov.
- Tur7b. Total range of *Dentatocrinus dentatus* forma *spinosus* nov.

– Tur8. Total range of *Dentatocrinus dentatus* forma *conicus* nov.
– TuR9. Base defined by the highest occurrences of *Dentatocrinus dentatus* forma *conicus* nov. and *Striacrinus striatulus* forma *cuspidatus*. Top defined by the lowest occurrence of *Roveacrinus falcifer*.

SYSTEMATIC PALAEONTOLOGY

This section provides a revision of the systematic palaeontology of the genera *Dentatocrinus*, *Drepanocrinus*, and *Striacrinus* gen. nov. from the Turonian of the Anglo-Paris Basin.

Family Roveacrinidae Peck, 1943
Subfamily Roveacrininae Peck, 1943
Genus *Dentatocrinus* Gale, 2019a

DIAGNOSIS: A roveacrinine in which spinose basals form the aboral portion of the cup and are overlapped radially by narrow aboral extensions of the radials.

TYPE SPECIES: *Dentatocrinus dentatus* Gale, 2019a.

ADDITIONAL REFERRED SPECIES: *Dentatocrinus compactus* Gale, 2019a, *D. hoyezi* Gale, 2019a and *D. serratus* Gale, 2023b.

REMARKS: *Dentatocrinus* is a most unusual roveacrinid, in which the basals are large and form the conical aboral part of the cup. The genus ranges in age from the late Cenomanian to the late Turonian.

Dentatocrinus dentatus Gale, 2019a
(Text-figs 5, 6)

2019a. *Dentatocrinus dentatus* Gale, 2019, p. 468, pl. 35, figs 1–13.
2023a. *Dentatocrinus dentatus* Gale; Gale, p. 10, fig. 9a–f.

DIAGNOSIS: *Dentatocrinus* in which the aboral portion of the cup is elongated into a spike composed of the basals. The radial buttresses possess flanges which bear 4–8 aborally directed spines. IIBr2 bear a median support of anastomosing smooth ridges.

TYPES: The cup figured by Gale (2019a, pl. 35, fig. 1a, b) is the holotype (NHMUK PI EE 16992), from the middle Turonian, level of the Round Down Marl, west of St Martin Plage, near Dieppe, Seine-Maritime, France.

REMARKS: This species displays significant evolutionary development, characterised by a succession of formae, over its middle Turonian range. The species first appears in the lower part of the middle Turonian in microcrinoid zone TuR6 as a form which lacks basal spines and has a swollen aboral part to the cup (forma *inflatus* nov.; Text-figs 5U–Y, 6O–Q). This is succeeded by a form with a finely spinose aboral margin and serrate radial ridges (forma *subspinosus* nov.; Text-figs 5P–T, 6L–N) limited to TuR7a. It is followed by a form with a cluster of coarse, pendant aboral spines (forma *spinosus* nov.; Text-figs 5K–O, 6E–G, J, K) that is limited to and defines TuR7b. This is replaced by a forma (*conica* nov.; Text-figs 5A–E, 6A–D, H, I) in which the aboral portion of the cup is elongated and cylindrical and the radial ridges lack serrations. The lower two formae are sharply demarcated stratigraphically, but intermediates between forma *spinosus* nov. and forma *conicus* nov. do occur (Text-fig. 5F–J). Primibrachial IBr2 also shows significant stratigraphical changes, discussed below.

Dentatocrinus dentatus forma *inflatus* nov.
(Text-figs 5U–Y, 6O–Q)

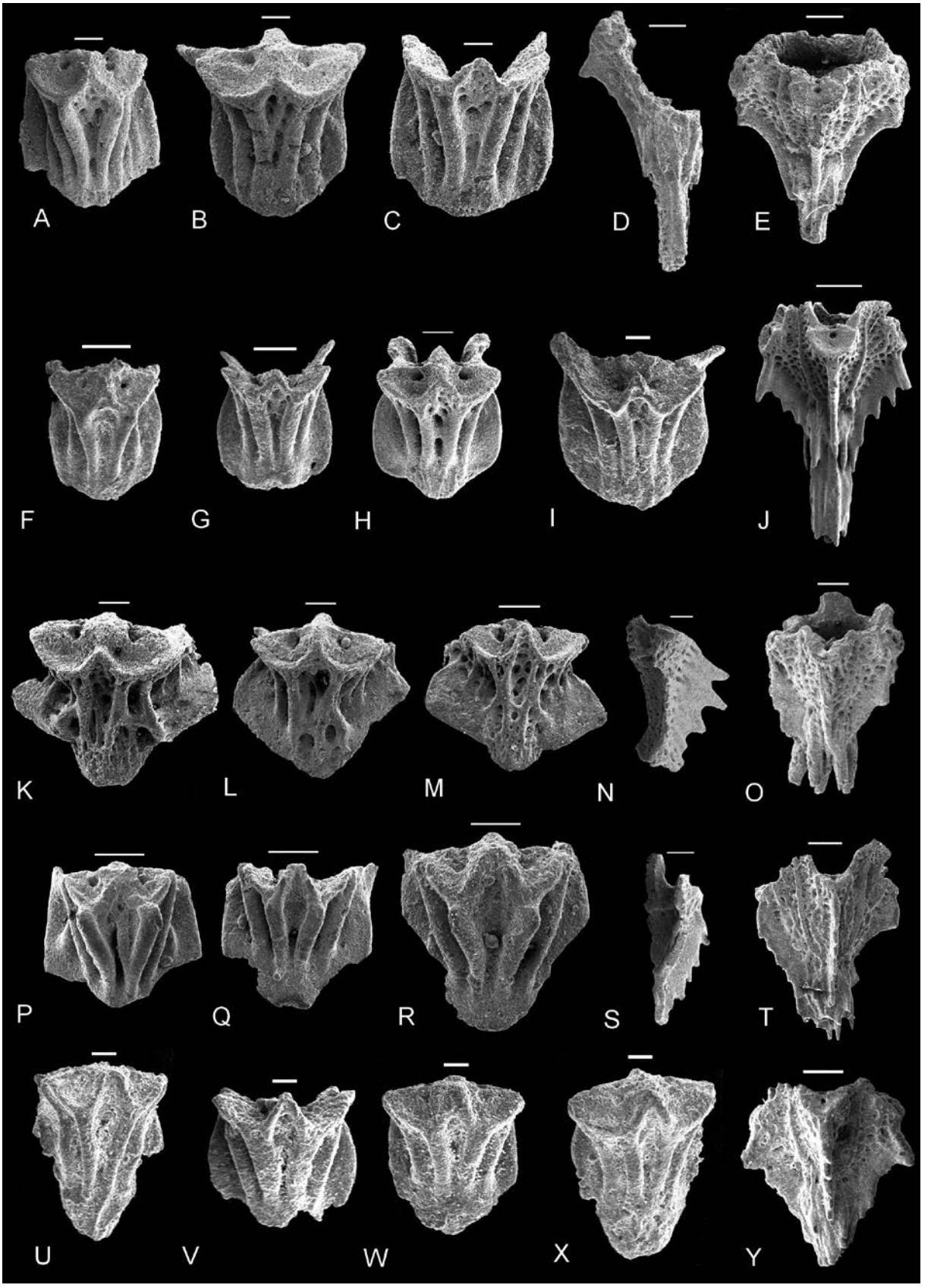
DIAGNOSIS: Cup conical, aboral cup lacking spines but variably inflated. An irregular flange runs from the base of the radial articular facet to the aboral cup.

