GEOLOGICAL SURVEY OF CANADA
COMMISSION GÉOLOGIQUE DU CANADA

PAPER 79-15



# LOWER AND MIDDLE PENNSYLVANIAN CONODONTS FROM THE CANADIAN ARCTIC ARCHIPELAGO

K.P. BENDER



Energy, Mines and Resources Canada
Énergie, Mines et Ressources Canada

1980


**GEOLOGICAL SURVEY**
**PAPER 79-15**

# LOWER AND MIDDLE PENNSYLVANIAN CONODONTS FROM THE CANADIAN ARCTIC ARCHIPELAGO

K.P. BENDER

1980

Available in Canada through

authorized bookstore agents
and other bookstores

or by mail from

Canadian Government Publishing Centre
Supply and Services Canada
Hull, Québec, Canada K1A 0S9

and from

Geological Survey of Canada
601 Booth Street
Ottawa, Canada K1A 0E8

A deposit copy of this publication is also available
for reference in public libraries across Canada

Cat. No. M44-79/15E Canada: $3.50
ISBN – 0-660-10567-5 Other countries: $4.20

Price subject to change without notice

**Critical readers**

*P.H. von Bitter*
*T.T. Uyeno*
*W.W. Nassichuk*

*Original manuscript submitted: 1978 - 11 - 24*
*Approved for publication: 1979 - 01 - 17*

## CONTENTS



### Illustrations



### Tables



### Figures

***Abstract***

Eleven stratigraphic sections of the Otto Fiord Formation and lower parts of the Hare Fiord and Nansen Formations were sampled on northern Ellesmere Island. Samples from these sections yielded 7789 conodont specimens which are assignable to 27 form-species (19 platform and 8 ramiform elements) and 3 multielement species. An informal zonation based on four distinct faunas is established. In ascending order, the faunal units are: Adetognathus lautus, Idiognathoides lateralis-I. noduliferus, Idiognathoides sinuatus, and Idiognathoides opimus. Correlation of these units with Upper Carboniferous zonations established elsewhere is made difficult because some species appear to have a slightly different stratigraphic range in Arctic regions than they do elsewhere.

***Résumé***

Des échantillons de 11 coupes stratigraphiques ont été prélevés dans la formation d'Otto Fiord et à la base des formations de Hare Fiord et Nansen, dans le nord de l'île Ellesmere. Les échantillons, provenant de ces sections, ont donné 7789 spécimens de conodontes qui ont été classés dans 27 espèces-formes (19 éléments plate-formes et 8 éléments ramiformes) et 3 espèces à éléments multiples. On a établi une zonation arbitraire basée sur quatre faunes distinctes. Dans un ordre ascendant ce sont: Adetognathus lautus, Idiognathoides lateralis-I. noduliferus, Idiognathoides sinuatus, et Idiognathus opimus, qui constituent autant d'unités fauniques. La corrélation entre ces unités et la zonation du Carbonifère supérieur déjà établie ailleurs est difficile à cause de quelques espèces qui semblent accuser une légère différence dans l'échelle stratigraphique des régions arctiques au regard de celles qui existent ailleurs.

# LOWER AND MIDDLE PENNSYLVANIAN CONODONTS FROM THE CANADIAN ARCHIPELAGO

## INTRODUCTION

Outcrops of upper Paleozoic sediments are widely distributed in the northeastern part of the Sverdrup Basin on Axel Heiberg Island and Ellesmere Island. These sediments have been subject to intensive investigations during the last two decades. Details of upper Paleozoic lithostratigraphy and biostratigraphy have been described recently by Thorsteinsson (1974) and by Nassichuk (1975).

In the axial region of the Sverdrup Basin the basal coarse clastic sediments of the Borup Fiord Formation are overlain either by a thick limestone sequence (Nansen Formation) or by evaporites with interbedded limestone and shale (Otto Fiord Formation) overlain in turn by limestone and shale (Hare Fiord Formation). The stratigraphic interval represented by these formations ranges from Upper Mississippian (Namurian) to Lower Permian (Artinskian).

During the summer of 1972, 150 conodont samples were collected from the Otto Fiord, Hare Fiord and Nansen Formations in the Hare Fiord area of northern Ellesmere Island. Samples were recovered from the type sections of the Otto Fiord and Hare Fiord Formations near van Hauen Pass, from the type section of the Nansen Formation at Girty Creek, and from a section in the upper part of the Nansen Formation on the west side of Krieger Mountains, south of Hare Fiord. Additionally, samples collected by W.W. Nassichuk and G.R. Davies from the Otto Fiord, Hare Fiord and Nansen Formations in the Hare Fiord area, the Blue Mountains of Ellesmere Island and in western and eastern regions of Axel Heiberg Island were available for this study.

The report describes conodont faunas from the Otto Fiord Formation, the lowermost part of the Hare Fiord Formation and the lower Nansen Formation and compares them with conodonts described from Upper Carboniferous successions elsewhere in North America and Europe.

The conodont faunas from the Middle Pennsylvanian to Lower Permian parts of the studied sections will be described in a subsequent report.


### Ackowledgments

These are the first results of a research project commenced while I was a Post-Doctoral Fellow at the Institute of Sedimentary and Petroleum Geology in Calgary in 1972 and 1973. The project continued over succeeding years at the Institut für Geologie und Paläontologie der Philipps-Universität Marburg. Field work in northern Ellesmere Island in the summer of 1972 was arranged and sponsored by the Geological Survey of Canada. The Deutsche Forschungsgemeinschaft provided additional funds for travel in connection with my stay in Canada.

I am especially grateful to T.T. Uyeno, for critical discussion of paleontological problems. I also wish to thank G.R. Davies and W.W. Nassichuk for providing additional samples and stratigraphic information. E.W. Bamber, R.L. Christie, A.R. Sweet, R. Thorsteinsson, H.P. Trettin and H. Steghaus provided useful discussions and other help. G. Ward of Calgary ably performed as student field assistant.

Peter H. von Bitter of the Royal Ontario Museum, Toronto, loaned comparative material and provided me with information on Pennsylvanian conodonts.

R. Lane of Tulsa, Oklahoma and M. Lindström and W. Ziegler of Marburg, discussed stratigraphic and taxonomic problems and critically read parts of the manuscript.


## LOCALITIES

Type section of the Otto Fiord Formation, about 3.2 km northeast of van Hauen Pass, Ellesmere Island (81°04'N, 85°30'W) (Fig. 1, loc. 1). Eleven samples from different levels in this section yielded conodonts (see Fig. 2 for locations; conodonts are listed on Table 1).

| GSC loc. | Height above base |
|---|---|
| C-23881 | 5 m |
| C-23884 | 23 m |
| C-23885 | 46 m |
| C-23886 | 64 m |
| C-23889 | 161 m |
| C-23890 | 177 m |
| C-23891 | 196 m |
| C-23892 | 221 m |
| C-23893 | 258 m |
| C-23894 | 263 m |
| C-23895 | 266 m |

Type section of the Hare Fiord Formation, about 3.2 km northeast of van Hauen Pass, Ellesmere Island. This section is continuous with the type section of the Otto Fiord Formation (Fig. 1, loc. 1). Three samples from the basal part of the Hare Fiord Formation are described (see Fig. 2 for locations; conodonts are listed in Table 1).

| GSC loc. | Height above base |
|---|---|
| C-23896 | 1.5 m |
| C-23897 | near base, float sample |
| C-23898 | 11 m |

Section 0.8 km south of the type section of the Otto Fiord Formation, 2.6 km north of van Hauen Pass, Ellesmere Island (81°03'30"N, 85°32'00"W) (Fig. 1, loc. 2). Eight samples from the Otto Fiord and Hare Fiord Formations are described (conodonts are listed on Table 1).

Otto Fiord Formation:

| GSC loc. | Height above base |
|---|---|
| C-10676 | 73 m |
| C-10677 | 176 m |
| C-10681 | 191 m |
| C-10684 | 233 m |
| C-10686 | 244 m |
| C-10690 | 354 m |
| C-10692 | 399 m |

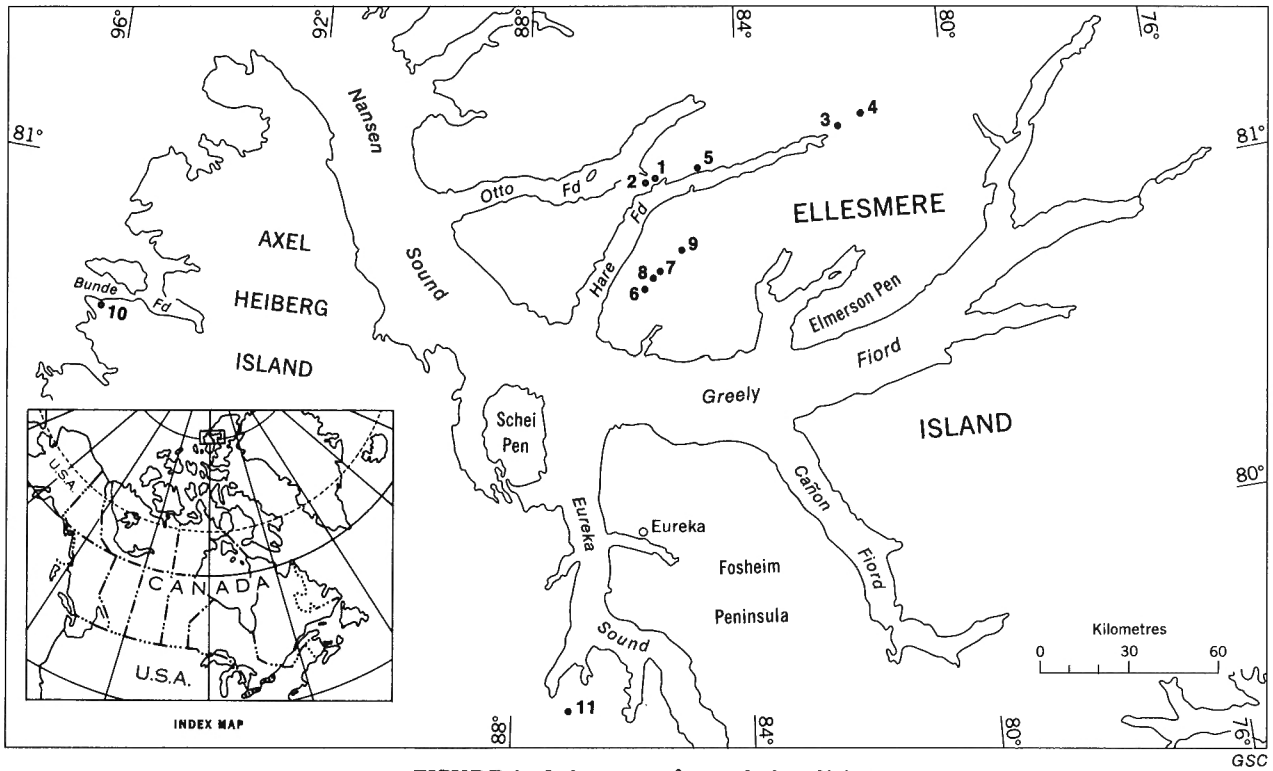


***FIGURE 1.*** *Index map of sample localities.*

Hare Fiord Formation:

GSC loc. C-10693 7 m above base

Type section of the Nansen Formation, along Girty Creek, 4.2 km northeast of the head of Hare Fiord, northern Ellesmere Island (81°13'N, 82°05'W) (Fig. 1, loc. 3). Twenty samples from different levels in the lower part of this section yielded conodonts (see Fig. 2 for locations; conodonts are listed in Table 2).

| GSC loc. | Height above base |
|---|---|
| C-23770 | basal bed |
| C-23771 | 1 m |
| C-23772 | 19 m |
| C-23773 | 37 m |
| C-23774 | 38 m |
| C-23775 | 53 m |
| C-23776 | 75 m |
| C-23777 | 104 m |
| C-23778 | 116 m |
| C-23779 | 129 m |
| C-23781 | 157 m |
| C-23784 | 199 m |
| C-23785 | 204 m |
| C-23787 | 251 m |
| C-23788 | 312 m |
| C-23789 | 331 m |
| C-23790 | 373 m |
| C-23791 | 392 m |
| C-23792 | 407 m |
| C-23793 | 431 m |

Section about 11.3 km northeast of Girty Creek, head of Hare Fiord, northern Ellesmere Island (Fig. 1, loc. 4). Three samples from different levels in the basal part of the Otto Fiord Formation yielded conodonts (listed in Table 2). Samples were collected by G.R. Davies and W.W. Nassichuk in 1972.

| GSC loc. | Height above base |
|---|---|
| C-20460 | 3 m |
| C-20463 | 6 m |
| C-20468 | 14 m |

GSC locality 56430, 3.2 km west of the midpoint of the delta formed by Stepanow Creek, north of Hare Fiord, Ellesmere Island (81°07'30"N, 84°20'W) (Fig. 1, loc. 5). According to Nassichuk (1975), who described an ammonoid fauna of early Atokan age from this locality, it occurs near the top of a small biogenic mound about 30 m above the base of the Hare Fiord Formation. W.W. Nassichuk provided a conodont faunal list and samples which yielded additional conodonts (Table 1).

Samples from different localities in the Blue Mountains, southeast of Hare Fiord, Ellesmere Island, were collected by G.R. Davies and W.W. Nassichuk. Most of these are from the "Tellevak Limestone", a fossiliferous unit occurring as biogenic mounds in the lower part of the Hare Fiord Formation. The ammonoid faunas and the stratigraphic relationships of the "Tellevak Limestone" are described by Nassichuk (1975). The samples yielded mostly well-preserved conodonts (Table 3).

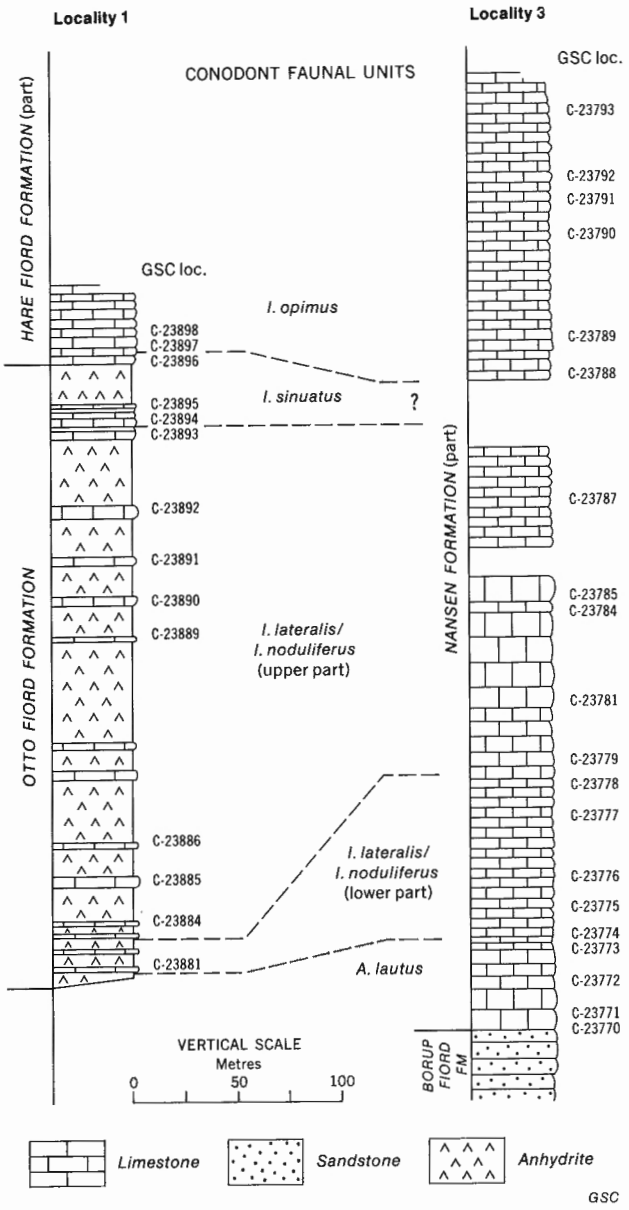


***FIGURE 2.*** *Type section, Otto Fiord Formation and lowermost part of type section, Hare Fiord Formation (loc. 1); and lower part of type section, Nansen Formation (loc. 3).*

GSC locality C-10836 is in the southwestern region of the Blue Mountains, 3.2 km northeast of Hare Fiord Diapir (80°42'41"N, 85°52'05"W) Fig. 1, loc. 6). It is in the Otto Fiord Formation, 104 m above the base.

GSC locality C-10840 is from the same section as C–10836. According to Nassichuk (1975), it occurs in red-weathering silty limestone 12 m above the "Tellevak Limestone".

GSC locality C-4085 occurs in the upper 3 m of the "Tellevak Limestone" (Nassichuk, 1975). It is on the southwestern side of the Blue Mountains, 5.8 km northeast of the north tip of Hare Fiord Diapir (80°44'N, 85°40'54"W) (Fig. 1, loc. 7).

GSC locality C-10774 occurs in the "Tellevak Limestone" in the southern Blue Mountain section (Nassichuk, 1975), 55 m below the top of the section. The locality is 5.5 km northeast of the northern edge of Hare Fiord Diapir (80°43'33"N, 85°42'25"W) (Fig. 1, loc. 8).

GSC locality C-10775 is from the same section as C–10774, 58 m below the top of the "Tellevak Limestone".

GSC locality C-29269 is from the same section as C–10774 and C-10775, near the base of the "Tellevak Limestone".

GSC locality C-10804 occurs in the "Tellevak Limestone" of the "Glacier Lake" section (Nassichuk, 1975) on the west side of the Blue Mountains, west of Mount Schuchert, 83 m above the base of the lowest exposure. The section is 2.6 km southeast of the southern tip of a prominent glacial lake northwest of Mount Schuchert (80°50'N, 85°04'W) (Fig. 1, loc. 9).

GSC locality C-10812 is from the same section as C–10804, 240 m above the base of the lowest exposure.

GSC locality C-57137 is a float sample of fenestrate bryozoan reef limestone ("Tellevak Limestone") from the Blue Mountains, collected by G.R. Davies in 1971. The sample is listed because of its well-preserved conodont fauna, which was obtained from a single piece of limestone.

Section in the Nansen Formation of the west side of Arthaber Creek, 0.5 km south of the mouth of the creek running into Bunde Fiord, northwestern Axel Heiberg Island (80°34'30"N, 95°34'55"W) (Fig. 1, loc. 10). Five samples from different levels, collected by G.R. Davies and W.W. Nassichuk in 1972 are described in this report (conodonts are listed in Table 3).

| GSC loc. | Height above base |
|---|---|
| C-20016 | 200 m |
| C-20022 | 233 m |
| C-20036 | 305 m |
| C-20041 | 347 m |
| C-20045 | 360 m |

GSC locality C-4013 is 6.4 km southeast of the northern end of Buchanan Lake on eastern Axel Heiberg Island (Fig. 1, loc. 11). The locality is at the base of the Hare Fiord Formation. The sample was collected by W.W. Nassichuk in 1969. The conodonts are listed in Table 3.

## PREVIOUS STRATIGRAPHIC INTERPRETATION

All samples are from the Otto Fiord Formation, the basal parts of the Hare Fiord Formation, and the lower part of the Nansen Formation. Thorsteinsson (1970) gave a general description of the three formations. The type sections were identified by Thorsteinsson et al. (1972). Thorsteinsson (1974) described the three formations and Nassichuk (1975) dealt primarily with their fossil content. Both authors gave detailed descriptions of the environmental and stratigraphic relationships of the formations.

