THE MIDDLE ORDOVICIAN
OF THE OSLO REGION, NORWAY

18. Rare trilobites of the families Olenidae, Harpidae, Ityophoridae and Cheiruridae

BY

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Abstract. Six rare trilobites from the Middle Ordovician of the Oslo region are described. The genus Frognaspis, related to the Swedish Ityophorus, is new, and so are the species Frognaspis stoermeri, Pseudosphaerexochus (Pseudosphaerexochus) bulbosus, P. (P.) densigranulatus, and the subspecies Paraharpes ottawaensis similis.

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Introduction

The present paper appears as No. 18 in a series dealing with the Middle Ordovician stratigraphy and fossils of the Oslo region. Team work on this subject was initiated by Professor Leif Störmer in 1950 and is supported by grants from the Norwegian Council for Science and the Humanities.

The term Middle Ordovician is taken in the sense defined by Störmer (1953), i.e. from and including the Llandvirnian zone of Didymograptus bifidus to and including the Caradocian zone of Discranograptus clingani.

The present paper gives descriptions of some relatively rare trilobites belonging to families which are poorly represented in the Middle Ordovician of Norway. The cheirurids have been treated in a previous paper (Nikolaensen 1961), but Pseudosphaerexochus (P.) densigranulatus n. sp. was not described at that time, and Pseudosphaerexochus (P.) bulbosus n. sp. was found in 1964.

The species are from various localities, but each species is known from one or two localities only. Some, viz. Frognaspis stoermeri n. gen., n. sp., are found in great abundance.

ABBREVIATIONS

The following abbreviations are used with the catalogue numbers:

P.M.O. = Paleontologisk Museum, University of Oslo, Norway
P.I.L. = Paleontologiska Institutionen, University of Lund, Sweden

Family Olenidae Burmeister, 1843

[= Leptoplastiidae Angelin, 1854]
Subfamily Triarthrinae Ulrich, 1930
[nom. transl. Kobayashi, 1935 (ex Triarthridae Ulrich, 1930)]
Genus Triarthrus Green, 1832

Type species: — Triarthrus beckii Green, 1832, by monotypy.
(According to Vogdes (1893) a junior synonym of Brongniartia carcinodea Eaton, 1832.)

Triarthrus humilis Hadding, 1913

Pl. 1, Figs. 1–5

1913 Triarthrus beckii Green var. humilis n. var. — Hadding, p. 69, Pl. VI, Figs. 18–19. (Description and Figs. of cranidium and young cranidium.)
1935 *Triarthrus beckii humilis* Hadding — THORSLUND in THORSLUND and ASKLUND, pp. 18, 58, Pl. II, Fig. 13. (Remarks and Fig. of cranidium.)

1953 *Triarthrus* sp. — STORMER, p. 103. (Recorded.)

1957 *Triarthrus beckii humilis* Hadding, 1913 — HENNINGSMOEN, p. 151. (Listed.)

*Type data:* — As *lectotype* the writer selects the cranidium (P.I.L. no. LO 2516 t) from Andersön in Jämtland, figured by HADDING (1913) Pl. VI, Fig. 18.

*Norwegian material:* — Several more or less complete pygidia are preserved at the Paleontological Museum in Oslo.

*Diagnosis:* — A *Triarthrus* species with: subquadrate, somewhat rounded cephalic axis with convex, indented front; S1 and S2 slightly curved, parallel, not united across glabella; S3 rather shallow, elongate, located nearer to axial line than to axial furrows; occipital furrow slightly composite; occipital ring with distinct axial node; preglabellar field very short; centres of palpebral lobes located opposite S2; fixigenae about half as wide as occipital ring; pygidium entire with five axial rings; librigenae, hypostoma, and thorax unknown.

*Remarks:* — The Norwegian specimens are preserved in limestone, and they show many details which cannot be studied in the Swedish type material, preserved in rather shaly and impure limestone. The whole cranidium is densely ornamented with extremely small nodes. S1 and S2 are deeply impressed and not shallow as originally described; S3, observed only in a few well-preserved specimens, are shallow, elongate scars located nearer to the axial line than to the axial furrows. The occipital furrow is slightly composite. The occipital ring is relatively wide (long.) at the axial line, but narrows rapidly laterally, and has a distinct axial node as mentioned by THORSLUND (1935). The preglabellar field is rather narrow. The posterior margins are almost straight, so that the postero-lateral corners are almost right-angled. However, the posterior border furrows are well-rounded at the postero-lateral corners. The palpebral lobes are well defined, and located opposite S2. A poorly preserved pygidium shows that the axis has five rings.

*Dimensions:* — The largest Norwegian specimen preserved is 4.6 mm wide and 3.3 mm long.