TYPE: The cup figured in Text-fig. 6O is the holotype (NHMUK PI EE 18202) from the New Pit Chalk Formation, *Terebratulina lata* Zone, 8 m level on Text-fig. 3, East Woodhay, Hampshire, UK.

MATERIAL: Five cups, numerous fragmentary cups and brachials from the same locality and horizon as the holotype. Isolated radial plates from the middle Turonian of Pougy (Aube, France).

DESCRIPTION: Cup conical, height slightly greater than breadth. An irregular mid-radial flange extends aborally from a process at the base of the articular facet and narrows to the base of the cup (Text-fig. 6O–Q). The aboral base of the cup (formed by basals) lacks spines and is inflated in some individuals (Text-fig. 6O) but narrow in others (Text-fig. 5Y). Brachials IBr2 (Text-fig. 5U–X) are triangular in outline and the articular facets are supported by 2–4 rounded ridges.

REMARKS: *Dentatocrinus dentatus* forma *inflatus* nov. differs from later formae in the absence of spines on the aboral cup and in the irregular form of the mid-radial flange. It occurs only in the lower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← Text-fig. 5. Formae of *Dentatocrinus dentatus* Gale, 2019a. A–E – *D. d.* forma *conicus* nov. A–C – NHMUK PI EE 18152–18154, brachials IBr2 in external view; D – NHMUK PI EE 18155, fragmentary cup in lateral view; E – NHMUK PI EE 18156, holotype cup in lateral view. F–J – *D. d.* transitional between forma *spinosus* nov. and forma *conicus* nov.; F–I – NHMUK PI EE 18157–18160, brachials IBr2 in external view; J – NHMUK PI EE 16992, cup in lateral view, holotype of *Dentatocrinus dentatus* Gale, 2019a, original of Gale (2019a, pl. 32, figs 1, 2). K–O – *D. d.* forma *spinosus* nov.; K–M – NHMUK PI EE 18161–18163, brachials IBr2 in external view; N – NHMUK PI EE 18164, isolated radial; O – NHMUK PI EE 18165, holotype cup in lateral view. P–T – *D. d.* forma *subspinosus* nov. P–R – NHMUK PI EE 18166–18168, brachials IBr2 in external view; S – NHMUK PI EE 18169, isolated radial; T – NHMUK PI EE 18170, holotype cup in lateral view. U–Y – *D. d.* forma *inflatus* nov.; U–X – NHMUK PI EE 18171–18174, brachials IBr2 in external view; Y – NHMUK PI EE 18175, paratype cup in lateral view. Provenance: A–E are from the New Pit Chalk Formation, *Terebratulina lata* Zone, 23–24 m interval on Text-fig. 3, East Woodhay, Hampshire, UK; F–J are from the middle Turonian, 5 m above Round Down Marl, St Martin Plage, near Dieppe, Seine-Maritime; P–T are from the New Pit Formation, middle Turonian *Terebratulina lata* Zone, level of Round Down Marl and underlying 1 m of chalk, New Pit Chalk Formation, *Terebratulina lata* Zone, 19–20 m interval on Text-fig. 3, East Woodhay, Hampshire, UK; U–Y are from the New Pit Chalk Formation, *Terebratulina lata* Zone, 8 m level on Text-fig. 3, East Woodhay, Hampshire, UK. Scale bars equal 0.2 mm (A–C, F–I, P–R, U–X), 0.5 mm (D, E, J, O, T, Y). Note the difference in size between the cups (D, E, J, O, T, Y) and brachials (all other illustrations).

part of microcrinoid zone TuR6, where it co-occurs with *Caveacrinus asymmetricus*, *Striacrinus ornatus* gen. et sp. nov. and *Drepanocrinus westphalicus* forma *meadsensis* (Text-fig. 4). It is known only from East Woodhay, Hampshire, UK and Pougy, the Aube, France.

Dentatocrinus dentatus forma *subspinosus* nov.
(Text-figs 5P–T, 6L–N)

DIAGNOSIS: Aboral portion of cup bearing short, fine spines. Mid-radial flange with serrated border. IBr2 triangular, coarsely ribbed.

TYPE: The cup illustrated in Text-fig. 5T is the holotype (NHMUK PI EE 18170). The figured IBr2 (Text-fig. 5P–R) are paratypes (NHMUK PI EE 18166–18168). From New Pit Formation, middle Turonian *Terebratulina lata* Zone, 50–54 m interval on Text-fig. 3, East Woodhay, Hampshire, UK.

MATERIAL: More than 20 cups and fragmentary cups and numerous brachials from the New Pit Formation, middle Turonian *Terebratulina lata* Zone, of Sussex, Hampshire and the Isle of Wight, UK. The species occurs commonly between 46 and 53 m in the section at East Woodhay (Text-fig. 3).

DESCRIPTION: Cup conical, height slightly greater than breadth (Text-figs 5S, T, 6L–N). A broad, serrate flange extends from the lower margin of the articular facet of the radials to the base of the cup, bearing 4–5 short, aborally directed processes. The aboral part of the cup bears short, fine, aborally directed spines. The IBr2 (Text-fig. 5P–R) are robust, triangular to subrectangular in outline, and carry 2–4 stout, rounded ribs which run from the proximal margin to the distal articular facets.

REMARKS: *Dentatocrinus dentatus* forma *subspinosus* nov. differs from the older *D. d.* forma *inflatus* nov. in its possession of serrated radial flanges, and the presence of short, aborally directed spines on the base of the cup. It differs from the later *D. d.* forma *spinosus* nov. in that the aboral spines are small and short, whereas these are larger and more elongated in forma *spinosus* nov. Additionally, the brachials IBr2 lack the lateral wings present in forma *spinosus* nov. Stratigraphically, the forma *subspinosus* nov. occurs above forma *inflatus* nov. and beneath forma *spinosus* nov. and serves to define microcrinoid zone TuR7a.