The Otto Fiord Formation is a sequence of anhydrite with interbedded layers of limestone and shale that occurs in axial regions of the Sverdrup Basin in the Basinal Clastic and Evaporitic Belt (Thorsteinsson, 1974). In the type area, where its base is marked by a thrust fault, the formation attains a thickness of 296 to 396 m.

| FORMATION | | OTTO FIORD | | | | | | | | | | | HARE FD. | | | OTTO FIORD | | | | | | | | H. FD. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LOCALITY | | 1 (TYPE OTTO FIORD) | | | | | | | | | | | 1 (TYPE HARE FD.) | | | 2 | | | | | | | | 5 | |
| METRES ABOVE BASE | | 5 | 23 | 46 | 64 | 161 | 177 | 196 | 221 | 258 | 263 | 266 | 1.5 | BASAL BED | 11 | 73 | 176 | 191 | 233 | 244 | 354 | 399 | 7 | | |
| GSC LOCALITY NUMBER | | C-23881 | C-23884 | C-23885 | C-23886 | C-23889 | C-23890 | C-23891 | C-23892 | C-23893 | C-23894 | C-23895 | C-23896 | C-23897 | C-23898 | C-10676 | C-10677 | C-10681 | C-10684 | C-10686 | C-10690 | C-10692 | C-10693 | 56430 | |
| SAMPLE WEIGHT IN KILOGRAMS | | 2.8 | 2.5 | 4.0 | 3.2 | 4.2 | 4.0 | 2.0 | 3.8 | 3.5 | 3.9 | 3.4 | 4.2 | 1.8 | 2.9 | 0.7 | 0.9 | 1.2 | 0.2 | 0.4 | 0.5 | 0.4 | 0.2 | 4.0 | |
| CONODONTS | | | | | | | | | | | | | | | | | | | | | | | | | TOTAL |
| SPECIES | CONSTITUENT ELEMENTS | | | | | | | | | | | | | | | | | | | | | | | | |
| *Diplognathodus coloradoensis* | | | | 2 | 7 | 1 | | | | 4 | | | | | | | | | | | | | | | 14 |
| *Diplognathodus ellesmerensis* | | | | | | | | | | 1 | | | | 25 | 4 | | | | | | | | | 1 | 31 |
| *Diplognathodus* n. sp. A | | | | 2 | 4 | | | | | | | | | | | | | | | | | | | | 6 |
| *Hindeodus* ex. gr. *Hindeodus minutus* | | | | | | | 1 | | | | | | 1 | | | | | | | | | | | | 2 |
| *Idiognathodus clariformis* | | | | | | | | | | 1 | | | 1 | | | | | | | | | | | | 2 |
| *Idiognathodus delicatus* | | | 19 | 14 | | | 8 | 5 | 9 | 9 | 1 | | | 4 | | 10 | 8 | 1 | | 1 | | | | 15 | 104 |
| *Idiognathodus sinuosus* | left | | | | | | | | | | | | | 5 | | | | | | | | | | 21 | 26 |
| | right | | | | | | | | | | | | | 5 | 1 | | | | | | | | | 32 | 38 |
| *Idiognathodus* sp. indet. | | | | | | | 2 | | | 3 | 1 | 3 | | 23 | 2 | | | | | 1 | | | | 4 | 39 |
| *Idiognathoides lateralis* | | 109 | 2 | 7 | 12 | | 2 | | | | | | | | | 1 | | | | 1 | | | | | 134 |
| *Idiognathoides noduliferus* | | 190 | 11 | 17 | 8 | | 8 | | 4 | | | | 2 | | | 1 | 3 | | 3 | | | | | | 247 |
| *Idiognathoides sinuatus* | left | | | | | | | | | | 73 | 89 | 12 | | | | | | | | 5 | 2 | | 1 | 182 |
| | right | | | | | | | | | | 70 | 84 | 17 | | | | | | | | 4 | 4 | | | 179 |
| *Idiognathoides opimus* | | | | | | | | | | | | | | 139 | 26 | | | | | | | | 3 | 51 | 219 |
| *Neognathodus colombiensis* | | | | | | | | | | | | | | | | | | | | | | | | 1 | 1 |
| *Neognathodus medexultimus* | | | | | | | | | | | | | | | 4 | | | | | | | | | | 4 |
| *Idiognathodus* spp., *Idiognathoides* spp., *Neognathodus* spp. and/or *Streptognathodus* spp. | Tr | 3 | | | 1 | | | | | 1 | | 1 | 1 | 4 | 1 | | | | | | | | | | 12 |
| | $Hi_1$ | 5 | 1 | 1 | 1 | | 4 | 1 | 1 | | | 2 | | 12 | 1 | | | | | | | | 1 | 3 | 33 |
| | $Hi_2$ | 9 | | | 1 | | | | | | | 5 | | 3 | 2 | | | | | | | | | 2 | 22 |
| | Ne | 3 | 2 | 1 | | | | 1 | | | 2 | 2 | | 16 | 1 | | | | | | | | | | 28 |
| | $O_2$ | 24 | 4 | 3 | 12 | | 2 | 2 | 3 | 4 | 3 | 17 | 1 | 30 | 7 | | | 1 | | | | 2 | | 4 | 119 |
| *Hindeodella parva* | (see text) | | 1 | | 1 | | | | | | | | | 1 | 1 | | | | | | | | | | 4 |
| *Idioprioniodus conjunctus* | "*Hibbardella*" | | | | | | | | | | | | | 2 | 1 | | | | | | | | | | 3 |
| | "*Ligonodina*" (typa) | | | | | | 2 | | | | | | 1 | 2 | 2 | | | | | | | | | 1 | 8 |
| | "*Ligonodina*" (lexingtonensis) | | | | | | | | | | | 1 | 1 | | 1 | | | | | | | | | 1 | 4 |
| | "*Lonchodina*" (clarki) | | | | | | | | | | | 4 | | | 2 | | 1 | | | | | 1 | | 1 | 9 |
| | "*Lonchodina*" (ponderosa) | | | | | | | | | | | | | 1 | 1 | | | | | | | | | | 2 |
| | "*Metalonchodina*" | | | | | | | | | | | | 1 | | 1 | | | | | | | | | | 2 |
| | "*Neoprioniodus*" | | | | | | | | | | | 1 | | 1 | | | | | | | | | | | 2 |

GSC

***TABLE 1.*** *Conodont distribution, Otto Fiord and Hare Fiord Formations, localities on the north side of Hare Fiord (locality numbers same as on Fig. 1).*

Ammonoids identified by Nassichuk (1975) from a locality in the type area of the Otto Fiord Formation are of late Morrowan (Bloydian); that is, Bashkirian age. Calcareous foraminifers and algae identified by Mamet (in Nassichuk, 1975) from different localities in the type area are of Morrowan (Mamet's foraminifer zone 20) and possibly early Atokan (zone 21) age. According to Nassichuk (1975), the Otto Fiord Formation in the type area is mainly of Morrowan (Bashkirian) and probably early Atokan (early Moscovian) age, but elsewhere the age of the formation seems to vary much more. Mamet (in Nassichuk, 1975) identified calcareous foraminifers belonging to his zone 18 (lower Namurian) near the base of the Otto Fiord Formation 11.3 km east of Girty Creek (Fig. 1, loc. 4). According to Nassichuk (1975), the oldest fossils from the Otto Fiord Formation occur on Melville Island and are of Namurian (Eumorphoceras) age, whereas the youngest fossils from the formation are reported from a locality in the Krieger Mountains, Ellesmere Island, and are indicative of an early Moscovian, that is Atokan age.

The Hare Fiord Formation overlies the Otto Fiord Formation in the Basinal Clastic and Evaporitic Belt (Thorsteinsson, 1974). In the type area it includes up to 732 m of mainly thin bedded limestone, siltstone, and shale with some biogenic mounds occurring near the base. In the area of the Blue Mountains, south of Hare Fiord, the lower part of the formation contains up to 305 m of biogenic and fossiliferous limestone mounds, informally designated "Tellevak Limestone" by Bonham-Carter (1966). According to Thorsteinsson (1974), the Hare Fiord Formation ranges from early Moscovian to early Artinskian. Apart from conodonts, no fossils are reported from the lowermost 15 m of the Hare Fiord Formation in the type area but, according to Nassichuk, ammonoids recovered 27 m above the base of the formation in the type area and 15 m above the base of the formation in a section northeast of the type section provide a definite early Moscovian (Atokan) age. Calcareous foraminifers identified by Mamet (in Nassichuk, 1975) from a similar stratigraphic position in this area also were assigned an early

