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A new ophiuroid from the Maastrichtian type area (Late Cretaceous, SE Netherlands, NE Belgium)

by John W.M. JAGT

Abstract

From the Kunrade limestone facies and from the Emael, Nekum and Meerssen Members of the Maastricht Formation (late Maastrichtian) in the type area of the Maastrichtian Stage, a new genus and species of ophiuroid, *Felderophiura vanderhami* n. gen., n. sp., is described and illustrated. In addition to numerous disarticulated ossicles of disc and arms some twenty more or less complete specimens and several dozens of arm fragments are available for study; occurrences like these have recently proved to be comparatively common in the Maastrichtian type area. A brief discussion of ophiuroid remains collected from Campanian and Maastrichtian strata in this area is added.

Key-words: Echinodermata, Ophiuroidea, SE Netherlands, NE Belgium, Maastrichtian, new taxa.

Résumé

Felderophiura vanderhami n. gen., n. sp. (Ophiuroidea) est décrite et figurée sur base de spécimens provenant du Calcaire de Kunrade et des Membres d'Emael, de Nekum et de Meerssen de la Formation de Maastricht (Maastrichtien supérieur), dans la région-type de l'Etage Maastrichtien. En plus des nombreux ossicules (désarticulés) de disque et de bras, cette étude se base sur une vingtaine d'exemplaires plus ou moins complets et sur plusieurs douzaines de fragments de bras. De telles occurrences se sont révélées récemment assez communes dans la région-type du Maastrichtien. Les restes d'Ophiures récoltés dans les couches campaniennes et maastrichtiennes dans cette région sont brièvement discutés.

Mots-clefs: Echinodermata, Ophiuroidea, SE Pays-Bas – NE Belgique, Maastrichtien, taxa nouveaux.

Introduction

Amongst the echinoderm faunas from Campanian and Maastrichtian deposits in the Maastrichtian type area (SE Netherlands, NE Belgium; Figure 1), ophiuroids have virtually been neglected, despite the fact that disarticulated ossicles abound in many lithostratigraphical units and that an unexpectedly large number of species can be recognised.

The earliest record of ophiuroids from the area is that by J. MÜLLER (1847-1859), who described (pp. 5-6, pl. 1, figs. 3a-f) a new species from the early Campanian Vaals Formation at Vaals (southern Limburg) under the name *Ophiura Fürstenbergii*. This species is in need of revision; it certainly cannot be referred to the contemporary genus *Ophiura* LAMARCK, 1801 (= *Ophioglypha* LYMAN, 1860). Recently collected material from Vaals-Eschberg (see VAN BIRGELEN, 1989) will be described in detail in the near future.

BOSQUET (*in* STARING, 1860; *in* DEWALQUE, 1868) listed *Palaeocoma Furstenbergi* Müll. sp. (*Palaeocoma Furstenbergi*, d'Orb., 1847 [*Ophiura Furstenbergi*, Mull., 1847]) for the Hervien and Maestrichtien, units which, in modern terminology, correspond to the Vaals Formation and Maastricht Formation, respectively. UBAGHS (1879, p. 87, see also p. 229) recorded an ophiuroid species referred to as *Palaeocoma Furstenbergi*, Muller spec., from the "Partie supérieure du tuffeau de Maastricht". It is quite possible that this record refers to the new species described herein. From the "craie blanche" (= late Campanian, Zeven Wegen Member, Gulpen Formation) of Heure-le-Romain (Liège, NE Belgium), UBAGHS (1879, p. 129) recorded *Palaeocoma* sp. of which he stated literally:

"C'est un bras entièrement orné de petits tubercules et dont les articulations sont au moins quatre fois plus grandes que celles de l'espèce indiquée dans le Hervien, sables verts de Vaals, par Jos. Müller, l'*Ouphiura* [*sic*] *Furstenbergi*."

This appears to be either *Ophiomusium* gr. *granulosum* (ROEMER, 1840, p. 28, pl. 6, fig. 22) (= *Ophiura pustulosa* J. MÜLLER, 1847, p. 6, *nom. nov. pro Ophiura granulosa* VON HAGENOW, 1840 [p. 660, pl. 9, fig. 6] *non* ROEMER, 1840) or *Ophiura ? hagenowi* RASMUSSEN, 1950 (p. 114, pl. 17, figs. 1-5). Both species are now known to occur in the late Campanian Zeven Wegen Member (Gulpen Formation) as exposed at Heure-le-Romain, Haccourt (CPL quarry) and Lixhe (CBR-North quarry) (Figure 1).

UBAGHS (1887, p. 221) recorded *Palaeocoma Furstenbergi*, d'Orb. from the "Maestrichtien inférieur", which would correspond to the lower Maastricht Formation. The species meant here is probably *Ophiomusium* gr. *subcylindricum* (VON HAGENOW, 1840), of which copious material has recently