*Affinities:* — *T. humilis* Hadding, 1913, seems to be closely related to the Swedish Caradocian species *T. linnarssoni* Thorslund, 1940, but
differs from this in having the palpebral lobes located somewhat farther back and at a greater distance from the glabella.

The species was earlier referred to as a subspecies of *T. beckii* Green, 1832 (according to Vogdes, 1893, p. 358, a junior synonym of *T. carcinodea* Eaton, 1832), but *T. humilis* differs distinctly from *T. beckii*, e.g. in having the eyes farther from the glabella, and in having the posterior parts of the facial sutures more parallel to the axial line, and the writer considers it a valid separate species.


*Triarthrus* cf. *skutensis* Thorslund, 1940

*Pl. 4, Fig. 4*

**Norwegian material:** — Only one fragmentary cranidium is preserved at the Paleontological Museum in Oslo (P.M.O. no. 8910).

**Remarks:** — The cranidium resembles that of *T. skutensis* Thorslund, 1940, but differs slightly in having larger and more anteriorly situated eye lobes.

**Dimensions:** — The cranidium is 5.7 mm wide and 4.9 mm long.

**Occurrence:** — Upper Chasmops limestone (4bδ<sub>1</sub>). *Oslo–Asker:* Nakkholmen in Oslo.

**Family Harpidae Hawle & Corda, 1847**

*[nom. correct. Miller, 1889 (ex Harpides Hawle & Corda, 1847)] [emend. Whittington, 1950] [= Arraphidae Angelin, 1854; Harpedidae (Hawle & Corda, 1847) Raymond, 1913]*

Genus *Paraharpes* Whittington, 1950

**Type species:** — *Harpes* (Eoharpes) *hornei* Reed, 1914

*Paraharpes ottawaensis similis* n. subsp.

*Pl. 1, Figs. 6–7*

**Name:** — From Latin *similis* (like, resembling), alluding to the likeness to the Canadian form *P. ottawaensis* Billings, 1865.

**Type data:** — Holotype is a fragmentary genicranium (P.M.O. no. 38237) from the Cyclocrinus Beds (4bγ?), at Furuberget in the district of Nes–Hamar.
Material: — In addition to the holotype only one fragmentary genicranium (P.M.O. no. 73645) and seven fragments of the brim (P.M.O. nos. 9385 and counter-piece 9399, 9386, 38000, 38203, 38204, 38205, and 73662) are preserved at the Paleontological Museum in Oslo.

Diagnosis: — A Paraharpes ottawaensis subspecies with the brim prolongations about as long as the genicranium at the axial line.

Description: — The genicranium is horse-shoe shaped to nearly oval in outline, rather convex in its middle part, widest in the vicinity of the occipital ring, and about as long as wide; the length at the axial line is about half that of the entire genicranium.

The median portion of the genicranium, inside the brim, is strongly convex, rises very steeply from the brim at the sides, somewhat more gently in front, tapers slightly forward with distinctly convex sides, and is bluntly rounded in front. The glabella and occipital ring are not preserved. The alae are smooth and large, extend far forward, and have a very shallow groove subcentrically to the lateral outline. The genae and the preglabellar area are bounded by a narrow continuous inner margin of the fringe that is generally distinctly impressed in front, but becomes fainter laterally and posteriorly; it is bluntly rounded in front, but more strongly arched and slightly protruding in the middle in front of the glabella. The preglabellar field is short, slopes gently downward, and is slightly rounded both transversally and longitudinally. The surface of the genae rises from all sides towards the eye tubercles, which seem to be situated a little behind the frontal end of the glabella, and about half-way between this and the inner margin of the fringe. The eye tubercles are relatively large and prominent, and are connected with the sides of the glabella by narrow, low eye ridges, directed obliquely forward from the eyes, and increasing slightly in width inwards. From the outside of the eyes, a narrow, slightly raised ridge runs in a slightly outward convex curve backwards down to the genal roll, becoming fainter posteriorly, and dying out near the girder about opposite to the occipital furrow. The genal roll is steeply bent down; it is highest in front where it adjoins the preglabellar area, decreases very gradually in height laterally and posteriorly, and reaches almost to the end of the brim prolongations. The girder of the upper lammella of the fringe is indicated by two rows of relatively large pits, evenly following the
outline curve of the genicranium frontally and laterally, but being more backwardly directed posteriorly, and extending to the tips of the brim prolongations. The brim is broadest laterally, reaches backward about twice the length of the genicranium at the axial line, is slightly concave, and has the inner part of the brim prolongations raised upward. The external rim is strongly raised and rather convex, relatively broad anteriorly, but tapers very gradually backwards. The internal rims are convex and very strongly raised. The whole surface of the genicranium, except for the alae (and the glabella?), is densely pitted.