| FORMATION | | NANSEN | | | | | | | | | | | | | | | | | | | | | OTTO FD. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LOCALITY | | 3 (TYPE NANSEN) | | | | | | | | | | | | | | | | | | | | | 4 | | | |
| METRES ABOVE BASE | | BASAL BED | 1 | 19 | 37 | 38 | 53 | 75 | 104 | 116 | 129 | 157 | 199 | 204 | 251 | 312 | 331 | 373 | 392 | 407 | 431 | 3 | 6 | 14 | |
| GSC LOCALITY NUMBER | | C-23770 | C-23771 | C-23772 | C-23773 | C-23774 | C-23775 | C-23776 | C-23777 | C-23778 | C-23779 | C-23781 | C-23784 | C-23785 | C-23787 | C-23788 | C-23789 | C-23790 | C-23791 | C-23792 | C-23793 | C-20460 | C-20463 | C-20468 | |
| SAMPLE WEIGHT IN KILOGRAMS | | 3.8 | 3.1 | 3.7 | 3.1 | 3.4 | 4.4 | 3.7 | 4.3 | 4.0 | 4.7 | 5.0 | 2.0 | 3.8 | 3.9 | 3.5 | 3.0 | 3.4 | 3.2 | 3.0 | 2.5 | 0.2 | 0.1 | 1.1 | |
| CONODONTS | | | | | | | | | | | | | | | | | | | | | | | | | |
| SPECIES | CONSTITUENT ELEMENTS | | | | | | | | | | | | | | | | | | | | | | | | TOTAL |
| *Adetognathus lautus* | left | 2 | | 4 | 3 | | | | 2 | | | | | | | | | | | | | 1 | | | 12 |
| | right | 2 | | 4 | 1 | | | | | | | | | | | | | | | | | | | | 7 |
| *Adetognatus* sp. indet. | | 1 | | | 2 | | | | | | | | | | | | | | | | | | | | 3 |
| *Adetognathus* sp. | Hi | 1 | 1 | 1 | | | | | 1 | | | | | | | | | | | | | | | | 4 |
| | Ne | | | 1 | | | | | | | | | | | | | | | | | | | | | 1 |
| | Oz | | 1 | 1 | | | | | | | | | | | | | | | | | | | | | 2 |
| *Dipilognathodus coloradoensis* | | | | | | | | | | | 2 | 1 | 11 | 1 | 9 | | | | | | | | | | 24 |
| *Diplognathodus ellesmerensis* | | | | | | | | | | | | | | | | 2 | 43 | 9 | 2 | 3 | 1 | | | | 60 |
| *Diplognathodus* n. sp. A | | | | | | | | | | | | 1 | | 1 | | | | | | | | | | | 2 |
| *Idiognathodus delicatus* | | | | | | | | | | | 2 | 4 | | | | 18 | 70 | 8 | 1 | 3 | 10 | | 1 | | 117 |
| *Idiognathodus sinuosus* | left | | | | | | | | | | | | | | | | 73 | | | | 1 | | | | 74 |
| | right | | | | | | | | | | | | | | | | 61 | | | | 2 | | | | 63 |
| *Idiognathodus* sp. indet. | | | | | | | | | | | 1 | | | | 2 | 15 | 135 | | 14 | 4 | | | | | 171 |
| *Idiognathoides lateralis* | | | | | | 4 | 7 | 4 | 1 | 8 | | 1 | 3 | | | | | | | | | 1 | 1 | 40 | 70 |
| *Idiognathoides noduliferus* | | | | | | | | | | 8 | 1 | 1 | 7 | | | | | | | | | | | 11 | 28 |
| *Idiognathoides opimus* | | | | | | | | | | | | | | | | 81 | 1603 | 86 | 54 | 25 | 16 | | | | 1865 |
| *Neognathodus bassleri bassleri* | | | | | | 1 | | | | | | | | | | | | | | | | | | | 1 |
| *Neognathodus medexultimus* | | | | | | | | | | | | | 1 | | | | 5 | | | | 1 | | | | 7 |
| *Idiognathodus* spp., *Idiognathoides* spp., *Neognathodus* spp. and/or *Streptognathodus* spp. | Tr | | | | | | | | | | | | | | | 4 | 23 | 2 | 8 | | | | | | 37 |
| | $Hi_1$ | | | | | | | | | | | | 1 | | | 4 | 123 | | 10 | 1 | | | | 3 | 142 |
| | $Hi_2$ | | | | | | | | | | | | | | 1 | 1 | 9 | | 3 | | | | | | 14 |
| | Ne | | | | | | | | | 1 | | | | | | 4 | 70 | 5 | 11 | 1 | | | | 2 | 94 |
| | Oz | | | | | | | | | 1 | | | 1 | | | 7 | 213 | 12 | 19 | 3 | 4 | | | 6 | 266 |
| *Hindeodella parva* | (see text) | | | | | | | | | | | | | | | 1 | 15 | | 1 | | | | | | 17 |
| *Idioprioniodus conjunctus* | *"Hibbardella"* | | | | | | | | | | | | | | | | 4 | | | | | | | | 4 |
| | *"Ligonodina" (typa)* | | | | | | | | | | | | | | | | 5 | 1 | | | | | | | 6 |
| | *"Ligonodina" (lexingtonensis)* | | | | | | | | | | | | | | | | 3 | | 1 | | | | | | 4 |
| | *"Lonchodina" (clarki)* | | | | | | | | | | | | | | | | 16 | | | | | | | | 16 |
| | *"Lonchodina" (ponderosa)* | | | | | | | | | | | | | | | | 6 | | 1 | | | | | | 7 |
| | *"Metalonchodina"* | | | | | | | | | | | | | | | | 2 | | | | 1 | | | | 3 |
| | *"Neoprioniodus"* | | | | | | | | | | | | | | | | 2 | | | | 1 | | | | 3 |
| *Stepanovites confluxa* | (see text) | | | | | | | | | | | | | | | | 7 | 2 | 2 | 2 | 2 | | | | 15 |

GSC

***TABLE 2.*** *Conodont distribution, Nansen and Otto Fiord Formations, localities northeast of head of Hare Fiord (locality numbers same as on Fig. 1).*

Atokan (early Moscovian) age. Nassichuk described ammonoids of early Atokan (early Moscovian) age from various localities near the base of the Hare Fiord Formation on eastern Axel Heiberg Island (GSC loc. C-4013) and also from various localities in the upper part of the "Tellevak Limestone" in the Blue Mountains.

The Nansen Formation was named by Thorsteinsson for a thick sequence of limestones with minor amounts of quartzose clastic sediments that is widely distributed on northern Ellesmere Island and on Axel Heiberg Island. It occurs in two belts surrounding the Basinal Clastic and Evaporitic Belt in the northwest and the southeast. Laterally the Nansen Formation grades into the Otto Fiord and the Hare Fiord Formations. In the type section, which occurs in the northwestern Carbonate Belt, the Nansen Formation consists of about 2150 m of thin- and thick-bedded limestone overlying the coarse clastic sediments of the Borup Fiord Formation.

Mamet (in Nassichuk, 1975) has identified calcareous foraminifers belonging to his zone 18 (Lower Namurian) from the lower 76 m of the type section, foraminifers belonging to his zone 19 (Homoceras Zone) between 82 and 86 m above the base of the type section and foraminifers of Moscovian age between 408 and 462 m above the base of the type section. According to Nassichuk (1975), the Nansen Formation is as young as Early Permian (Artinskian).

## CONODONT SEQUENCE AND CORRELATION

A total of 7789 conodonts were recovered from 62 samples studied; 5866 were platform elements of species of Adetognathus, Hindeodus, Diplognathodus, Idiognathodus, Idiognathoides, and Neognathodus. Only these conodonts will be considered in the stratigraphic part of the present study. The total fauna is listed on Tables 1 to 3.

| FORMATION | | O.F. | HARE FIORD (TELLEVAK) | | | | | | | | | NANSEN | | | | | H.F. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LOCALITY | | 6 | | 7 | 8 | | | 9 | | | | 10 | | | | | 11 | |
| METRES ABOVE BASE/BELOW TOP (B.T.) | | 104 | 12 | | 55 B.T. | 58 B.T. | BASAL BED | 83 | 240 | BASAL BED | | 200 | 233 | 305 | 347 | 360 | | |
| GSC LOCALITY NUMBER | | C-10836 | C-10840 | C-4085 | C-10774 | C-10775 | C-29269 | C-10804 | C-10812 | C-10817 | C-57137 | C-20016 | C-20022 | C-20036 | C-20041 | C-20045 | C-4013 | |
| SAMPLE WEIGHT IN KILOGRAMS | | 0.9 | 1.3 | 4.2 | 0.9 | 2.0 | 0.6 | 1.8 | 0.8 | 0.7 | 1.9 | 0.2 | 0.2 | 0.3 | 0.2 | 0.2 | 4.3 | |
| CONODONTS | | | | | | | | | | | | | | | | | | TOTAL |
| SPECIES | CONSTITUENT ELEMENTS | | | | | | | | | | | | | | | | | |
| *Diplognathodus ellesmerensis* | | | | | | | | | | | | | | | | 1 | 5 | 6 |
| *Hindeodus* ex gr. *Hindeodus minutus* | | | | | | | | | | | | | | | | 2 | | 2 |
| *Idiognathodus delicatus* | | 16 | 19 | 57 | | 4 | | | 1 | | 12 | 1 | 1 | 9 | 15 | 23 | 3 | 161 |
| *Idiognathodus sinuosus* | left | | | | | | | | | | | | | | | | 28 | 28 |
| | right | | | | | | | | | | | | | | | | 25 | 25 |
| *Idiognathodus* sp. indet. | | | 6 | 7 | | 2 | | | | | 27 | | | | | | 110 | 152 |
| *Idiognathoides lateralis* | | 2 | | | | | | | | | | | | | | | | 2 |
| *Idiognathoides noduliferus* | | 7 | | | | | | | | | | | | | | | | 7 |
| *Idiognathoides sinuatus* | left | | | 11 | | | 2 | | | | | | 9 | | | | 1 | 23 |
| | right | | | 14 | | | 1 | | | 1 | | | 13 | | | | 5 | 34 |
| *Idiognathoides opimus* | | | 34 | 93 | 4 | 23 | | 38 | 36 | | 165 | | | 7 | 14 | 189 | 816 | 1419 |
| *Neognathodus bothrops* | | | | | | | | | | | | | | | | 1 | | 1 |
| *Neognathodus colombiensis* | | | | | | | | | | | | | | | | | 4 | 4 |
| *Neognathodus medadultimus* | | | | | | | | | | | | | | | | | 1 | 1 |
| *Neognathodus medexultimus* | | | | | | | | 1 | | | | | | | | | 2 | 3 |
| *Streptognathodus* ? sp. A | | | | | | | | | | | | | | | | | 2 | 2 |
| *Idiognathodus* spp., *Idiognathoides* spp., *Neognathodus* spp. and/or *Streptognathodus* spp. | Tr | | | 1 | | | | 4 | | 1 | 4 | | | 1 | | 8 | 26 | 45 |
| | $Hi_1$ | | 1 | 6 | | 1 | | 5 | | | 11 | | 2 | 2 | 3 | 31 | 249 | 311 |
| | $Hi_2$ | | | 1 | | | | 1 | | | 7 | | 3 | 3 | 3 | 20 | 230 | 268 |
| | Ne | | | | | | | 3 | 1 | 1 | 7 | | 1 | 1 | 2 | 28 | 109 | 153 |
| | Oz | 2 | 2 | 26 | 1 | 5 | | 9 | 1 | 1 | 28 | | 1 | 4 | | 40 | 186 | 306 |
| *Hindeodella parva* | (see text) | | | 2 | | | | 1 | | | 3 | | | | | 6 | 24 | 36 |
| *Idioprioniodus conjunctus* | "*Hibbardella*" | | | 3 | | 2 | | 1 | | | 1 | | 1 | | | 2 | 10 | 20 |
| | "*Ligonodina*" *(typa)* | | 1 | 8 | | | | | | | 4 | | | | 1 | 4 | 33 | 51 |
| | "*Ligonodina*" *(lexingtonensis)* | | | 4 | | | | | 1 | | 2 | | 1 | | | 1 | 14 | 23 |
| | "*Lonchodina*" *(clarki)* | | 1 | 9 | | | | | | | 3 | | 1 | | | 1 | 24 | 39 |
| | "*Lonchodina*" *(ponderosa)* | | 1 | 3 | | 1 | | 1 | | | 1 | | | | | 1 | 11 | 19 |
| | "*Metalonchodina*" | | 1 | 6 | | | | | | | | | | | | 1 | 11 | 19 |
| | "*Neoprioniodus*" | | | 4 | | | | | | | | | | | | 1 | 4 | 9 |
| *Stepanovites conflexa* | (see text) | | | | | | | | | | | | | 1 | 1 | | 1 | 3 |
| *Aethotaxis advena* | (see text) | | | | | | | | | | 1 | | | | | | | 1 |