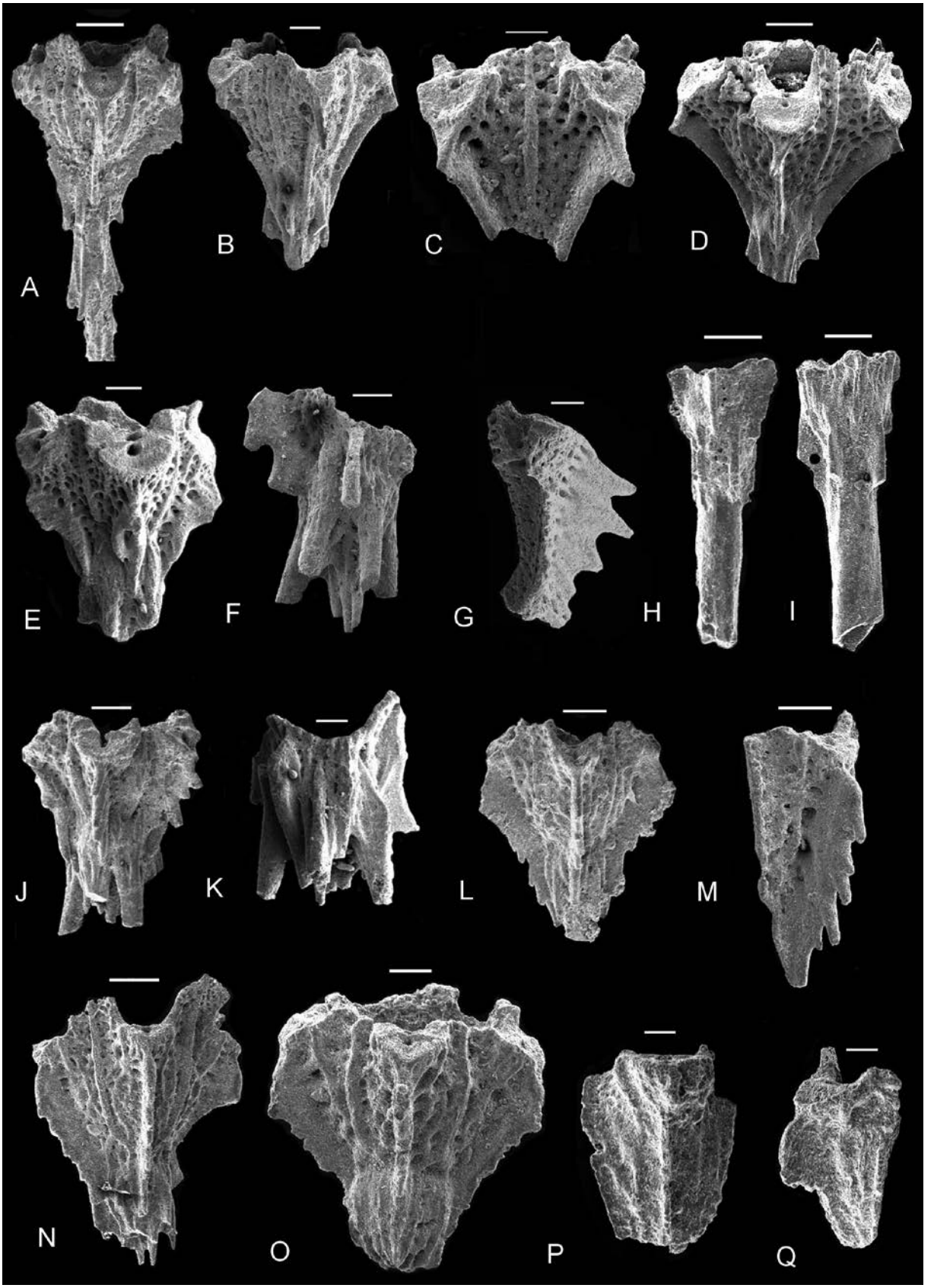
Dentatocrinus dentatus forma *spinosus* nov.
(Text-figs 5K–O, 6E–G, J, K)

DIAGNOSIS: Aboral portion of cup bears a cluster of aborally directed, narrowing spines. Radial flange forms saw-tooth like crest. IBr2 bears short lateral flanges.

TYPE: A cup from the New Pit Formation, middle Turonian *Terebratulina lata* Zone, 0.6 m beneath the Round Down Marl of East Woodhay, Hampshire, UK is the holotype (Text-fig. 5O; NHMUK PI EE 18165). Other figured specimens from the same level and locality are paratypes (NHMUK PI EE 18161–18164).

MATERIAL: More than 100 cups and proximal brachials from the level of the Round Down Marl in Sussex, Dorset, Hampshire and the Isle of Wight, UK, and from St Martin Plage, Seine-Maritime and the Aube, France.

DESCRIPTION: Cup conical (Text-figs 5O, 6F, J), radial ridges bearing 5–7 saw-tooth like processes, decreasing in size aborally from the radial facet (Text-fig. 6G). Interradial cup coarsely reticulate. A cluster of up to 10 aborally or obliquely directed spines extending from the aboral pole. IBr2 (Text-fig. 5L–M) rhombic in outline, a central buttress of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← Text-fig. 6. Formae of *Dentatocrinus dentatus* Gale, 2019a. A–D, H, I – *D. d.* forma *conicus* nov.; A–D – NHMUK PI EE 18176–18179, cups and fragmentary cups in lateral view; H, I – NHMUK PI EE 18180, 18181, basal processes in lateral view. E–G, J, K – *D. d.* forma *spinosus* nov.; E, F, J, K – NHMUK PI EE 18182–18185, cups in lateral view; G – NHMUK PI EE 18186, radial in lateral view. L–N – *D. d.* forma *subspinosus* nov.; L, N – NHMUK PI EE 18187, 18188, cups in lateral view; M – NHMUK PI EE 18189, radial in lateral view. O–Q – *D. d.* forma *inflatus* nov.; O – NHMUK PI EE 18202, holotype cup in lateral view. P, Q – NHMUK PI EE 18190, radial in lateral view. Provenance: A is from the New Pit Formation, middle Turonian *Terebratulina lata* Zone, level of Round Down Marl, Lydden, near Dover, Kent, UK; H, I are from the middle Turonian, immediately beneath New Pit Marl 1, Belignicourt, Aube, France (text-fig. 5 of Gale 2023a); P, Q are from the middle Turonian, Pougy, Aube, France, base of section on log of Gale (2023a, fig. 5); all other specimens are from the New Pit Formation, middle Turonian *Terebratulina lata* Zone of East Woodhay, Hampshire, UK. A–D are from 2–4 m above the Round Down Marl, 22–24 m on Text-fig. 3; E, F, G, K are from the level of the Round Down Marl and underlying 1 m of chalk, 19–20 m on Text-fig. 3; L–N are from the 12–14 m interval on Text-fig. 3; O is from level 8 m on Text-fig. 3. Scale bars equal 0.2 mm.

coarse, irregularly conjoined trabeculae is present, and short, smooth lateral wings.

REMARKS: This highly distinctive forma, in which the cup bears a cluster of elongated aboral spines, has a short range of 4–5 m. This extends from 2 m beneath the Round Down Marl to 2.5–3.0 m above it across the Anglo-Paris Basin. At the top of its range transitional forms to *Dentatocrinus dentatus* forma *conicus* nov. occur (Text-fig. 5F–J). These retain the serrated mid-radial ridge but possess an aborally extended, cylindrical basal cone.

Dentatocrinus dentatus forma *conicus* nov.
(Text-figs 5A–E, 6A–D, H, I)

DIAGNOSIS: Aboral part of the cup forms an elongated, cylindrical projection. Radial flanges typically possess only a single, short process, immediately aboral to the radial facet. 1Br2 narrow, elevated.