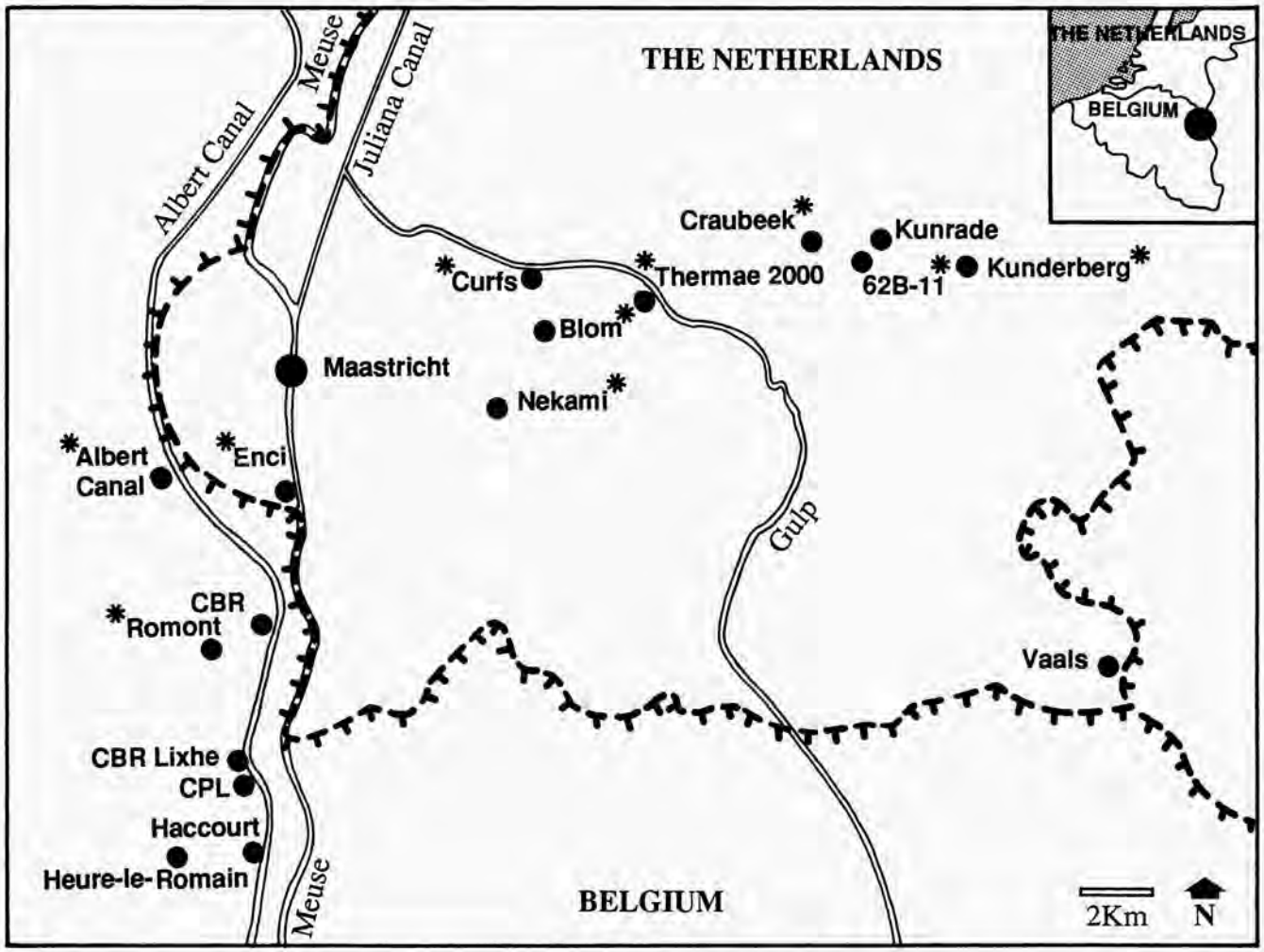


Fig. 1 – Map of the Maastrichtian type area with localities mentioned in the text; those that have yielded the material of *Felderophiura vanderhami* n. gen., n. sp., described herein, are marked with an asterisk.

been collected from Upper Campanian and Upper Maastrichtian deposits in the area.

KLINGHARDT (1930, 1933) provided good illustrations of MÜLLER's (1847) species, which he referred to as *Ophiolepis (Ophiura) fürstenbergii* Josef Müller, 1843 [*sic*], using MÜLLER's original material and a few additional specimens. He was interested mainly in the coiling mode of the arms, and remarked that the species' ability to coil the arms over the disc implied that it had streptospondyline (streptospondylous) vertebrae. As mentioned above, this species will shortly be revised and earlier descriptions amended. Assignment to the ophiodermatid *Palaeocoma* D'ORBIGNY, 1850 (of early and middle Jurassic age; see HESS, 1960b, 1962b, 1964, 1975) is open to criticism. BERRY (1938, p. 65) remarked that this species might be congeneric with the species described by him under the name *Asteronyx valkenburgensis*.

BERRY (1938) was the first to describe in admirable detail disarticulated ophiuroid ossicles from the Maastricht Formation (Nekum and Meerssen Members), but he was subsequently rightly criticised by RASMUSSEN (1950, 1952) for his methods. BERRY attempted to establish associations amongst the various disarticulated disc and arm ossicles on a purely hypothetical basis, concentrating mainly on their relative abundances. In this way, four new species and two new genera were established; generic assignments were based on the vertebrae. As will be pointed out below, BERRY's species are best treated as *nomina dubia*, since subsequent studies have shown that ossicles BERRY assumed to have belonged to a single species in fact represent two or more taxa. His new genera, *Platyarthra* (type species *P. jekerica*) and *Dolicharthra* (type species *D. bemelenica*), were listed under "Generic names of indeterminate or unrecognizable status applied to fossil Ophiuroidea" by SPENCER & WRIGHT (1966, pp. U102, 103), who noted that *Dolicharthra* was, "based on isolated ossicles of several genera, including vertebrae that may belong to *Ophiomusium*", and that *Platyarthra* was, "based on ossicles of several genera, including lateral arm plates perhaps belonging to *Ophiomusium*".

A.H. MÜLLER (1950) also erected new genera on the basis of isolated vertebrae, viz. *Schizospondylus* (type species *S. jasmundiana*), *Transspondylus* (type species *T. bubnoffi*) and *Ophiaxina* (type species *O. intercarinata*): these names were considered dubious by SPENCER &

WRIGHT (1966, p. U103), who, however, were wrong in considering their stratigraphic age to be Campanian. An early Maastrichtian age has now been firmly established. RASMUSSEN (1952) pointed out the errors in A.H. MÜLLER's paper and treated a number of his taxa as indeterminate.

In spite of the difficulties in identifying dissociated ophiuroid ossicles, it is very unfortunate that these are virtually neglected by most private collectors (see CUPEDO, 1980). More or less complete specimens therefore deserve the closest possible attention, particularly so as these allow dissociated ossicles to be identified at the species level. Because of an intensive, time-consuming collecting and processing of large sediment samples carried out by a number of amateur palaeontologists during recent years, a considerable amount of interesting material (in part new to science) is now available. The taphonomy of such occurrences will be analysed in detail and discussed in another paper. First of all, a taxonomic framework is needed. The reader is referred to JAGT (in prep.) for more details.

