

# Late Cretaceous anomurans and brachyurans from the Maastrichtian type area

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Collins, J.S.H., Fraaye, R.H.B., & Jagt, J.W.M. 1995. Late Cretaceous anomurans and brachyurans from the Maastrichtian type area. *Acta Palaeontologica Polonica* **40**, 2, 165–210.

From the late Maastrichtian of southern Limburg (The Netherlands) and northeast Belgium, three species of anomurans in as many genera and sixteen brachyuran species in fourteen genera are described. Of the anomurans, *Paguristes floriae* and *Eomunidopsis meerssensensis*, are new; of the brachyurans seven species and one genus are new. These are: *Glyptodynamene inornata*, *Dromiopsis praelaevalor*, *Dromiopsis mosae*, *Homolopsis declinata*, *Raninoides? quadrispinosus*, *Raniliformis oclusa* and *Binkhorstia euglypha*. A new genus, *Leptoidea*, is erected to contain *Titanocarcinus briarti* (Forir 1887) and a concise historical account of the crabs of the Liège-Limburg Maastrichtian is given.

Key words: decapod crustaceans, systematics, Maastrichtian, The Netherlands, Belgium, new taxa.

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## Introduction

The crabs of the late Maastrichtian of Liège-Limburg (southeast Netherlands and northeast Belgium) contain a mixed assemblage comprising elements of a cosmopolitan fauna as well as local or endemic genera. The oldest known genus in this assemblage is *Paragalathea*, first described from the Tithonian (Jurassic), but about half of the genera involved have their origins in the Early or Middle Cretaceous and, for the most part, their palaeogeographic occurrences are cosmopolitan. Apart from the raninids, some of which were almost undoubtedly burrowing species, the crabs apparently occupied a moderately shallow-water habitat as typified by genera common to earlier Cretaceous deposits and there seems to have

been little need to adapt morphologically to the conditions prevailing during late Maastrichtian times. Seven genera, *Stephanometopon*, *Pseudoraninella*, *Raniliformis*, *Binkhorstia*, *Leptoides*, *Aulacopodia* and possibly *Raninoides*, make their first appearance in the Maastrichtian of the region here considered. Of these, all but *Raniliformis* and *Raninoides* are endemic. *Binkhorstia* Noetling 1881 has a relationship with the English Aptian genus *Withersella* Wright & Collins 1972 and later American carcineretids. Better preserved material confirms the assignment of *Stephanometopon granulatum* Bosquet 1854 — originally described from a fragment of the frontal region — in the Dynomenidae. There is a clear indication that the raninid *Pseudoraninella muelleri* (van Binkhorst 1857) is close to the extant genus *Cosmonotus* Adams & White 1848 through *C. eocenicus* Beschin *et al.* 1988 from the middle Eocene of Italy. The relationship between the raninids *Eumorphocorystes sculptus* van Binkhorst 1857 and *E. naseiensis* (Rathbun 1926) is doubtful, but in the nature of the cuticular terraces, there is a distant relationship between *Eumorphocorystes* van Binkhorst 1857 and *Notopocorystes* (*Eucorystes*) Bell 1863, a widespread subgenus. *Aulacopodia riemsdyki* Bosquet 1854, known only by chelae, has no known fossil affinities.

Of the genera that may be considered to be local in distribution, *Glyptodynamene* van Straelen 1944 is known elsewhere only from the Cenomanian of Navarra (Spain), while *Raniliformis* Jagt *et al.* 1993 is probably ancestral to the closely allied extant genus, *Ranilia* H. Milne Edwards 1837, by way of *Raniliformis oclusa* sp. n., the Danian *Raniliformis baltica* (Segerberg 1900), and the early Eocene Italian *Ranilia punctulata* Beschin *et al.* 1988. *Dromiopsis praelaevious* sp. n. would appear to be directly ancestral to the Danian *D. laevious* Reuss 1859, while *Prehepatus* spp. are described from the Late Cretaceous of North America. The deep fronted, ridged, nature of the gastric lobes of *Leptoides* gen. n. indicate not only a relationship with the Recent genus *Leptodius* A. Milne Edwards 1863, but also to other xanthoid genera such as *Panopeus* H. Milne Edwards 1834 and *Ozius* H. Milne Edwards 1834. Former considerations of a relationship with *Titanocarcinus* A. Milne Edwards 1863, may be somewhat remote, because in that genus, the entire margins of the lobes have a marked tendency to be sharply and/or evenly defined.

These diverse anomuran and brachyuran faunas in the type area of the Maastrichtian Stage are of especial importance in the light of discussions on pre- and post-K/T boundary faunal responses. The high diversity appears to be an expression of Vermeij's (1977) 'Mesozoic marine revolution' (see also Taylor 1981), and in a number of lineages the late Maastrichtian species seem to be the direct precursors of early Palaeocene taxa, and of those of the famous Fakse fauna in particular. The reader is referred to an exhaustive discussion of the evolutionary and palaeobiogeographic significance of the Maastricht faunas currently under way (Fraaye, in preparation).

## Previous work

Previous contributions describing and illustrating decapod species from the Maastrichtian type area are rather limited; most of them suffer from lack of stratigraphic control. Despite this, the most important papers will be briefly discussed here.

Bosquet (1854) was the first to describe the decapod crustaceans in detail, and he introduced the nephropid genus *Oncopareia* (type species *Oncopareia bredai*), from the Kunrade facies of the Maastricht Formation (late Maastrichtian), and introduced *Oncopareia? heterodon* on the basis of fragmentary claws from the middle of the Maastricht Formation (Emael Member inferred). Newly discovered specimens confirm this provenance. *Protocallianassa faujasi* (Desmarest 1822) was also described and figured, as was *Aulacopodia riemsdyki* based on a single claw from the upper part of the Maastricht Formation. Another brachyuran genus was also proposed, *Stephanometopon*, type species *Stephanometopon granulatum*, inferred to be from the Meerssen Member.

Van Binkhorst (1857) described and illustrated a new genus and two new species of raninid crab (*Notopocorystes mulleri* and *Eumorphocorystes sculptus*). The first-named taxon, now the type species of the genus *Pseudoraninella* Beurlen 1929 (*P. muelleri*) (see Glaessner 1969), was erected on the basis of a single specimen from near Valkenburg aan de Geul (The Netherlands) from the upper part of the Maastricht Formation (Meerssen Member inferred). *Eumorphocorystes sculptus* was recorded from the lower part of the Maastricht Formation, which is characterised by the occurrence of many cirripede remains and the brachiopod '*Trigonosemus? pectiniformis*' (von Schlottheim 1813). In modern lithostratigraphic terminology this would mean the Valkenburg, Gronsveld, Schiepersberg, and Emael Members. Wright & Collins (1972: p. 78) concluded that these two species were synonymous; the peculiar carapace ornament of *E. sculptus* was considered to be the product of weathering of a uniform test. This matter is dealt with in the discussion of *E. sculptus* below. The third species, *Binkhorstia ubaghsii*, was collected from the upper part of the Maastricht Formation (top of Nekum Member or Meerssen Member).

Binkhorst van den Binkhorst (1861: pl. 9) published a plate illustrating decapod crustaceans without any accompanying text. Illustrated are species now recognised as *Pseudoraninella muelleri*, *Eumorphocorystes sculptus*, *Binkhorstia ubaghsii*, *Paranecrocarcinus* (*Pseudonecrocarcinus*) *quadriscissus*, and a nephropid lobster.

Noetling (1881) erected a new genus, *Binkhorstia*, to which he referred *Dromilites ubaghsii* of van Binkhorst (1857), and described a new species, *Necrocarcinus quadriscissus*, which is the type of *Pseudonecrocarcinus* Förster 1968. In addition, he (Noetling 1881: p. 370) stressed the rarity of brachyurans in the type Maastrichtian.

Pelseneer (1886) introduced a new genus and species, *Ischnodactylus inaequidens* from the Kunrade facies; the genus was synonymised with

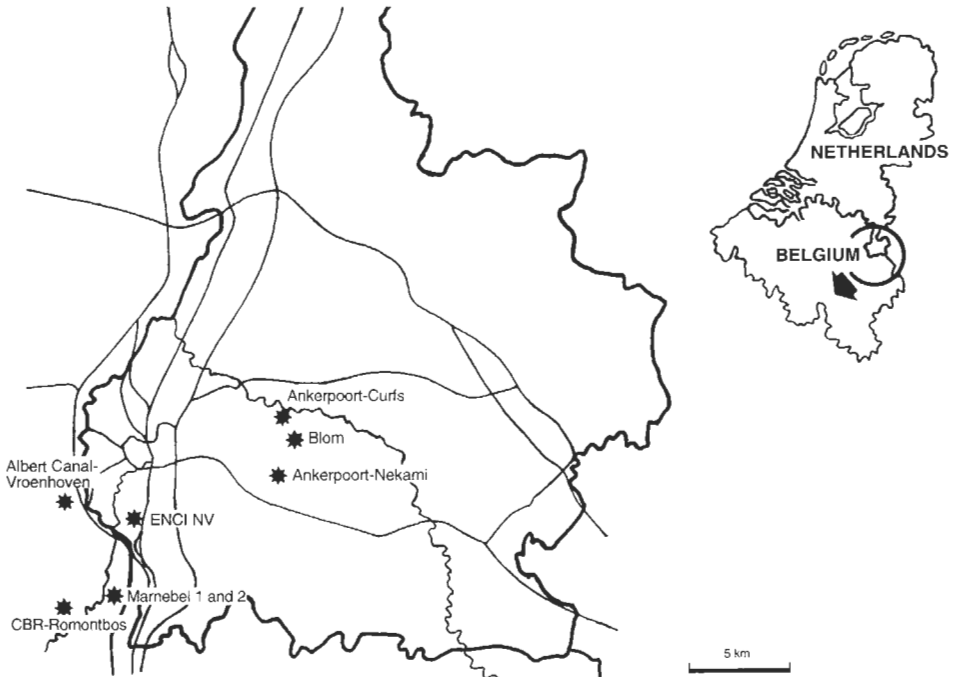


Fig. 1. Locality map showing locations of the various quarries and outcrops/exposures from which the crustacean material was collected.

*Oncopareia* by Mertin (1941). From the same strata he described two other new species, *Homarus bosqueti* and *Galathea ubaghysi*, the latter based on a single carapace from the upper Maastricht Formation. Also included were descriptions of two limb fragments, *Pseudomicippe granulosa* (Bosquet MS, Pelseneer 1886), which might be a calappid (see Förster 1968), and a 'pince indéterminée'. In a tabular overview Pelseneer (188) discussed the stratigraphic distribution of the various species then recognised: he referred to the Kunrade facies as 'Maestrichtien inférieur'. As characteristic species for the 'Maestrichtien moyen' he cited '*Oncopareia*' *heterodon*, *Dromiopsis elegans*, *Necrocarcinus* (?) *quadriscissus*, *Raninella sculpta*, and the 'pince indéterminée'. Typical of the 'Maestrichtien supérieur' are *Callianassa faujasi*, *Galathea ubaghysi*, *Binkhorstia ubaghysii*, *Aulacopodia riemsdyki*, *Stephanometopon granulatum*, *Pseudomicippe granulosa*, and *Raninella muelleri*.

Forir (1887a) described *Dromiopsis briarti* [= *Leptoides briarti* (Forir 1887) herein] from the upper tuffaceous chalk (late Maastrichtian) near Valkenburg aan de Geul, and in (1887b) he introduced *Nymphaeops belgicus* for a specimen from the 'craie blanche silex noirs', which would probably correspond with the Lanaye Member of the Gulpen Formation (late Maastrichtian); *Homarus senonensis* for a claw from Gulpen (Vijlen Member ?); recorded *Dromiopsis rugosa* (von Schlottheim 1820) from the

top of the Maastrichtian and described *Necrocarcinus ornatissimus* for a claw from the bryozoan biocalcarenes of the uppermost Maastricht Formation. The last-named species has a superficial resemblance to *Prehepatus werneri* Fraaye & Collins 1987.

Forir (1889) described and illustrated *Dromiopsis ubaghsi* from the middle part of the Maastricht Formation (Nekum and Meerssen Members inferred). In addition, he referred to possible galatheid claws from the same locality, and briefly described two indeterminate claw fragments from the middle Maastricht Formation, as well as peculiar claws comparable with those of corystids and oxyrhynchs (see also Pelseneer 1886).

Förster (1968) erected *Pseudonecrocarcinus* for *Necrocarcinus quadrisissus* (of which *Dromiopsis ubaghsi* Forir 1889 is a junior synonym), and provided a photograph of the holotype of that species.

Mulder (1981) described specimens referred to *Callianassa faujasi*, and paid attention to morphology and ecology of this species.

Fraaye & Collins (1987) introduced *Prehepatus werneri* for a left chela and some fragments of fingers from the Meerssen Member.

Feldmann *et al.* (1990) illustrated the nephropid *Oncopareia bredai* from the lower Vijlen Member (late Maastrichtian) of NE Belgium.

## Geographic and stratigraphic setting

All material described herein has been collected from various members of the Maastricht Formation (*sensu* Felder 1975) in the type area of the Maastrichtian Stage. The locations of a number of key sections in this area are illustrated in Fig. 1.

Field work during the past four years has concentrated mainly on the following quarries:

- (1) in the province of Liège (Belgium): Cimenterie Belge Réunion (CBR)-Romontbos and Marnebel 1 and 2 (new quarry),
- (2) in the province of Limburg (Belgium): temporary exposures along the Albert Canal near Vroenhoven-Riemst,
- (3) in the province of Limburg (The Netherlands): Eerste Nederlandsche Cement Industrie (ENCI) NV quarry, Blom quarry, Ankerpoort-Nekami ('t Rooth) quarry, Ankerpoort-Curfs quarry.

The majority of the specimens come from the upper part of the Maastricht Formation, Nekum, and Meerssen Members (Figs 2, 3). Despite the fact that the refined lithostratigraphical subdivision (Felder 1975) of the type Maastrichtian is not matched by a comparably detailed biozonation, the occurrence of the coleoid cephalopod *Belemnitella ex gr. junior* Nowak 1913 throughout the Maastricht Formation (Valkenburg, Gronsveld, Schiepersberg, Emael, Nekum, and Meerssen Members) indicates the formation to be of early late Maastrichtian age. The upper half of the Meerssen Member witnesses the first appearance of another coleoid species, *Belemnella ex gr. casimirovensis sensu* Jeletzky 1951, index of the

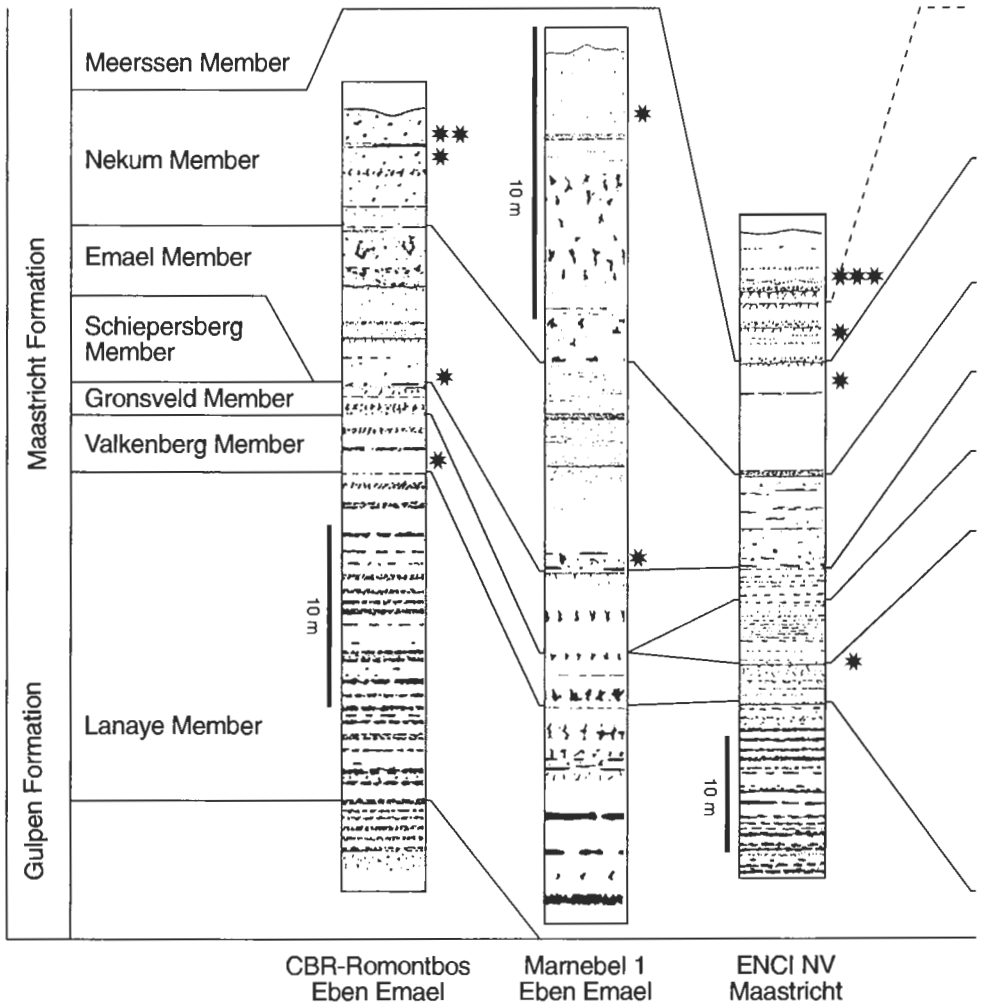
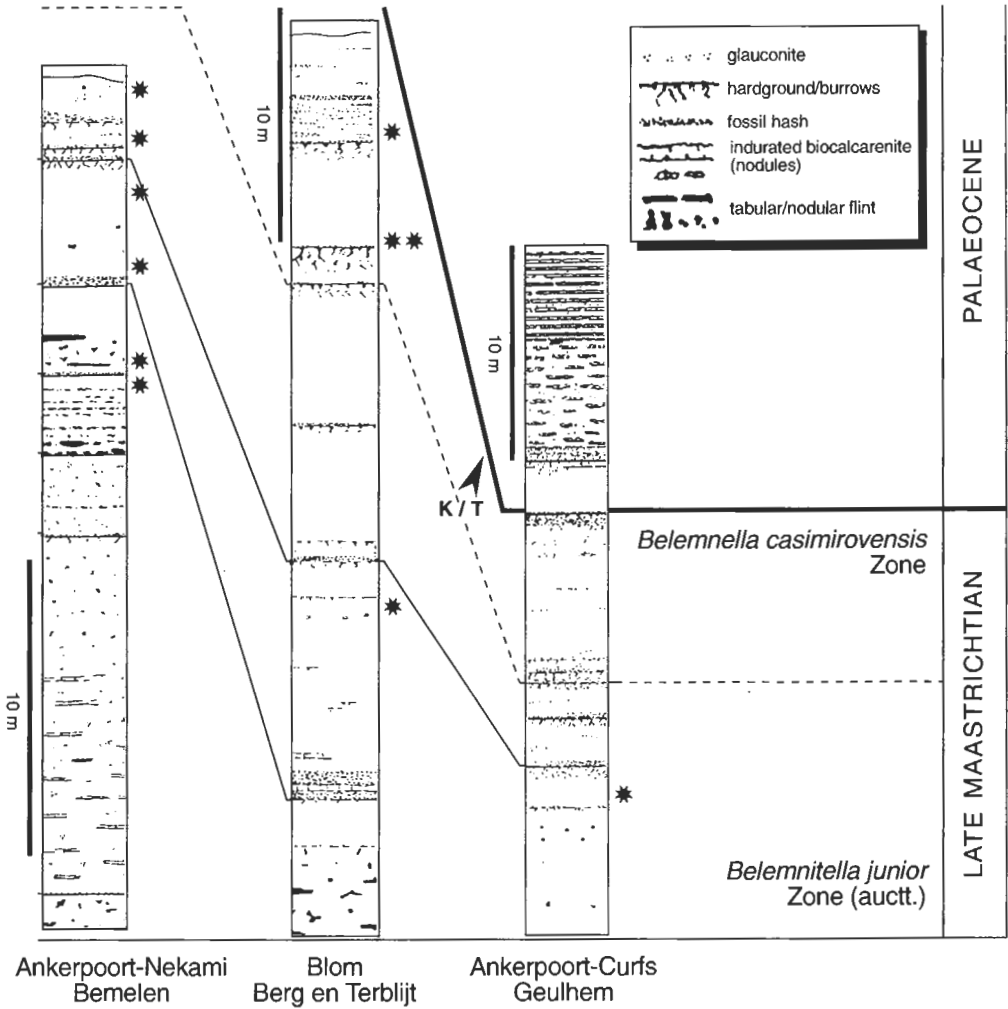


Fig. 2. Logs of key sections in the Maastrichtian type area (southeast Netherlands and northeast Belgium), indicating local lithostratigraphy and preliminary biozonation. Asterisks mark the provenance of decapod crustacean faunules described herein.

latest Maastrichtian *B. casimirovensis* Taxon Range Zone of northern Europe (Denmark, Poland), as well as the pachydiscid ammonite *Menuites terminus* (Ward & Kennedy 1993), index of the latest Maastrichtian *M. terminus* Zone of the Bay of Biscay sections (northern Spain, southwest France). The reader is referred to Jagt & Felder (in press) and Jagt (in press) for further details.