TYPE: The cup figured in Text-fig. 5E is the holotype (NHMUK PI EE 18156), from the New Pit Formation, middle Turonian *Terebratulina lata* Zone, 3 m above Round Down Marl, New Pit Chalk Formation, *Terebratulina lata* Zone, East Woodhay, Hampshire, UK. The paratypes (Text-fig. 5A–D) are from the same locality and horizon (NHMUK PI EE 18157–18160).

MATERIAL: More than 50 cups, fragmentary cups and proximal brachials from the New Pit Formation, middle Turonian *Terebratulina lata* Zone, 2–6 m above the Round Down Marl, from Kent, Sussex, Hampshire and the Isle of Wight, UK, and from St Martin Plage, Seine-Maritime and the Aube, France.

DESCRIPTION: Cup conical, elongated aborally into a cylindrical process composed of basals (Text-figs 5D, E, 6A, H, I). This is smooth and hollow in some specimens (Text-fig. 6H, I) or may bear flanged ridges (Text-fig. 6A). A short process extends from the margin of the articular facet of each radial, from the base of which a smooth, concave radial ridge extends aborally to the top of the cylindrical basal tube. Brachial IBr2 is rectangular in outline and bears 4–6 coarse, rounded ridges which extend from the distal articular facets to the base.

REMARKS: This forma replaces *Dentatocrinus dentatus* forma *spinosus* nov. 2–3 m above the Round Down Marl and extends up to New Pit Marl 1. In more expanded successions (e.g., Beachy Head, Dieppe) it has a range of 11–13 m. The forma (and the species) disappears within New Pit Marl 1.

Genus *Drepanocrinus* Jækel, 1918

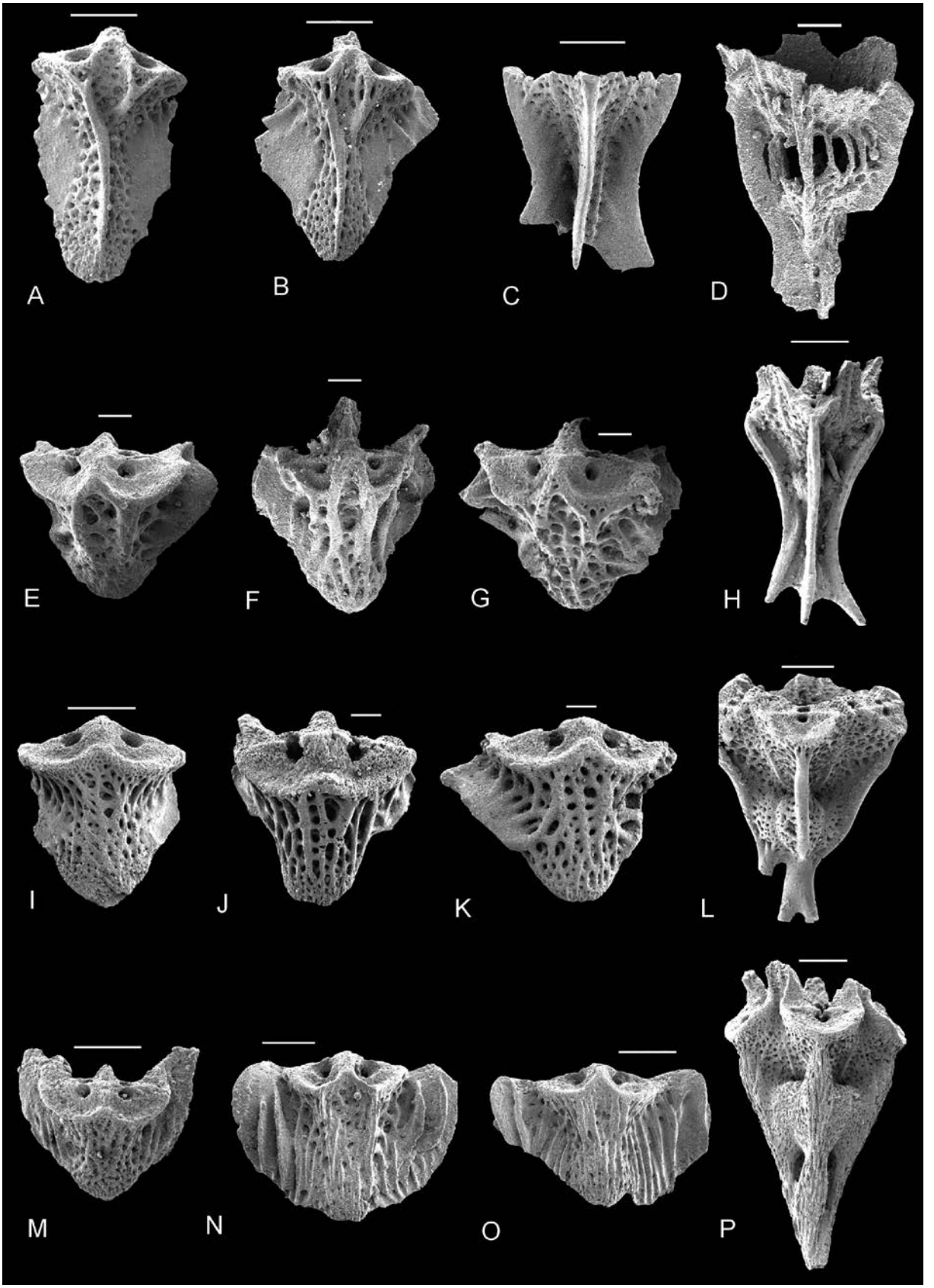
DIAGNOSIS: Cups conical, robust, with radial buttresses lacking alar extensions or flanges. Basal cavity inconspicuous on cup exterior. Basals entirely internal, not visible on exterior of cup. IBr2 triangular, sculpture reticulate, lacking spines or flanges.

TYPE SPECIES: *Drepanocrinus sessilis* Jækel, 1918.

ADDITIONAL INCLUDED SPECIES: *Roveacrinus westphalicus* Sieverts, 1933, *Roveacrinus geinitzi* Schneider, 1989, and *Drepanocrinus wardorum* Gale, 2020.

REMARKS: *Drepanocrinus* differs from the later *Striacrinus* gen. nov., to which it is considered ancestral (Text-fig. 4), in the entirely internal basals and the triangular outline of the IIBr2. In *Striacrinus* gen. nov. the basals possess a variably sized surface on the exterior of the cup and the IIBr2 are trapezoidal to rectangular in outline. The genus occurs from the middle Cenomanian to the base of the middle Turonian.