Systematic description

Order Ophiurida MÜLLER & TROSCHEL, 1840
Suborder Chilophiurina MATSUMOTO, 1915
Family Ophiuridae LYMAN, 1865
Subfamily Ophiurinae LYMAN, 1865 (= Ophiomastinae MATSUMOTO, 1915)

Genus ***Felderophiura*** n. gen.

TYPE SPECIES
Felderophiura vanderhami n. sp., late Maastrichtian, SE Netherlands and NE Belgium, by monotypy.

DERIVATIO NOMINIS
Combination of Felder-, after P.J. and W.M. FELDER, in recognition of their outstanding contributions to the stratigraphy of late Cretaceous strata in the Maastrichtian type area, and *Ophiura*, a genus of ophiuroid.

DIAGNOSIS
Disc low, flat, adorally covered with distinct centrale, primary circlet and additional smaller plates. Interbrachial area covered by two large and a few smaller plates or by a number of plates of various sizes, and a single large marginal plate. Radial shields comparatively large, triangular, only partially visible in external view, separated above arm base by two wedge-shaped plates with minute papillae. Small triangular dorsal arm plate between these two wedge-shaped plates. Arms widest at base, tapering gradually, with well-developed lateral, dorsal and ventral plates. Lateral arm plates not touching, neither ventrally nor dorsally. Tentacle pores over entire arm length, with one large or, proximally, two smaller scales. Second oral tentacle pore opening outside oral slit. Arm spines short, small, few in number (3 [?4]), appressed. Genital slit not very distinct. No genital papillae. Radial genital plate bar-like, genital scale sickle-shaped, wide at its outer end and in contact with the wedge-shaped plates between the radial shields, distinct arm comb, but apparently no comb papillae. A single apical papilla at end of each jaw. Two, possibly three, thick oral papillae on either side of oral plate. Teeth stout. Vertebrae zygophiuroid.

DISCUSSION
This new genus is readily distinguished from other late Cretaceous and Palaeogene ophiuroids known to date by its disc plating and the radial shields in particular. It appears to be closely related to *Ophiura* LAMARCK, 1801 (type species *Asterias ophiura* LINNÉ, 1758, = *Ophioglypha* LYMAN, 1860, *Ophioglyphina* LUDWIG, 1886, *Ophiozea* A.H. CLARK, 1920) from which is differs in having fewer tentacle scales and oral papillae. In addition, the peculiar shape of the radial shields and of the wedge-shaped ossicles separating them over each arm base is quite unique and typifies this new genus.

Many little-known Mesozoic ophiuroids have been referred to *Ophiura* (SPENCER & WRIGHT, 1966, p. U95), which is unfortunate but at the same time inescapable, since generally only dissociated ossicles, or arm fragments at best, are known in the fossil record. When more or less complete specimens (discs, preferably with arms attached) are available, it is advisable to make an effort to include fossil species in contemporary ophiuroid systematics, however imperfect this classification may at present be. *Felderophiura* n. gen. is based on a suite of well-preserved specimens from various localities and lithostratigraphic units and the main feature differentiating it from other ophiuroid genera is readily recognised even in disarticulated disc ossicles and precludes confusion with other species.

The only genus to show a superficial resemblance is *Ophiocrossota* H.L. CLARK, 1928 (p. 452, monotypic genus, type species *Ophioglypha multispina* LJUNGMAN, 1867 = *Ophiocrossota heteracantha* H.L. CLARK, 1928), which FELL (1960, p. 30) characterised as follows:

"Radial shields contiguous proximally, but separated distally by a conspicuous triangular plate wedged into the disc-margin: the three sides of this plate carry minute papillae: oral shield elongate, occupying most of the interbrachium below: arms flattened, broad at base".

This genus includes a single littoral southern Australian Recent species (see H.L. CLARK, 1915, pl. 19, figs. 1, 2, as *Ophiura multispina* (LJUNGMAN, 1867); BLAKE & ALLISON, 1970, fig. 1). BLAKE (1975) and BLAKE & ALLISON (1970) described two West American fossil species of *Ophiocrossota*, of middle Miocene and late Eocene age, respectively. This genus differs from *Felderophiura* in that:

- there is but a single [= undivided] wedge-shaped plate separating the radial shields distally only (plate termed triangular radial ossicle by BLAKE, 1975, fig. 1),
- it has a less complex mouth frame,

- arms taper rapidly, and show very large tentacle pores,
- oral shields are more massive and cover most of the oral interbrachial areas,
- ossicles are granular,
- ventral arm plates differ markedly in outline and successive plates are not in contact.

Ophiotitanos SPENCER, 1907 (p. 104, type species *Ophiotitanos tenuis* SPENCER, 1907 [Ophiolepidinae]) has heavily granulate disc plates except for the radial shields, five short arm spines, and lacks comb plates, features which readily differentiate this late Cretaceous (Cenomanian) genus from *Felderophiura* (see also redescription by HESS, 1960a).

OCCURRENCE - At present, *Felderophiura* is known only from deposits of late Maastrichtian age in the Dutch province of Limburg and the Belgian provinces of Limburg and Liège: Emael, Nekum and Meerssen Members of the Maastricht Formation (*sensu* W.M. FELDER, 1975). The material from the Kunrade limestone facies was collected mainly from an exposure (62B-11) close to the former Schunck quarry at Kunrade, which was placed in ecozone V (upper part of Kunrade facies, late Maastrichtian) and correlated with HOFKER's (1966) benthic foraminifer zone H of the ENCI quarry (= Mb of UHLENBROEK [1912], Gronsveld, Schiepersberg and Emael Members of Maastricht Formation) by P.J. FELDER & BLESS (1989). The so-called *oesterlaag van Craubeek* was correlated on lithological grounds with the Romontbos Horizon (= base of Emael Member) by W.M. FELDER *et al.* (1978a). The top of the Kunrade limestone in its type area was considered coeval with the same horizon, a conclusion subsequently substantiated by BLESS *et al.* (1986). Careful analysis of various exposures in the Ubachsberg-Kunrade area (P.J. FELDER & BLESS, 1989) has recently shown that the Craubeek locality is not correlatable with the Kunderberg section (exposure 62B-9), but is to be considered stratigraphically older, and is therefore best compared with the Schiepersberg Member at the Maastrichtian type locality (ENCI quarry, Maastricht). P.J. FELDER (oral communication, January 1991) assumes exposure 62B-11, southwest of Schunck, to be somewhat higher than the top of the Kunrade limestone at the Kunderberg, which would imply a correlation with the basal Emael Member of the Maastricht Formation. The geographical and stratigraphical distribution of the new species can only be determined exactly through an analysis of the large suites of samples that have been taken previously for ecostratigraphical purposes. Fortunately, the species is readily recognised by its lateral arm plates, and, even more easily, by its radial shields (see e.g. P.J. FELDER, 1981, figs. 86, 91). CUPEDO (1970) provided detailed descriptions of the sections exposed at the Schunck (Kunrade) and Craubeek (Klimmen) quarries and noted that BERRY's ophiuroid "species" were suspicious and should be treated accordingly. Relative numbers of the various arm and disc ossicles varied enormously from one exposure to the other, which again suggests that BERRY's method should be discarded.