Most of the specimens represent moulted carapaces, corpses being extremely rare, except for a few specimens of the raninid *Pseudorarinella muelleri*, as well as isolated chelae and fingers. The upper part of the Nekum Member and the Meerssen Member have been deposited under (temporarily) high-energy conditions, and it appears that the occurrence



of crab carapaces reflects deposition in discrete lenticular structures. However, additional observations on the spatial distribution of the taxa described herein are necessary, being highly dependent of the method and speed of excavation in the various quarries.

**Systematic palaeontology**

- Order Decapoda Latreille 1803
- Suborder Pleocyemata Burkenroad 1963
- Infraorder Anomura Macleay 1838 (*sensu* McLaughlin & Holthuis 1985)
- Superfamily Paguroidea Latreille 1802
- Family Diogenidae Ortmann 1892

|  | Maastricht Formation<br>Late Maastrichtian |                  |                      |              |              |                 |
|--|--|------------------|----------------------|--------------|--------------|-----------------|
|  | Valkenburg Member                          | Gronsveld Member | Schiepersberg Member | Emael Member | Nekum Member | Meerssen Member |
| <i>Paguristes florae</i>               | -  | -                | -                    | 1            | 1            | 9               |
| <i>Paragalathea ubaghst</i>            | -  | -                | -                    | -            | -            | 2               |
| <i>Eomunidopsis meerssens</i>          | -  | -                | -                    | -            | -            | 1               |
| <i>Stephanometopon granulatum</i>      | -  | -                | -                    | -            | 1            | 3               |
| <i>Glyptodynamene inornata</i>         | -  | -                | -                    | -            | -            | 1               |
| <i>Dromiopsis praelaevis</i>           | -  | -                | -                    | -            | -            | 1               |
| <i>Dromiopsis mosae</i>                | -  | -                | -                    | -            | -            | 2               |
| <i>Homolopsis declinata</i>            | -  | -                | -                    | -            | 1            | 5               |
| <i>Eumorphocorystes sculptus</i>       | -  | -                | 2                    | 4            | 2            | 5               |
| <i>Pseudorantinella muelleri</i>       | -  | -                | -                    | -            | 1            | 32              |
| <i>Raninoides?quadrspinus</i>          | 2  | 1                | -                    | 1            | -            | 1               |
| <i>Raniliformis occlusa</i>            | 2  | -                | -                    | 4            | -            | -               |
| <i>Paranecrocarcinus quadriscissus</i> | -  | -                | -                    | 2            | 24           | 39              |
| <i>Prehepatus werneri</i>              | -  | -                | -                    | -            | -            | 4               |
| <i>Binkhorstia ubaghstii</i>           | -  | -                | -                    | -            | 23           | 12              |
| <i>Binkhorstia euglypha</i>            | -  | -                | -                    | -            | -            | 3               |
| <i>Xanthosia semiornata</i>            | -  | -                | -                    | -            | -            | 14              |
| <i>Leptoides briarti</i>               | -  | -                | -                    | -            | -            | 2               |
| <i>Aulacopodia riemsdyki</i>           | -  | -                | -                    | -            | 2            | 5               |

Fig. 3. Numbers of specimens per lithostratigraphic unit for the late Maastrichtian of the type area of the Maastrichtian Stage (The Netherlands, Belgium) as used for the present paper.

### Genus *Paguristes* Dana 1853

Type species: *Paguristes hirtus* Dana 1853, by subsequent designation of Stimpson (1858).

#### *Paguristes florae* sp. n.

Fig. 4A–D.

Holotype: Geo Centrum Brabant Collections, no. MAB k.1031 (ex Jagt Collection, no. 5535, donated by M. Langeveld).

Type horizon and locality: Maastricht Formation, upper third of Meerssen Member, latest Maastrichtian, *Belemnella casimirovensis* Zone; Vroenhoven-Riemst (Limburg, Belgium).

Derivation of name: from Blom quarry, derivative of the Dutch word 'bloem' for 'flower'.

**Material.** — Paratypes: Geo Centrum Brabant Collections, nos. MAB k.0523, k.0718, k.0738, k.1016, k.1022, k.1023, in addition to three specimens in the Jagt Collection.



**Diagnosis.** — Chelae more or less equal in size, subquadrate in outline; lower margin curving smoothly into the fixed finger which is a little shorter than the propodus; outer surfaces weakly reticulated.

**Description.** — Left and right chelae are more or less equal in size, subquadrate in outline, slightly higher distally; the lower margin is rather more strongly curved than the upper, continuous with the stout fixed finger and granulate from the middle of the fixed finger to the carpal margin. The outer surface (of the right hand chela) is gently convex with a finely granulated ridge along the upper and lower margins; the upper surface is flat and finely and irregularly granulated. The inner surface is rather more boldly convex than the outer and the fixed finger is slightly inturned. The interdigital margin is straight and vertical with a shallow indentation for the articular boss of the dactylus. The inner surface of the left chela is more or less flat, and slightly depressed towards the fixed finger. The fixed finger is about half the length of the propodus; a line of five or six setae pores extends below the opposing margin which has two paired cusps proximally followed by a large, then progressively smaller cusps distally, the tip is shallowly spooned.

**Discussion.** — The similarity in size of left and right chelae has influenced the decision to place this species in *Paguristes* rather than in *Pagurus* Fabricius 1775, a contemporary genus in which the species tend towards heterochely; the discovery of further specimens of *P. floriae*, however, may provide grounds for revision of opinion.

Knowledge of Late Cretaceous pagurids is sparse: of North American species of approximate age, *Pagurus pilsbryi* Roberts 1962 (early to mid Campanian), differs from *Paguristes floriae* in having a concavity in the lower margin proximal to the fixed finger and a slightly receding interdigital margin. The latest Campanian *Paguristes ouachitensis* Rathbun 1935 also has a concavity in the lower margin and the outer surface is regularly granulate; the more coarsely granulate ornament and strongly deflexed fixed finger of *Paguristes whitteni* Bishop 1983 (Bishop 1983: p. 420, figs 3–5) readily distinguishes that species from *P. floriae*. There is a similarity in outline to the propodus of *Paguristes santamartaensis* Feldmann *et al.* 1993 (Feldmann *et al.* 1993: p. 24, fig. 16; ?late Santonian/middle Campanian of James Ross Island, Antarctica), but the interdigital margin of the latter is oblique rather than vertical as in *P. floriae* and the outer surface is densely nodose.

**Occurrence.** — Late Maastrichtian Emael, Nekum, and Meerssen Members (Maastricht Formation) of Maastricht, Berg en Terblijt, Bemelen (Limburg, The Netherlands), Eben Emael (Bassenge), and Vroenhoven (Riemst) (Liège and Limburg, Belgium), *B. junior* and *B. casimirovensis* Zones.

Superfamily Galattheoidea Samouelle 1819

Family Galatheidae Samouelle 1819

Subfamily Munidopsinae Ortmann 1892

Genus *Paragalathea* Patruilius 1960

Type species: *Galathea verrucosa* (Moericke 1899) by original designation.

*Paragalathea ubaghsi* (Pelseneer 1886)

Fig. 4E–H.

*Galathea Ubaghsi*, n. sp., Pelseneer 1886: p. 167 [7], fig. 5.

*Galathea Ubaghsi*, Pels; Pelseneer 1886: p. 173 [13].

*Galathea ubaghsi* Pelseneer; Glaessner 1929: p. 174.

Holotype: Institut royal des Sciences naturelles de Belgique Collections (Brussels), no. T 10651 (IG 6521).

Type horizon and locality: Maastricht Formation, lower part of Meerssen Member inferred (late Maastrichtian, *Belemnitella junior* Zone); Sint Pietersberg, south of Maastricht (southern Limburg, The Netherlands).

**Material.** — A single carapace, Natuurhistorisch Museum Maastricht Collections, no. NHMM 1991030 (*ex* Regout Collection).

**Description.** — Carapace, from base to rostrum, rather longer than wide, the lateral margins slightly divergent posteriorly. Of the front little more than the basal ridge of the rostrum remains; it continues round the upper orbital margin which terminates in a sharp external orbital spine. Five sharp spines line the anterolateral margins and there are five or six on the posterolateral margins. Broadly rounded posterolateral corners lead to a slightly concave posterior margin bounded by a wide rim, on which is a medial line of granules, followed by an equally wide groove. The regions are well defined by fine, but distinct furrows; the cervical furrow crosses the midline a little more than half the distance from the front. The rostrum is missing; a small part of the postrostral area preserved on specimen NHMM 1991030 is smooth. The tip of the anterior mesogastric process, enclosed by gastro-orbital grooves dividing from the postrostral median furrow, extends beyond a transverse row of four tubercles. The dorsal surface is traversed by rows of scale-like granules increasing in size posteriorly and denticulate along the fore edge; tubercles more or less even in size amongst the granules are bilaterally arranged anteriorly and a row of similar tubercles runs parallel to those lining the posterolateral margins.

**Discussion.** — While coarser granules form part of the ornament of *Paragalathea multisquamata* Vía Boada 1981, they tend to form short ridges and are more numerous than those of *P. ubaghsi* whose striking tubercular ornament immediately distinguishes it from other known members of the genus.

**Occurrence.** — Confined to the late Maastrichtian (*B. junior* Zone) lower Meerssen Member (Maastricht Formation) of Maastricht (southern Limburg, The Netherlands).

Genus *Eomunidopsis* Vía Boada 1981

Type species: *Galathea orobensis* Ruíz de Gaona 1943, by original designation.

*Eomunidopsis meerssensensis* sp. n.

Fig. 4I.

Holotype: Geo Centrum Brabant Collections, no. MAB k.1032 (*ex* Jagt Collection, no. 6218).

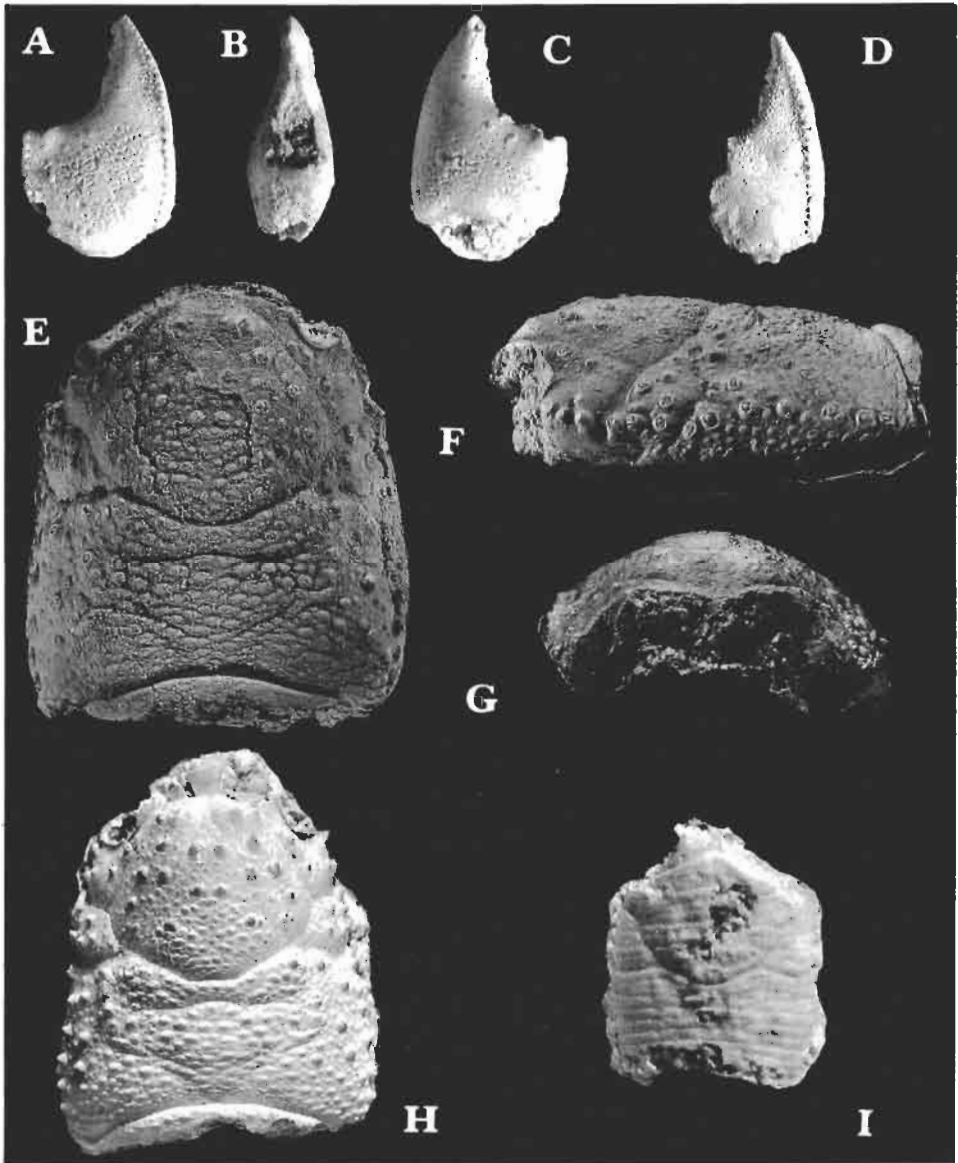


Fig. 4. Late Maastrichtian decapod crustaceans from The Netherlands and Belgium. □A–D. *Paguristes florae* sp. n., holotype MAB k.1031, outer surface, interdigital view and inner surface of right chela (A–C); paratype MAB k.1023, outer surface of fragmentary right chela (D), × 3. □E–H. *Paragalathea ubaghsi* (Pelseneer 1886), holotype IRSNB T 10651 (IG 6521), dorsal, lateral and frontal views of carapace (E–G); NHMM 1991030, dorsal aspect of carapace (H), × 3. □I. *Eomunidopsis meerssensensis* sp. n., holotype MAB k.1032, dorsal aspect of carapace, × 5.

Type horizon and locality: Maastricht Formation, upper third of Meerssen Member, latest Maastrichtian, *Belemnella casimirovensis* Zone; ENCI NV quarry, Maastricht (The Netherlands).

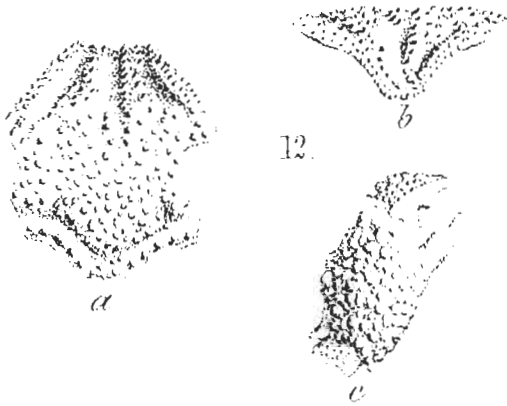


Fig. 5. *Stephanometopon granulatum* Bosquet 1854, copy of Bosquet's illustration (1854, pl. 10: 12),  $\times 1.5$ .

Derivation of name: from Meerssen, the village lending its name to the member of the Maastricht Formation from which the species was collected.

**Material.** — The type is the only specimen known at present.

**Diagnosis.** — Carapace subrectangular, regions weakly defined; the median transverse ridges anterior to the cervical furrow are poorly delineated.

**Description.** — Carapace, from base of rostrum, subrectangular, a little longer than wide, moderately rounded in transverse section and almost flat longitudinally. The anterolateral margins are rounded; the posterolateral margins gently rounded to greatest carapace width, some three fourths distance from the front, then sharply rounded at the posterolateral angles. The posterior margin is missing. The rostrum occupies about 20 % of the frontal width and is convex laterally to a pair of blunt spines, the tip is not preserved; the basal part is concave, V-shaped in section with a fine median ridge dividing and continuing behind the upper orbital margin which is lined with four or five uneven spinules. The prominent cervical furrow is transverse and sinuous, crossing the midline posterior to carapace midlength. The antennar grooves extend forward and outward in a series of short angular curves. The median part of the gastro-orbital furrow is very weak, but the lateral (transverse) extension is as strong as the cervical furrow. The mesogastric, urogastric and cardiac regions are poorly defined. Transverse ridges cover the entire carapace; the nine or so between the antennal furrows being less well delineated than the eleven behind the cervical furrow, the second and third ridges behind the furrow coalesce laterally.