Other parts of the trilobite are unknown.

Dimensions: — The holotype genicranium is about 12 mm wide and 12 mm long restored. The brim prolongations are about 12 mm long.

Affinities: — *P. ottawaensis similis* n. subsp. seems to be rather closely related to the Canadian *P. ottawaensis* (BILLINGS 1865). The Norwegian subspecies differs from the Canadian form only in having the brim prolongations about as long as the length of the genicranium at the axial line. The Canadian form occurs in the Coburg beds, upper part of the Ottawa Formation, which seems to correspond very well with the age of the Norwegian subspecies. *P. ottawaensis similis* may also be related to the Scandinavian Upper Ordovician *P. costatus* (ANGELIN 1854), but differs in having a wider genicranium and having the brim broader laterally than anteriorly.

Occurrence: — Cyclocrinus Beds (4by?) and Upper Chasmops Limestone (subzone with *Tretaspis kiaeri*, 4bδ₂). RINGERIKE: Western side of Frognøy (4bδ₂). — NES-HAMAR: Furuberget (Cycl.).

**Family Ityophoridae Warburg, 1925**

Diagnosis: — Cephalon of harpid form. Glabella convex, reaching inner margin of bilaminar fringe, slightly expanding or tapering forward, with three pairs of glabellar furrows, S1 slightly connected across glabella, S2 and S3 short. Occipital ring prolonged backward, with low median tubercle. Genae narrower than glabella, convex, sloping steeply or moderately outward, with narrow (long.) posterior border. Eye lobes close to antero-lateral margins of genae, bulbous eye ridges extending directly inward to axial furrows. Anterior section of facial sutures running outward and forward in curve to margins,
posterior sections curving outward along edge of genae to posterior margins. Fringe concave upward, genal roll sloping steeply or moderately down to gently inclined brim, with prolongations about one-half of length (long.) of cephalon, narrow convex external and internal rims, lamellae or only lower lamella of fringe bent into four or five folds that are separated by narrow furrows subconcentric with rim so that three inner folds extend back along prolongation, outer fold being placed just outside anterior section of facial sutures. Thorax with six segments, axis convex, pleurae straight, inner part horizontal, outer portion beyond fulcrum bent down and faceted, with deep pleural furrows. Pygidium wider than long, convex axis divided into five or six to ten or eleven rings, narrow or relatively broad postaxial ridge, inner part of pleural fields horizontal, outer part sloping gently to narrow border, five or eight pairs of pleural furrows extending to border, interpleural grooves shallower. Doublure narrow or broad. External surface smooth or granulated.

Remarks: — The family Ityophoridae was erected by Warburg (1925 p. 229) for the genus Ityophorus Warburg, 1925. Up till now the family, with its single species Ityophorus undulatus Warburg, 1925, has only been known from the Upper Ordovician of Sweden. The new genus Frognaspis from the uppermost part of the Middle Ordovician of Norway resembles Ityophorus so much that the writer is convinced that Frognaspis may be included in the Ityophoridae.

The systematic position of the Ityophoridae is rather uncertain, inasmuch as the family differs rather distinctly from all other trilobites described. The family combines characters from very different families or even suborders, e.g. the Harpina and the Ptychopariina.

The writer agrees with Warburg in that the likeness of this specialized family to the Harpidae and the Trinucleidae may be due to the same mode of living. However, the genus Frognaspis shows some characters not known in Ityophorus, pointing more towards the Ptychopariina, e.g. the slightly bifurcate first pair of lateral glabellar furrows, which are also connected across the glabella. The family most resembles the two Upper Cambrian genera Lauzonella Rasetti, 1944, and Levisella Ulrich, 1944, assigned to the Loganellidae. Especially Lauzonella resembles Frognaspis rather much, though the large eyes of Lauzonella and the small eyes of Frognaspis clearly distinguish them. The pygidium of Frognaspis may be easily mistaken for that of
Lauzonella. However, the most striking similarity between the two genera is the first pair of lateral glabellar furrows; both Lauzonella and Frognaspis have bifurcate S1, and both have them connected across the glabella, although very faintly in Frognaspis. The writer therefore regards the ityophorids as constituting a separate family (or even superfamily) of the Ptychopariina. Professor Franco Rasetti has kindly lent the writer some hypostomes which probably belong to either Lauzonella or Levisella. Two of the hypostomes show some likeness to that of Frognaspis, but they lack the peculiar axial groove from the anterior border to the middle body. Probably the groove in the hypostome of Frognaspis is produced by the large anterior wings, which may be a consequence of the large brim of the cephalon.