Felderophiura vanderhami n. sp.
(Pl. 1; Text-figs. 2, 3)

?1879 *Palaeocoma Furstenbergi*, Muller spec. – UBAGHS, p. 87.
1938 *Ophiura kunradeca* C. Berry, n. sp. – BERRY, p. 66 (pars), pl. 14, figs. 10, 13, 18-21 only.
1938 *Platyarthra jekerica* C. Berry, n. sp. – BERRY, p. 68 (pars), pl. 15, figs. 6, 8, 11, 12 only.

TYPES
The specimen illustrated in Plate 1, Fig. 3 and in Text-figures 2 and 3a-d, k-s is designated holotype (collections of the Institut royal des Sciences naturelles de Belgique at Brussels, catalogue number IST 10507; leg. R.W.J.M. van der Ham); paratype material includes a disc with proximal portions of arms from the Nekum Member (Maastricht Formation) of the CBR-Romontbos quarry (Eben Emael-Bassenge, Liège, NE Belgium) (IST 10508; leg. J.W.M. Jagt), several discs with proximal portions of arms (van Birgelen Collection) from the Kunrade limestone facies of the Maastricht Formation at Kunrade (exposure 62B-11) and the disarticulated ossicles illustrated in Text-figures 3e-j (IST 10509-10510; leg. J.W.M. Jagt). Additional material is listed under the heading *Material studied*.

DERIVATIO NOMINIS
The species is dedicated to Dr Raymond W.J.M. van der Ham, who collected the type specimen and prepared camera lucida drawings of type material.

LOCUS TYPICUS AND STRATUM TYPICUM
Blom quarry (exposure 62A-19; file number Geological Survey Heerlen) (see W.M. FELDER *et al.*, 1978b, pp. 81-84), Berg en Terblijt, municipality of Valkenburg aan de Geul, southern Limburg, The Netherlands. Maastricht Formation, Meerssen Member, base of section IVf-3 (correlatable with IVf-1 in the ENCI NV quarry, see VAN DEN ELSEN, 1985, fig. 3). Late Maastrichtian, equivalents of the *argentea/junior* Zone of the north German biozonation (SCHULZ *et al.*, 1984; SCHULZ & SCHMID, 1983).

MATERIAL STUDIED
In addition to the material listed above (Types) a considerable number of discs (with or without arm fragments) as well as numerous (several thousands) of disarticulated ossicles, mainly lateral arm plates and radial plates, have been studied. The material collected from the middle/upper Nekum Member in the CBR-Romontbos quarry stems from an echinoderm breccia which yielded numerous comatulid crinoids (JAGT, 1990a) and is now housed in private collections (M.J. van Birgelen, J.W.M. Jagt). Material from the upper Meerssen Member at the ENCI NV quarry (a few discs with arm portions and