**Discussion.** — Only one other Maastrichtian member of the genus, *Eomunidopsis cobrani* Bishop 1985, from Colorado, is known; it differs from the present species in having an apparently longer rostrum, fewer and more distinct ridges between the antennal furrows and more clearly defined gastro-orbital furrows; there is a similar number of ridges behind the cervical furrow, but the second and third remain entire. Of the two European Cenomanian species, *Eomunidopsis orobensis* (Ruíz de Gaona 1943) is closer in outline to *E. meerssensensis* than *E. navarrensis* (van

Straelen 1940), but the transverse bands of *E. orobensis* are much less regular, some composed only of granules. The greatest carapace width of *E. navarrensis* is more posterior than that of the present species, the rostral margins are less raised and the median ridge is stronger; the gastric transverse ridges are similar in number and although discontinuous, have quite a distinct arrangement.

**Occurrence.** — Apparently confined to the latest Maastrichtian (Meerssen Member, Maastricht Formation, *Belemnella casimirovensis* Zone) of Maastricht.

Infraorder Brachyura Latreille 1803

Section Podotremata Guinot 1977

Subsection Dromiacea de Haan 1833

Family Dynomenidae Ortmann 1892

Genus *Stephanometopon* Bosquet 1854

Type species: *Stephanometopon granulatum* Bosquet 1854, by monotypy.

### *Stephanometopon granulatum* Bosquet 1854

Figs 5, 6A–D.

*Stephanometopon granulatum* nov. spec. 1853, Bosquet 1854: p. 137, pl. 10: 12a, b (*non* 12c).

*Stephanometopon granulatum* Bosquet; Pelseneer 1886: p. 176.

*Stephanometopon granulatum* Bosquet; Glaessner 1929: p. 381.

*Stephanometopon granulatum* Bosquet; Glaessner 1969: p. R489.

Holotype: Institut royal des Sciences naturelles Belgique (Brussels) Collections, no. T 10652 (IG 6521, Ubahgs Collection), since damaged, the cervical furrow corresponds to the size and direction of Bosquet's figure (Bosquet 1854: pl. 10: 12).

**Material.** — Four specimens, Geo Centrum Brabant Collections, nos. MAB k.0834, k.1017, k.1019 and k.1020.

**Remarks.** — The species was founded on only the broad rostral region enclosing the epigastric and distal part of the anteromesogastric process (Fig. 5); recently found material includes the greater part of the carapace. Glaessner (1969) was uncertain about family assignment, although he recognised an affinity with the closely allied genus *Cyphonotus* Bell 1863 (= *Palaeodromites* A. Milne Edwards 1865).

**Diagnosis.** — Carapace broadly ovate, anterolateral margins rounded and granulate, orbitofrontal margin wide; front moderately depressed, broadly rounded-triangular; dorsal surface coarsely granulate.

**Description.** — The broadly ovate carapace is moderately arched in both longitudinal and transverse sections, widest between well-rounded lateral angles some two thirds distant from the front. The orbitofrontal margin occupies a little more than half the carapace width and of this the slightly produced, moderately depressed broadly triangular front takes up the median third; from its well-rounded apex straight, thickened, slightly upturned sides lead into shallow upper orbital margins. The outer orbital angle appears to be gently rounded as are the coarse-granulated anterolateral margins. Straight posterolateral margins extend to the (missing) posterior margin which was probably as wide as the front. The regions are

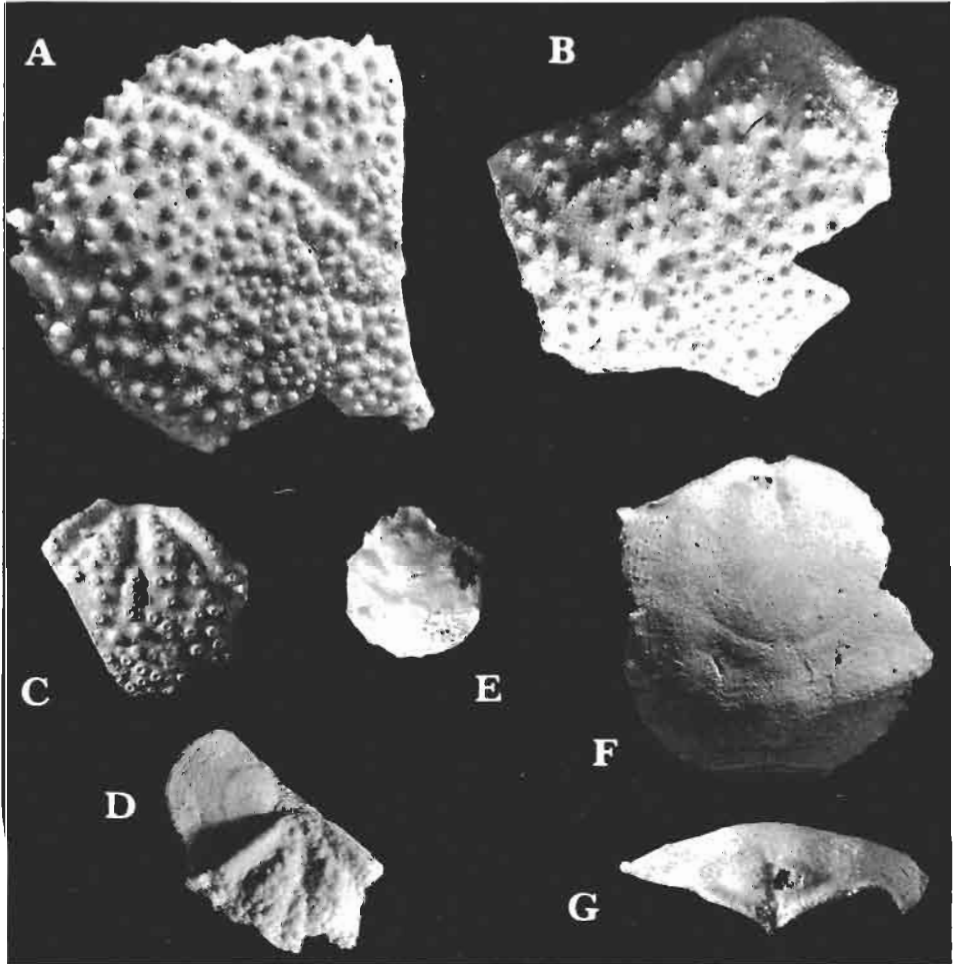


Fig. 6. Late Maastrichtian decapod crustaceans from The Netherlands and Belgium. □A-D. *Stephanometopon granulatum* Bosquet 1854, MAB k.1039, dorsal aspect of fragmentary carapace (A),  $\times 2.5$ ; MAB k.0834, dorsal aspect of fragmentary carapace (B),  $\times 3$ ; MAB k.1017, dorsal aspect of rostral region (C),  $\times 3$ ; MAB k.1019, dorsal aspect of rostral region (D),  $\times 3$ . □E. *Glyptodynamene inornata* sp. n., holotype MAB k.0668, dorsal view of fragmentary carapace,  $\times 3$ . □F, G. *Dromiopsts praelaevis* sp. n., holotype MAB k.1015, dorsal and frontal views of carapace,  $\times 3.5$ .

poorly defined. The broad, shallow cervical furrow is acutely curved across the midline, it extends straight forwards and outwards to the hepatic lobe, at which point it curves gently to the margin. The branchiocardiac furrow is as broad and shallow for half the distance along the base of the epibranchial lobe when it becomes obsolete, to reappear as a narrow, deep groove behind the mesobranchial lobe and separates the urogastric lobe from the shield-shaped cardiac region. At its base the mesogastric lobe is about as wide as the front, the sides are angularly indented by the protogastric lobes and the anterior part is equitriangular; the tip of its

anterior process extends between tumid, triangular epigastric lobes. Straight, medially inclined grooves delimit the urogastric lobe from the mesobranchial lobes.

Coarse granules of several diameters crowding the dorsal surface tend to form rows corresponding with the curves of the cervical and branchio-cardiac furrows. The c. 5th–6th rows anterior to the cervical furrow are distinctly separated from one another and form a line of weakness along which the carapace fractures to produce the (more commonly found) frontal fragments corresponding to that part upon which the species was founded. Finer granules are interspersed over the medial branchial and cardiac areas.

**Discussion.** — There is a marked similarity between *Stephanometopon* and the known members of *Palaeodromites*, and in particular to *Palaeodromites incertus* (Bell 1863) (see Wright & Collins 1972: p. 50, pl. 8: 6, 9: 1; text-fig. 9c), but the front of *Palaeodromites* is generally more steeply downturned, appearing almost bilobed when viewed from above and the anterolateral margins have large tooth-like spines or lobes rather than the continuation of the dorsal granulation of *Stephanometopon*; also, there is no indication in *Palaeodromites* of the anterior 'division' of the surface ornament. Where these differences from *Palaeodromites* may seem to be no more than within the limits of specific variation, it is considered worth retaining the two genera.

The narrow front and cratered ornament of *Graptocarcinus* Roemer 1887 readily distinguishes that genus from *Stephanometopon*.

Examples of chelae attributed to *S. granulatum* by Bosquet (1854: pl. 10: 12c) are in the collections of the Institut royal des Sciences naturelles at Brussels (IG 6521, Cornut Collection, IG 5496). Their relationship to that species is unfounded and equivocal. The dactylus figured (Bosquet 1854: pl. 10: 12c) detached from the propodus agrees closely with that described and illustrated by Pelseneer (1886: fig. 6) as *Pseudomicippe granulosa*.

**Occurrence.** — Nekum and Meerssen Members of Maastricht Formation (*B. junior* and *B. casimirovensis* Zones) of Maastricht, Bemelen, Berg en Terblijt (The Netherlands) and Eben Emael (Belgium).

#### Genus *Glyptodynamene* van Straelen 1944

Type species: *Glyptodynamene alsasuensis* van Straelen 1944, by monotypy.

#### *Glyptodynamene inornata* sp. n.

Fig. 6E.

Holotype: Geo Centrum Brabant Collections, no. MAB k.0668.

Type horizon and locality: Maastricht Formation, upper third Meerssen Member, latest Maastrichtian, *Belemnella casimirovensis* Zone; ENCI NV quarry, Maastricht.

Derivation of name: with reference to the smooth dorsal surface.

**Material.** — The type is the sole specimen known to date.

**Diagnosis.** — Carapace almost flat in transverse section, the cervical furrow broadens toward the lateral margins, dorsal surface smooth.

**Description.** — Carapace probably subovate, widest posterior to mid-length, slightly downturned anteriorly in longitudinal section and almost flat transversely, the orbitofrontal margin occupies about two thirds of the carapace width, the rostral area is damaged, but viewed from above, the front is bluntly triangular with thin, raised sides leading to oblique upper orbital margins. The cervical furrow is narrow, fairly deep and broadly curved where it crosses the midline about mid-carapace length then, becoming very broad, extends forward and outward to meet the hepatic furrow at which point it curves posteriorly to the margin. The hepatic furrows, almost as broad as the cervical, reach the margin close to the orbital angle and separate small hepatic regions from ovate, anteriorly tumid protogastric lobes. The branchiocardiac furrow is rather broader than the cervical and lies parallel to it. The anterior mesogastric process is very short, reaching only to midlength of the protogastric lobes and the mesogastric lobe is subtriangular. A fine ridge borders the anterior margin of the otherwise depressed urogastric lobe which is separated by a fine groove from the rounded pentagonal, tumid cardiac region. The epi- and mesobranchial lobes are confluent and tumid. The dorsal surface is smooth.

**Discussion.** — As preserved, the new species resembles the type species of the genus, *C. alsasuensis*, in the course of the cervical furrow, and juxtaposition of the lobes, but differs principally in having weaker branchiocardiac furrows, and what appears to be a pointed, rather than a downturned, rostrum and a smooth dorsal surface.

**Occurrence.** — Apparently confined to the latest Maastrichtian (Meerssen Member, Maastricht Formation, *Belemnella casimirovensis* Zone) of Maastricht.

#### Genus *Dromiopsis* Reuss 1859

Type species: *Brachyurites rugosus* von Schlotheim 1820, by subsequent designation of Beurlen (1928).

#### *Dromiopsis praelaeior* sp. n.

Fig. 6F, G.

Holotype: Geo Centrum Brabant Collections, no. MAB k.1015.

Type horizon and locality: Maastricht Formation, upper third Meerssen Member, latest Maastrichtian, *B. casimirovensis* Zone; ENCI NV quarry, Maastricht (The Netherlands).

Derivation of name: Indicating an early form of *Dromiopsis laeior* Reuss 1859.

**Material.** — The type is the only specimen known to date.

**Diagnosis.** — Carapace subglobose, depressed behind the metabranchial lobes; dorsal surface smooth anteriorly, finely ridged posteriorly.

**Description.** — Carapace probably subcircular in outline, the anterolateral margins are not preserved, steeply arched in longitudinal section, moderately so transversely. The orbitofrontal margin occupies about three fourths of the carapace width; the front is produced and strongly downturned, a deep, median sulcus separates thin, raised upper orbital margins bounded by a narrow depression. The orbits are deep and broadly



ovate. The median sulcus extends back between tumid epigastric lobes, and divides round the tip of a very narrow anterior mesogastric process. The posterior margin is slightly concave, narrower than the front and finely rimmed. From a pair of gastric pits posterior to midlength the cervical furrow curves to short spurs forming the basal part of the hepatic furrows, then curves broadly round the metabranchial lobes. A distinct depression bounded by a ridge behind the epi-mesobranchial lobes indicates the course of the branchiocardiac furrow. The poorly defined mesogastric lobe is vaguely bilobed basally. On the protogastric lobes a low node anteriorly lies on line with an equally low, hourglass-shaped node on the epi-mesobranchial lobes. A rather wide, laterally depressed urogastric lobe is barely separated from the pentagonal cardiac region which has three tubercles in an inverted triangle. Deep pits mark the attachment of the attractor epimeris muscles. The dorsal surface is smooth anteriorly, the branchial region being lined with several rows of very fine ridges.

**Discussion.** — As preserved, the carapace of the present species has much in common with *Dromiopsis laevior* (see e.g. Segerberg 1900), but that species differs in having a much weaker cervical furrow, the nodes on the epi-metabranhial lobes are absent while those on the protogastric lobes are suppressed, the posterior ornament is also wanting.

**Occurrence.** — Confined to the upper Meerssen Member (Maastricht Formation, *B. casimirovensis* Zone) of Maastricht.

### *Dromiopsis mosae* sp. n.

Fig. 7A–F.

*Dromiopsis elegans* (Steenstrup & Forchhammer, MS) Reuss; Pelseneer 1886: p. 172.

*Dromiopsis elegans*, Steenstrup et Forchhammer sp.: Forir 1887b: p. 173.

Holotype: Institut royal des Sciences naturelles de Belgique (Brussels) Collections, no. T 10653 (IG 4285, Bosquet Collection).

Type horizon and locality: Maastricht Formation, lower part of Meerssen Member inferred, late Maastrichtian (*B. junior* Zone); Sint Pietersberg, south of Maastricht (The Netherlands).

Derivation of name: from the region of the River Maas (Meuse).

**Material.** — A single paratype (IRSNB, no. T 10654 [IG 4285]) in the collections of the Institut royal des Sciences naturelles de Belgique at Brussels.

**Diagnosis.** — Carapace almost circular in outline with sublobate antero-lateral margins; the cervical furrow weakens laterally and the dorsal surface is sparsely tuberculate.

**Description.** — The carapace is almost circular in outline, moderately arched transversely, in longitudinal section it is moderately rounded to midlength, slightly depressed and flattened, then strongly curved to the posterior margin. The orbitofrontal width occupies about two thirds of the carapace width. Viewed from above, the front appears bifid, but the broadly triangular rostrum is steeply downturned with raised sides leading smoothly into the upper orbital margins, inclined at about 38° to the midline, to a vague notch at which point the margin becomes concave to

the rounded outer angle. The orbits are deep and narrowly ovate and the lower margin extends a little beyond the upper. The anterolateral margin is lined with three elongate, bluntly bifid spines increasing in basal length posteriorly. A much narrower spine lies behind the cervical notch and a similar one is situated mid distant to the branchiocardiac notch. The posterolateral angles are weakly concave before the rather sharp posterior angle and the nearly straight, thin posterior margin is bounded by a groove and a low rim.

The furrows are well defined; the cervical crosses the midline in a shallow curve a little more than half the distance from the front, weakening, it extends slightly forward and outward before turning gently to the lateral margin. Crossing the margin it turns down at which point it curves sharply forwards and downwards to join the branchiocardiac furrow and continues to the front. A low ridge borders the branchiocardiac furrows as far as their downward curve towards the base of the cardiac region. The postcervical, separating the epi- and metabranchial lobes, is represented by a vague depression terminating in deep grooves bounding the lateral extremities of a rather narrow urogastric lobe. The urogastric is separated by a groove from the rounded pentagonal cardiac region. The mesogastric and protogastric lobes are weakly delineated and the tip of the anterior mesogastric process extends to the base of circular epigastric lobes which are scarcely larger than the scattering of tubercles over the front and lateral parts of the dorsal surface.

**Discussion.** — The original labels preserved with the present specimens clearly indicate that they are those considered by early authors of Maastrichtian crabs to be *Dromiopsis elegans* Reuss 1859. That species, however, assumes a more transversely ovate carapace (Fischer-Benzon 1866; Segerberg 1900) as growth advances; young forms are readily distinguished from *D. mosae* by absence of dorsal tuberculation, in having almost smooth anterolateral margins or with four faint granules and four marginal granules between the cervical and branchiocardiac furrows. *Dromiopsis* cf. *rugosa* (von Schlotheim 1820) has been recorded from the early Santonian and late Campanian of Misburg, near Hannover (Germany; Förster 1975). It differs from *D. mosae* in having deeper furrows and more strongly developed postcervical furrows. Although the surface ornament is variable amongst Danian specimens of *D. rugosa*, the granules are relatively smaller and more widely distributed. The carapace of *D. minor* Fischer-Benzon 1866 is similar in outline to that of *D. mosae*, but the furrows are more pronounced, and the branchiocardiac furrows, not bounded by a ridge, more closely approach the cardiac region. *Dromiopsis granulata* Collins & Rasmussen 1992 (Collins & Rasmussen 1992: p. 14, fig. 7a–d), from the Maastrichtian of West Greenland, and *D. americana* Roberts 1956, from the Palaeocene of New Jersey, both have subpentagonal carapaces, that of *D. granulata* having sharp lateral edges, while the cervical furrow of *D. americana* becomes obsolete towards the lateral margin.