There is a possibility that the Ityophoridae may be related to the Proetacea, but the hypostome differs distinctly, as does the type of glabella.

Genus Frognaspis n. gen.

Name: — The genus is named after the type locality Frognoy in Lake Tyrifjorden, Ringerike.

Type species: — Frognaspis stoermeri n. sp.

Type stratum and type locality: — Upper Chasmops Limestone (subzone with Tretaspis kiaeri, 4bδ2). Western side of Frognoy, Lake Tyrifjorden, Ringerike.

Diagnosis: — Cephalon of harpid form, gently convex. Glabella convex, almost reaching inner margin of bilaminar fringe, moderately tapering forward, with three pairs of short but distinct lateral glabellar furrows. Occipital ring broad (long.) at axial line, and with a low median tubercle. Postocular fixigenae narrower than glabella, sloping gently outward, with narrow posterior border. Eyes located opposite S3, and close to glabella. Eye ridges faint, extending directly inward to axial furrows. Preocular parts of facial sutures curving outward and forward to anterior margins, posterior parts curving outward along inner margin of fringe to posterior margins. Fringe concave upwards, genal roll sloping gently down to gently inclined brim, no visible division between genal roll and brim on upper lamella; brim prolongations about one-third of length of cephalon; narrow and convex external and internal rims. Lower lamella of fringe bent into five slightly convex folds that are separated by narrow furrows concentric
with the rim. External surface except for glabella and occipital ring densely but faintly granulated.

Hypostoma with subelliptic middle body, slightly swollen, wide anterior wings, and with a peculiar axial groove from the anterior border to the middle body.

Thorax unknown.

Pygidium wider than long, semielliptical in outline. Axis convex, about two-thirds as long as the pygidium, divided into ten or eleven rings. Faint but broad postaxial ridge. Inner part of pleural field horizontal, outer part slightly sloping. Eight or nine pairs of pleural furrows extending to border, interpleural furrows shallow anteriorly, lacking posteriorly. Doublure rather broad, paradoublural line conspicuous.

Affinities: — The genus resembles considerably *Ityophorus* Warburg, 1925, and for this reason the genus is placed in the *Ityophoridae*. However, it differs distinctly from *Ityophorus* in some characters, e.g. in being less convex, in having the glabella tapering forwards, upper lamella of fringe unfurrowed, lower lamella with five folds, external surface of cephalon except glabella densely granulated, pygidial axis with ten or eleven rings, pygidium with eight or nine pleural furrows and doublure rather wide.

*Frognaspis stoermeri* n. gen., n. sp.

Pl. 2, Figs. 1–8, Pl. 3, Figs. 1–8

Name: — The species is named in honour of Professor, Dr. Leif Störmer, who started this team work on the Middle Ordovician of the Oslo Region.

Type data: — Holotype is a fragmentary cephalon (P.M.O. no. H 0011 a) from the Upper Chasmops Limestone (subzone of *Tretaspis kiaeri*, 4bd₂) on the western side of Frognøy, Lake Tyrifjorden, Ringereike.

Material: — In addition to the holotype, several more or less fragmentary cranidia, five fragments of brims, three hypostoma, and several more or less fragmentary pygidia are preserved at the Palaeontological Museum in Oslo.

Diagnosis: — See that of genus.