GSC

***TABLE 3.*** *Conodont distribution, Otto Fiord, Hare Fiord (including Tellevak Limestone) and Nansen Formations, localities on the southeast side of Hare Fiord and on Axel Heiberg Island (locality numbers same as on Fig. 1).*

Relative ranges of Early Pennsylvanian conodonts from the Arctic Islands differ somewhat from the ranges of corresponding conodonts in other areas of the world so that it was not possible to use zonations established elsewhere. Instead, the following four faunal units characterized by certain conodonts are recognized (in ascending order):

1. Adetognathus lautus (Gunnell).

2. Idiognathoides lateralis (Higgins and Bouckaert) and Idiognathoides noduliferus (Ellison and Graves) before the first occurrence of Idiognathoides sinuatus Harris and Hollingsworth. This faunal unit probably can be divided into a lower part, before the first appearance of Idiognathodus delicatus Gunnell, and into an upper part, in which the two characteristic conodonts occur together with Idiognathodus delicatus.

3. Idiognathoides sinuatus before the first occurrence of Idiognathoides opimus (Igo and Koike).

4. Idiognathoides opimus.

The Adetognathus lautus faunal unit was found only in the lowermost 37 m of the type section of the Nansen Formation. The samples from this part of the section yielded only a poor conodont fauna consisting of Adetognathus lautus elements. According to R. Lane (pers. com., 1978), these elements seem to represent relatively early types of Adetognathus lautus, similar to those in the lower Morrowan of the United States. Adetognathus lautus has not been reported from strata older than Pennsylvanian (Dunn, 1970b, Fig. 4; Lane et al., 1972, p. 552, Fig. 2). Higgins (1975, p. 26) described Adetognathus gigantus (which is considered in this report to be the right element of Adetognathus lautus)

from the $H_{1a}$ Zone of Northern England. In the Arctic Islands, Adetognathus lautus also has been recovered from younger parts of the Nansen Formation. Above the Adetognathus lautus faunal unit, Adetognathus lautus has no further biostratigraphic value within the Pennsylvanian of this area. It is interpreted as an environmental indicator for nearshore conditions (Merrill in Lane et al., 1971, p. 410). Its occurrence in the lowermost parts of the Nansen Formation might be due to facies conditions indicating the transition from the underlying more continental Borup Fiord Formation to more pelagic limestones in the higher parts of the Nansen Formation.

The Idiognathoides lateralis/Idiognathoides noduliferus faunal unit occurs in the Otto Fiord Formation with the exception of the uppermost limestone unit in the type area, and in the type section of the Nansen Formation from 38 m through 199 m. In the United States, Idiognathoides noduliferus does not occur below the Morrowan, while its upper range extends into the Atokan (Lane and Straka, 1975, Fig. 8). In western Europe, the range of Idiognathoides noduliferus – with the exception of some specimens doubtfully recorded from the $E_{2a1}$ Subzone of Belgium (Higgins and Bouckaert, 1968), and from the basal $E_2$ beds in northern Spain (Higgins, 1962) – is restricted to the $H_1$ through $R_1$ Zone. In Russia, Idiognathoides noduliferus has been reported from the Namurian and Bashkirian of the Donets Basin (Nemirovskaya, 1974) and from the lowermost Moscovian (Vereyan) of the Moscow Basin (Barskov and Aleksejev, 1975).

Idiognathoides lateralis occurs in western Europe from the $H_{1a}$ Zone through the $G_{2a}$ Zone (Higgins, 1975). In the Arctic Islands, the range of this conodont seems to be more restricted than that of Idiognathoides noduliferus. Idiognathoides lateralis has been recovered in the type section of the Otto Fiord Formation up to 113 m above the base, whereas single specimens of Idiognathoides noduliferus have been recovered from the basal beds of the Hare Fiord Formation, which overlies the Otto Fiord Formation. Idiognathodus delicatus, which may help to define an upper part of the Idiognathoides lateralis/Idiognathoides noduliferus faunal unit, first appears in the type Otto Fiord 18 m above its base and in the type Nansen 129 m above its base. Webster (1969) has reported the appearance of Idiognathodus delicatus in middle Morrowan strata in Nevada. In Europe this species first appears in the $R_{2b}$ Zone (Higgins, 1975). The occurrence of Diplognathodus coloradoensis (Murray and Chronic) in the upper part of this faunal unit is remarkable. Diplognathodus coloradoensis has been recovered in the type section of the Otto Fiord Formation between 41 m and 253 m above its base and in the type section of the Nansen Formation between 129 m and 251 m above its base. In the United States, Diplognathodus coloradoensis ranges from Atokan through Desmoinesian and in the Soviet Union this species appears in lower Moscovian (Kashirian) strata in the Moscow Basin (Barskov and Aleksejev, 1975).

The Idiognathoides sinuatus faunal unit occurs in the uppermost parts of the Otto Fiord Formation and in the lowermost parts of the Hare Fiord Formation. It has been found also in the Nansen Formation in a section in the Bunde Fiord area on western Axel Heiberg Island; its lack in the type section of the Nansen Formation is probably due to insufficient sampling. In the United States, Idiognathoides sinuatus seems to be restricted to the Morrowan (Lane and Straka, 1974), but in Europe its range is greater. In western Europe it occurs from the $R_{1a}$ Zone to the $G_{2b}$ Zone (Higgins, 1975), and in eastern Europe from the Namurian through the Vereyan (Nemirowskaya, 1974; Barskov and Aleksejev, 1975). In Japan, Idiognathoides sinuatus occurs in the Gondolella clarki-Polygnathodella ouachitensis Zone of the Kodani Formation. According to Koike (1967), this zone is early Atokan.

The Idiognathoides opimus faunal unit was found in the basal part of the Hare Fiord Formation with exception of the lowermost beds and in the lower part of the Nansen Formation. In the type section of Nansen Formation it has been recovered from between 312 and 431 m above the base. In the Arctic Islands, Idiognathoides opimus first appears relatively high in the Pennsylvanian sequence, in parts of the sections which probably are not older than Atokan, but elsewhere it appears earlier. In the United States this species first occurs in the Morrowan and in western Europe in the $R_{1a}$ Zone. In Japan it ranges from lower Morrowan through Atokan. Diplognathodus ellesmerensis n. sp. occurs in the Arctic Islands together with Idiognathoides opimus, but a single specimen also has been found in a sample from the Otto Fiord Formation. Idiognathodus sinuosus Ellison and Graves also appears in the Idiognathoides opimus faunal unit. In the United States it first occurs in the upper Morrowan.

Other stratigraphically important conodonts which occur in the Idiognathoides opimus faunal unit are Neognathodus bothrops Merrill, Neognathodus colombiensis (Stibane), Neognathodus medadultimus Merrill, and Neognathodus medexultimus Merrill. One specimen of N. medexultimus has been recovered in the uppermost part of the I. lateralis/I. noduliferus faunal unit. In the United States, Neognathodus bothrops, N. medadultimus and N. medexultimus occur in Atokan and younger strata (Merrill, 1973).

The correlation of the lower parts of the upper Carboniferous formations of the Arctic Islands with the North American Pennsylvanian (Fig. 3) on the basis of the conodont sequence described here leads to the following conclusions:

A. The lowermost parts of the Otto Fiord and Nansen Formations (lower 116 m in the type section of the Nansen Formation) in the type areas, which contain the Adetognathus lautus, the lower part of the Idiognathoides lateralis/Idiognathoides noduliferus unit and the upper part of the Idiognathoides lateralis/Idiognathoides noduliferus unit below the first occurrence of Diplognathodus coloradoensis, probably can be correlated with the Morrowan. The conodonts which were recovered from these parts of the sections have not been reported from strata older than Morrowan. They also do not occur in strata older than H-Zone. A descrepancy exists between this correlation and the correlation with calcareous foraminifers and algae. Mamet (in Nassichuk, 1975, p. 186, 187, 192, 193) has described Late Mississippian (zone 18) foraminifers and algae from the lowermost 70 m of the type section of the Nansen Formation and from a section in the Otto Fiord Formation near the type section of the Nansen Formation (Fig. 1, loc. 4). Conodonts from this interval, and in one case from the same sample, indicate an Early Pennsylvanian age.

B. The upper part of the Otto Fiord Formation, the lowermost parts of the Hare Fiord Formation and the lower part of the Nansen Formation – with the exception of the lowermost 116 m (in the type section) – which contain the upper part of the Idiognathoides lateralis/Idiognathoides noduliferus unit, the Idiognathoides sinuatus unit, and the Idiognathoides opimus unit, probably can be correlated with the Atokan. The beds are considered to be Atokan at the first appearance of Diplognathodus coloradoensis, because this conodont has not been reported from strata older than Atokan.