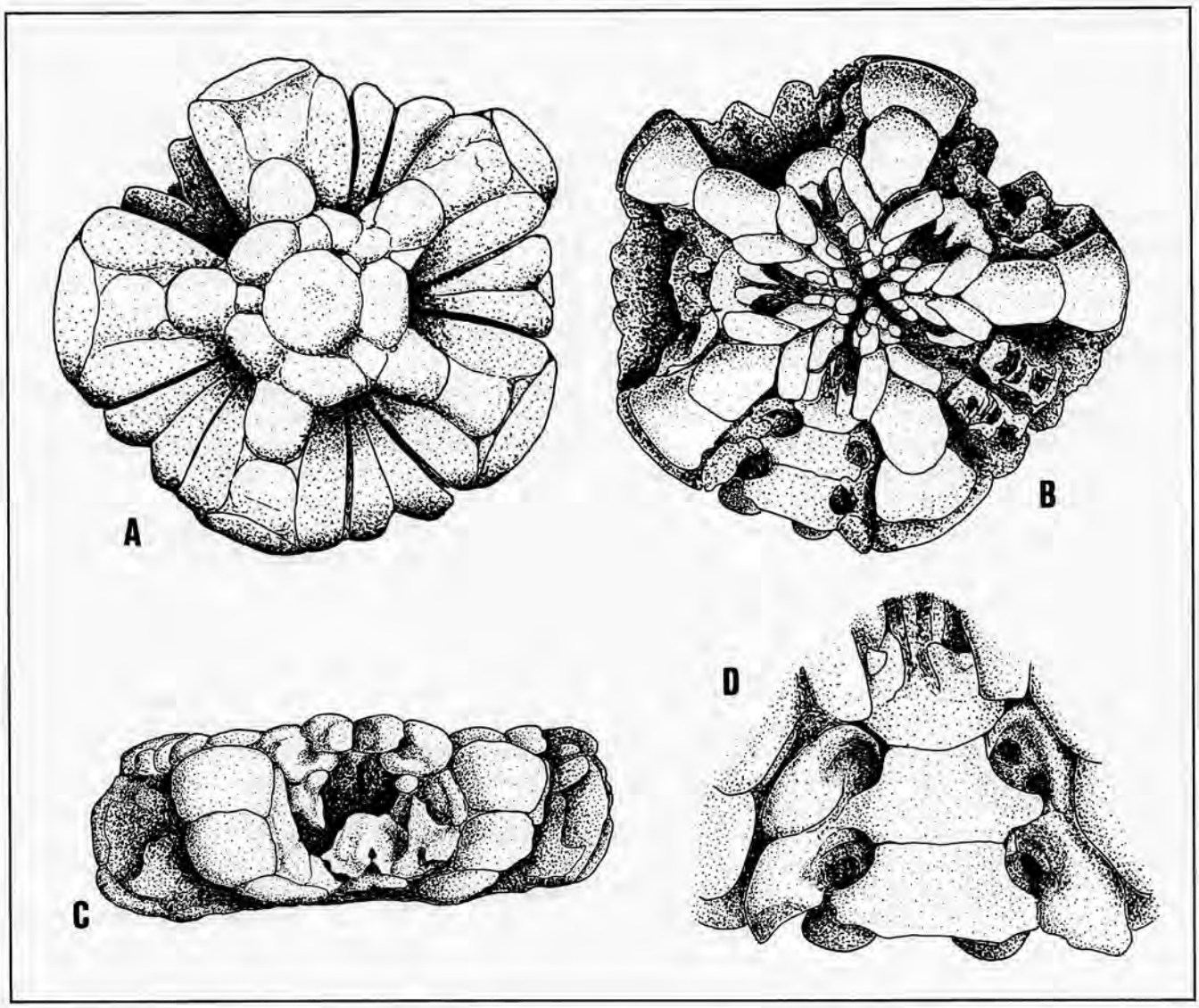
numerous disarticulated ossicles) is in the G. Michels, R.W. Dortangs, Jagt and van Birgelen Collections. The van Birgelen Collection also includes specimens from Blom quarry (Meerssen Member) and isolated ossicles from Craubeek-Klimmen (Zevensprong quarry, exposure 62B-61). In the Jagt Collection are isolated ossicles from the uppermost Meerssen Member (*c.* 0.5 m below the Cretaceous-Tertiary [K-T] boundary) as exposed at the Albert Canal, Vroenhoven-Riemst, and from the Meerssen Member (lower and middle part) of the Nekami-Ankersmit and Curfs-Ankersmit quarries. Material from the Thermae 2000 boreholes at Valkenburg aan de Geul is housed in the collections of the Natuurhistorisch Museum at Maastricht. See Figure 1 for localities.

DIAGNOSIS

As for genus (monotypy).

DESCRIPTION

Disc low and flat, pentagonal with nearly straight margins to round with slightly convex interradial margins. Disc diameter of presumedly adult specimens varying between 6 and 8 mm; disarticulated radial shields indicate a maximum disc diameter of *c.* 10 mm. Arms reaching lengths that are at least 3 times the diameter of the disc. Width of arms near disc between 1.8 and 2.2 mm, being widest just within the disc. Adoral surface of disc covered with smooth plates and scales, amongst which a distinct central plate and a primary circlet. Central plate



Figs. 2a-d – *Felderophiura vanderhami* n. gen., n. sp. Holotype, disc (compare Pl. 1, Fig. 3), a – adoral view (x12), b – oral view (x12), c – lateral view showing first vertebra, genital bars and genital scales, interradial marginal plates and wedge-shaped triangular ossicles (x12), d – enlarged view of arm base showing first dorsal and lateral arm plates, as well as tentacle pores (x24). Blom quarry, Berg en Terblijt (Valkenburg aan de Geul, Limburg, The Netherlands), Maastricht Formation, Meerssen Member, base of unit IVf-3 (late Maastrichtian). Collections IRScNB, IST 10507. R. van der Ham leg./del.

comparatively large and conspicuous in some specimens, especially the smaller ones (*e.g.* Pl. 1, Fig. 3; Text-fig. 2a), outline circular; in other specimens, there is a ring of small scales or plates either of similar size as or larger than the central plate, their outline being near-circular to squarish with rounded angles.

Second series surrounding the central plate, consisting of plates that vary considerably in outline and size, the smallest amongst them intercalated between the larger ones. Third series in interradial position, consisting of tongue-shaped plates, rounded distally and partially covered proximally by plates of the second series, and as large as or slightly larger than these. Interbrachial area covered by a single large plate (of roughly the same size as the second and third series plates) and some inconspicuous smaller plates and a single, large convex marginal plate. In some specimens there are additional imbricating scales of various sizes; in these the third series cannot be recognised. The plates of the second series and those that cover the interbrachial areas conceal part of the radial shields. Radial shields are large, reaching half the diameter of the disc in length, only partially visible (Pl. 1; Text-fig. 2a), distinctly longer than wide, rounded distally and more or less pointed proximally; overall aspect rounded-triangular. Outer surface gently arched, interradial margin bevelled and much thinner than the rest of the plate (Text-figs. 3h-j). Shields in contact over half to two-thirds of their length, but separated on the outside over most of their length by triangular wedge-shaped plates (Text-figs. 2a, c, 3a-d). To accommodate these plates there are distinct grooves over two-thirds of the inside margins of the radial shields. The notch (Text-figs. 2, 3h) seen when two radial shields are in contact is partially filled by the slightly thickened distal end of these triangular plates (Text-figs. 3a-d). Inner surface of radial shields concave with a distinctly raised area proximally consisting of two rounded projections separated by a depression, with which the genital bar articulates (Text-fig. 2c). There is a small circular pit below these condyles.