Drepanocrinus westphalicus forma *digitatus* Gale, 2019a
(Text-fig. 7I–L)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← Text-fig. 7. Species and formae of *Caveacrinus* Gale, 2019a (A–D) and *Drepanocrinus* Jækel, 1918 (E–P). A–D – *Caveacrinus asymmetricus* Gale, 2019a. A, B – NHMUK PI EE 16595, 16956, brachials IBr2 in external view, the originals of Gale (2019a, pl. 29, figs 2, 3); C – NHMUK PI EE 16951, basal part of cup in lateral view, the original of Gale (2019a pl. 28, fig. 8); D – NHMUK PI EE 18137, cup in lateral view, the original of Gale (2023a, text-fig. 7A). E–H – *Drepanocrinus westphalicus* forma *meadsensis* Gale, 2019a; E–G – NHMUK PI EE 16830, 16841, 16841a, brachials IBr2 in external view, the originals of Gale (2019a, pl. 16, figs 14, 13, 16, respectively); H – NHMUK PI EE 16834, cup in lateral view, the original of Gale (2019a, pl. 16, fig. 8). I–L – *Drepanocrinus westphalicus* forma *digitatus* Gale, 2019a; I–K – NHMUK PI EE 16856–16859, brachials IBr2 in external view, the originals of Gale (2019a, pl. 17, figs 13, 15, 16, respectively); L – NHMUK PI EE 16848, holotype cup in lateral view, the original of Gale (2019a, pl. 17, fig. 5). M–P – *Drepanocrinus sessilis* Jækel, 1918; M–O – NHMUK PI EE 16821, 16823, 16795, brachials IBr2 in external view, the originals of Gale (2019a, pl. 15, figs 10, 11, and pl. 13 fig. 10, respectively); P – NHMUK PI EE 16811, cup in lateral view, the original of Gale (2019a, pl. 24, fig. 10). Provenance: A–C are from the New Pit Formation, *Terebratulina lata* Zone, 45 m on log of Gale (2019a, fig. 10), Holywell Pinnacle, Eastbourne, East Sussex, UK; D is from the New Pit Formation, *Terebratulina lata* Zone, Ashwell, Hertfordshire, 10.5 m on log of Gale (2023a, fig. 4); E–H are from the basal New Pit Chalk Formation, Holywell Pinnacle, Eastbourne, East Sussex, UK; I–L are from the lower Turonian, 2 m above *Filograna avita* level, St Martin Plage, near Dieppe, Seine-Maritime, France; N, O are from the Holywell Nodular Chalk Formation, Holywell Marls 2–3, lower Turonian, Eastbourne, East Sussex, UK; M, P are from the lower Turonian, Meads Marl 5, Penly, near Dieppe, Seine Maritime, France. Scale bars equal 0.5 mm.

2019a. *Drepanocrinus westphalicus* forma *digitatus* Gale, p. 452, pl. 17, figs 1–16.
2023a. *Drepanocrinus westphalicus* forma *digitatus* Gale; Gale, fig. 9l.

DIAGNOSIS: *Drepanocrinus westphalicus* in which the cup has a marked swelling of the basal cavity; the aboral portion of the cup bearing irregularly shaped spines, sometimes clustered, which project aborally from the radials.

TYPES: The cup illustrated by Gale (2019a, pl. 17, fig. 5) is the holotype (NHMUK PI EE 16848). The other figured cups and brachials are paratypes (NHMUK PI EE 16844–16847; 16849–16859). Lower Turonian, *M. nodosoides* Zone, St. Martin Plage, near Dieppe, Seine-Maritime, France.

REMARKS: This forma is characterised by the fine, finger-like processes which are developed on the base of the cup (Text-fig. 7L) and is restricted to, and defines, microcrinoid zone TuR4 in the lower Turonian across the Anglo-Paris Basin (Text-figs 2, 3).

Drepanocrinus westphalicus forma *meadsensis* Gale, 2019a
(Text-fig. 7E–H)

2019a. *Drepanocrinus westphalicus* forma *meadsensis* Gale; Gale, p. 454, pl. 16, figs 7, 8, 11, 12, 15, 16, pl. 18, figs 1–5.
2023a. *Drepanocrinus westphalicus* forma *meadsensis* Gale; Gale, fig. 9M–P.

DIAGNOSIS: Cup is hourglass-shaped, bearing laterally directed prongs at the aboral margin. Proximal brachials IBr2 and IIBr2 very robust, compact, with short, blunt lateral flanges and strong anastomosing vertical ridges.

TYPES: The IBr2 figured in Gale (2019a, pl. 21, fig. 11) from the R2 bed overlying the Lulworth Marl at Holywell Pinnacle is the holotype (NHMUK PI EE 16839). The other illustrated specimens are paratypes (NHMUK PI EE 16833, 16834, 16840, 16842, 16843, 16860–16872).

REMARKS: This form is best characterised by the distinctive, waisted cup, from the base of which oblique, pointed projections extend as extensions of the mid-radial ridges (Text-fig. 7H). The forma is a possible ancestor of the genus *Caveacrinus*, in which large fenestrae are present in the cup (Text-fig. 7D), with which it shares the sharp mid-radial ridges and oblique aboral radial processes. The forma appears in the upper part of the lower Turonian Holywell Nodular Chalk Formation, 2–3 m beneath the Lulworth Marl (Text-figs 2, 3) and extends up into the overlying middle Turonian New Pit Formation, basal microcrinoid zone TuR6. It is abundant in the basal bed of the New Pit Formation, immediately overlying the Lulworth Marl. The forma occurs across southern England and is present at equivalent levels in Seine-Maritime and the Aube, France.

Genus *Striacrinus* gen. nov.

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DIAGNOSIS: Cup and proximal brachials IBr2 and IIBr2 bearing coarse adoral-aboral or oblique striations. IBr2 trapezoidal in outline, distal articular facets for IIBr1 supported by twin buttresses.

TYPE SPECIES: *Drepanocrinus striatulus* Gale, 2019a.

ADDITIONAL INCLUDED SPECIES: *Drepanocrinus marocensis* Gale, 2019a, *Roveacrinus communis* Douglas, 1912, and *Striacrinus ornatus* sp. nov.

REMARKS: It is evident that the species which I included in *Drepanocrinus* in 2019 (Gale 2019a) include two lineages that diverged during the early Turonian (Text-fig. 4). Proximal brachials of some specimens of *Drepanocrinus sessilis* include forms that develop strongly striate, trapezoidal to rectangular IBr2 (e.g., Gale 2019a, pl. 15, fig. 15) with weak buttresses. These are considered probably ancestral to *S. marocensis*.

Striacrinus marocensis (Gale, 2019a)
(Text-fig. 8M–P)

2019a. *Drepanocrinus marocensis* Gale, p. 454, pl. 16, figs 7, 8, 11, 12, 15, 16, pl. 18, figs 1–15.
2020. *Drepanocrinus marocensis* Gale; Gale, p. 302, pl. 10, fig. 11, pl. 18, figs 1–3, 5, 6, 9, 10.

DIAGNOSIS: Cup low, broad, conical, with prominent, strongly striated, robust radial buttresses. IBr1 tall, trapezoidal, bearing a raised, bifid, triangular buttress to the distal facets and striated lateral surfaces.

TYPES: The IBr2 refigured in Text-fig. 8N is the holotype (NHMUK PI EE 16889). Other specimens from Morocco are paratypes (NHMUK PI EE 16876, 16886–16888, 16890, 16892, 16895). All are from the lower Turonian, *Mammites nodosoides* ammonite Zone at Asfla, Morocco.