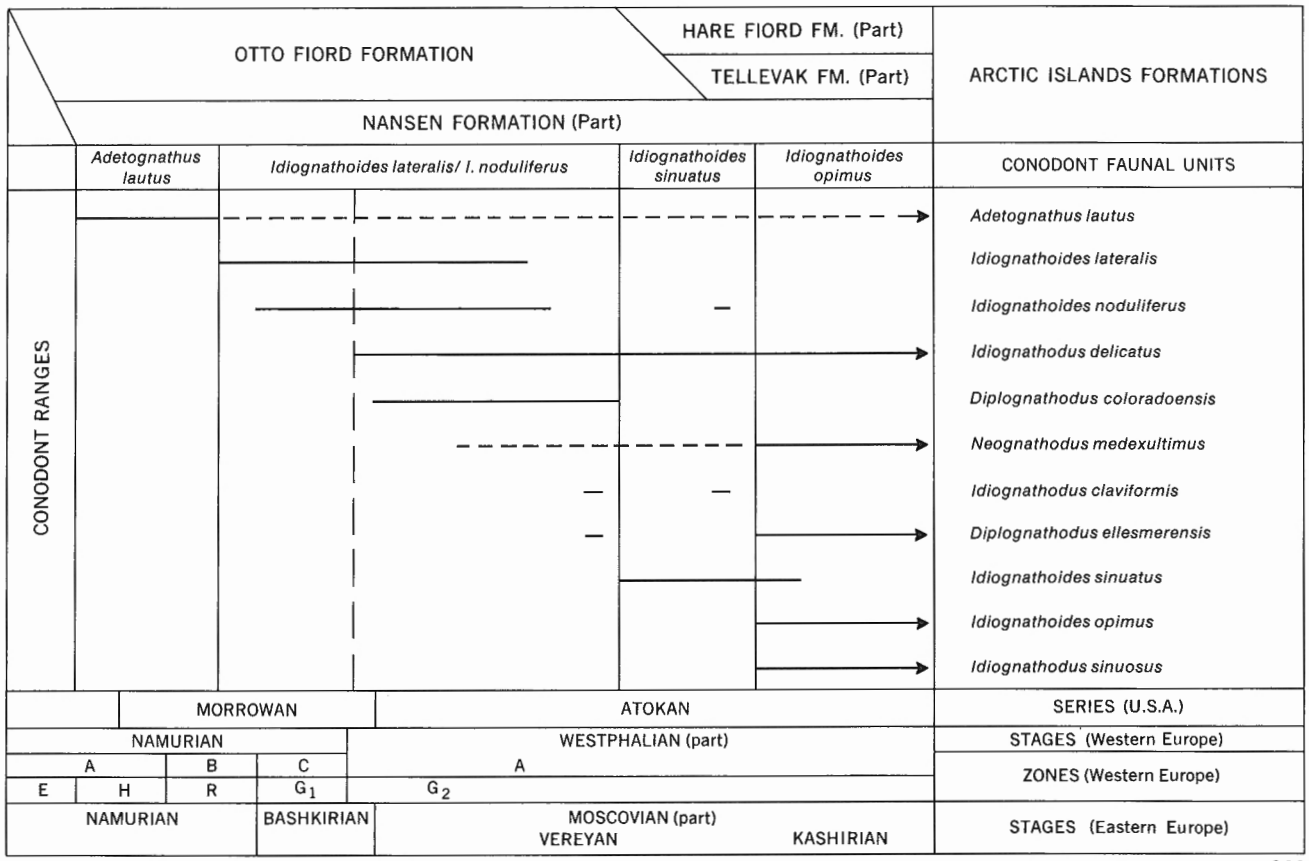


***FIGURE 3.*** *Ranges of stratigraphically important conodonts in the Lower to Middle Pennsylvanian of the Arctic Islands.*

## SYSTEMATIC PALEONTOLOGY

All figured specimens are deposited in the collections of the Geological Survey of Canada, Ottawa. Multielement taxonomy is used whenever possible. In many cases, however, difficulties arise in judging which platform elements and ramiform elements occur jointly in skeletal apparatuses. While in most platform elements a relatively rapid phylogenetic development can be observed, the ramiform elements which are part of the same skeletal apparatuses do not develop as rapidly. For example, most species of the genera Idiognathodus and Streptognathodus seem to have the same skeletal apparatus. According to Merrill and von Bitter (1977) who have described apparatuses of Neognathodus, the skeletal apparatus of this genus also is very similar to that of Idiognathodus and Streptognathodus. It can be distinguished by the platform elements, whereas the ramiform elements differ only slightly from the ramiform elements of Idiognathodus and Streptognathodus. The composition of some of the conodont faunas used for this report – for example GSC locality C-23881 from the type Otto Fiord – seems to suggest similar skeletal apparatuses also for Idiognathoides. The platform elements are thus the most critical elements of the whole apparatus. For biostratigraphic purposes there seems to be little difference between the multielement and form taxonomy in this time interval. Therefore, the ramiform elements, which might be part of the skeletal apparatuses of species of Idiognathodus, Idiognathoides, Neognathodus, and Streptognathodus, as well as Adetognathus, are described only once and placed after the corresponding group of platform elements.

Genus Adetognathus Lane, 1967

*Type species.* Cavusgnathus lautus Gunnell, 1933

Adetognathus lautus (Gunnell, 1933)

Plate 4, figures 26-33

Cavusgnathus lautus Gunnell, 1933, p. 286, Pl. 31, figs. 67, 68, Pl. 33, fig. 9.

Cavusgnathus gigantus Gunnell, 1933, p. 286, Pl. 33, figs. 7, 8.

Adetognathus giganta (Gunnell), Lane, 1967, p. 931, Pl. 120, figs. 16, 18, 19, Pl. 121, figs. 8, 12, 13, 16.

Adetognathus lauta (Gunnell), Lane, 1967, p. 933, Pl. 121, figs. 1-3, 7, 10, 11, 15, 17.

Cavusgnathus lautus Gunnell, Sp element, von Bitter, 1972, p. 61-63, Pl. 4, fig. 3a-h, Pl. 5, fig. 1a-h.

Adetognathus lautus (Gunnell), Lane and Straka, 1974, p. 64, 65, Fig. 36: 17, 21, 22, 25-31, Fig. 38: 1-4, 6-8, 10-15, 20, Fig. 39: 1-3, 7-14.

For additional synonymy and for description, see Lane (1967) and Lane and Straka (1974).

*Material and occurrence.* 19 specimens (12 lefts, 7 rights) including GSC 49281-49283, 49264. Nansen Formation; lowermost beds of Otto Fiord Formation.

Adetognathus, ramiform elements of skeletal apparatus:

Hi element

Figure 4a

Cavusgnathus Hi element, von Bitter, 1972, p. 64, 65, Pl. 11, fig. 2a, b.

*Material and occurrence.* 4 specimens, including GSC 58680; Nansen Formation.

Ne element

Figure 4b

Cavusgnathus Ne element, von Bitter, 1972, p. 64, Pl. 9, fig. 5a, b.

*Material and occurrence.* 1 specimen including GSC 58681; Nansen Formation.

Oz element

Figure 4c

Cavusgnathus Oz element von Bitter, 1972, p. 64, Pl. 8, fig. 1a-e.

*Material and occurrence.* 2 specimens including GSC 58682; Nansen Formation.

Genus Diplognathodus Kozur and Merrill, 1975

*Type species.* Spathognathodus coloradoensis Murray and Chronic, 1965.

*Remarks.* Diplognathodus originally was stated to be a multielement genus, but only the spathognathodiform elements were recovered in the samples from the Pennsylvanian of the Arctic Islands.

Diplognathodus coloradoensis (Murray and Chronic, 1965)

Plate 4, figures 8-10, 12-14

Spathognathodus coloradoensis Murray and Chronic, 1965, p. 606, 607, Pl. 72, figs. 11-13.

Diplognathodus coloradoensis (Murray and Chronic, 1965), Sweet in Ziegler, 1977, p. 87-89, Diplognathodus Pl. 1, fig. 1a-c.

For complete synonymy and description see Sweet, in Ziegler (1977).

*Material and occurrence.* 38 specimens including GSC 49270, 49272-49274; Otto Fiord Formation; lower part of Nansen Formation.

Diplognathodus ellesmerensis n. sp.

Plate 4, figures 5-7, 11, 15-21, 23-25

*Diagnosis.* A small species of Diplognathodus consisting anteriorly of a blade-like portion and posteriorly of an enlarged cup of subelliptical shape, both portions of conodont separated orally by a distinct notch. The blade-like portion is formed by laterally compressed, relatively high denticles and extends anteriorly into a single row of more rounded denticles, very fine in the notch and thicker on the cup.

*Description.* In lateral view, conodont straight to slightly arched; blade consisting of 5 to 9 denticles, normally of subequal size, about twice or three times as high as denticles on cup, highest at posterior end of blade, one or two smaller at the anterior end of blade, long axis of denticles of blade slightly diverging orally, thus giving a fan-like appearance to the blade especially in smaller specimens; basal cavity extends from the posterior end of the conodont to the aboral midpoint of the blade especially in smaller specimens; basal cavity extends from the posterior end of the conodont to the aboral midpoint of the blade, orally arched, apex of arch under notch between blade and posterior part of conodont; in posterior extension of blade a single row of denticles is developed on the basal cavity consisting of 2 to 4 fine denticles in notch, long axis of these denticles converging orally, and 4 to 6 more rounded denticles on the posterior part, highest usually the third denticle from posterior end, long axis of these denticles diverging orally.