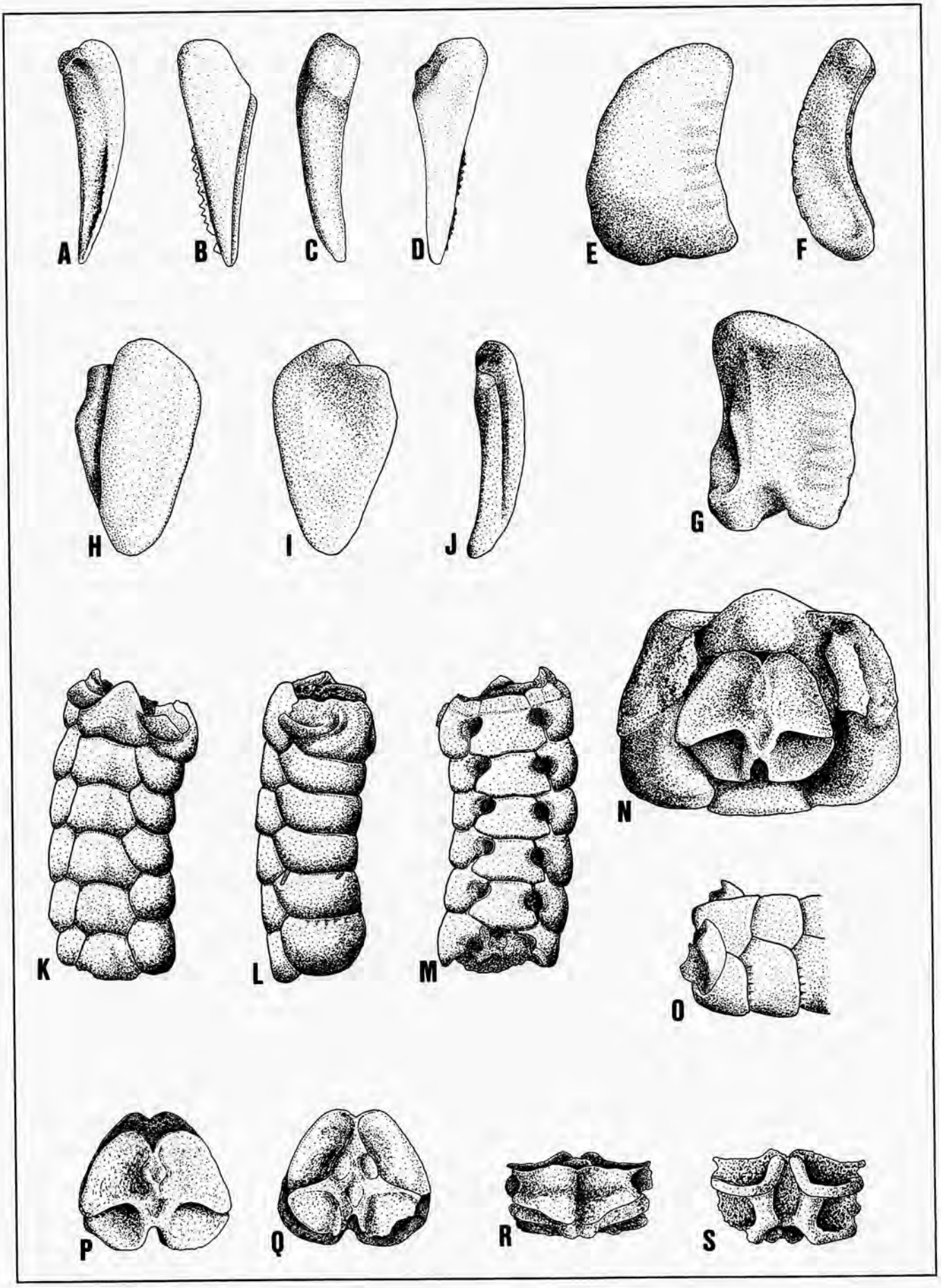
The triangular wedge-shaped plates between the radial shields are comparatively massive, gently arched and with a thickened rounded distal end and a pointed proximal end. The inner surface shows a raised area proximally (Text-figs. 3a, d) which fits tightly in the notch between the radial shields (Text-fig. 2c). The outer margin of this plate shows minute papillae (Text-figs. 3b, d), as do the ridges bordering the grooves of the radial shields (Text-fig. 2a). These triangular plates are partially covered by the plates of the other series (Text-fig. 2a; Pl. 1). In the notch between the triangular plates there is the first, small, triangular, dorsal arm plate (Text-fig. 2a). The disc margin is covered by two large squarish plates with rounded angles, the upper one of which is larger and visible from above (Text-figs. 2a-c). Orally, the interbrachial area is covered by a single large plate, with a convex distal margin, slightly smaller than the upper marginal plate and proximally partially covered by the oral shield, which is narrowly rounded distally, longer than wide with straight or weakly concave lateral margins and a pointed proximal end, the proximal margins being concave.

Genital slit not very distinct, no genital papillae seen. Genital bar long, with club-shaped distal end (Text-fig. 2c), genital scale sickle-shaped (Text-fig. 2c); wide at its outer end (a distinct comb plate) and in contact with the wedge-shaped plates that separate the radial shields (Pl. 1). There apparently were no comb papillae. Adoral ossicles longer than wide, broadly in contact and rectangular. Oral ossicles (jaws) similar in outline to adoral ossicles, but smaller, with more or less rounded margins, broadly in contact. Two (in larger specimens, possibly three) oral papillae of similar size, pointed, thick. A single apical papilla at the end of each jaw, squarish or more or less diamond-shaped, and slightly smaller than the teeth. Scales of second tentacle pore (which opens outside the oral slit) three or four in number pointed and as large as the oral papillae, except for the outer one, which is the largest and squarish in outline.

First ventral arm plate with rounded distal margin, partially covered by adoral ossicles. Successive plates with straight or slightly concave distal margins, wider than long, with large tentacle pores (Text-fig. 3m), not tumid. In proximal arm portions, there are two scales to each tentacle pore, the inner one being roughly twice as large as the outer, in other portions of the arm either a single large, elongate scale, or two equal-sized scales. First lateral arm plates (within the disc, Text-fig. 2b) small and rather inconspicuous. Lateral arm plates not meeting ventrally nor dorsally, evenly arched (in some specimens tumid), smooth, with bar-like notches and ridges lining the proximal plate margin (Text-figs. 3e, g, o). Distal margin thin, with three (? four) shallow spine pits, bearing two (possibly three) spines close to each other on the lower half of the plate and one above mid-height, which is the shortest.