Description: — The cephalon is horse-shoe shaped, gently convex, probably large in proportion to the complete dorsal shield, widest
near eye-line, width about seven-eighths of total length, length at
axial line about five-sevenths of width. The outer surface of the
cephalon except for the glabella and the occipital ring is densely but
faintly granulated. The cranidium is about as long as wide, widest just
in front of the glabella. The glabella is convex, moderately raised above
the genae, broadest across the rear end where the width is six-sevenths
of the length, tapers forward to about four-sevenths of its posterior
width, somewhat truncate and gently bent down in front and rather
faintly defined by shallow preaxial furrows, with three pairs of deep
and conspicuous lateral glabellar furrows. S1 slightly bifurcate laterally,
very faintly connected across the glabella by a shallow but broad
groove, and not touching the axial furrows. S2 convex, directed ob-
liguely backward, reaching across about one-third of the glabella, and
not touching the axial furrows. S3 located about two-fifths of the
length of the glabella from the front, elongate, straight, reaching
across one-fourth of the glabella, and faintly touching the axial fur-
rows. The occipital furrow is narrow but moderately deep and well
defined at its middle part, becoming somewhat wider and shallower
behind the preglabellar lobes, and slightly composite. The occipital
ring is of moderate width (tr.), wide (long.) at axial line, but tapering
rapidly laterally, rather strongly arched transversally and distinctly
compressed from the sides, moderately rounded longitudinally, with
a faint, low median tubercle, and with the posterior margin strongly
arched backward. The postocular fixigenae are narrow, the posterior
width of each being almost exactly two-thirds of the posterior part of
the glabella, rapidly narrowing forwards, their inner part being rather
gently convex, but at the postero-lateral corner, where the inner
margin of fringe cuts a small part of the fixigenae, they slope steeply
down to the inner margin of the fringe; outside this they are almost
horizontal. The axial furrows are deep and conspicuous, and curve
slightly inward opposite S2, and slightly outward in front of S3. The
eyes are small, strongly convex in both directions, located opposite S3,
and close to the glabella. The eye-ridges are faint, and extend directly
inward to the axial furrows (discernible only in some specimens). The
posterior border furrows are strongly impressed, becoming somewhat
broader and shallower laterally, sloping steeply down in front, but
more moderately so posteriorly, bent somewhat downward just inside
the inner margin of the fringe, and almost horizontal outside this. The
posterior borders are narrow near the glabella, but widen laterally, moderately convex, bent somewhat downward just inside the inner margin of the fringe, almost horizontal outside this, directed outward and slightly backward from the axial furrows, curving strongly backward outside the inner margin of the fringe to pass into the internal rims. The anterior parts of the facial sutures form a wide curve obliquely outward and forward from the eyes, and bend inward near the anterior margin of the cephalon. The posterior parts of the facial sutures curve obliquely outward and backward, following the inner margin of the fringe for a short distance, then curve anew outward and backward to cut the posterior margins at an angle of about 60°. The inner margin of the fringe is indicated only by a shallow groove subconcentric with the external rim, somewhat deeper laterally and posteriorly than anteriorly, running just in front of the glabella, coinciding for some distance with the facial sutures laterally, and, as mentioned above, cutting the postocular fixigenae just inside the postero-lateral corners. The preglabellar field is indicated only by a shallow groove. The fringe is bilaminar (easily seen in most of the specimens, because the upper lamella and the infilling matrix come off very easily, and also by the different colour of the upper and lower lamellae), about two-fifths as wide as the length of the cephalon at the axial line, and horse-shoe shaped. The upper lamella of the fringe is densely ornamented with large but shallow granules, and with no traces of a bend, so that the genal roll continues imperceptibly into the brim. However, in order to make the description easier, the fringe will be divided into a genal roll and a brim by an imaginary girder (above the probable girder of the lower lamella, cf. below). The genal roll is almost horizontal at its inner part, slopes rather gently down to the girder in front, but is somewhat steeper laterally, and is about half as wide as the whole fringe anteriorly, and tapers gradually backward. The brim is concave, about half as wide as the whole fringe anteriorly, tapers very gradually posteriorly to a position opposite the occipital ring, and is prolonged backward into more sharply tapering horns which end in short spines formed by the prolongations of the external and internal rims; length of horns more than half the length of cephalon at the axial line, outer margin of horns slightly curved and directed very slightly inward, inner margin somewhat more strongly curved than the outer and directed almost straight backward. The outer edge
of the brim is gently upturned, forming a narrow and convex upper external rim, equally wide anteriorly and posteriorly. The internal rims, being the prolongations of the posterior borders, taper strongly backward, and are posteriorly almost half as broad as the posterior borders. The prolongations of the posterior border furrows strongly increase in width, and are about five times as wide as the external rims as near the glabella; the triangular fields limited by the frontal edge of the prolongations and the rims are nearly smooth. The lower lamella of the fringe is bent into five slightly convex folds that are separated by narrow furrows concentric with the rim. The inner furrow may possibly be equivalent to the girder of *Ityophorus*.

Three hypostomes belonging to this species are preserved. The middle body is suboval, somewhat more strongly rounded posteriorly than anteriorly, without traces of maculae, strongly convex, sloping rather steeply down to lateral border furrows, somewhat less steeply anteriorly and posteriorly than laterally. The anterior border is somewhat elevated, and located relatively far in front of the middle body. A shallow groove is discernible extending from the middle body to the anterior border along the axial line, and on each side of this groove there is a slightly swollen area which constitutes the main part of the large and relatively wide anterior wings. The frontal border furrow is deep but faint. The lateral border furrows are deep and narrow, but somewhat broader posteriorly than laterally. The lateral and posterior borders are narrow and strongly upturned, evenly following the outline of the middle body.