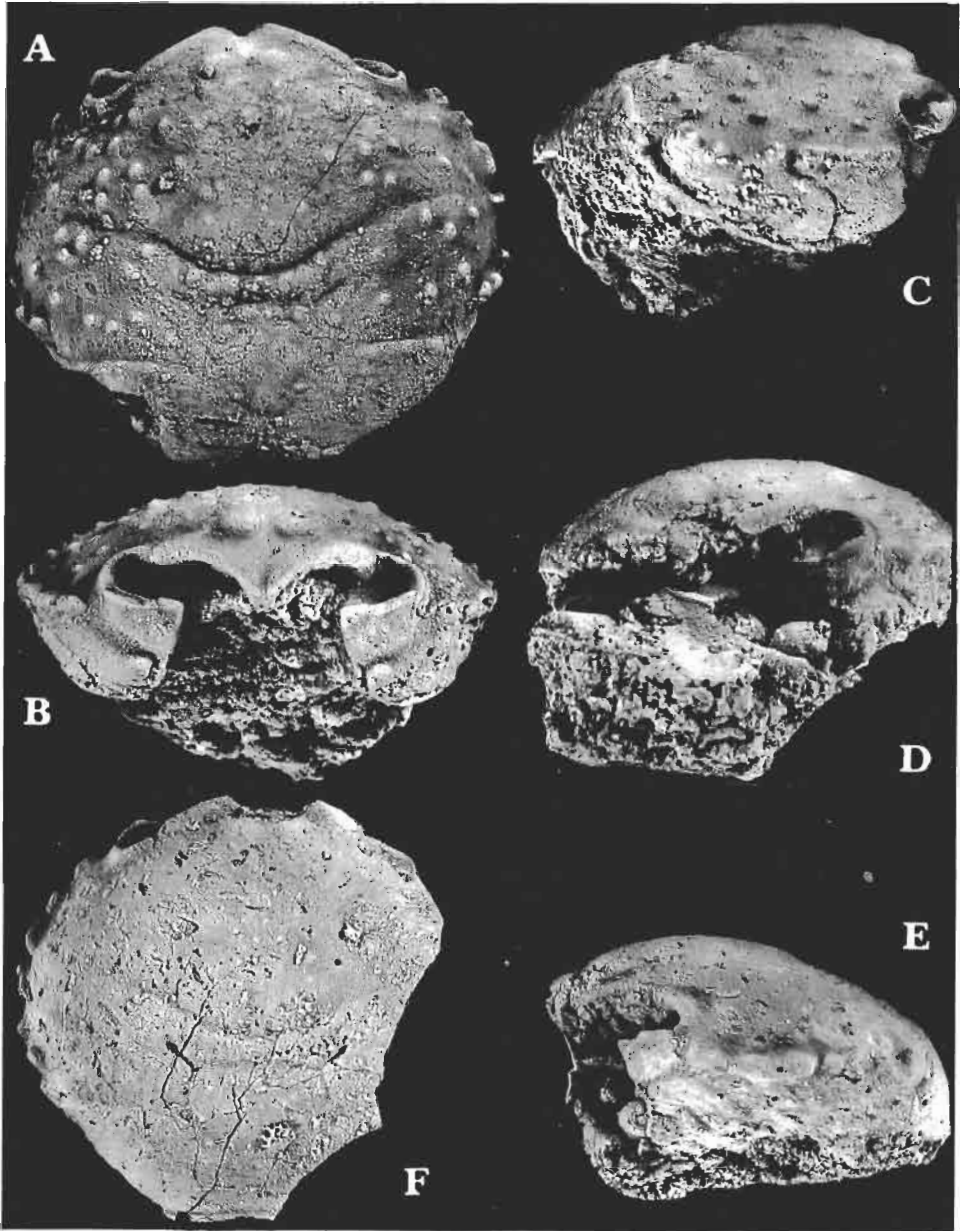


Fig. 7. Late Maastrichtian decapod crustaceans from The Netherlands and Belgium. □A-F. *Dromiopsis mosae* sp. n., holotype IRSNB T 10653 [IG 4285], dorsal, frontal and lateral aspects of carapace (A-C); paratype IRSNB T 10654 [IG 4285], frontal, lateral and dorsal views of carapace (D-F),  $\times 4$ .

Differences in ornament displayed by the holotype and paratype of *D. mosae* are a matter of preservation, the holotype apparently having been collected from an indurated portion of one of the many bryozoan hash

deposits which characterise the lower part of the Meerssen Member, and the paratype presumably from a less-indurated, coarse-grained portion, having been subject to abrasion.

**Occurrence.** — Apparently confined to the middle part of the Meerssen Member (top *Belemnitella junior* Zone/base *Belemnella casimirovensis* Zone) of the Maastricht Formation of Maastricht.

Subsection Archaeobrachyura Guinot 1977

Superfamily Homoloidea de Haan 1839

Family Homolidae de Haan 1839 (ICZN Opinion 1987)

Genus *Homolopsis* Bell 1863

Type species: *Homolopsis edwardsi* Bell 1863, by monotypy.

*Homolopsis declinata* sp. n.

Fig. 8A, B.

Holotype: Geo Centrum Brabant Collections, no. MAB k.1006.

Type horizon and locality: Maastricht Formation, upper third Meerssen Member, latest Maastrichtian, *Belemnella casimirovensis* Zone; ENCI NV quarry, Maastricht (The Netherlands).

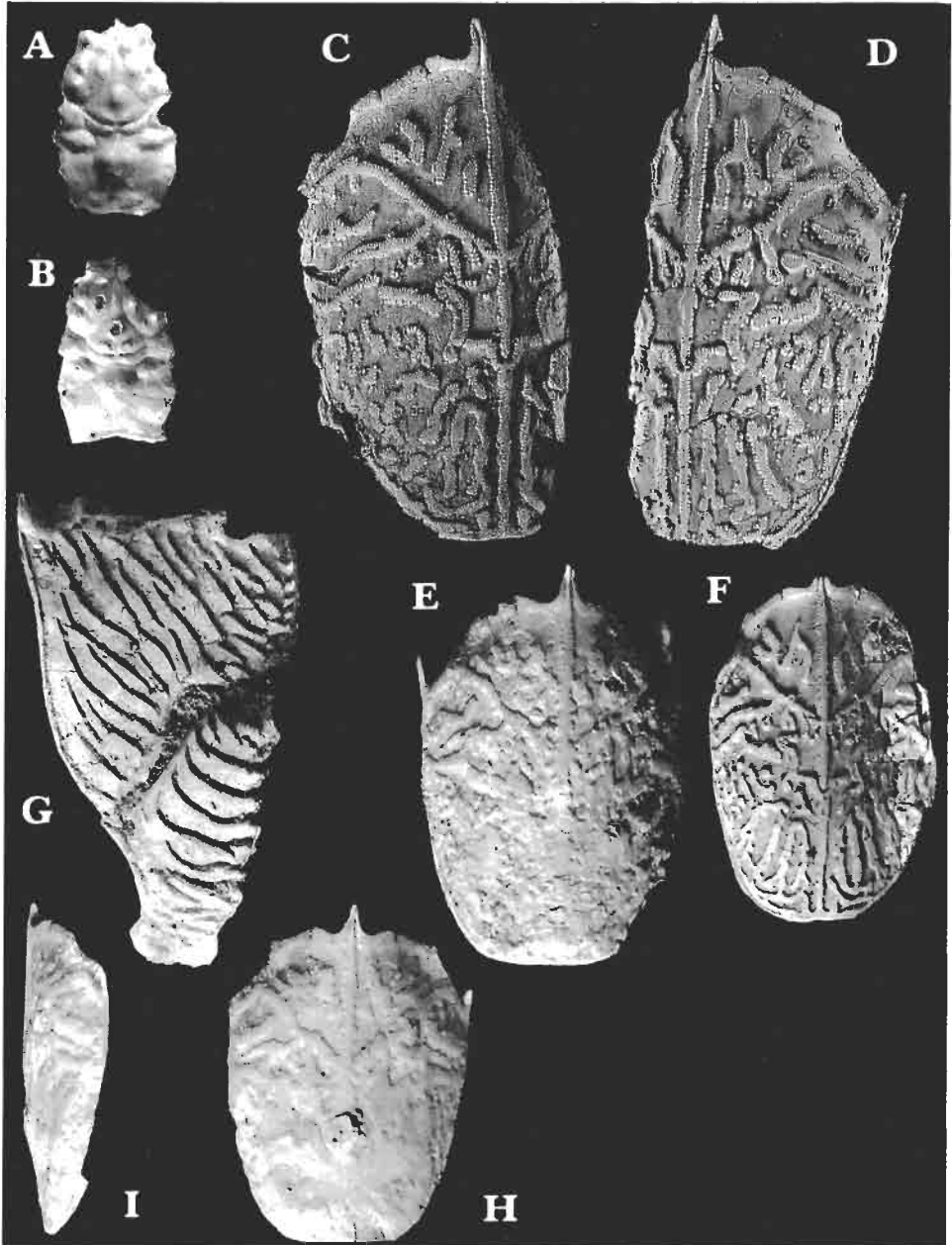
Derivation of name: alluding to the diverging posterolateral margins.

**Material.** — Paratypes: Geo Centrum Brabant Collections, nos. MAB k.0729, k.0818, k.0845 and k.1005. Two specimens in the Jagt Collection.

**Diagnosis.** — Carapace broadening posteriorly, regions steeply demarcated, urogastric lobe small and bilunate laterally.

**Description.** — Carapace strongly arched in longitudinal section, rising steeply from the front to its maximum height at the mesogastric lobe, and moderately rounded in transverse section; the width about four fifths of the length, widest about two thirds distant from the front. The orbitofrontal margin is narrow, occupying a little less than half the carapace width, of which the orbits take up the outer thirds. A long, narrow rostrum extends almost straight from the frontal margin; thickened sides, producing a sulcate appearance, curve smoothly back to the upper orbital margins, set slightly oblique to the midline, to a sharply spinose outer angle. Short anterolateral margins lead to a shallow, rather long cervical notch and convex posterolateral margins diverge posteriorly as growth advances to narrowly rounded posterior angles; the posterior margin is wider than the front and bounded by a ridge. The cervical furrow is weakly convex where it crosses the midline at about half carapace length, then turns sharply forwards before curving round the hepatic region to reach the margin in a broad V-shaped depression; equally deep, transverse, convex branchiocardiac furrows reach the margin in a much shallower notch. A groove extending posteriorly from the rostral sulcus divides round the base of circular frontal lobes and continues to the margin. The narrow, parallel-sided anterior mesogastric process extends between the epigastric

Fig. 8. Late Maastrichtian decapod crustaceans from The Netherlands and Belgium. □A, B. *Homolopsis declinata* sp. n., holotype (♂) MAB k.1006, dorsal aspect of carapace (A), 3.5;



paratype (♀) MAB k.1005, dorsal aspect of carapace (B),  $\times 3$ . □C-I. *Eumorphocorystes sculptus* van Binkhorst 1857, IRSNB T 10655 [IG 4285], dorsal view of fragmentary carapace (C),  $\times 2$ ; IRSNB T 10656 [IG 4285], dorsal view of fragmentary carapace (D),  $\times 2$ ; MAB k.1027, dorsal view of carapace (E),  $\times 3$ ; NHMM 1993097, dorsal view of carapace (F),  $\times 1.5$ ; NHMM 001047, outer surface of right chela (G),  $\times 3$ ; MAB k.1026, dorsal and lateral views of carapace (H, I),  $\times 3$  (specimens of figs C and D were whitened with ammonium chloride prior to photography to bring out subtle differences in ornament).

lobes; the mesogastric lobe is lozenge shaped with a median tubercle and a low basal ridge on either side of the midline. The urogastric lobe is very narrow medially and the sides form narrow lunate ridges well separated from the tumid pentagonal cardiac region. Trapezoidal epibranchial lobes are depressed, bordered posteriorly by ridged mesobranchial lobes and a bluntly rounded ridge extending a short way onto the metabranchial lobes develops in larger specimens. There are three tubercles, the median the largest, on the small hepatic regions and three even-sized ones on each protogastric lobe. Minute punctae are scattered over the lobes; the furrows are smooth.

**Discussion.** — The diverging posterolateral margins, together with the steeply arched longitudinal section, and narrow orbitofrontal margin immediately distinguishes the present species from other known members of *Homolopsis*. The metabranchial ridge occurring on larger forms of *H. declinata* develops from a node near the margin not from the widest point of the cardiac region as in the genus *Hoplitocarcinus* Beurlen 1928 (= *Metahomola* Collins & Rasmussen 1992).

**Occurrence.** — Nekum and Meerssen members of Maastricht Formation (late Maastrichtian, *B. junior* and *B. casimirovensis* Zones) of Maastricht and Berg en Terblijt (The Netherlands) and Eben Emael (Belgium).

Superfamily Raninoidea de Haan 1841

Family Raninidae de Haan 1841

Subfamily Ranininae de Haan 1841

Genus *Eumorphocorystes* van Binkhorst 1857

Type species: *Eumorphocorystes sculptus* van Binkhorst 1857, by monotypy.

### *Eumorphocorystes sculptus* van Binkhorst 1857

Fig. 8C–I.

*pars* v. *Eumorphocorystes sculptus* Nob.: van Binkhorst 1857: p. 108, pl. 6 [2]: 1–3, 5 (*non* 4).

*Eumorphocorystes sculptus* Binkhorst; Glaessner 1929: p. 170 (with additional synonymy).

*Eumorphocorystes sculptus* Binkhorst; Glaessner 1969: p. R498.

*Eumorphocorystes sculptus* Binkhorst; Wright & Collins 1972: p. 78.

Holotype: Museum für Naturkunde der Humboldt-Universität Berlin Collections, no. MB.A. 240 (van den Binkhorst Collection).

Type horizon and locality: Maastricht Formation, Emael Member inferred; environs of Maastricht (no locality given).

**Material.** — Seven specimens in Geo Centrum Brabant Collections, IRSNB nos. T 10655–10657 (IG 4285), NHMM 001047, NHMM 1993097, and eleven specimens in the Jagt Collection.

**Description.** — Carapace subovate, about one fourth longer than wide, widest at base of the lateral spine, almost flat longitudinally and gently arched in transverse section. The orbitofrontal margin occupies rather more than two thirds of the carapace width; the front occupies the median third, on either side of the narrow, triangular rostrum the margin is transverse and weakly concave to a bluntly rounded inner orbital angle. The orbits are moderately oblique and ovate; there are two fissures in the

finely granulated upper orbital margin which is straight and inclined to bluntly rounded outer angles. Sinuous anterolateral margins terminate at a small, sharp, forwardly directed spine one fourth distant from the front. The posterolateral margins are slightly convergent for half their length, then curve abruptly to a narrow posterior margin.

A median carina in two parts has the anterior part terminating within a Y-shaped bifurcation of the posterior part; it is flat topped, the edges are undulate, more regularly so posteriorly and the almost vertical sides are steeper in the anterior part. On either side of the median carina the surface is covered in longitudinal and oblique ridges (cuticular terraces) with more or less lobate margins lined with granules. Although there is a general arrangement of these ridges they are not, as remarked by Savazzi (1981), while discussing *Ranina (Lophoranina)* spp., homologous amongst different specimens, nor bilaterally distributed on individuals; generally speaking, however, the most prominent ridge is that bordering the cervical furrow and this divides with the anterior branch lining the hepatic region. On each protogastric lobe is a tuning fork-like ridge with a short, curved ridge lateral to it; the epibranchial lobes have three anteriorly directed ridges the lowest uniting with one, parallel with the cervical ridge, on the mesobranchial lobe which also carries several irregularly shaped ridges; the metabranchial lobes carry a complex, irregular system of ridges, some forming loops, others nodes.

Both sides of all the ridges are lined with a complex system of granules; those on the forward facing edge of transverse and lateral-facing edge of oblique ridges are subfusiform and (on that particular section of ridge) of regular size; medially facing granules are also directed forwards, but are rounded and less regular in size, as are those on posterior facing edges.

The left and right chelipeds are typically raninid and similar to one another. The height of the propodus is about equal to the length, the upper margin is smooth to finely spinulate and half the length of the lower margin which is convex posteriorly, becoming straighter to a weak depression before the fixed finger. The fixed finger is curved, very short and pointed. On the outer surface, a fine ridge on the straight interdigital margin borders a depressed area. The carpal margin is deeply indented and oblique in its lower part. The surface ornament is of deep, convex and concave grooves obliquely arranged; a granulated ridge borders the upper margin and a smooth one extends along the lower margin onto the fixed finger. The length of the carpus is about twice its height; there is a blunt spine at the lower articulating facet.

**Discussion.** — Glaessner (1969) pointed out that, 'according to Pelseneer (1886) the drawing (of Binkhorst 1857) is incorrect in that it should show a ridged rostrum 4 mm long.' The specimen figured by Binkhorst van den Binkhorst (1861: pl. 9: 2b) has a well-preserved front including, part at least, of a rostrum; of this figure the outline of the anterolateral margin on the right-hand side is more reliable.

Wright & Collins (1972) were of the opinion that, 'the vermiform granular ridges' on the surface of the figured specimen (Binkhorst 1857: pl. 2: 1), 'are no more than the product of the weathering of a uniform test'. This is clearly not the case.

A more ovate outline, absence of cuticular terraces and stouter lateral spines at once distinguish *Eumorphocorystes naselensis* Rathbun 1926 from the present species. Recently found specimens of *E. naselensis* permitted Tucker & Feldmann (1990) to describe the sternum of that species and indeed of *Eumorphocorystes* for the first time. It differs from the fragment assigned above to *E. sculptus* in that its 1st–3rd elements are more triangular and separated by a more parallel-sided part from the 4th element the sides of which are not concave and the inserted secondary elements at the junction with the 5th element absent. If correctly placed, the sternum of *E. sculptus* would serve to isolate that species even further from *E. naselensis*. As preserved, the sternum attributed to the present species has, particularly in the secondary element at element 5, much in common with that of the genus *Laeviranina* Lórenthey 1929.

There has been considerable research into the functional morphology of cuticular terraces (e.g. Savazzi 1985, with additional bibliography) with regard to the burrowing habits of crabs. Carapaces with irregular, non-transverse, terraces, however, do not appear to have received attention.

Environmental conditions favourable to this species would appear to have existed in the neighbourhood of Sibbe (near Valkenburg aan de Geul) where adults occur in large numbers in the Emael and/or Nekum member. Only the occasional juvenile has been found at other localities, such as ENCI-Maastricht and Blom quarry. Near-complete carapaces, however, are extremely rare, most specimens being preserved as fragments, or slightly more than halves of carapaces, suggesting predation to be an important factor determining their preservation. R.M. Feldmann (personal communication) wonders whether the 'slightly-more-than-half' carapace preservation might be explained as soft moults having folded over upon themselves.

**Occurrence.** — Schiepersberg, Emael, Nekum and Meerssen members of Maastricht Formation (late Maastrichtian, *B. junior* and *B. casimirovensis* Zones) of Maastricht, Berg en Terblijt, Bemelen, and Sibbe (The Netherlands) and Eben Emael (Belgium).

### Genus *Raninoides* H. Milne Edwards 1837

Type species: *Ranina loevis* Latreille 1825, by monotypy.

### *Raninoides?* *quadriscopinosus* sp. n.

Fig. 9A–D.

Holotype: Geo Centrum Brabant Collections, no. MAB k.1010.

Type horizon and locality: Maastricht Formation, Meerssen Member, late Maastrichtian, *B. casimirovensis* Zone; ENCI NV quarry, Maastricht, The Netherlands.

Derivation of name: From the four spines present on the lower margin of the propodus.