Spines pointed, appressed, small, short (reaching one third the length of a lateral arm plate). Dorsal arm plates massive, tumid (Text-fig. 3n), the midline being crest-

Figs. 3a-s – *Felderophiura vanderhami* n. gen., n. sp. Holotype, arm fragment (compare Pl. 1, Fig. 3), and paratypes, a-d – single triangular ossicle (x *c* 25) from the holotype, e-g – lateral arm plate (x23), Maastricht Formation, Nekum Member, CBR-Romontbos quarry, Eben Emael-Bassenge (IST 10510), h-j – radial shield (x *c* 13), Maastricht Formation, Nekum Member, CBR-Romontbos quarry, Eben Emael-Bassenge (IST 10509), k-o – arm fragment (holotype), dorsal, lateral, and ventral views (x12), fourth vertebra (x *c* 25) and oblique view of comb plate (x12), respectively (IST 10507), p-s – vertebra (holotype), distal, proximal, dorsal and ventral views, respectively (x24) (IST 10507). R. van der Ham del.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like, with straight or concave distal margin, the proximal margin covered by adjacent plate. Vertebrae (Text-figs. 3n, p-s) zygophiuroid, showing no special features, and in fact closely comparable to the vertebrae of other ophiurid ophiuroids.

REMARK

As mentioned above, BERRY's taxa are best treated as *nomina dubia*. Ossicles undoubtedly belonging to *Felderophiura vanderhami* were assigned to two species (placed in two genera!) by BERRY. *Ophiura kunradeca* BERRY, 1938 was referred to the genus *Ophiura* on account of the structure of the vertebrae. However, there is no absolute proof that this type of vertebra belongs to the new species, despite the overall similarity. Accompanying *F. vanderhami* at a number of localities is another, possibly undescribed, ophiuroid species which appears to have similar vertebrae. HESS (1962a) pointed out that ophiuroid species should in fact not be based on vertebral features. Lateral arm plates show much more reliable features (granulation, number of arm spines etc.) and are therefore to be preferred. In view of the obscurity surrounding *O. kunradeca*, as well as the other species and genera erected by BERRY, it was decided to introduce a new generic and specific name, both based on complete specimens, i.e. discs with portions of arms preserved. Such a course of action is much to be preferred and may preclude any uncertainties over the identification of disarticulated ossicles.

There is still another point with regard to BERRY's publication that needs to be stressed. A comparison of his material with the copious material studied here reveals that BERRY's specimens are on the whole rather poorly preserved (worn, abraded) and that in his samples there is some size selection.

SPENCER & WRIGHT (1966, p. U93) remarked that early Mesozoic ophiuroids for which previous authors had erected generic names subsequently were shown to have a distinctly modern aspect and they were therefore assigned to modern genera. Stricter generic diagnoses are needed, but because of the fact that many diagnostic characters are not or only poorly exposed in fossils, this makes attribution to recent genera often dubious. BÖHM (1889) was aware of such difficulties and coined the collective name *Ophiurites* for fossil ophiuroids that could not be referred to modern genera with any certainty.

Felderophiura appears to be a well-defined genus. None of the genera classed in the Ophiuridae (Ophiurinae) and listed and illustrated in LYMAN (1882), MATSUMOTO (1915, 1917), FELL (1960) and SPENCER & WRIGHT (1966) shows the distinctive character of the radial shields.

COMPARISONS

The number of NW European late Cretaceous and Palaeogene ophiuroids known to date is rather limited. This is even more true for occurrences outside Europe. Below a number of previously described taxa will be briefly compared with *Felderophiura vanderhami*.

W.B. CLARK (1893, pp. 29-31, pl. 4, figs. 1, 2) described and figured *Ophioglypha bridgerensis* (MEEK, 1873) (Montana, of Cretaceous age) and *Ophioglypha texana* W.B. CLARK, 1893; the illustrations are rather poor, but from the descriptions it is clear that confusion with *F. vanderhami* is quite impossible. *Ophioglypha graysonensis*, an early Cretaceous species from Texas described by ALEXANDER (1931), differs from *F. vanderhami* in details of disc plating and mouth frame. CHAPMAN (1934) erected a new species and subgenus of ophiacanthid ophiuroid [*Ophiacantha (Ophioglyphoida) fosteri*] of early Cretaceous age from Queensland, Australia. This species is readily distinguished from *F. vanderhami* on account of its arm structure (with erect spines) and distinctive ophiacanthid disc plating. All species described by VALETTE (1915) from Upper Cretaceous deposits of Yonne (northern France) are easily separated.

BERRY (1941) redescribed *Ophioglypha texana* W.B. CLARK, 1893 (early Cretaceous, Texas), *O. graysonensis* ALEXANDER, 1931 and erected *Ophiura travisana* (late Cretaceous, Texas) for dissociated ossicles. These three species show typical ophiurid disc plating, which differs markedly from the plating seen in *F. vanderhami*.

SKWARKO (1963) described an Australian Cenomanian species under the name *Nullamphiura felli*. This is an amphiurid and as such it is easily differentiated from the new species described herein.

BIGNOT *et al.*'s (1987) *Bibophiura opercularis*, a diminutive species from the Palaeocene of the Paris Basin, has very distinctive lateral arm plates, large arm spines and a characteristic disc plating.

Of the various new ophiuroid species described and referred to *Ophiura* in its broadest sense by RASMUSSEN (1972), only one shows a superficial resemblance with *F. vanderhami*, viz. *Ophiura davisi* RASMUSSEN, 1972 (p. 75, pl. 10, figs. 10-15; late Eocene, southern England), especially the lateral arm plates. These, however, appear even more massive than in some specimens of *F. vanderhami*, are less arched and show 4-6 spine pits. Of this species only disarticulated ossicles are known; the other ossicles referred to it by RASMUSSEN differ markedly from those of the present species.