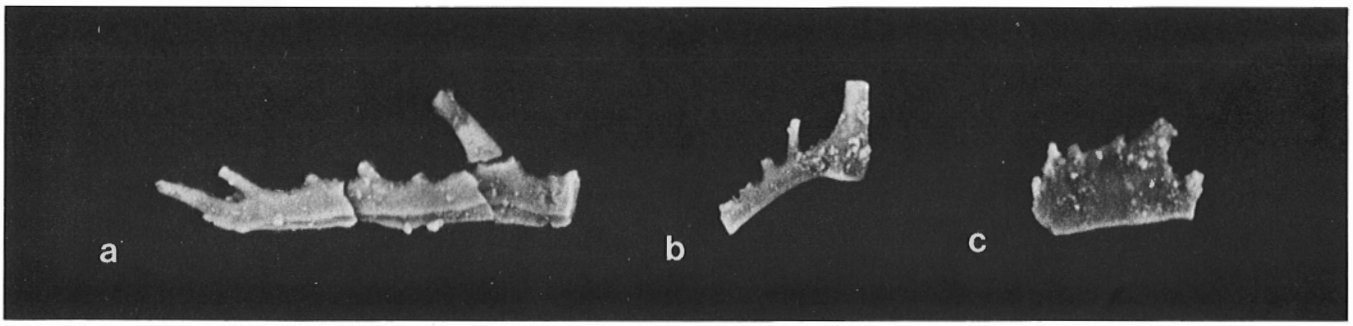


***FIGURE 4.*** *Adetognathus, ramiform elements of skeletal apparatus, all x65. All specimens from type section, Nansen Formation.*

*a. Hi element, lateral view, specimen broken during preparation; GSC 58680 from GSC loc. C-23770.*
*b. Ne element, lateral view; GSC 58681 from GSC loc. C-23772.*
*c. Oz element, lateral view; GSC 58682 from GSC loc. C-23772.*

In upper view conodont bowed, cavity extends over posterior three-quarters of conodont, basal cavity subelliptical with undulate margins; denticles of blade laterally compressed, elliptical in cross-section on posterior part.

In lower view fine striation of basal cavity parallel to the margins can be observed, anteriorly basal cavity continues as a fine groove, tip of basal cavity under posterior denticle of blade. Both right and left forms, forming symmetrical pairs (class II symmetry of Lane) have been recovered.

*Remarks.* Diplognathodus ellesmerensis seems to be related to Diplognathodus orphanus (Merrill), from which it can be distinguished by its larger basal cavity, by its distinct notch between blade and posterior part, and by its different denticulation.

*Name.* After Ellesmere Island.

*Material and occurrence.* 97 specimens including holotype GSC 49280 and paratypes GSC 49268, 49269, 49271, 49275-49278; uppermost part of Otto Fiord Formation, lower part of Hare Fiord Formation, lower part of Nansen Formation (with exception of lowermost 300 m).

Diplognathodus n. sp. A

Plate 4, figures 1-4

*Description.* A small species of Diplognathodus with a short blade in the anterior third of the conodont and a nearly elliptical cup which extends from the posterior end nearly over three quarters of the conodont; margins of cup undulate; the anterior and posterior margins of conodont are nearly vertical; blade consists of 4 to 5 laterally compressed denticles, about 1.5 times as high as denticles on posterior part; in extension of blade a single row of 7 to 9 fine denticles is developed on posterior part of conodont, in mature specimens these denticles coalesce to a ridge; the ridge (in smaller specimens, row of denticles) is arched downward toward the posterior end; only mature specimens exhibit a small notch between blade and posterior ridge.

*Material and occurrence.* 8 specimens including GSC 49265-49267; lower parts of Otto Fiord and Nansen Formations.

Genus Hindeodus Rexroad and Furnish, 1964

Hindeodus Rexroad and Furnish, 1964, p. 671.

Anchignathodus Sweet, 1970a, p. 7.

Hindeodus Rexroad and Furnish, Sweet in Ziegler, 1977, p. 203.

*Type species.* Hindeodus cristulus (Youngquist and Miller, 1949).

Hindeodus ex. gr. Hindeodus minutus (Ellison, 1941)

Plate 4, figure 22

Spathodus minutus Ellison, 1941, p. 120, Pl. 20, figs. 50-52.

Anchignathodus minutus (Ellison), von Bitter, 1972, p. 65, 66, Pl. 6, fig. 2a-i.

Spathognathodus minutus (Ellison), Merrill, 1973, p. 305, 306, Pl. 1, figs. 1-14, Pl. 2, figs. 1-28.

Anchignathodus minutus (Ellison), Sweet in Ziegler, 1973, p. 15-17, Anchignathodus Pl. 1, fig. 2a, b.

For additional synonymy and description of the spathognathodiform element see von Bitter (1972) and Merrill (1973); for discussion of multielement problematic see Sweet in Ziegler, (1977, p. 204).

*Remarks.* Only 4 spathognathodiform elements, which in form taxonomy would be identified as Spathognathodus minutus (Ellison), were recovered. No ramiform elements, which could be considered to form skeletal apparatuses with these spathognathodiform elements, were found.

*Material and occurrence.* 4 specimens including GSC 49279; Nansen, Otto Fiord, and Hare Fiord Formations.

Genus Idiognathodus Gunnell, 1931

*Type species.* Idiognathodus claviformis Gunnell, 1931.

Idiognathodus claviformis Gunnell, 1931

Plate 3, figures 14, 15

Idiognathodus claviformis Gunnell, 1931, p. 249, Pl. 29, figs. 21, 22.

Idiognathodus claviformis Gunnell, Webster, 1969, p. 35, Pl. 6, fig. 13.

Idiognathodus claviformis Gunnell, Sweet in Ziegler, 1975, p. 167, Idiognathodus Pl. 1, fig. 6a, b.

For additional synonymy see Webster (1969); for description see Sweet in Ziegler (1975).

*Material and occurrence.* 2 specimens including GSC 49251; upper part of Otto Fiord, lowermost part of Hare Fiord Formations.

Idiognathodus delicatus Gunnell, 1931

Plate 3, figures 4-8, 10, 11, 16, 28-31, 33-38

Idiognathodus delicatus Gunnell, 1931, p. 250, Pl. 29, figs. 23-25.

Idiognathodus delicatus Gunnell, Ellison, 1941, p. 134, Pl. 22, figs. 31-36.

Idiognathodus delicatus Gunnell, Sp element, von Bitter, 1972, p. 58, Pl. 3, fig. 4.

non Idiognathodus delicatus Gunnell, P element, Baesemann, 1973, Pl. 1, figs. 18, 19, 23, 24.

Idiognathodus delicatus Stauffer et Plummer, 1932 (sic), Barskov and Aleksejev, 1975, Fig. 2: 7 (non 8, 9 = Idiognathodus sinuosus?).

non Idiognathodus delicatus Gunnell, P element, Sweet in Ziegler, 1975, Idiognathodus Pl. 1, figs. 1g, h.

For additional synonymy see von Bitter (1972); for diagnosis and description see Gunnell (1931) and Ellison (1941).

*Remarks.* The platform elements of this species from the Lower to Middle Pennsylvanian of the Arctic Islands are, in accord with the original description of Idiognathodus delicatus by Gunnell (1931) and the description given by Ellison (1941), characterized by the slender lanceolate outline of the platform in upper view, by accessory lobes on both sides of the anterior end of the platform, and by the transverse ridges on the platform surface. The platform surface may be slightly concave in transverse section, but no longitudinal upper trough is developed in the posterior part. In some specimens, however, the transverse ridges are dissected either by a fine groove in the posterior extension of the carina or, more rarely, by two fine grooves extending posteriorly from the shallow troughs on both sides of the carina.

The platform element of Idiognathodus delicatus occurs in symmetrical pairs (class II symmetry of Lane).

Webster (1969, p. 36, 37) gives a description of the ontogenetic development of Idiognathodus delicatus. Because of the non-simultaneous appearance of the accessory lobes in juvenile specimens, it is difficult to identify specific extremely immature specimens of Idiognathodus. Therefore such specimens are listed in this report under Idiognathodus sp. indet.

*Material and occurrence.* 382 specimens (180 lefts, 202 rights) including GSC 49243-49246, 49248, 49249, 49252, 49260, 49261, 49263, 49264; Nansen, Otto Fiord and Hare Fiord Formations.

Idiognathodus sinuosus Ellison and Graves, 1941

Plate 3, figures 17-19

Idiognathodus sinuosus Ellison and Graves, 1941, p. 6, Pl. 3, fig. 22.

Idiognathodus humerus Dunn, 1966, p. 1300, 1301, Pl. 158, figs. 6, 7.

Idiognathodus sinuosis Ellison and Graves, Lane and Straka, 1974, p. 81, 82, Fig. 37: 10-13, 21, Fig. 42: 1-11, Fig. 43:1-8. 10-15, 19, 20.

Idiognathodus sinuosus Ellison and Graves, Sweet in Ziegler, 1975, p. 179, 180, Idiognathodus Pl. 1, fig. 3.

Idiognathodus humerus Dunn, Sweet in Ziegler, 1975, p. 173, 174, Idiognathodus Pl. 1, figs. 4a, b.

?Idiognathodus delicatus Stauffer et Plummer, 1932 (sic), Barskov and Aleksejev, 1975, Fig. 2: 8, 9 (only).

For additional synonymy and description see Lane and Straka (1974).

*Remarks.* The platform elements of Idiognathodus sinuosus occur in non-symmetrical pairs (class IIIb symmetry of Lane). They can be distinguished from platform elements of Idiognathodus delicatus by their asymmetry, by the missing or only weakly developed accessory lobes on the outer side of the platform and by the strongly incurved outer platform margins. The specimens from the Lower to Middle Pennsylvanian of the Arctic Islands seem to display these characteristics less clearly than the specimens figured by Lane and Straka. In some of the Arctic Island specimens a distinct groove which dissects the transverse ridges is developed in the posterior extension of the carina. Such specimens perhaps are transitional forms to Streptognathodus cancellosus (Gunnell).

The occurrence of Idiognathodus sinuosus in only some samples from the Arctic Islands is remarkable and seems to indicate a dependence of this species on particular environmental conditions.

*Material and occurrence.* 254 specimens (128 lefts, 126 rights) including GSC 49253-49255; Nansen and Hare Fiord Formations.

Idiognathodus sp. indet.

Plate 3, figure 9

*Remarks.* This designation includes all specimens of platform elements of Idiognathodus which could not be assigned to a definite species, mainly extremely immature specimens, but also a few broken and gerontic specimens.