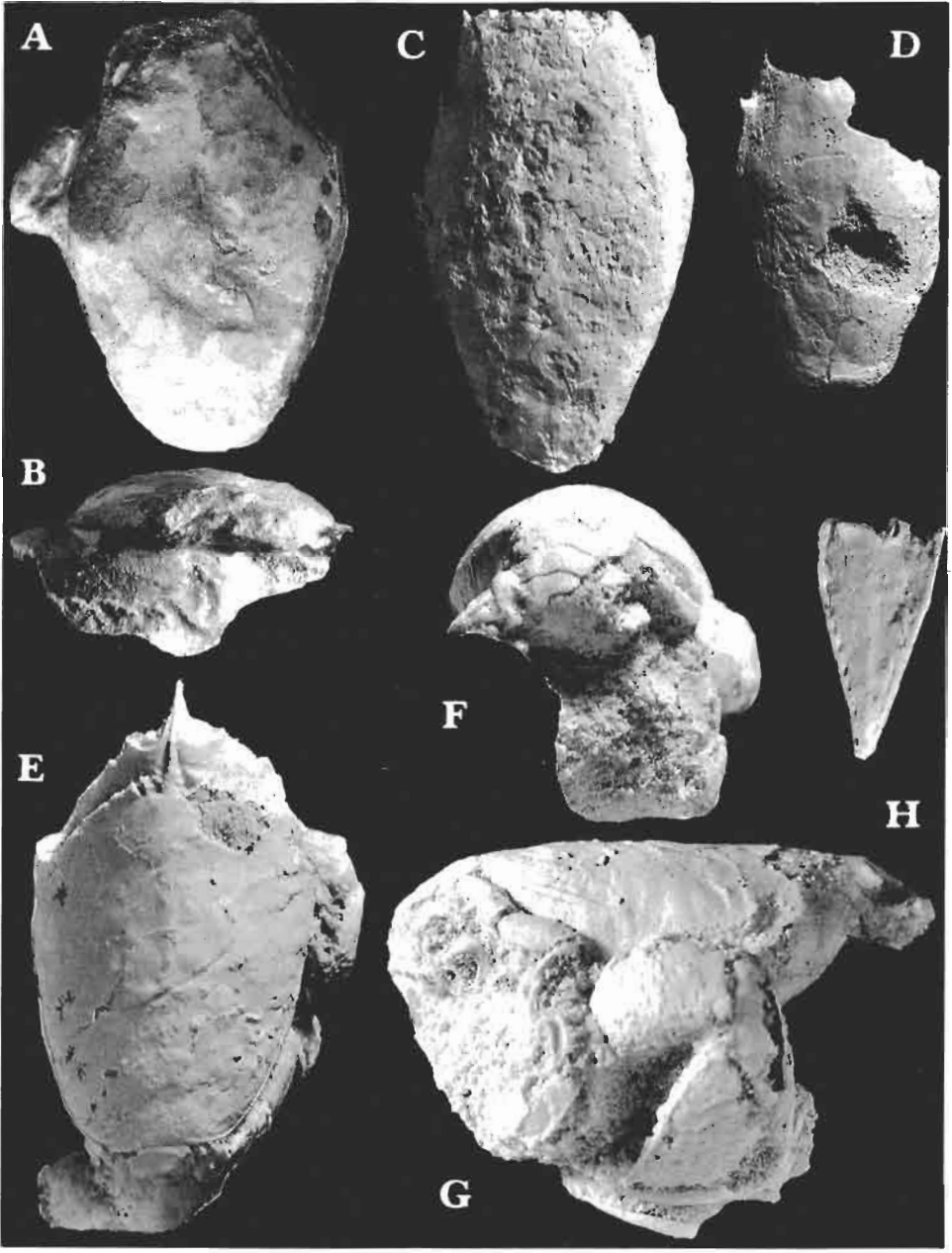


Fig. 9. Late Maastrichtian decapod crustaceans from The Netherlands and Belgium. □A-D. *Raninoides?quadrispinosa* sp. n., paratype MAB k.0813, dorsal view of carapace and frontal view of carapace and outer surface of right chela (A, B),  $\times 1.5$ ; holotype MAB k.1010, dorsal aspect of carapace (C),  $\times 3$ ; Jagt Collection, no. 7746, dorsal view of fragmentary carapace (D),  $\times 1.5$ . □E-H. *Pseudoraninella muelleri* (van Binkhorst 1857), MAB k.1024, dorsal, posterior and lateral views of carapace, chelae and abdomen (E-G),  $\times 3$ ; Jagt Collection, no. 6252, isolated paddle-shaped dactylus (H),  $\times 3$ .

**Material.** — Holotype is an almost complete carapace with well-preserved anterolateral spines; paratypes, a part cast/part decorticated carapace with remains of an articulated right cheliped, MAB k.0813 (donated by M. Machalski) and k.1003. Two additional specimens are in the Jagt Collection.

**Diagnosis.** — Carapace with two pairs of acicular spines; weakly convex transversely; four spines on the basal margin of the propodus, fixed finger abruptly downturned.

**Description.** — Carapace subovate about twice as long as wide, flattened in longitudinal section, gently arched transversely. The orbitofrontal margin occupies about half of the carapace width. As preserved, the outer part of the upper orbital margin has a sharp triangular spine between deep notches, the outer notch alongside a slender, slightly incurved spine at the outer angle. The orbits are transverse and broadly ovate. The rostrum is not preserved. The anterolateral margins are deeply scalloped to a short triangular spine about midlength, then convex to a slender, needle-pointed spine at the lateral angle a little before midlength. Anteriorly parallel, the posterolateral margins converge and become slightly concave toward rounded posterior angles and the posterior margin is broadly rounded. From the base of the outer orbital spine to the mid-antrolateral spine the dorsal surface is crowded with flattened, forward-facing spiny granules, the remaining surface is finely and evenly pitted.

Elements of the right cheliped are preserved almost entirely as an internal mould, the shell remaining in part of the more thickly calcified area around the spines and fingers. Propodus short, about twice as long as high; four evenly spaced spines line the lower margin between the carpus and the base of the fixed finger. The better preserved distal pair indicate they were sharply triangular; the fixed finger is stout, triangular, directed downwards at about 45°; the opposing margin has a large proximal cusp and a smaller one distally. The proportionally stout dactylus lacks definition.

**Discussion.** — The diagnostic features of the genus *Raninoides* are an elongate carapace with the greatest width behind the middle part, transversely convex, surface smooth, fronto-orbital border less than greatest width of carapace together with critical details of the sternum. Of carapace requirements, *R.?* *quadrispinosus* can be said to fulfil all but the transverse convexity. Other characters in common with *Raninoides* are the rounded posterior margin and propodus of the cheliped with a spinose basal margin together with the deflexed fixed finger. Although the majority of *Raninoides* species have only one pair of anterolateral spines, two pairs are present in *R. nitidus* A. Milne Edwards 1880, a species now assigned to the genus *Lyreidus* de Haan 1839 (Feldmann 1992). No sternites have yet been found associated with *R.?* *quadrispinosus*.

The specimens have characters shared with other raninid genera: in carapace outline, two pairs of anterolateral spines and form of cheliped, *R.?* *quadrispinosus* much resembles the genus *Lyreidus*, but differs in

having well-developed orbital notches, separated by a spine. The carapace of *Raninella* also agrees by and large with that of the present species, except that the posterior margin is generally well defined; the cheliped of *Raninella carlilensis* Feldmann & Maxey 1980 contrasts sharply in having relatively shorter propodus with a smooth basal margin and in being subchelate. Chelae preserved with specimen In. 63689 of *Raninella trigeri* A. Milne Edwards 1862 in the Natural History Museum (London), however, show the propodus to have a smooth basal margin distinctly concave before a sturdy, slightly downturned fixed finger.

**Occurrence.** — Valkenburg, Gronsveld, Emael, and Meerssen members of Maastricht Formation (late Maastrichtian, *B. junior* and *B. casimirovensis* Zones) of Maastricht.

Subfamily Notopodinae Serène & Umali 1972

Genus *Pseudoraninella* Beurlen 1930

Type species: *Notopocorystes muelleri* van Binkhorst 1857, by subsequent designation of Glaessner (1929).

### *Pseudoraninella muelleri* (van Binkhorst 1857)

Figs 9E–H, 10A–C.

*Notopocorystes Mulleri* nobis.: van Binkhorst 1857: p. 107, pl. 5[1]: 1 (non 2).

*Raninella mulleri* (Binkhorst): A. Milne Edwards 1862: p. 493.

*Raninella mulleri* (Binkhorst): Glaessner 1929: p. 369 (with additional synonymy).

*Pseudoraninella muelleri* (Binkhorst): Glaessner 1969: p. R500, fig. 311.2.

Holotype: Museum für Naturkunde der Humboldt-Universität Berlin Collections, no. MB.A. 238 (van den Binkhorst Collection).

Type horizon and locality: Maastricht Formation. Meerssen Member, late Maastrichtian (*B. junior* Zone inferred); near Valkenburg aan de Geul (southern Limburg, The Netherlands).

**Material.** — IRSNB no. T 10658 (IG 4285), nine specimens in Geo Centrum Brabant Collections, twenty-four specimens in the Jagt Collection.

**Description.** — Carapace, excluding rostrum, is about one third longer than wide, widest about midlength, boldly rounded in transverse section, gently so longitudinally. The orbitofrontal margin occupies about four fifths of the carapace width. The narrow rostrum, produced well beyond the outer orbital spines, is directed gently downwards; in dorsal view it is triangular and fortified by a strong median ridge broadening posteriorly and extending slightly beyond the transverse ridge bounding a conspicuous postfrontal depression. The median (antennal) part of the upper orbital margin is concave to a broad, flat triangular spine before the internal orbital notch, from the base of that spine two or three acicular spines increase in size before the similarly spinose margin extends posteriorly to the outer angle. The inconspicuous outer notch occurs rather more than half the distance to the outer angle. Deep, ovate orbits, strongly inclined downwards and outwards are slightly constricted medially; the lower margin is finely granulated. The orbital peduncles are long and circular in section. Sharply angulate anterolateral margins lead to a small, needle sharp lateral spine opposite, but isolated from the postfrontal ridge;

immediately behind the spine a lower, shorter ridge follows the angular curvature of the anterior one. A row of five or six minute, sharp triangular spines lines the shallow constriction of the margin behind the lateral spine after which the margin is gently convex to the nearly straight posterior margin.

Fine granules crowd the postfrontal depression and there is a scattering around a depressed area behind the lateral spine and on the subhepatic regions. Shallow indentations on either side of the midline mark the position of the posterior gastric muscles.

A broad ridge borders granulated pterygostomian processes and the buccal margins are concave; basiognath rectangular; ischiognath strongly curved and bordered by a groove along the outer margin, about twice as long as wide, broadening distally, the distal margin is deeply indented for articulation with the merognath; merognath parallel sided, about twice as long as broad, on its outer surface both margins are lined with a groove and the whole surface is coarsely granulate; the protognath (damaged) is rounded in cross section. The curved, slightly tapering exopodite is articulated at the extreme corner of the basiopodite and subtrapezoidal coxopodite and extends a little beyond the ischiognath.

The fused 1st/3rd sternal elements are broadly onion shaped; the thickened head of the 4th element is about twice the width of the base, the lateral margin, ending in a short spur, is deeply concave. The 5th element, separated by a transverse groove, is wider than the 4th, anteriorly the lateral margin is excavated to accommodate a short episternum, the deeply concave posterior margin is bounded by a ridge. The 4th elements have a scale-like ornament laterally, or there may be a ring of shallow pits on an otherwise smooth surface, the difference probably due to sexual dimorphism. The 5th have a median cleft extending to midlength and on either side are numerous scales each with a granulated fore edge obscuring a pit seen only when viewed from the front.

The 1st to 4th abdominal somites are more or less similar in length and width and divided longitudinally by broad depressions on either side of the midline, the median part being about twice the width of the outer parts. The sides of the 1st and 2nd are deeply embayed for the 5th pair of limbs.

The left and right chelipeds (Fig. 9G) are similar in size and form and are typically raninid. The propodus is almost as broad as high, the upper margin is about half the length of the lower, grooved along its upper edge and boldly curved to the carpal articulation. The lower margin is straight to gently convex and rimmed, there is no depression before the very short fixed finger; the opposing (interdigital) margin is convex and finely denticulate; the outer surface is evenly rounded and ornamented with fine granule-lined scales. The upper margin of the curved dactylus is tricarinate converging distally, the outer surface is rounded and sparsely granulate; the opposing margin is sharp. The carpus is triangular in section, length rather less than half the height, the upper margin is rounded, the

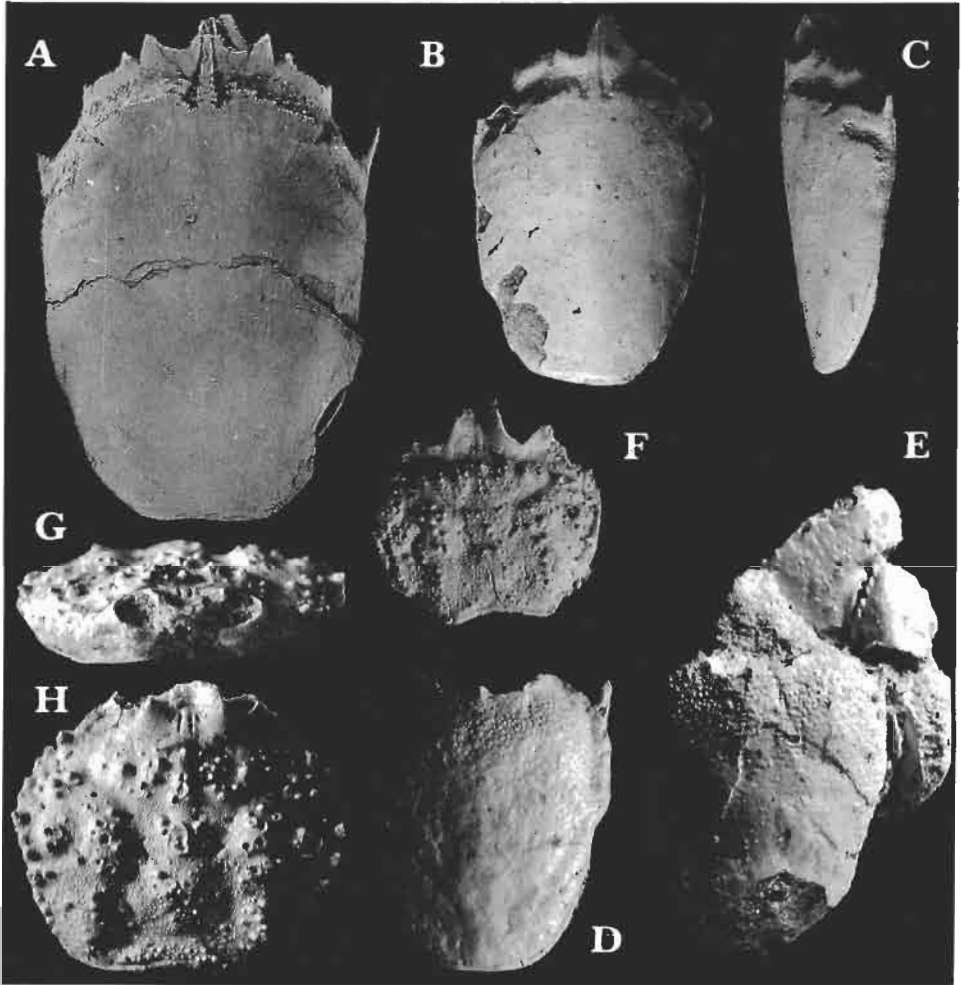


Fig. 10. Late Maastrichtian decapod crustaceans from The Netherlands and Belgium. □A–C. *Pseudorantnella muelleri* (van Binkhorst 1857), IRSNB T 10658 [IG 4285], dorsal aspect of carapace (A),  $\times 2$ ; MAB k.1028, dorsal and lateral aspect of carapace (B, C),  $\times 3$ . □D, E. *Ranilliformis occlusa* sp. n., holotype MAB k.1000, dorsal view of carapace (D),  $\times 3.3$ ; paratype MAB k.1002, dorsal view of carapace and right chela (E),  $\times 3$ . □F–H. *Paranecrocarcinus* (*Pseudonecrocarcinus*) *quadriscissus* (Noetling 1881), Jagt Collection, no. 6737, dorsal view of carapace (F); MAB k.1011 (G, H), frontal and dorsal view of carapace,  $\times 3$ .

lower margin nearly straight; outer surface ornamented similarly to the propodus.

Of the second to fifth legs, the paddle-shaped dactylus (Fig. 9H) is occasionally found isolated.

**Discussion.** — Despite considerable differences in the structure of the front between *Cosmonotus eocenicus* Beschin *et al.* 1988 from the middle Eocene of Italy, and *P. muelleri* there is a remarkable similarity in details of the sternites, in particular to the presence of episternites lateral to the

5th elements, and also in the shape of the chelae. There is a clear indication that *P. muelleri* is close to the extant genus *Cosmonotus* (see Goeke 1985), while *Raniliformis* is closely allied to the extant *Ranilia*.

An almost complete carapace (Geo Centrum Brabant Collections, no. MAB k.1036) found *in situ* in its burrow was lying at an angle of 32° to the substrate; the entire pleural suture and perfect juxtaposition of the mouthparts suggests it to be a corpse rather than a moult, and the position of the limbs further suggests that it died of natural causes rather than being overwhelmed.

**Occurrence.** — Nekum and Meerssen members of Maastricht Formation (late Maastrichtian, *B. junior* and *B. casimirovensis* Zones) of Maastricht, Berg en Terblijt and Bemelen (The Netherlands, Eben Emael (Belgium)).

Genus *Raniliformis* Jagt, Collins, & Fraaye 1993

Type species: *Raninella baltica* Segerberg 1900, by monotypy.

### *Raniliformis oclusa* sp. n.

Fig. 10D, E.

Holotype: Geo Centrum Brabant Collections, no. MAB k.1000 (donated by M. Deckers).

Type horizon and locality: Maastricht Formation, basal metre of Emael Member, late Maastrichtian, *B. junior* Zone; Marnebel 1, Eben Emael (Liège, Belgium).

Derivation of name: Latin *occluso*, to enclose, with reference to the embayed position of the rostrum.

**Material.** — Paratypes: Geo Centrum Brabant Collections, nos. MAB k.1001 and 1002, in addition to three specimens in the Jagt Collection.

**Diagnosis.** — Upper orbital margin smooth; dorsal surface granulate anteriorly.

**Description.** — The carapace is subovate, length, exclusive of the rostrum, a little more than the width, widest about one third distant from the front; boldly arched anteriorly in transverse section and more steeply inclined anteriorly in longitudinal section.