The pygidium is semielliptical in outline, very faintly granulated, about three-fifths as long as wide, and rather slightly convex. The axis is strongly convex, relatively narrow (its width at the anterior margin being only two-ninths of the total width of the pygidium), and tapers gradually backward, not quite reaching the posterior border, thus being about seven-ninths as long as the total length. The axis is divided into ten, or in a few specimens eleven, longitudinally gently rounded axial rings, and a relatively large axial piece, by moderately strong furrows, which become shallower posteriorly. The axial furrows are relatively shallow. The pleural fields are divided rather distinctly by the strong paradoublural line, a somewhat elevated ridge running from the furrow between the axial piece and the last axial ring to somewhat outside midway between the axis and the lateral margin anteriorly.
The pleural fields are horizontal inside the paradoublural line, but very slightly sloping down to the border outside it. There are eight or nine pairs of elevated and convex regular ribs behind the anterior pair of half ribs, and a relatively broad and slightly swollen postaxial piece; the ribs become successively weaker, decrease in size, and become strongly turned backwards posteriorly; the ninth pair, which is discernible only in some of the specimens, is directed nearly straight backward. Furthermore, the ribs are bent at the paradoublural line, so that the outer part is directed more strongly backward than the inner part. The posterior bands of the ribs are narrower and lower than the anterior ones, and slightly increasing in width laterally. The pleural furrows are rather strong and reach the marginal border. The interpleural furrows also reach the marginal border, anteriorly very faint adjacent to the axial furrows, somewhat increasing in strength laterally, and lacking posteriorly. The border furrow is shallow. The border is relatively wide, broadest posteriorly, and gently convex. The doublure is rather wide (width anteriorly slightly more than one-fifth of the total width of the pygidium, somewhat narrower posteriorly), and apparently without terrace-lines.

**Dimensions:** — The *holotype* cephalon (restored) is 3.1 mm wide and 2.1 mm long (at axial line). The largest cranidium present is 3.4 mm long and 3.5 mm wide (restored). The largest pygidium present is 3.1 mm wide and 1.7 mm long.

**Remarks:** — Young individuals differ considerably from adults in that the former exhibit the following characters. Cephalon is rather convex and steeply sloping laterally. Glabella is rather strongly convex and distinctly increasing in width forwards. S1 is conspicuous and distinctly connected across the glabella. S2 and S3 are faint. Median tubercle of occipital ring is rather large. Eyes are located some distance from the glabella, somewhat larger and more bulbous.

Some of these youthful characters are similar to the adult characters of the genus *Ityophorus*, thus confirming the relationship between the two genera.

**Affinities:** — This new trilobite is no doubt related to the Swedish Upper Ordovician *Ityophorus undulatus* Warburg, 1925, with which it has several characters in common, but there are also so many very different features that the writer has found it necessary to describe it not only as a new species, but as a new genus. However, it is
probable that *Frognaspis* belonged to the same line of descent as *tyophorus*.

*Occurrence:* — Upper Chasmops Limestone (subzone of *Tretaspis kiaeri, 4bδ₂*). *Ringerike:* Western side of Frognøy, Lake Tyrifjorden.

**Family Cheiruridae Salter, 1864**

[= Chirurides Hawle & Corda, 1847; Chiruridae Angelin, 1854, suppression of both pend. ICZN; = Cerauridae Miller, 1889]

**Subfamily Cyrtometopinae ÖPik, 1937**

**Genus Pseudosphaerexochus** Schmidt, 1881

*?Synonym:* — Zethus Pander, 1830

**Subgenus Pseudosphaerexochus** Schmidt, 1881

*Type species:* — *Sphaerexochus hemicranium* Kutorga, 1854

**Pseudosphaerexochus (Pseudosphaerexochus) bulbosus** n. sp.

Pl. 4, Figs. 5-6

*Name:* — From Latin *bulbosus* (swollen).

*Type data:* — *Holotype* is a fragmentary cranidium (P.M.O. no. 73660) from the Upper Chasmops Limestone, 4bδ₁, at Terneholmen in Asker.

*Material:* — The *holotype* is the only specimen present.

*Diagnosis:* — A *Pseudosphaerexochus* species with: Glabella rather distinctly longer than wide, subelliptical in outline, sloping steeply downwards and overhanging in front, distinctly but poorly granulated, and with three pairs of lateral furrows. S1 strongly convex, and faintly reaching the occipital furrow, S2 and S3 slightly convex, all directed obliquely backward. Occipital furrow prominent. Occipital ring rather narrow (long.), strongly convex (tr.) and with few but prominent nodes. Fixigenae densely pitted.

Other parts of the trilobite unknown.

*P. (Pseudosphaerexochus) bulbosus* n. sp. differs from the type species in having the glabella more poorly granulated, and in having the posterior part of the facial suture directed almost at a right angle to the axial furrow.