REMARKS: This species is distinguished particularly by IBr2 which are trapezoidal in outline, taller than broad, and possess a raised triangular complex which support the IIBr1 articulations. This comprises two strongly striated buttresses separated by a deep groove. IIBr2 is triangular and approximately twice as tall as broad, with a raised, striated support for the IIBr3 articulation. This species is present, and locally abundant in the lower Turonian *Mammites nodosoides* Zone of the Anti-Atlas, Morocco (Gale 2019a, 2020). In southern England, it occurs only at a single level in the Holywell Nodular Chalk Formation (Gun Gardens Marl 1) in East Sussex and on the Isle of Wight (Gale 2019a).

Striacrinus striatulus (Gale, 2019a)
(Text-figs 8A–H, 9A–S)

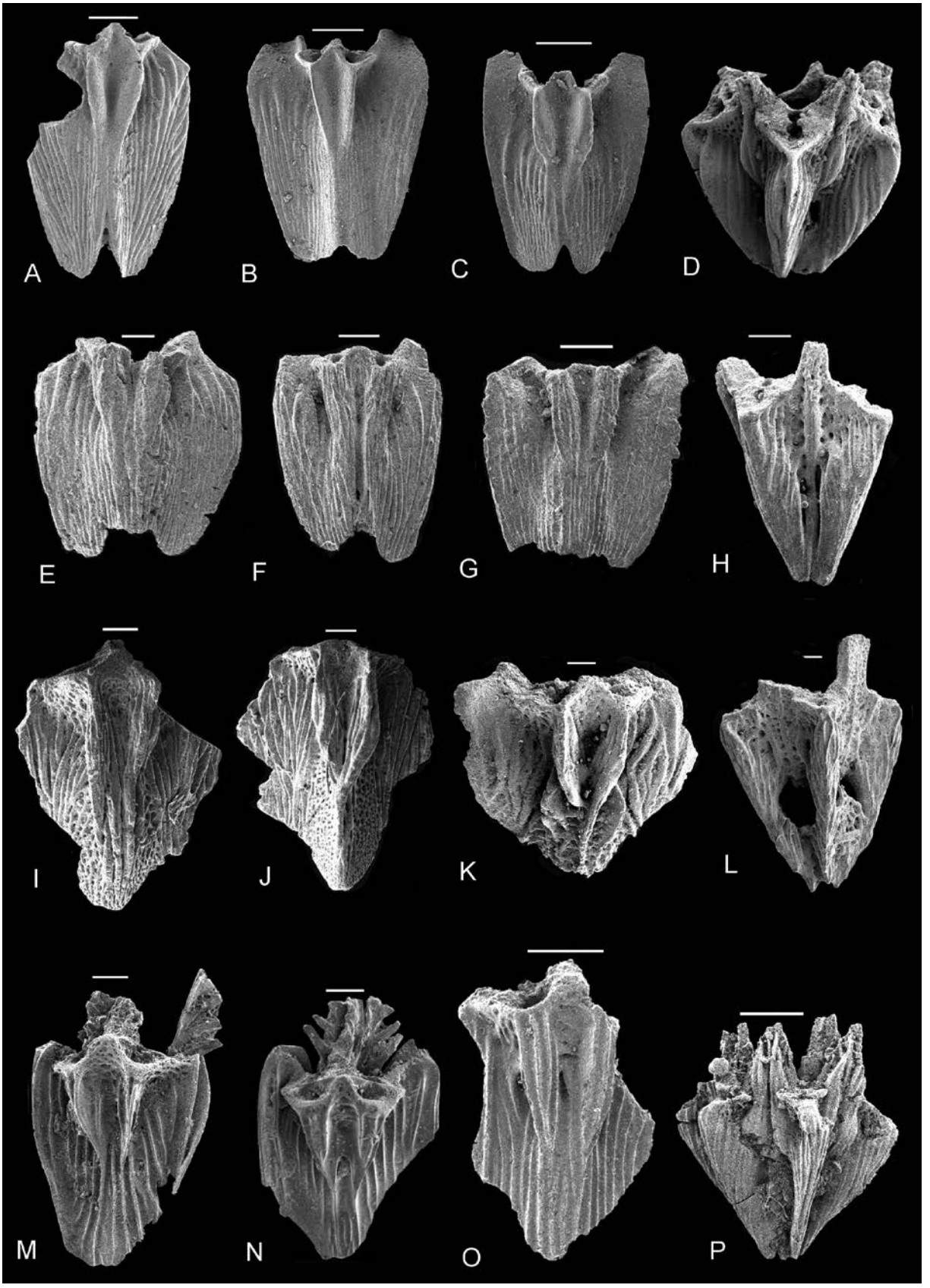
pars 1961. *Roveacrinus communis* Douglas; Wienberg Rasmussen, pl. 53, fig. 6 only.
2019a. *Drepanocrinus striatulus* Gale, p. 456, pl. 21, figs 1, 2, pl. 22, figs 1–10, pl. 23, figs 1–9, pl. 24, figs 1–12.
2020. *Drepanocrinus striatulus* Gale; Gale, p. 303, pl. 16, figs 1–8, 12, 18.
2023a. *Drepanocrinus striatulus* Gale; Gale, fig. 9q–a1.

DIAGNOSIS: Cup finely striated and with tiny external basals that form an interradial grill. The proximal brachials IBr2 are trapezoidal in outline, delicately constructed, bearing numerous fine ridges subparallel to the lateral margins.

TYPE: The IIBr2 figured by Gale (2019a, pl. 21, fig. 7) is the holotype (NHMUK PI EE 16875), which is refigured here (Text-fig. 8C). Immediately beneath the Glynde Marls, East Cliff, Dover, Kent, UK.

REMARKS: This species differs from the older *S. ornatus* sp. nov. in possession of regular, proximal-distal striae on the cup and IBr2. It is a highly variable species which displays considerable diversity of cup morphology and external sculpture of both the cup and the proximal brachials (figs 8, 9). Older IBr2,