Short, well-rounded anterolateral margins extend beyond the rostrum and terminate behind in a small, sharp, forwardly directed spine. The lateral margins are almost parallel and weakly convex and the posterolateral margins converge to well-rounded posterior angles and posterior margin. The intestinal region interrupts a groove before a ridge which bounds the posterior margin, and, tapering, extends along the posterolateral margins. The orbitofrontal margin occupies half of the carapace width, the short, triangular rostrum has a median ridge and its sides curve shortly to the upper orbital margin which extends almost straight and a little forward to a bold step at mid-margin length, bringing the margin almost level with the rostral tip; the outer orbital margin is bluntly rounded. Broadly ovate orbits are directed steeply downwards and inwards. Numerous forwardly directed granules crowding the dorsal surface, become obsolete posteriorly and a pair of gastric pits occur close to the midline a little before midlength.

The 1st–3rd sternal elements are subtriangular with concave sides, the base of the 3rd expanded to the width of the 4th. The anterior part of the 4th is much wider than the base and the extended basal angles overlap the head of the large, triangular 5th elements which are deeply excavated basally to a narrow, sulcate median part, the sulcus continuing as a median cleft. The margins of the 4th are thickened with granules and large irregular pits are more numerous anteriorly. The 5th have similarly ornamented margins, a groove parallel to the basal margin is followed by a smooth ridge and a row of granules.

Elements of the chelipeds associated with specimen MAB k.1002 show a very short fixed finger in line with the basal margin which is bounded by a ridge. The (remaining) surface of the propodus is covered in groups of rather coarse granules forming short, overlapping rows. The dactylus is circular in cross section.

**Discussion.** — The generic position of *Raniliformis* was discussed by Jagt *et al.* (1993). *R. occlusa* has a greater width in proportion to length (from base of rostrum, c 82%) than has *R. baltica* (c 75%), but the orbitofrontal margin width in relation to the carapace width is much the same in both species, as is the angle of inclination of the orbits. The orbitofrontal margin of *R. occlusa* is smooth whereas that of *R. baltica* is finely granulate and the orbital notches are more clearly developed; the upper orbital margin from the rostrum to the inner notch is straighter in *R. occlusa* and the inner ‘step’ is steeper, the median section is shorter and straight while the outer ‘step’ is more angular. The surface ornament of *R. occlusa* consists of numerous coarse, forwardly directed granules which, in *R. baltica*, are grouped into short transverse cuticular terraces.

**Occurrence.** — Valkenburg and Emael members (Maastricht Formation, *B. junior* Zone) of Maastricht (The Netherlands) and Eben Emael (Belgium).

Section Heterotremata Guinot 1977

Superfamily Calappoidea de Haan 1833

Family Calappidae de Haan 1833

Subfamily Necrocarcininae Förster 1968

Genus *Paranecrocarcinus* van Straelen 1936

Subgenus *Pseudonecrocarcinus* Förster 1968

Type species: *Necrocarcinus quadriscissus* Noetling 1881, by monotypy.

### *Paranecrocarcinus* (*Pseudonecrocarcinus*) *quadriscissus* (Noetling 1881)

Figs 10F–H, 11A, B.

[unnamed]; Binkhorst van den Binkhorst 1861: pl. 9: 10a, b.

*Necrocarcinus quadriscissus* sp. n.; Noetling 1881: p. 368, pl. 20: 4a, b.

*Necrocarcinus* (?) *quadriscissus*, Nötl.; Pelseneer 1886: p. 174 [14].

*Dromiopsis Ubaghsi*, nobis.; Forir 1889: p. 452, pl. 14: 3.

*Necrocarcinus quadriscissus* Noetling; Glaessner 1929: p. 263.

*Pseudonecrocarcinus quadriscissus* (Noetling 1881); Förster 1968: p. 180, pl. 13: 3.

*Paranecrocarcinus* (*Pseudonecrocarcinus*) *quadriscissus* (Noetling 1881); Wright & Collins 1972: p. 71.

Holotype: Museum für Naturkunde der Humboldt-Universität Berlin Collections, no. MB.A. 239 (van den Binckhorst Collection).

Type horizon and locality: Maastricht Formation, Meerssen Member inferred, late Maastrichtian, *B. junior* Zone inferred; Valkenburg aan de Geul, The Netherlands.

**Material.** — Thirty-five specimens in Geo Centrum Brabant Collections and thirty specimens in the Jagt Collection.

**Description.** — The carapace is rounded pentagonal in outline, rather broader than long, widest a little anterior to midlength and gently arched in longitudinal and transverse sections. The anterolateral and posterolateral margins are drawn up into thin ridges, the lateral angle is broadly rounded and the margins are lined with granules. The posterior margin is wider than the orbitofrontal margin and bounded by a rounded rim. The front is broad and produced with a V-shaped median notch broadly rounded at its base and thin, upturned sinuous sides; from the bluntly rounded points of the V the margin is sinuous to a blunt spine where the margin thickens and extends straight to the first of two narrow fissures in the upper orbital margin. The forward-facing orbits are deep, there are two narrow fissures in the upper orbital margin and there is a weak spine at the outer orbital angle. The two halves of the cervical furrow commence at gastric pits on either side of the midline about mid-carapace length; equally deep hepatic furrows curve parallel to the anterolateral margins and delimit depressed, triangular hepatic regions. On either side of the midline at the rostrum are two pairs of slits, the outer pair oblique, the inner pair larger and parallel. Gastric and branchial lobes are weakly tumid and accentuated by a single or clusters of tubercles of varying diameters: the anteromesogastric process has a small tubercle and there are median clusters on the mesogastric, urogastric and cardiac lobes; a curving row is formed by two on each protogastric and a larger grouping on the epibranchial lobes, while another row, behind, is formed by two clusters on each metabranchial lobe and those on the urogastric region. While the general arrangement of these tubercles remains reasonably constant, the groupings vary among individual specimens. The dorsal surface between the tubercles is crowded with even-sized granules. On either side of the gastric pits are two others, evenly spaced, set on the branchial edge of the cervical furrow.

**Discussion.** — Förster (1968), while erecting *Pseudonecrocarcinus*, fully discussed the genus — apparently distinguished from *Paranecrocarcinus* by the presence of postrostral slits and more abundant and smaller tubercles — within the structure of *Paranecrocarcinus sensu lato*. Wright & Collins (1972: p. 69) considered these characters were insufficient to justify generic separation and treated *Pseudonecrocarcinus* as a subgenus of *Paranecrocarcinus*.

As the name implies, *Paranecrocarcinus* (*Ps.*) *biscissus* Wright & Collins 1972 (Wright & Collins 1972: p. 71, pl. 22: 6; text-fig. 10b) from the early Cenomanian of Wilmington (Devon, England) has only one pair of postros-



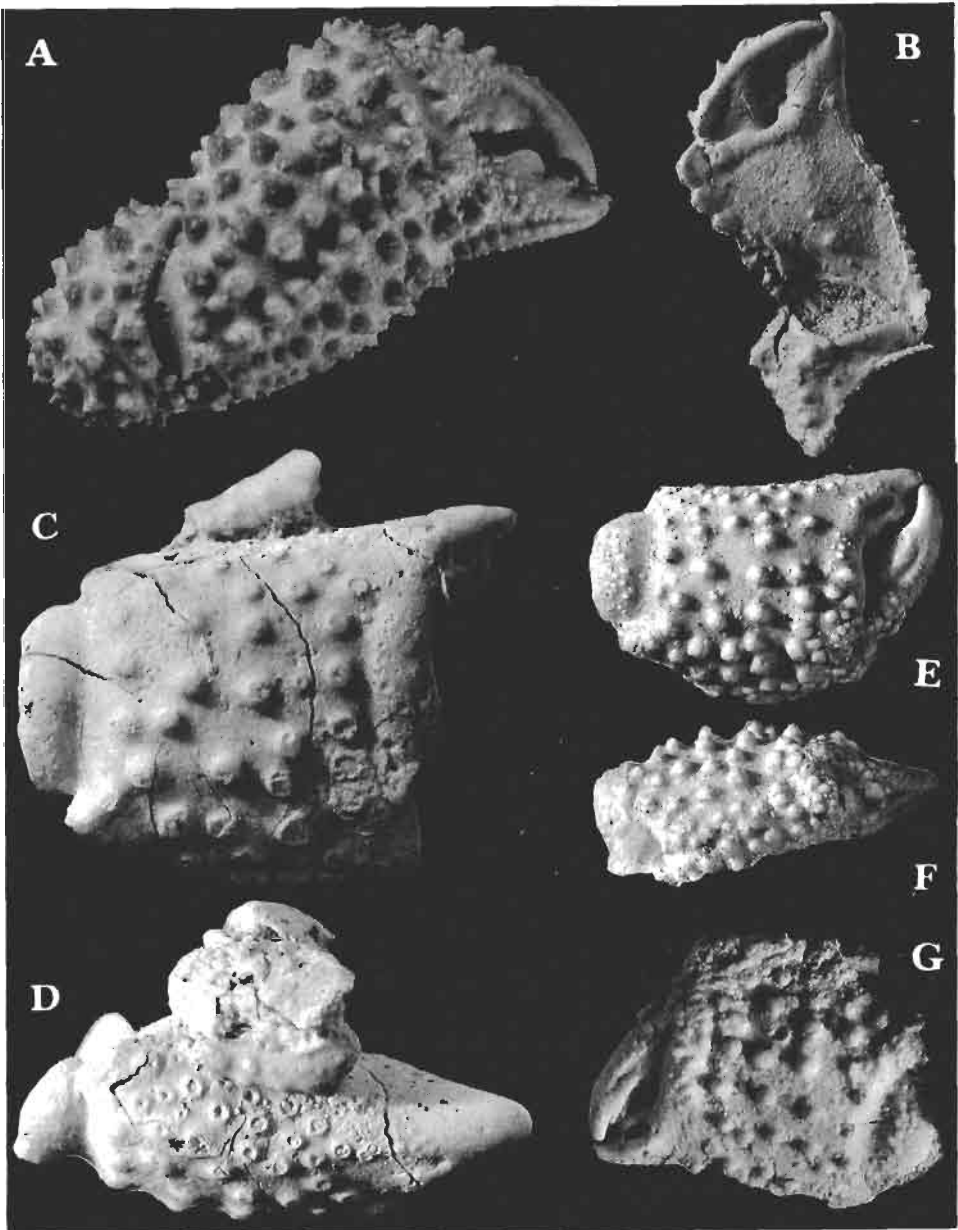


Fig. 11. Late Maastrichtian decapod crustaceans from The Netherlands and Belgium. □A, B. *Paraneocarcinus* (*Pseudoneocarcinus*) *quadriscissus* (Noetling 1881), Bayerische Staatssammlung für Paläontologie, München, BSP 1985I31, outer surface of right chela, × 8 (A); Jagt Collection, no. 7036, inner surface of left chela (B), × 2.5. □C–G. *Prehepatus werneri* Fraaye & Collins 1987, Dortangs Collection unregistered, outer surface and ventral margin of left chela (C, D); holotype MAB k.0017, outer surface and dorsal margin of left chela (E, F); MAB k.1037 (G), outer surface of left chela, × 3.

tral slits and this character readily distinguishes that species from *P. (Ps.) quadriscissus*; there is some homology in the distribution of the tubercles, however, and the species was considered by Wright & Collins (1972: p. 72) as a probable ancestor of the late Maastrichtian congener.

*Paranecrocarcinus (Ps.) digitatus* Wright & Collins 1972 (Wright & Collins 1972: p. 69, pl. 12: 7a–c; text-fig. 10a), also from the early Cenomanian of Wilmington, was described from four specimens all damaged about the postrostral area. Better-preserved carapaces reveal the presence of a single pair of slits in much the same position as in *P. biscissus*, and *P. digitatus* is here transferred to *Pseudonecrocarcinus*. It differs from *P. (Ps.) biscissus* in carapace outline and distribution of the dorsal tubercles.

*Pseudonecrocarcinus stenzeli* Bishop 1983 (Bishop 1983: p. 49, pl. 1: 3–5, text-fig. 8b) from the early Albian Glen Rose Limestone of central Texas was distinguished by its author from *P. quadriscissus* and *P. biscissus* in that the postrostral pits were not elongate and the carapace was smoother.

**Occurrence.** — Emael, Nekum and Meerssen members (Maastricht Formation, late Maastrichtian, *B. junior* and *B. casimirovensis* Zones) of Maastricht, Berg en Terblijt, and Bemelen (The Netherlands) and Eben Emael (Belgium).

Subfamily Matutinae Macleay 1838

Genus *Prehepatus* Rathbun 1935

Type species: *Prehepatus cretaceous* Rathbun 1935, by original designation.

*Prehepatus weneri* Fraaye & Collins 1987

Fig. 11C–G.

*Prehepatus weneri* n. sp.; Fraaye & Collins 1987: p. 549, figs 1, 2.

Holotype: Geo Centrum Brabant Collections. no. MAB k.0017; paratypes MAB k.0018–19.

Type horizon and locality: Maastricht Formation, middle part of Meerssen Member, late Maastrichtian, *B. junior* Zone; Blom quarry, Berg en Terblijt (Valkenburg aan de Geul, The Netherlands).

**Material.** — Geo Centrum Brabant Collections, nos. MAB k.1037–1038, Dortangs Collection, unregistered.

**Discussion.** — This species was originally founded on details of the outer surface of a left cheliped, a fragmentary fixed finger and dactylus. It is now possible to describe in detail the left claw. No right claws are yet known.

**Description.** — MAB k.1037 is much the same size as the type, while the unregistered specimen in the Dortangs Collection is about 1.5 times larger. The propodus is flatly ovate in transverse section, being rather more boldly curved on the outer surface. There is a slight deviation in tubercular ornament from the type, but well within specific limits. The well-rounded upper surface is lined with two rows of even-sized granules and another two transverse the upper part of the inner surface. The median part of the inner surface is lined with fine granules becoming stronger as the rows progress round the lower margin. The inner part of the occlusal margin is

thickened, the ridge flattening along the interdigital margin. There is a tripartite cusp proximal on the occlusal margin. The dactylus is smooth on its inner surface with a median groove lined with setae pits proximally.

Bishop (1985) separated the known species of the genus into two lineages, the group of *Prehepatas hodgesi* Bishop 1983 and that of *P. cretaceous*. The new details do not affect the opinion of Fraaye & Collins (1987) regarding the association of *P. werneri* with the latter group.

**Occurrence.** — Apparently confined to the Meerssen Member (Maastricht Formation, late Maastrichtian, *B. junior* and *B. casimirovensis* Zones) of Maastricht, Berg en Terblijt and Bemelen.

Superfamily Portunoidea Rafinesque 1815

Family Carcineretidae Beurlen 1930

Genus *Binkhorstia* Noetling 1881

Type species: *Dromilites Ubaghsii* van Binkhorst 1857, by monotypy.

### *Binkhorstia ubaghsii* (van Binkhorst 1857)

Fig. 12A–C.

*Dromilites Ubaghsii* Nobis.; van Binkhorst 1857: p. 109, pl. 5[1]: 3.

[unnamed]; Binkhorst van den Binkhorst 1861: pl. 9: 9a, b.

*Binkhorstia Ubaghsii* v. Binkhorst sp.; Noetling 1881: p. 365, pl. 20: 3.

*Binkhorstia Ubaghsi*, Binkh. sp.; Pelseneer 1886: p. 174 [14].

non *Dromiopsis Ubaghsi* sp. n.; Forir 1889: p. 452, pl. 14: 3 [= *Paranecrocarcinus* (*Pseudonecrocarcinus*) *quadriscissus* (Noetling 1881)].

*Binkhorstia Ubaghsii* (Binkhorst); Glaessner 1929: p. 65 (with synonymy).

Holotype: Institut royal des Sciences naturelles de Belgique (Brussels) Collections, no. T 10659 (IG 6521, Ubaghs Collection).

Type horizon and locality: Maastricht Formation, Meerssen Member ('oberste Bryozoen-schicht'), latest Maastrichtian, *B. junior* Zone inferred: Valkenburg aan de Geul (The Netherlands).

**Material.** — Twelve specimens in Geo Centrum Brabant Collections and twenty-three specimens in the Jagt Collection.

**Diagnosis.** — Rostrum produced, spatulate; mesobranchial lobe much smaller than the epibranchial lobe; dorsal surface finely granulate and tuberculate.

**Description.** — Carapace quadrate in outline, widest across the anterior third, weakly convex transversely and longitudinally. The downturned rostrum is produced and spatulate, its sides curving to a rounded obliquely directed 'spine' on the upper orbital margin followed by a sulcus at the same angle. There follows a rounded lobe, a brief notch, then a lower flatter lobe leads to a steeply angled outer orbital spine shorter than the rostrum. From the rostral apex to the 'spine' the margin is thin and flat, then the upper orbital margin rises and thickens slightly toward the outer spine. The edges of the gently curved anterolateral and lateral margins are sharp, slightly upturned anteriorly and the sides are near-vertical. Broadly rounded posterior angles leading to the concave posterior margin are bounded by a groove and a ridge leading from the lateral edges. There is a low granule on the epigastric margin, a prominent one on the hepatic

margin and a third behind the cervical notch. Very small posterior gastric pits lie close to the midline and from them the cervical furrow expands obliquely to the outer angle of the mesogastric lobe, weakens to a pit opposite the epibranchial lobe, curves round that lobe and turns obliquely to the margin. A very short furrow defines the small, triangular hepatic region. The protogastric furrow extends toward the inner orbital margin notch. The anterior mesogastric process extends to the base of ovate frontal lobes occupying the base of the rostrum, and a transversely elongate median tubercle on the mesogastric lobe forms a line with a similar tubercle on each epibranchial lobe. Similar tubercles on each protogastric lobe are in line with a round tubercle on the hepatic regions and another row is formed by a pair of round tubercles on the cardiac region and one on each metabranchial lobe. At the base of the mesogastric lobe a low granular ridge, interrupted medially, is coincident with a similar ridge forming the urogastric lobe delimited laterally by a number of pits marking the epimeral adductor muscle scars. The lingulate cardiac region sometimes carries in addition a pair of small granules at its base and the intestinal lobe is pentagonal in outline. The metabranchial lobe is comprised of three or four tubercles reducing in size in a curving row behind the rather large rounded epibranchial lobe. With the exception of the anterior part of the cardiac region the dorsal surface is covered with numerous fine granules increasing in size posteriorly.

**Remarks.** — Van Binkhorst's illustration (Binkhorst 1857: pl. 6: 3; see also Binkhorst 1861: pl. 9) since reproduced (*e.g.* Glaessner 1969: fig. 304/4) contains several anomalies, noticeable amongst which is the outline of the front and details of the mid-gastric region. Wright & Collins (1972: p. 91) compared *Binkhorstia* with *Withersella* Wright & Collins 1972 and considered it, 'to be best attached to Carcineretidae, rather than for example Tymolidae where it was placed by Glaessner (1969: p. R492)', but the outline of the front and surface details as originally depicted undoubtedly influenced Glaessner (1980) to include *Binkhorstia* in his new family Torymomidae (recte Torynommatidae, Art. 29(a), 29(b)(i), ICZN 1985), to which, indeed, Binkhorst's figure shows some resemblance. The front of the genus as now known, however, has much in common with that of *Withersella crepitans* Wright & Collins (Wright & Collins 1972: p. 91, pl. 19: 4, 5; text-fig. 13) — their figure somewhat hypothetical, having been constructed from imperfect specimens — and more so to recently collected specimens of that species which preserve an entire front (C.W. Wright personal communication December 1990).