*Description:* — The cranidium is strongly convex. The glabella is subelliptical in outline, about four-fifths as broad as long, rather bulbous, slopes steeply downward, and is overhanging in front; with few
and relatively small but very prominent nodes, and with three pairs of lateral furrows. S1 rather distinct, strongly convex, hardly reaching the occipital furrow, and reaching across almost one-third of the glabella. S2 directed obliquely backward, slightly convex, and reaching across about one-fourth of the glabella. S3 directed obliquely backwards, slightly convex, and slightly shorter than S2. The occipital furrow is deep and conspicuous, and almost straight. The occipital ring is rather narrow (long.), strongly convex (tr.), about four-sevenths as wide as the glabella, and with few but relatively large and prominent nodes. The fixigenae are moderately convex, and slope steeply downward on each side; preocular and interocular parts about one-fifth as wide as postocular parts; densely pitted, with very few and indistinct nodes, and probably provided with short genal spines. The eyes are relatively small, and located just in front of S1. The preocular parts of the facial sutures are almost parallel to the axial furrows, and the postocular parts are slightly convex and directed almost at a right angle to the preocular parts.

Other parts of the trilobite unknown.

*Dimensions:* — The holotype cranidium is (restored) 34.0 mm wide and 16.2 mm long.

*Affinities:* — P. (Pseudosphaerexochus) bulbosus n. sp. seems to be rather closely related to P. (Pseudosphaerexochus) elongatus Thorslund, 1940, but differs from this in having broader preocular fixigenae, and in being more poorly granulated.

*Occurrence:* — Upper Chasmops Limestone (4bδ1). Oslo–Ask: Terneholmen, Asker.

*Pseudosphaerexochus* (*Pseudosphaerexochus*) *densigranulatus* n. sp.

Pl. 4, Figs. 1–3

*Name:* — From Latin *densus* (thick, close) and *granulatus* (granulated).

*Type data:* — Holotype is a fragmentary cranidium (P.M.O. no. 9093) from the Upper Chasmops Limestone (subzone of *Tretaspis kiaeri*, 4bδ4) on the western side of Frognøy in Lake Tyrifjorden, Ringerike.

*Material:* — In addition to the holotype only one fragmentary cranidium (P.M.O. no. 9094) is preserved at the Palaeontological Museum in Oslo.
Diagnosis: — A *Pseudosphaerexochus* species with: Glabella large, relatively bulbous, nearly as wide as long, subelliptical in outline, sloping steeply downward and slightly overhanging in front, nearly semicircular in lateral view, densely and very finely granulated, and with three pairs of lateral furrows. S1 strongly convex, and almost reaching the occipital furrow on outer test, S2 and S3 moderately convex, all directed obliquely backwards. Occipital furrow prominent. Occipital ring moderately convex, densely and very finely granulated. Fixigenae densely and very finely granulated.

Other parts of the trilobite unknown.

*P. (P.) densigranulatus* n. sp. differs from the type species in having S1 stronger, more convex and reaching farther backwards, and in having dense and very fine granulation on the glabella and the fixigenae.

Description: — The glabella is large, subelliptical in outline, with the rear end truncated, relatively strongly and rather evenly convex, nearly semicircular in lateral view, sloping steeply downward and slightly overhanging in front, only slightly longer than wide with its greatest width across the second pair of the lateral lobes; extraordinary densely and finely granulated on outer test, inner test smooth, and with three pairs of lateral furrows. S1 directed obliquely backwards, deep and distinct, strongly convex, so that the inner part is directed almost straight backward, reaching across one-third of the glabella, and almost reaching the occipital furrow on outer test (on exfoliated cranidia distinctly reaching the occipital furrow). S2 directed obliquely backward, convex, relatively strongly impressed, deepest near the axial furrows, and reaching across nearly one-third of the glabella. S3 directed slightly more strongly backward than S2, convex, faintly impressed in proportion to S1 and S2, deepest near the axial furrows, and reaching across one-third of the glabella. The preoccipital glabellar lobes are obliquely oval in outline, and rather distinctly limited by the surrounding furrows. The occipital furrow is simple, convex, and rather broad and deep. The occipital ring is moderately convex, densely and very finely granulated. The axial furrows are deeply impressed, so that the glabella is overhanging. The preglabellar field is rather narrow. The fixigenae are densely and very finely granulated. The lateral border furrows are rather deep and broad. The lateral borders are relatively narrow and rather convex (long.). The eyes are not preserved.
Other parts of the trilobite are unknown.

**Dimensions:** — The *holotype*, which is the largest specimen present, is 19.8 mm long and 15.2 mm wide (fixigenae, which are very poorly preserved, are not included).

**Affinities:** — *P. (Pseudosphaerexochus) densigranulatus* n. sp. seems to be more or less related to *P. (P.) granulatus* (Angelín 1854), *P. (P.) tuberculatus* Warburg, 1925, and *P. (P.) elongatus* Thorslund, 1940, but differs from them all in having the extraordinarily dense and fine granulation on the outer test. Furthermore it differs from *P. (P.) granulatus* in having stronger and more convex Sl, and from *P. (P.) elongatus* in having shorter glabella and larger preoccipital lateral glabellar lobes.