Text-fig. 8. Species and formae of *Striacrinus* gen. nov. A–C – *Striacrinus striatulus* (Gale, 2019a), late form, brachials IBr2 in external view; → A – NHMUK PI EE 18193; B – NHMUK PI EE 17698, the original of Gale (2019a, pl. 23, fig. 7); C – NHMUK PI EE 16875, holotype, the original of Gale (2019a, pl. 21, fig. 7). D – *Striacrinus striatulus* forma *conicus* (Gale, 2019a), NHMUK PI EE 16902, holotype cup in lateral view, original of Gale (2019a, pl. 24, fig. 4). E–H – *Striacrinus striatulus* (Gale, 2019a), early form; E–G – NHMUK PI EE 18194–18196, brachials IBr2 in external view; H – NHMUK PI EE 18197, partial cup in lateral view. I–L – *Striacrinus ornatus* gen. et sp. nov.; I–K – brachials IBr2 in external view; I, K – NHMUK PI EE 18199, 18200, paratypes; J – NHMUK PI EE 18198, holotype; L – NHMUK PI EE 18201, paratype partial cup in lateral view. M–P – *Striacrinus marocensis* (Gale, 2019a); M–O – brachials IBr2 in external view; M – NHMUK PI EE 16876, the original of Gale (2019a, pl. 19, fig. 4); N – NHMUK PI EE 16889, holotype, the original of Gale (2019a, pl. 20, fig. 4); O – NHMUK PI EE 16893, the original of Gale (2019a, pl. 20, fig. 8); P – NHMUK PI EE 16886, cup in lateral view, original of Gale (2019a, pl. 20, fig. 1). Provenance: A–D are from New Pit Chalk Formation, level of Glynde Marls, middle Turonian, *Terebratulina lata* Zone, Dover, Kent, UK; E–H are from New Pit Chalk Formation, *Terebratulina lata* Zone, 48 m on log of Gale (2019a, fig. 10), Holywell Pinnacle, Eastbourne, East Sussex, UK; I, J are from the middle Turonian, Pougy, Aube, France, base of section on log of Gale (2023, fig. 5); K, L are from New Pit Chalk Formation, middle Turonian, *Terebratulina lata* Zone, 8 m on Text-fig. 3, East Woodhay, Hampshire, UK; M, N, P are from the lower Turonian, *Mammites nodosoides* Zone, Asfla, Goulemima, Morocco; O is from Holywell Nodular Chalk Formation, Gun Gardens Marl 1, lower Turonian, Holywell, Eastbourne, East Sussex. Scale bars equal 0.5 mm.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from TuR7A, B possess elongated, strongly striated buttresses on IBr2 (Text-fig. 8E–G), whereas those from higher levels (Text-fig. 8A–C) have shorter buttresses which are smooth. Distinctive forms of cups were named by Gale (2019a), and some of these have stratigraphical significance. The total range of *S. striatulus* is from 7–8 m beneath the Round Down Marl to the Caburn Marl (Gale 2019a, fig. 17), a total of approximately 40 m in expanded successions.

Striacrinus striatulus forma *cuspidatus* (Gale, 2019a)
(Text-fig. 9C–H)

2019a. *Drepanocrinus striatulus* forma *cuspidatus* Gale, p. 458, pl. 22, figs 1–10.
2023a. *Drepanocrinus striatulus* forma *cuspidatus* Gale; Gale, p. 10, fig. 9q–u.

DIAGNOSIS: Aboral part of the cup drawn out into a long, slowly tapering spike, constructed of the fused aboral part of the radials.

TYPES: The cup illustrated by Gale (2019a, pl. 22, fig. 1) is the holotype (NHMUK PI EE 16880), from sample LSP5, *Terebratulina lata* Zone, level of Glynde Marls, East Cliff path, Dover, UK.

REMARKS: The forma *cuspidatus* typically occurs between the Round Down Marl and New Pit Marl 1 in the middle Turonian (Gale 2023a, figs 2–5) in both southern England and northern France. It was used by Gale (2019a, b, 2023) as the index species of TuR8. However, new collecting in the Aube and southern England demonstrates that it does occur locally at lower levels (e.g., Text-fig. 2, column 9, Text-fig. 3) and is therefore replaced as an index for TuR8 by *Dentatocrinus dentatus* forma *conicus* nov. Forma *cuspidatus* disappears at the level of New Pit Marl 1 across the Anglo-Paris Basin (Gale 2023a).

Striacrinus striatulus forma *pentapodus* (Gale, 2019a)
(Text-fig. 9I–O)

2019a. *Drepanocrinus striatulus* forma *pentapodus* Gale, p. 258, pl. 23, figs 1–3, 5, 6, 9.
2023a. *Drepanocrinus striatulus* forma *pentapodus* Gale; Gale, p. 10, fig. 9v–y.

DIAGNOSIS: Cup with flattened, laterally divergent, elongated processes extending from the aboral part of the radials and set at 40–50º from the axis of the cup.

TYPES: The cup figured in Gale (2019a, pl. 23, fig. 1) is the holotype, from the Lydden Spout Path, Dover, sample LSP3, middle Turonian, *Terebratulina lata* Zone (NHMUK PI EE 16890). The other figured specimens are paratypes, from the same locality and horizon (NHMUK PI EE 16891, 16892, 16895).

REMARKS: This forma first appears between New Pit Marls 1 and 2 and extends up to a level above the Glynde Marls (Gale 2019a, figs 6, 17).

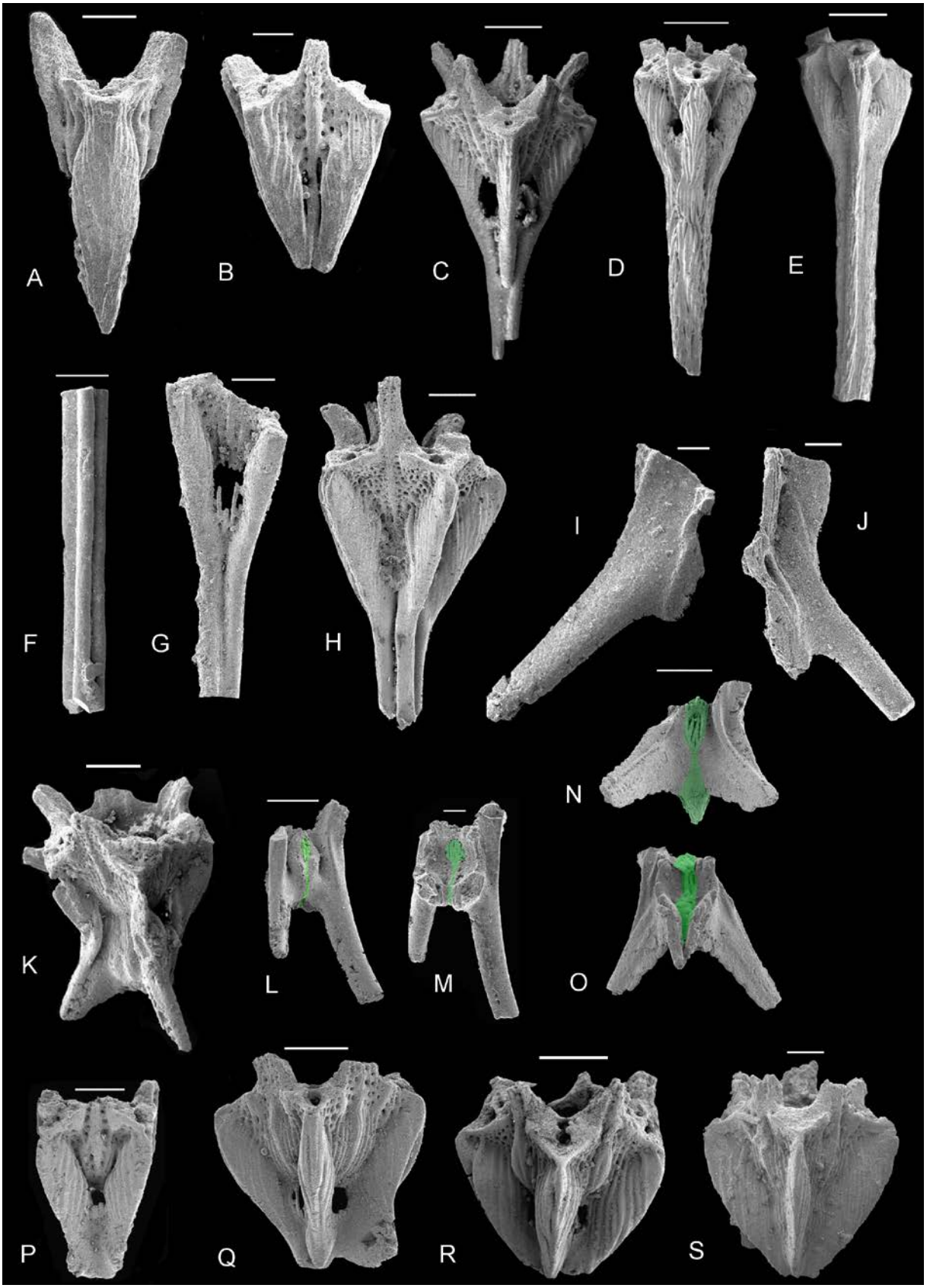
Striacrinus striatulus forma *conicus* (Gale, 2019a)
(Text-fig. 9P–S)