The Carcineretidae is a widespread Cretaceous family of which *W. crepitans* from the early Aptian of the Isle of Wight is the earliest known member. *Carcineretes woolacotti* Withers 1922 (Withers 1922: p. 535, pls 16, 17) from the ?Turonian of Jamaica, has a trilobed orbitofrontal margin with an oblique inner fissure, but has a broad, almost straight rostrum, the transverse ridges are weakly developed and there are no dorsal tubercles. Although differing in frontal details, *B. ubaghsii* most closely

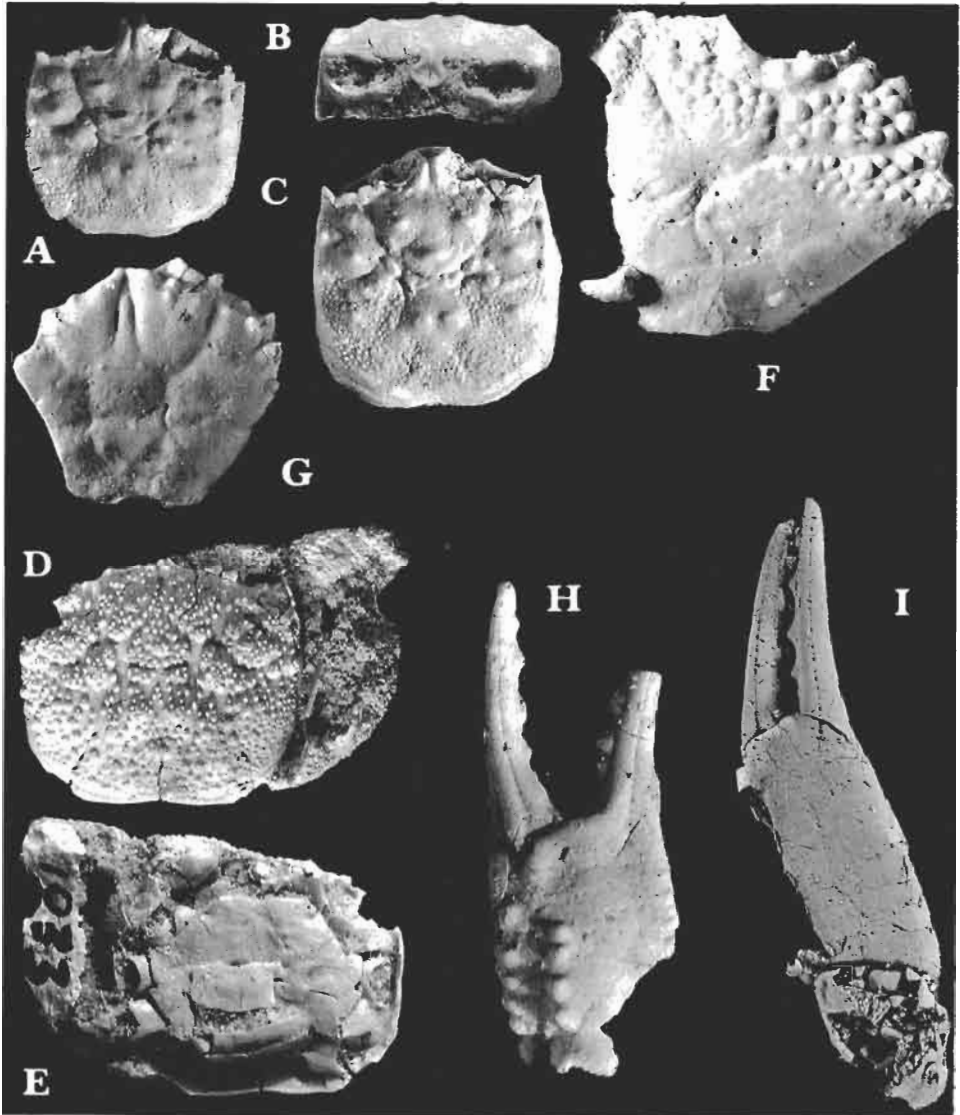


Fig. 12. Late Maastrichtian decapod crustaceans from The Netherlands and Belgium. □A–C. *Binkhorstia ubaghsii* (van Binkhorst 1857), Jagt Collection, no. 7325, dorsal view of carapace (A); MAB k.1009 (B, C), frontal and dorsal views of carapace,  $\times 3$ . □D, E. *Binkhorstia euglypha* sp. n., holotype MAB k.1033, dorsal view of carapace and sternum,  $\times 5$ . □F. *Xanthosia semiornata* Jagt et al. 1991, holotype MAB k.0020, dorsal view of fragmentary carapace,  $\times 2.5$ . □G. *Leptoides briarti* (Forir 1887), MAB k.1034, dorsal view of carapace,  $\times 5$ . □H, I. *Aulacopodia riemsdyki* Bosquet 1854, MAB k.1013, inner surface of right chela (H); ?holotype (labelled *A. leptida*) IRSNB T 10660 (IG 4285), outer surface of left chela (I),  $\times 3$ .

approximates *Ophthalmoplax stephensoni* Rathbun 1935 from the Upper Gulf Series of the USA in details of dorsal ornament, in which tubercles form ridges across the metabranchial, cardiac, protogastric and hepatic

lobes, but the ridge across the epibranchial and mesogastric lobes is represented only by a median mesogastric tubercle.

**Occurrence.** — Nekum and Meerssen members (Maastricht Formation, late Maastrichtian, *B. junior* and *B. casimirovensis* Zones) of Maastricht, Berg en Terblijt, and Bemelen (The Netherlands) and Eben Emael (Belgium).

*Binkhorstia euglypha* sp. n.

Fig. 12D, E.

Holotype: Geo Centrum Brabant Collections, MAB k.1033 (ex Jagt Collection).

Type horizon and locality: Maastricht Formation, upper part of Meerssen Member, latest Maastrichtian, *Belemnella casimirovensis* Zone; Blom quarry, Berg en Terblijt (Valkenburg aan de Geul, The Netherlands).

Derivation of name: Latin *euglypha*, meaning distinctly marked.

**Material.** — Paratype: NHMM 1993058; a single specimen in the Jagt Collection (donated by R. van Neer).

**Diagnosis.** — A species of *Binkhorstia* with the epi- and mesobranchial lobes sharply defined, almost equal-sized and parallel sided; the dorsal surface is coarsely granulated.

**Description.** — The carapace is essentially similar in outline to that of *B. ubaghsii*. Well-defined, curved epi- and mesobranchial lobes are of much the same size and parallel sided, sharply in contrast in size and outline difference seen in *B. ubaghsii*. The tubercles on the protogastric, hepatic, epi- and mesobranchial lobes, prominent in *B. ubaghsii*, are absorbed into the general coarse granulation of several diameters covering the dorsal surface, while the median mesogastric and cardiac tubercles are represented more or less by groups of granules.

The sternites are shallow with a weak median trough, presumably that of a female, narrow subtriangular 1st–3rd sternites are separated by a deep lateral cleft from the 4th sternites, the chela margin of which is near straight; the 5th–7th sternites are chordate in outline.

**Discussion.** — In their discussion of the early Aptian *Withersella creptans*, Wright & Collins (1972) stated that the notched posterior margin was a feature distinguishing that species from *Binkhorstia*; this feature possessed by *B. euglypha* (and to a less noticeable extent by *B. ubaghsii*), however, indicates a greater affinity between the two genera than hitherto suspected.

**Occurrence.** — Apparently confined to the Meerssen Member (Maastricht Formation, late Maastrichtian, *B. junior* and *B. casimirovensis* Zones) of Berg en Terblijt and Maastricht.

Superfamily Xanthoidea Macleay 1838

Family Xanthidae Macleay 1838

Genus *Xanthosia* Bell 1863

Type species: *Xanthosia gibbosa* Bell 1863 (= *Podophthalmus buchii* Reuss 1845) by subsequent designation of Glaessner 1929.

*Xanthosia semiornata* Jagt, Collins, & Fraaye 1991

Fig. 12F.

*Xanthosia semiornata* sp. nov.; Jagt *et al.* 1991: p. 556, fig. 3a–f.

Holotype: Geo Centrum Brabant Collections, no. MAB k.0020; paratypes, nos. MAB k.0021–0022.

Type horizon and locality: Maastricht Formation, lower part of Meerssen Member, late Maastrichtian, *B. junior* Zone; Ankerpoort-'t Rooth (Nekami) quarry, Bemelen (southern Limburg, The Netherlands).**Material.** — Seven specimens in the Geo Centrum Brabant Collections and four specimens in the Jagt Collection.**Discussion.** — The new material does not add anything further to the original description.**Occurrence.** — Apparently confined to the Meerssen Member (Maastricht Formation, *B. junior* and *B. casimirovensis* Zones) of Maastricht, Berg en Terblijt and Bemelen.Genus *Leptoïdes* n. gen.Type species: *Dromiopsis briarti* Forir 1887.Derivation of name: Denoting an early *Leptodius*, an allied genus.**Diagnosis.** — Carapace subhexagonal with the orbitofrontal margin abruptly advanced, front bilobed; regions moderately defined with steep fronted transverse ridges on protogastric, hepatic and epibranchial lobes.*Leptoïdes briarti* (Forir 1887)

Fig. 12G.

*Dromiopsis Briarti*, nobis.; Forir 1887a: p. 49, pl. 2: 8.*Dromiopsis briarti* Forir; Forir 1887b: p. 173.*Dromiopsis Briarti* Forir; Forir 1887c: p. 191.*Titanocarcinus briarti* (Forir); Beurlen 1928: p. 160.

Holotype: Université d'État à Liège, but its present whereabouts is unknown.

Type horizon and locality: Forir (1887a: p. 52) states 'dans le tufeau maestrichtien supérieur de Fauquemont (Pays-Bas)', e.g. the Meerssen Member (*Belemnitella junior* Zone inferred) of Valkenburg aan de Geul, The Netherlands.**Material.** — Two specimens (MAB k.0808 and k.1034) in the Geo Centrum Brabant Collections.**Diagnosis.** — As for genus.**Description.** — Carapace subhexagonal, one fifth broader than long, widest about mid carapace length; weakly convex in both longitudinal and transverse sections. The front occupies about half of the orbitofrontal margin which occupies two thirds of the carapace width and projects abruptly forward from short, rounded anterolateral margins; the median part of the transverse front is further extended and bilobed, its sides curve to rounded inner orbital angles. The orbits are inclined to a rounded external angle. The upper orbital margin is raised with two fissures and bounded by a broad depression. Basal scars indicate the presence of four spines or nodes on the anterolateral margin, and the first may well have softened the abrupt angle between the margin and the front; the third, largest spine is at the lateral angle. The lateral angle is broadly rounded,

the posterolateral margins are longer than the anterolateral and extend by well-rounded posterior angles to the slightly concave posterior margin which is about as wide as the extra-produced portion of the front. The cervical furrow is broad, shallow and almost transverse from the margin to its junction with the hepatic furrow, extends posteriorly and axially to the outer angle of the mesogastric lobe and is almost obsolete across the midline. Prominent steep-fronted epigastric lobes in line with the inner orbital angles are separated medially by a sulcus which divides round the apex of the anterior mesogastric process. A median fissure separates an inclined, steep-fronted ridge on each protogastric lobe, immediately behind and lateral to them a similar ridge is in line with another on each hepatic lobe. The large, reniform urogastric lobe is more clearly separated from the cardiac region than the rather small, triangular mesogastric lobe. The median forward margin of the epibranchial lobe is also steep fronted and little more than a depression separates that lobe from the mesobranchial lobe.

**Discussion.** — By and large, the present specimen agrees well with Forir's (1887a) description and also (with due allowance for artistic impression) the illustration. Steep-fronted ridges on the gastric region are, to a greater or lesser extent, a character shared by a number of xanthoid species assigned to the genera *Ozius*, *Leptodius*, *Panopeus* and allied taxa. Many have a bilobed, transverse front occupying between 2 to 3% of the carapace width and the position of the orbits may be transverse or inclined as in the present genus. Although none of the included species in those genera has the orbitofrontal area so abruptly produced as *Leptoides*, in the general form of that area and dorsal lobation, *Leptoides* more closely approximates *Leptodius*. One species in particular, *Leptodius exaractus* H. Milne Edwards 1834, has a produced front, noticeably inclined orbits, prominent epigastric lobes and corresponding ridges, but the urogastric lobe is smaller and, in common with members of the above-mentioned genera, the hepatic and epibranchial lobes are markedly subdivided.

*Titanocarcinus serratifrons* A. Milne Edwards 1863 from the late Cretaceous of southern Belgium (Mons Basin) differs in having a more obtuse orbital angle, no distinct groove bounding the upper orbital margin and a subpentagonal mesogastric lobe.

**Occurrence.** — Confined to the Meerssen Member (Maastricht Formation, *B. junior* and *B. casimirovensis* Zones) of Maastricht.

Incertae sedis

Genus *Aulacopodia* Bosquet 1854

Type species: *Aulacopodia riemsdyki* Bosquet 1854, by original designation.

*Aulacopodia riemsdyki* Bosquet 1854

Fig. 12H, I.

*Aulacopodia riemsdyki* nov. spec. 1853; Bosquet 1854: p. 135 [125], pl. 10: 11.

*Aulacopodia riemsdyki* Bosquet 1854; Jagt *et al.* 1991: p. 558, fig. 3g, h.



Holotype: A right chela and carpus, IRSNB no. T 10660 (IG 4285, Bosquet Collection), labelled *Aulacopodia lepida*, at the Institut royal des Sciences naturelles de Belgique at Brussels, agrees in size and general outline to Bosquet's figure (Bosquet 1854, pl. 10: 11) but lacks the longitudinal ridges. If this specimen is indeed that originally described by Bosquet, then it has subsequently been damaged along the upper margin.

Type horizon and locality: Maastricht Formation, Meerssen Member inferred, late Maastrichtian, *B. junior* Zone inferred; Sint Pietersberg, south of Maastricht (The Netherlands).

**Material.** — Five specimens in the Geo Centrum Brabant Collections and two specimens in the Jagt Collection.

**Description.** — The left and right claws are similar in size, the upper margin of the right somewhat straighter than the left. The propodus height is about half the length, with the upper and lower margins gently convex. The outer surface is flat to slightly concave to about level with the articulation with the dactylus where a row of fine granules extends parallel with the upper margin, immediately above is a deep groove followed by a row of coarser granules decreasing in size distally. The fixed finger is almost as long as the manus, gently downcurved and a little inclined inwards; along its length a groove lined with pits extends a little onto the manus. Of four cusps on the opposing the 1st–3rd increase in size distally and the 4th is reduced. The slender dactylus has a median groove and cusps on the opposing margin alternate with those on the fixed finger.

Of the inner surface, the upper margin is convex to the almost circular articular foramen; the lower margin is less strongly rounded; a groove extending the length of the fixed finger continues as a depression along the basal margin. The interdigital margin is straight and nearly vertical. There is a shallow depression before this margin and another extends parallel to the upper margin as far as the carpal foramen which is bounded by a groove; on the rim of the foramen is the first of four large tubercles directed towards the opposing margin and seven smaller tubercles extend parallel with the upper margin. The upper margin of the left dactylus is gently convex proximally, becoming more steeply curved toward the tip which is slightly inturned. There are a few pits along the midline and four or five even-sized, evenly spaced cusps line the opposing margin.

The convex upper margin of the carpus is about half the length of the manus and has two, or more, tubercles; with the claw in the folded position, a small node on the inner distal rim would coincide with the rim tubercle on the propodus.

**Discussion.** — Pelsener (1886) referred to a manuscript name of Bosquet's (viz. *Pseudomicippe granulosa*); thus, it could be that IG 4285, *A. lepida* is another of Bosquet's MS names referring to a species he considered distinct from *A. riemsdyki*. In which case, the original of that species has yet to be located.

**Occurrence.** — Nekum and Meerssen members (Maastricht Formation, *B. junior* and *B. casimirovensis* Zones) of Maastricht, Berg en Terblijt, and Bemelen.

## Acknowledgements

We wish to extend our best thanks to the following colleagues for assistance in various ways: S.F. Morris (formerly at The Natural History Museum London), Prof. Dr J.E. Meulenkamp, Prof. Dr G. van der Zwaan and W. den Hartog (Universiteit Utrecht), Prof. Dr G.J. Boekschoten (Vrije Universiteit Amsterdam), Dr A.V. Dhondt and A. Miseur (Institut royal des Sciences naturelles de Belgique, Bruxelles), Dr E. Pietrzeniuk (Museum für Naturkunde der Humboldt-Universität, Berlin), Dr L.B. Holthuis (Nationaal Natuurhistorisch Museum, Leiden), J.H.G. Peeters (Natuurhistorisch Museum Maastricht), B. van Bakel (Uden), M. van Birgelen (Ubachsberg-Voerendaal), G. Busch (Herzogenrath-Kohlscheid), Y. Coole (Stramproy), M. Deckers (Reuver), R. Dortangs (Amstenrade), L. Indeherberge (Zonhoven), E. Defour (Heusden-Zolder), P. van Knippenberg (Kessel), M. Kuypers (Ittervoort), M. Langeveld (Eindhoven), Dr M. Machalski (Instytut Paleobiologii PAN, Warszawa), E. Magnée (Heer), R. van Neer (Sittard), J. Reynders (Houthalen), M. Blom (Berg en Terblijt), J.C. van Veen (Teylers Museum, Haarlem) and the managements of ENCI NV Maastricht, Ankerpoort BV Maastricht, and CBR-Romontbos, Eben Emael. Prof. Dr R.M. Feldmann (Kent State University, Ohio) and Dr G.A. Bishop (Georgia Southern University) reviewed the typescript and offered helpful suggestions.