**Occurrence:** — Upper Chasmops Limestone (subzone of *Tretaspis kiaeri*, 4bδ2). RINGERIKE: Western side of Frognøy in Lake Tyrifjorden.

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PLATES 1—4

The photographs were taken by Miss B. Mauritz in co-operation with the author. The specimens were whitened with ammonium chloride before photographing, except that in Fig. 6, Plate 1, which is a cast (latex mixed with white paint). The photographs are not retouched, except the background of the cranidia and pygidia in Plates 2 and 3.

P.M.O. = Palaeontological Museum, Oslo
P.I.L. = Palaeontological Institute, Lund, Sweden
PLATE 1

_Triarthrus humilis_ Hadding, 1913 (p. 232)

Fig. 1. _Lectotype_ cranidium. Lower Dicellograptus Shale. Andersön, Jämtland, Sweden. Coll.: A. Hadding, 1912. P.I.L. no. LO 2516 T. (Figured by HADDING 1913, Pl. VI, Fig. 18.) x 10.


Fig. 5. Young cranidium. Ogygiocaris Shale. Andersön, Jämtland, Sweden. Coll.: A. Hadding, 1912. P.I.L. no. LO 2517 T. (Figured by HADDING 1913, Pl. VI, Fig. 19.) x 10.

_Paraharpes ottawaensis similis_ n. subsp. (p. 234)

Fig. 6. Latex cast of _holotype_ genericranium. Cyclocrinus Beds (4by?). Furu­berget, Nes–Hamar. Coll.: J. Kiær, 1896. P.M.O. no. 38237. x 2.

Fig. 7. Lower lamella of fringe. Cyclocrinus Beds (4by?). Railroad section, Furu­berget, Nes–Hamar. Coll.: S. Skjeseth, 1951. P.M.O. no. 73662. x 2.
PLATE 2

_Frognaspis stoermeri_ n. gen., n. sp. (p. 239)


Fig. 2. Cranidium. P.M.O. no. 9331. Other data as for Fig. 1.

Fig. 3. Cranidium. P.M.O. no. 61019 a. Other data as for Fig. 1.

Fig. 4. Librigenae, showing the folds of the lower lamella of fringe. P.M.O. no. H 0011 wa. Other data as for Fig. 1.

Fig. 5. Larval cranidium. P.M.O. no. H 0011 f. Other data as for Fig. 1.

Fig. 6. Hypostome. P.M.O. no. 61019 rb. Other data as for Fig. 1.

Fig. 7. Pygidium. P.M.O. no. H 0011 gb. Other data as for Fig. 1.

Fig. 8. Pygidium. P.M.O. no. H 0011 go. Other data as for Fig. 1.
PLATE 3

*Frognaspis stoermeri* n. gen., n. sp. (p. 239)


Fig. 2. *Holotype* cephalon. P.M.O. no. H 0011 a. Other data as for Fig. 1.

Fig. 3. Young cranidium. P.M.O. no. H 0011 o. Other data as for Fig. 1.

Fig. 4. Pygidium. P.M.O. no. 61018 c. Other data as for Fig. 1.

Fig. 5. Pygidium. P.M.O. no. H 0011 gm. Other data as for Fig. 1.

Fig. 6. Pygidium. P.M.O. no. H 0011 gq. Other data as for Fig. 1.

Fig. 7. Fragmentary pygidium. P.M.O. no. 61015 b. Other data as for Fig. 1.

Fig. 8. Librigena. P.M.O. no. 61019 wb. Other data as for Fig. 1.
PLATE 4

Pseudosphaerexochus (Pseudosphaerexochus) densigranulatus n. sp. (p. 245)

Fig. 1. Holotype cranidium. Upper Chasmops Limestone (subzone of Tretaspis kiaeri, 4bδ1). Western side of Frognøy, Lake Tyrifjorden, Ringerike. Coll.: J. Kiær, 1921. P.M.O. no. 9093. x 3.

Fig. 2. Right side view of the holotype.

Fig. 3. Cranidium. P.M.O. no. 9094. Other data as for Fig. 1.

Triarthrus cf. skutensis Thorslund, 1940 (p. 234)

Fig. 4. Cranidium. Upper Chasmops Limestone (4bδ1). Nakkholmen, Oslo. Coll.: Exc. 1925. P.M.O. no. 8910. x 5.

Pseudosphaerexochus (Pseudosphaerexochus) bulbosus n. sp. (p. 244)