2019a. *Drepanocrinus striatulus* forma *conicus* Gale, p. 460, pl. 24, figs 1–5, 7.
2023a. *Drepanocrinus striatulus* forma *conicus* Gale; Gale, p. 10, fig. 9z.

DIAGNOSIS: Cup low and conical, lacking aboral radial extensions.

TYPES: The well-preserved cup from East Cliff Path, Dover sample EC1 is the holotype (NHMUK PI EE 16902). Paratypes are from the same horizon

Text-fig. 9. Species and formae of *Striacrinus* gen. nov. A, B – *Striacrinus striatulus* (Gale, 2019a), NHMUK PI EE 18191, 18192, radial and → paired radials of early form in lateral view. C–H – *Striacrinus striatulus* forma *cuspidatus* (Gale, 2019a); C, D, E, H – cups in lateral view; C – NHMUK PI EE 16881, the original of Gale (2019a, pl. 22, fig. 2); D – NHMUK PI EE 16885, the original of Gale (2019a, pl. 22, fig. 6); E – NHMUK PI EE 18202, cup with elongated aboral process; H – NHMUK PI EE 16881; cup in lateral view, original of Gale (2019a, pl. 22 fig. 2). F, G – NHMUK PI EE 16882, 16884; aboral portions of cups in lateral view, the originals of Gale (2019a, pl. 22, figs 3, 5). I–O – *Striacrinus striatulus* forma *pentapodus* (Gale, 2019a); I, J – NHMUK PI EE 16891, 16892, isolated radials in lateral view, originals of Gale (2019a, pl. 23, figs 2, 3); N, O – NHMUK PI EE 16895, external (N) and internal (O) views of paired radials, original of Gale (2019a, pl. 23, figs 6a, b); K – NHMUK PI EE 16890, holotype cup in lateral view, original of Gale (2019a, pl. 23, fig. 1). L, M – NHMUK PI EE 16891, paired radials, in external (L) and internal (M) views, original of Gale (2019a, pl. 23, figs 5a, b). P–S – *Striacrinus striatulus* forma *conicus* (Gale, 2019a), NHMUK PI EE 16900, 16902, 16903, 16909, cups in lateral view, originals of Gale (2019a, pl. 24, figs 2, 4, 5, 11). Provenance: A, B are from the New Pit Chalk Formation, *Terebratulina lata* Zone, 48 m on log of Gale (2019a, fig. 10), Holywell Pinnacle, Eastbourne, East Sussex, UK; C, F–H are from the New Pit Formation, middle Turonian *Terebratulina lata* Zone, level of Round Down Marl, Lydden, near Dover, Kent, UK; D is from the middle Turonian, level of Round Down Marl, St Martin Plage, near Dieppe, Seine-Maritime, France; E is from 2 m above Round Down Marl, New Pit Chalk Formation, *Terebratulina lata* Zone, East Woodhay, Hampshire, UK; K–S are from the New Pit Formation, middle Turonian *Terebratulina lata* Zone, between New Pit and Glynde Marls, Lydden, near Dover, Kent, UK. Scale bars equal 0.2 mm (A, B) and 0.5 mm (C–S).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and locality (NHMUK PI EE 16900, 16901, 16903), middle Turonian, beneath the Glynde Marl 1.

REMARKS: This forma typically occurs beneath the Glynde Marls (Gale 2019a, fig. 17; Gale 2023a, fig. 2).

Striacrinus ornatus sp. nov.
(Text-fig. 8I–L)

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DIAGNOSIS: Cup and brachials characterised by complex sculpture of irregularly anastomosing ribs and densely reticulate areas developed on the interradial regions of the cup and the proximal parts of IBr2.

TYPES: The primibrachial IBr2 illustrated in Text-fig. 8J (NHMUK PI EE 18198) is the holotype. It and a paratype (Text-fig. 8I; NHMUK PI EE 18199) are from the middle Turonian, Pougy, Aube, France. The other illustrated specimens (Text-fig. 8K, L) from the New Pit Chalk of East Woodhay, Hampshire (8 m level on Text-fig. 3), are paratypes (NHMUK PI EE 18200, 18201).

MATERIAL: 15 isolated brachials and one cup from the New Pit Chalk Formation, middle Turonian, *Terebratulina lata* Zone, 8 m level on Text-fig. 3, East Woodhay, Hampshire, UK, and from the equivalent level in the middle Turonian, Pougy, Aube, France.

DESCRIPTION: Cup (Text-fig. 8L) low, conical, with narrow radial buttresses and moderately tall interradial processes; aboral pole bears very short radial processes. Interradial cavities low on cup were probably originally covered by grills of coarse stereom, not preserved. Adoral to these are regions of coarse trabeculae arranged in a grid pattern. Interradial butressess bear irregular, anastomosing adoral-aboral ridges. IBr2 (Text-fig. 8I–K) triangular, with robust buttresses aboral to the distal facets for IIBr1 which bear irregular, anastomosing striae. Similar striae are present on the lateral surface of IBr2. The proximal region of the plate has a central ridge and is composed of dense, reticulate stereom.

REMARKS: This species of *Striacrinus* gen. nov. species differs from all its congeners in the complex, anastomosing sculpture on the cup and the IBr2. It occurs in the lower part of the middle Turonian, in the basal part of microcrinoid zone TuR6 in the New Pit Chalk Formation, Middle Turonian, *Terebratulina lata* Zone, 8 m level on Text-fig. 3, East Woodhay, Hampshire, UK, and at the equivalent level in the middle Turonian, Pougy, Aube, France (Text-fig. 2, marked as A in column 9).

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