## References

- Adams, A. & White, A. 1848. Crustacea. In: A. Adams. *The Zoology of the Voyage of H.M.S. 'Samarang' under the command of Captain Sir E. Belcher during the years 1843–1848*. viii + 66 pp. London.
- Bell, T. 1863. A monograph of the fossil malacostracous Crustacea of Great Britain, 2. Crustacea of the Gault and Greensand. *Monograph of the Palaeontographical Society of London* **1863**, viii + 40 pp.
- Beschin, C., Busulini, A., Angeli, A. de. & Tessier, C. 1988. Raninidae del Terziario Berico Lessineo (Italia settentrionale). *Lavore della Società Veneziano di Scienza naturali* **13**, 155–215.
- Beurlen, K. 1928. Die fossilen Dromiaceen und ihre Stammesgeschichte. *Paläontologische Zeitschrift* **10**, 144–183.
- Beurlen, K. 1929. Parallelentwicklung und Iterationen bei Decapoden. *Paläontologische Zeitschrift* **11**, 50–52.
- Beurlen, K. 1930. Vergleichende Stammesgeschichte. Grundlagen, Methoden, Probleme unter besonderer Berücksichtigung der höheren Krebse. *Fortschritte in der Geologie und Paläontologie* **8**, 317–586.
- Binckhorst van den Binckhorst, J.T. 1861. *Monographie des Gastéropodes et des Céphalopodes de la Craie supérieure du Limbourg, suivie d'une description de quelques espèces de Crustacés du même dépôt crétacé, avec dix-huit planches dessinées et lithographiées par C. Hohe, de Bonn*. vi + 83 + 44 pp. A. Muquardt, Bruxelles/Muller Frères, Maastricht.
- Binkhorst, J.T. van 1857. Neue Krebse aus der Maestrichter Tuffkreide. *Verhandlungen des naturhistorischen Vereins im Preußischen Rheinland und Westfalen* **14**, 107–110.
- Bishop, G.A. 1983. Fossil decapod crustaceans from the Lower Cretaceous, Glen Rose Limestone of Central Texas. *Transactions of the San Diego Society of natural History* **20**, 27–55.
- Bishop, G.A. 1985. A new crab, *Eomunidopsis cobhani* n. sp. (Crustacea, Decapoda) from the Pierre Shale (early Maastrichtian) of Colorado. *Journal of Paleontology* **59**, 601–604.
- Bosquet, J. 1854. Les Crustacés fossiles du Terrain Crétacé du Limbourg. In: *Verhandelingen uitgegeven door de commissie belast met het vervaardigen eener geologische beschrijving en kaart van Nederland, Tweede deel*. 1–127 [10–137]. A.C. Kruseman, Haarlem.
- Burkenroad, M.D. 1963. The evolution of the Eucarida (Crustacea, Eumalacostraca), in relation to the fossil record. *Tulane Studies in Geology* **2**, 3–16.

- Checchia Rispoli, C. 1917. *Distefania*, nuove genere di Brachiuri del Cenomaniano della Sicilia. *Bollettino della Società geologica Italiana* **3**, 173–186.
- Collins, J.S.H. & Wienberg Rasmussen, H. 1992. Upper Cretaceous-Lower Tertiary decapod crustaceans from West Greenland. *Grønlands geologiske Undersøgelse Bulletin* **162**, 1–46.
- Dana, J.D. 1853. *United States exploring expedition during the years 1838, 1839, 1840, 1841, 1842 under the command of Charles Wilkes, U.S.N.* Crustacea. viii + 685 pp. C. Sherman, Philadelphia.
- Desmarest, A.G. 1822. *Histoire naturelle des crustacés fossiles, sous les rapports zoologiques et les crustacés proprement dits*. vii + 154 pp. L.T. Cellot, Paris.
- Fabricius, J.C. 1775. *Systema entomologicae, sistens insectorum classes, ordines, genera, species, adiectis synonymis, locis, descriptionibus, observationibus*. 832 pp. Libraria Kortii, Flensburgi et Lipsiae.
- Felder, W.M. 1975. Lithostratigrafie van het Boven-Krijt en het Dano-Montien in Zuid-Limburg en het aangrenzende gebied. In: W.H. Zagwijn & C.J. van Staalduinen (eds) *Toelichting bij geologische overzichtskaarten van Nederland*. 63–75. Rijks Geologische Dienst, Haarlem.
- Feldmann, R.M. 1992. The genus *Lyreidus* de Haan, 1839 (Crustacea, Decapoda, Raninidae): systematics and biogeography. *Journal of Paleontology* **66**, 943–957.
- Feldmann, R.M., Jagt, J.W.M., & Tshudy, D.M. 1990. Late Maastrichtian isopod and decapod Crustacea from Haccourt (Liège), northeastern Belgium. *Mededelingen van de Rijks Geologische Dienst* **44**, 23–35.
- Feldmann, R.M. & Maxey, M. 1980. *Raninella carlilensis*, a new raninid crab from the Carlile Shale (Turonian) of Kansas. *Journal of Paleontology* **54**, 858–861.
- Feldmann, R.M., Tshudy, D.M., & Thomson, M.R.A. 1993. Late Cretaceous and Paleocene Crustaceans from James Ross Island, Antarctic Peninsula. *Paleontological Society Memoir* **28**, 1–41.
- Fischer-Benzon, R. von 1866. *Ueber das relative Alter des Faxekalkes und über die in demselben vorkommenden Anomuren und Brachyuren*. 30 pp. Schweis'sche Buchhandlung, Kiel.
- Förster, R. 1968. *Paranecrocarcinus libanoticus* n. sp. (Decapoda) und die Entwicklung der Calappidae in der Kreide. *Mitteilungen der Bayerischen Staatssammlung für Paläontologie und historische Geologie* **8**, 167–195.
- Förster, R. 1975. Ein Krebs aus dem oberen Campan von Misburg. *Berichte der naturhistorischen Gesellschaft zu Hannover* **119**, 285–294.
- Forir, H. 1887a. Contributions à l'étude du système crétacé de la Belgique. I. Sur quelques poissons et crustacés nouveaux ou peu connus. *Annales de la Société géologique de Belgique* **14**, 25–56.
- Forir, H. 1887b. Contributions à l'étude du système crétacé de la Belgique. II. Études complémentaires sur les crustacés. *Annales de la Société géologique de Belgique* **14**, 155–175.
- Forir, H. 1887c. Contributions à l'étude du système crétacé de la Belgique. III. Bibliographie et tableau des thoracostracés crétacés décrits jusqu'à ce jour. *Annales de la Société géologique de Belgique* **14**, 176–195.
- Forir, H. 1889. Contributions à l'étude du système crétacé de la Belgique. IV. Troisième note sur des poissons et crustacés nouveaux ou peu connus. *Annales de la Société géologique de Belgique* **16**, 445–460.
- Fraaye, R.H.B. & Collins, J.S.H. 1987. A new crab, *Prehepatus wernert* (Crustacea, Decapoda) from the Maastrichtian of The Netherlands. *Journal of Paleontology* **61**, 549–551.
- Glaessner, M.F. 1929. Crustacea Decapoda. In: F.J. Pompeckji (ed.) *Fossilium Catalogus* **41**, 1–464. W. Junk, Berlin.
- Glaessner, M.F. 1969. Decapoda. In: R.C. Moore (ed.) *Treatise on Invertebrate Paleontology*, Part R, Arthropoda **4** (2). R 399–533, 626–628. Geological Society of America, Boulder/University of Kansas Press, Lawrence.

- Glaessner, M.F. 1980. New Cretaceous and Tertiary crabs (Crustacea: Brachyura) from Australia and New Zealand. *Transactions of the royal Society of South Australia* **104**, 171–192.
- Goeke, G.D. 1985. Decapod Crustacea: Raninidae. In: Résultats des Campagnes Musorstom, I & II. Philippines, 2. *Mémoires du Musée national d'Histoire naturelle, A. Zoologie* **133**, 205–228.
- Guinot, D. 1977. Propositions pour une nouvelle classification des crustacés décapodes brachyours. *Compte rendu hebdomadaire des Séances de l'Académie des Sciences (Paris)* **D285**, 1049–1052.
- Haan, W. de. 1833–1850. Crustacea. In: P.F. von Siebold. *Fauna japonica sive descriptio animalium, quae itinere per Japoniam jussu et auspiciis superiorum, qui summum in India Batavia Imperium tenent, suscepto, annis 1832–1830 cc legit, notis observationibus et adumbrationibus illustravit*. ix–xvi, 1–xxxI, vii–xvii + 243 pp. J. Muller, Amsterdam.
- International Code of Zoological Nomenclature* 1985, 3rd edition, 338 pp. H. Charlesworth & Co., Huddersfield.
- Jagt, J.W.M. (in press) Late Maastrichtian and early Palaeocene key index macrofossils from the Maastrichtian type area (SE Netherlands, NE Belgium). *Geologie en Mijnbouw*.
- Jagt, J.W.M., Collins, J.S.H., & Fraaye, R.H.B. 1991. A new late Maastrichtian xanthid crab from southern Limburg (The Netherlands). *Cretaceous Research* **12**, 553–560.
- Jagt, J.W.M., Collins, J.S.H., & Fraaye, R.H.B. 1993. A new early Palaeocene genus of raninid crab (Crustacea, Decapoda) from Denmark, southern Sweden and The Netherlands. *Contributions to Tertiary and Quaternary Geology* **30**, 177–182.
- Jagt, J.W.M. & Felder, P.J. (in press) The Campanian–Maastrichtian of the Maastrichtian type area (Netherlands) (B-3 Field excursion). *Mitteilungen aus dem Geologisch-Paläontologischen Institut der Universität Hamburg*.
- Jeletzky, J.A. 1951. Die Stratigraphie und Belemnitenfauna des Obercampan und Maastricht Westfalens, Nordwestdeutschlands und Dänemarks, sowie einige allgemeine Gliederungs-Probleme der jüngeren borealen Oberkreide Eurasiens. *Beihfte zum Geologischen Jahrbuch* **1**, 1–142.
- Latreille, P.A. 1802–1803. *Histoire naturelle générale et particulière des crustacés et des insectes*. 468 + 391 pp. F. Dufart, Paris.
- Latreille, P.A. 1825. *Familles naturelles du règne animal*. 570 pp. Paris.
- Lórenthey, E. 1929. Die fossilen Dekapoden der Länder der ungarischen Krone. *Mathematisch-naturwissenschaftliche Berichte aus Ungarn* **25**, 1–420.
- McLaughlin, P.A. & Holthuis, L.B. 1985. Anomura versus Anomala. *Crustaceana* **49**, 204–209.
- Macleay, W.S. 1838. On the brachyurous decapod Crustacea brought from the Cape by Dr. Smith. In: A. Smith. *Illustrations of the Zoology of South Africa*, 5. *Invertebratae*. 53–71. Smith, Elder & Co., London.
- Mertin, H. 1941. Decapode Kriebse aus dem subhercynen und Braunschweiger Emscher und Untersenon, sowie Bemerkungen über einige verwandte Formen in der Oberkreide. *Nova Acta Leopoldina*, neue Folge **10**, 149–264.
- Milne Edwards, A. 1862–1865. Monographie des crustacés fossiles de la famille des cancériens. *Annales des Sciences naturelles, Zoologie* **18**, 31–85 (1862); **20**, 273–324 (1863); **21**, 31–88 (1864); **22**, 297–351 (1865).
- Milne Edwards, A. 1880. Etudes sur les Xiphosures et les Crustacés de la région mexicaine. In: *Mission scientifique au Mexique et dans l'Amérique centrale, Recherches zoologiques de la Faune de l'Amérique centrale et Mexique* **5**, 1–368. Imprimerie nationale, Paris.
- Milne Edwards, H. 1834–1837. *Histoire naturelle des Crustacés, comprenant l'anatomie, la physiologie et la classification des ces animaux* **2**, 1–532. Roret, Paris.
- Moericke, W. 1899. Die Crustaceen der Stramberger Schichten. *Palaeontographica* (Suppl.) **2**, 43–72.
- Mulder, E.W.A. 1981. Bijdrage tot de karakterisering van de kreeft *Callianassa faujast* Desmarest. *Natuurhistorisch Maandblad* **70**, 170–174.

- Noetling, F. 1881. Ueber einige Brachyuren aus dem Senon von Mastricht und dem Tertiär Norddeutschlands. *Zeitschrift der deutschen geologischen Gesellschaft* **33**, 357–371.
- Nowak, J. 1913. Untersuchungen über die Cephalopoden der oberen Kreide in Polen. III. Teil. *Bulletin international de l'Académie des Sciences de Cracovie, Classe des Sciences mathématiques et naturelles* (B) **1913**, 335–415.
- Ortmann, A.E. 1892. Die Decapoden-Krebse des Strassburger Museums, 4. Die Abteilungen Galatheidea und Paguridea. *Zoologisches Jahrbuch* **6**, 241–326.
- Patrullius, D. 1960. Contribution à la systématique des décapodes néojurassiques. *Revue de Géologie et Géographie* **3**, 249–257.
- Pelseneer, P. 1886. Notice sur les crustacés décapodes du Maestrichtien du Limbourg. *Bulletin du Musée royal d'Histoire naturelle de Belgique* **4**, 161–175 [1–15].
- Rafinesque, C.S. 1815. *Analyse de la Nature ou Tableau de l'Univers et des Corps organisés*. 224 pp. Palermo.
- Rathbun, M.J. 1926. The fossil stalk-eyed Crustacea of the Pacific Slope of North America. *Bulletin of the United States National Museum* **138**, vii + 1–155.
- Rathbun, M.J. 1935. Fossil Crustacea of the Atlantic and Gulf Coast Plain. *Geological Society of America, Special Paper* **2**, 1–160.
- Reuss, A.E. 1845. *Die Versteinerungen der Böhmisches Kreideformation*. iv + 1–58 pp. Schweizerbart, Stuttgart.
- Reuss, A.E. 1859. Zur Kenntniss fossiler Krabben. *Denkschrift der königlichen Akademie der Wissenschaften zu Wien* **17**, 1–90.
- Roberts, H.B. 1956. Early Tertiary decapod crustaceans from the Vincentown Formation in New Jersey. *Bulletin of the Wagner Free Institute of Science* **31**, 5–12.
- Roberts, H.B. 1962. The Upper Cretaceous decapod crustaceans of New Jersey and Delaware. In: The Cretaceous fossils of New Jersey. *Bulletin of New Jersey Bureau of Geology and Topography* **61**, 163–191.
- Roemer, F.A. 1887. *Graptocarcinus texanus*, ein Brachyure aus der oberen Kreide von Texas. *Neues Jahrbuch für Mineralogie, Geologie und Paläontologie* **1**, 173–176.
- Ruiz de Gaona, M. 1943. El piso Maestrichtiense en Olazagutia (Navarra). *Boletín de Sociedad española Historia natural* (Madrid) **40**, 425–433.
- Samouelle, G. 1819. *The entomologist's useful compendium, or an Introduction to the knowledge of British Insects*, etc. 496 pp. T. Boys, London.
- Savazzi, E. 1981. Functional morphology of the cuticular terraces in *Ranina* (*Lophoranina*) (brachyuran decapods; Eocene of NE Italy). *Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen* **162**, 231–243.
- Savazzi, E. 1985. Functional morphology of the cuticular terraces in burrowing terrestrial brachyuran decapods. *Lethaia* **18**, 147–154.
- Schlotheim, E.F. von 1813. Beiträge zur Naturgeschichte der Versteinerungen in geognostischer Hinsicht. In: C.C. Leonhard. *Taschenbuch für die gesamte Mineralogie mit Hinsicht auf die neuesten Entdeckungen* **7**, 3–134. Frankfurt am Main.
- Schlotheim, E.F. von 1820. *Die Petrefaktenkunde auf ihrem jetzigen Standpunkte, durch die Beschreibung seiner Sammlung versteinertes und fossiler Überreste des Thier- und Pflanzenreiches der Vorwelt erläutert*. lxii + 437 pp. Becker, Gotha.
- Seeger, K.O. 1900. De anomura och brachyura dekapoderna inom Skandinaviens yngre krita. *Geologiska Förening i Stockholm Forhandlingar* **22**, 347–390 [1–42].
- Serène, R. & Umali, A.F. 1972. The family Raninidae and other new and rare species of brachyuran decapods from the Philippines and adjacent regions. *Philippian Journal of Science* **99** (1970), 21–105.
- Stimpson, W. 1858. Prodromus descriptionis animalium invertebratorum, quae in expeditione ad oceanum pacificum septentrionale, a republica federata missa cadwaldaro, ringgold er Johanne Rodgers, ducibus, observavit et descripsit, 7. Crustacea Anomura. *Proceedings of the Academy of Natural Sciences of Philadelphia* **10**, 225–252.
- Straelen, V. van 1936. Crustacés nouveaux ou peu connus de l'époque crétacique. *Bulletin du Musée royal d'Histoire naturelle de Belgique* **12**, 1–50.

- Straelen, V. van 1940. Crustacés décapodes nouveaux du Crétacique de la Navarre. *Bulletin du Musée royal d'Histoire naturelle de Belgique* **16**, 1–5.
- Straelen, V. van 1944. Anomoures et brachyures du Cénomaniens de la Navarre. *Bulletin du Musée royal d'Histoire naturelle de Belgique* **20**, 1–12.
- Taylor, J.D. 1981. The evolution of predators in the late Cretaceous and their ecological significance. In: P.L. Forey (ed.) *The Evolving Biosphere*, 229–240. Cambridge University Press, London.
- Tucker, A.B. & Feldmann, R.M. 1990. Fossil decapod crustaceans from the Lower Tertiary of the Prince William Sound region, Gulf of Alaska. *Journal of Paleontology* **64**, 409–427.
- Vermeij, G.J. 1977. The Mesozoic marine revolution: evidence from snails, predators and grazers. *Paleobiology* **3**, 245–258.
- Vía Boada, L. 1981. Les crustacés décapodes du Cénomaniens de Navarre (Espagne): premiers résultats de l'étude des Galatheidae. *Géobios* **14**, 247–251.
- Ward, P.D. & Kennedy, W.J. 1993. Maastrichtian Ammonites from the Biscay Region (France, Spain). *Paleontological Society Memoir* **34**, 1–58.
- Withers, T.H. 1922. On a new brachyurous crustacean from the Upper Cretaceous of Jamaica. *Annals and Magazine of natural History* **10**, 534–541.
- Wright, C.W. & Collins, J.S.H. 1972. British Cretaceous crabs. *Monograph of the Palaeontographical Society of London* **126**, 1–114.

## Streszczenie

Publikacja zawiera opisy trzech gatunków raków pustelników i szesnastu krabów ze stratotypowych odsłoneń mastrychtu na pograniczu Holandii i Belgii. Spośród pustelników dwa gatunki są nowe a z krabów siedem gatunków i jeden rodzaj. Zespół krabów zawiera zarówno kosmopolityczne jak i endemiczne gatunki. Najbardziej konserwatywnym ewolucyjnie rodzajem jest *Paragalathea*, znany od tytonu; połowa rodzajów jest znana również z wczesnej lub środkowej kredy, są to głównie formy kosmopolityczne. Poza raninidami, spośród których przynajmniej niektóre ryły w osadzie, kraby z mastrychtu holendersko-belgijskiego zasiedlały stosunkowo płytkowodne środowiska. Wysokie zróżnicowanie taksonomiczne późnokredowych pustelników i krabów jest wyrazem „morskiej rewolucji mezozoicznej”. Liczne ciągi ewolucyjne późnomastrychckich skorupiaków kontynuują się w paleocenie.

- Straelen, V. van 1940. Crustacés décapodes nouveaux du Crétacique de la Navarre. *Bulletin du Musée royal d'Histoire naturelle de Belgique* **16**, 1–5.
- Straelen, V. van 1944. Anomoures et brachyures du Cénomaniens de la Navarre. *Bulletin du Musée royal d'Histoire naturelle de Belgique* **20**, 1–12.
- Taylor, J.D. 1981. The evolution of predators in the late Cretaceous and their ecological significance. In: P.L. Forey (ed.) *The Evolving Biosphere*, 229–240. Cambridge University Press, London.
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