The Campanian-late Palaeocene *Amphiura ? senonensis* VALETTE, 1915 (p. 16, fig. 6; see also RASMUSSEN, 1950, p. 118, pl. 15, figs. 6-10; 1952, p. 50, figs. 4, 5), Maastrichtian-early Palaeocene *Ophiacantha ? danica* RASMUSSEN, 1952 (p. 52, fig. 6) and late Eocene *Ophiocoma hessi* RASMUSSEN, 1972 (p. 76, pl. 6, figs. 6, 7) have very distinctive arm plating, which is quite unlike that seen in *F. vanderhami*. The early Palaeocene (? latest Maastrichtian) *Ophiomusium danicum* BRÜNNICH NIELSEN, 1926 (p. 11, figs. 2-4; see also RASMUSSEN, 1950, p. 102, pl. 12, figs. 1-6; MARYANSKA & POPIEL-BARCZYK, 1969, p. 135, pl. 2, fig. 2) and the Campanian-Maastrichtian (? earliest Palaeocene) *Ophiomusium subcylindricum* (VON HAGENOW, 1840) (see RAS-

MUSSEN, 1950, p. 108, pl. 14, figs. 4-6; MARYANSKA & POPIEL-BARCZYK, 1969, p. 135, pl. 2, fig. 3) have different radial shields and tentacle scales are confined to the proximalmost arm segments.

The Campanian-early Palaeocene *Ophiura serrata* F.A. ROEMER, 1840 (see SPENCER, 1907, p. 102, pl. 27, fig. 3; p. 103, pl. 27, fig. 4 [as *Ophiura parvisentis*]; RASMUSSEN, 1950, p. 111, pl. 16, figs. 1-8), and the Campanian-Maastrichtian (? early Palaeocene) *Ophiura* ? *hagenowi* RASMUSSEN, 1950 (p. 114, pl. 17, figs. 1-5; see also MARYANSKA & POPIEL-BARCZYK, 1969, p. 133, pl. 1, figs. 1, 2) differ from the new species described herein in arm structure and in disc plating (known only in the former species).

The early Palaeocene *Ophiura achatae* RASMUSSEN, 1972 (p. 61, pl. 6, fig. 3), early Eocene *Ophiura furiae* RASMUSSEN, 1972 (p. 62, pl. 6, figs. 4, 5; pl. 13, fig. 1), early Eocene *Ophiura wetherelli* FORBES, 1852 (see RASMUSSEN, 1972, p. 64, pl. 7, figs. 1-5; pl. 13, figs. 2, 3), early Eocene *Ophiura bognoriensis* RASMUSSEN, 1972 (p. 66, pl. 8, figs. 1-10; pl. 14, fig. 1), late Eocene *Ophiura bartonensis* RASMUSSEN, 1972 (p. 68, pl. 9, figs. 1-9; pl. 14, figs. 2-4), late Eocene *Ophiura costata* RASMUSSEN, 1972 (p. 70, pl. 6, figs. 8, 9), and late Eocene *Ophiura carpelloides* RASMUSSEN, 1972 (p. 71, pl. 10, figs. 1-9) are all easily distinguished from *F. vanderhami*, either on account of disc plating or arm structure. So are the (? early-middle) Eocene *Ophiozona* ? *eocaena* (LERICHE, 1931) (see JAGT, 1990b) and Maastrichtian *Asteronyx* ? *ornatus* RASMUSSEN, 1950 (p. 121, pl. 18, fig. 11; = *Asteronyx granulosus* A.H. MÜLLER, 1950, p. 33, pl. 2, figs. H 1-5; ? = *Asteronyx valkenburgensis* BERRY, 1938, p. 65, pl. 16, figs. 13-16, 19 only). The latter species is based on isolated vertebrae of the streptospondyline type. In conclusion, *Felderophiura vanderhami* is a well-defined species characterised by a distinctive disc plating, which precludes confusion with other late Cretaceous-Palaeogene ophiuroids.

CAMPANIAN-MAASTRICHTIAN OPHIUROID FAUNAS FROM THE MAASTRICHTIAN TYPE AREA

RASMUSSEN (1965) did not mention BERRY's species, but recorded *Ophiomusium subcylindricum* from the Tuffeau de Maastricht Mb, which corresponds to the lower part of the Maastricht Formation. JAGT (1987) pointed out that representatives of the *Ophiomusium subcylindricum* group ranged from the late Campanian to the late Maastrichtian, and that populations from the various lithostratigraphical units in the Maastrichtian type area were morphologically distinct.

A recent survey (unpublished) of the ophiuroid species known to date from the area will be used as basis for a detailed study of late Cretaceous ophiuroids from northwestern Europe (JAGT & KUTSCHER, in prep.). The Zeven Wegen and Vijlen Members of the Gulpen Formation (late Campanian and late Maastrichtian, respectively) as exposed in quarries at Heure-le-Romain, Haccourt and Lixhe (Figure 1) have yielded a total of some 20 different species of ophiuroid, many of them apparently new to science. Other previously described species have not yet been recorded from the area. Material that may be referred to the Ophiodermatidae, Ophiacanthidae, Amphiuridae, Hemieuryalidae and Ophiothricidae poses some problems, because of the fragility of the ossicles. It is difficult to obtain a sufficiently large sample on which to determine the range of variation of the various ossicles, and lateral arm plates in particular. Of other species discs with proximal portions of arms have been collected recently, and these will be described in detail in forthcoming papers.

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PLATE 1

Felderophiura vanderhami n. gen., n. sp. Late Maastrichtian, southern Limburg (The Netherlands) and Liège province, NE Belgium. Specimens deposited in the collections of the Institut royal des Sciences naturelles de Belgique (Brussels) have IST catalogue numbers.

Figs. 1a, b: Paratype (IST 10508; leg. J.W.M. Jagt), CBR-Romontbos quarry, Eben Emael-Bassenge (Liège), Maastricht Formation, Nekum Member, oral and adoral views, x3.5.

Figs. 2a, b: Paratype (van Birgelen Collection, no. 655/1), Kunrade (Limburg, The Netherlands), outcrop 62B-11, Maastricht Formation, Kunrade limestone facies, oral and adoral views, x6.1.

Fig. 3: Holotype (compare Text-figs. 2 and 3k-s), Blom quarry, Berg en Terblijt (Valkenburg aan de Geul), Maastricht Formation, Meerssen Member, base of unit IVf-3, adoral view, x4.3.

Figs. 4-6: Paratypes (van Birgelen Collection, nos 655/2-4), provenance as Figs 2a, b, x4.4, 5.0 and 5.5, respectively.