*Material.* 362 specimens including GSC 49247.

Genus Idiognathoides Harris and Hollingsworth, 1933

Idiognathoides Harris and Hollingsworth, 1933, p. 201.

Polygnathodella Harlton, 1933, p. 15.

Declinognathodus Dunn, 1966, p. 1299.

Oxinagnathus Ellison, 1972, p. 138, 139.

Idiognathoides Harris and Hollingsworth, Lane and Straka, 1974, p. 83.

*Type species.* Idiognathoides sinuata Harris and Hollingsworth, 1933.

Idiognathoides lateralis (Higgins and Bouckaert, 1968)

Plate 1, figures 1, 2, 4-7

Streptognathodus lateralis Higgins and Bouckaert, 1968, p. 45, 46, Pl. 5, figs. 1-4, 7, Text-fig. 6d-f.

Declinognathodus lateralis (Higgins and Bouckaert), Dunn, 1970a, p. 330, Pl. 62, figs. 5-7, Text-fig. 9E.

Streptognathodus lateralis Higgins and Bouckaert, Austin, 1972, Pl. 1, figs. 7, 16, 25, 33, 43, 55, Pl. 2, figs. 22-24, 31, 32, 34.

Idiognathoides noduliferus (Ellison and Graves) Streptognathodus lateralis Higgins and Bouckaert Transition Series, Austin, 1972, Pl. 1, figs. 8, 9, 12-14, 17-20, 26, 27, 34-37, 42, 46-48, 54, 56-59, Pl. 2, figs. 37-55.

Streptognathodus lateralis Higgins and Bouckaert, Higgins, 1975, p. 73, Pl. 12, fig. 9, Pl. 17, figs. 10, 11, 13, 14.

Declinognathodus lateralis (Higgins and Bouckaert), Sweet in Ziegler, 1975, p. 61, 62, Neognathodus Pl. 1, figs. 8a, b.

For description see Higgins and Bouckaert (1968) and Higgins (1975).

Idiognathoides lateralis is characterized by a short carina terminating against a row of transverse ridges on the outer platform surface, whereas in Idiognathoides noduliferus the blade, without continuing into a carina, curves laterally

to meet the outer platform margin in a subcentral position. Transitional forms between the two species, similar to the transition series figured by Austin (1972), were recognized in the conodont faunas of the Otto Fiord and the lower part of the Nansen Formations. The ranges of the two species, however, are different. Idiognathoides lateralis occurs only in the lower part of the Otto Fiord and the Nansen Formation, but Idiognathoides noduliferus ranges higher and has been recovered from the lowermost beds of the Hare Fiord Formation.

*Material and occurrence.* 206 specimens (101 lefts, 105 rights) including GSC 49198, 49199, 49201, 49202; lower parts of Otto Fiord and Nansen Formations.

Idiognathoides noduliferus (Ellison and Graves, 1941)

Plate 1, figures 3, 8-16

Cavusgnathus nodulifera Ellison and Graves, 1941, p. 4, Pl. 3, figs. 4, 6.

Idiognathoides noduliferus (Ellison and Graves), Austin, 1972, Pl. 1, figs. 1, 11, 21, 29, 38, 49.

Idiognathoides noduliferus (Ellison and Graves) Streptognathodus lateralis Higgins and Bouckaert Transition Series, Austin, 1972, Pl. 1, figs. 2-6, 15, 22-24, 30-32, 39-41, 44, 45, 50-53, Pl. 2, figs. 35, 36.

Idiognathoides noduliferus (Ellison and Graves), Lane and Straka, 1974, p. 85-87, Fig. 35: 1-15, Fig. 41: 15-17.

Declinognathodus noduliferus (Ellison and Graves), Barskov and Aleksejev, 1975, Fig. 2: 1, 2.

Idiognathoides noduliferus noduliferus (Ellison and Graves), Higgins, 1975, p. 54, Pl. 14, figs. 15-17.

Idiognathoides noduliferus inaequalis, Higgins, 1975, p. 53, Pl. 12, figs. 1-7, Pl. 14, figs. 11-13, Pl. 15, figs. 10, 14.

Declinognathodus noduliferus (Ellison and Graves), Sweet in Ziegler, 1975, p. 63-65, Neognathodus Pl. 1, fig. 6.

For additional synonymy and description see Lane and Straka (1974).

*Material and occurrence.* 282 specimens (145 lefts, 137 rights) including GSC 49200, 49203-49211; Otto Fiord, lower part of Nansen (with exception to lowermost beds), and lowermost beds of Hare Fiord Formation.

Idiognathoides opimus sensu lato (Igo and Koike, 1964)

Plate 2, figures 1-38

Gnathodus opimus Igo and Koike, 1964, p. 189, 190, Pl. 28, figs. 15-18.

Gnathodus opimus Igo and Koike, 1965, p. 89, Pl. 9, figs. 1-4 (non figs. 5-8).

Gnathodus opimus Igo and Koike, Koike, 1967, p. 298-299, Pl. 1, figs. 20, 21.

Idiognathoides opimus (Igo and Koike), Igo, 1974, p. 234, 235, Pl. 2, figs. 4-7.

?Idiognathoides sulcatus Higgins and Bouckaert, Lane and Straka, 1974, p. 90-93, Fig. 36: 1-6, 18-20, 23, 24, Fig. 39: 1-10.

For additional synonymy of Idiognathoides opimus and/or Idiognathoides sulcatus see Lane and Straka (1974).

*Diagnosis.* Idiognathoides opimus is a slender, straight or slightly inwardly curved conodont, characterized by two subparallel rows of nodes or short ridges which form the platform margins. They are separated by a narrow trough which extends from the anterior to the posterior end of the platform. No carina is developed. At the blade-platform junction the blade curves outward and continues posteriorly into the outer platform margin, thus giving an indistinct sinuous outline to the platform in upper view. The platform elements always occur in symmetrical pairs (Class II symmetry of Lane).

*Remarks.* Idiognathoides opimus has been considered a synonym of Idiognathoides sulcatus Higgins and Bouckaert by Lane and Straka (1974) and Higgins (1975) on the basis that the holotype of Idiognathoides opimus is conspecific with the left element of Idiognathoides sinuatus. Although the holotype of Idiognathoides opimus is an extreme form which, indeed, seems to be transitional with the left element of Idiognathoides sinuatus (like the morphotype 3 of this report), the original description of Igo and Koike (1964, p. 189, 190) and also the upper view of the holotype seem to suggest that the median trough is developed over the whole length of the platform and is not crossed by transverse ridges. This suggests that Idiognathoides opimus is a valid species. The discussion of the taxonomic problems which result from this assumption, especially the possibility that Idiognathoides sulcatus might be a junior synonym of Idiognathoides opimus will depend on a study of Igo and Koike's original type material. However, it should be pointed out that the collection on which this conclusion is based was collected from a stratigraphic horizon younger than that of the holotype of Idiognathoides sulcatus.

About 75 per cent of the platform elements identified as Idiognathoides opimus sensu lato in this report fit into the general concept of Idiognathoides opimus and/or Idiognathoides sulcatus; i.e. they possess the two parallel rows of nodes or short ridges forming the platform margins which are separated by a median trough over the whole length of the platform. The blade of these specimens usually is one and one-half times longer than the platform. In lateral view the platform is flexed downward posteriorly. Subspecies in the sense of Idiognathoides sulcatus sulcatus and Idiognathoides sulcatus parvus of Higgins and Bouckaert (1968) could not be distinguished. However in all faunas with a reasonable number of specimens, at least three types of elements could be recognized which distinctly differ in morphological features from the typical elements. They are considered herein as four different morphotypes:

Morphotype 1

This morphotype includes all specimens with the typical characteristics of Idiognathoides opimus (Pl. 2, figs. 8, 9, 12, 15, 16, 23, 24, 27-31, 34, 38).

Morphotype 2

This morphotype includes specimens with a fine node on the outer side of the platform near the blade platform junction. Transitions between specimens with only a tiny node (Pl. 2, figs. 19-22, 32, 33) and specimens with a more

robust node (Pl. 2, figs. 1, 2, 10, 11) are recognized. These transitional forms correspond to the morphologic transition series A of Straka and Lane (1970). The specimens with a more robust node of this morphotype resemble in this respect specimens described as Idiognathoides noduliferus japonicus (Igo and Koike) by Higgins (1975, p. 54, Pl. 14, figs. 7-10).

Morphotype 3

This morphotype includes specimens in which the posterior 2 to 4 nodes or ridges are fused into transverse ridges that cross the median trough (Pl. 2, figs. 13, 14, 25, 26, 35-37). These specimens resemble juvenile specimens of the left element of Idiognathoides sinuatus. However in addition to the fact that Idiognathoides opimus displays class II symmetry, mature specimens of morphotype 3 have a median trough that is not completely filled by the transverse ridges. On the other hand, the trough is completely filled by the posterior 2 to 10 ridges in the left element of Idiognathoides sinuatus with the exception of extreme juvenile specimens.

Morphotype 4

This morphotype includes specimens in which in the anterior half of the inner platform margin the nodes are fused completely to form a longitudinal ridge, whereas the posterior half of the inner platform margin consists merely of 1 to 3 discrete nodes or is missing completely in extreme variants. The sequence shown in Plate 2, figures 17, 18, and Plate 2, figures 3 to 6 demonstrates a transition series from nearly typical specimens to an extreme form of morphotype 4.

Transitions between all four morphotypes are observed.

*Material and occurrence.* 3503 specimens (1779 lefts, 1724 rights) including GSC 49223-49241; Hare Fiord Formation with the exception of lowermost beds, middle part of Nansen Formation. Idiognathoides opimus sensu lato is the most numerous platform element in the conodont faunas of Middle Pennsylvanian age of the Arctic Islands. It appears first in parts of the sections classified as Atokan and ranges up through Desmoinesian and perhaps still younger Pennsylvanian strata. It has not been recovered from older strata on the Arctic Islands.

Idiognathoides sinuatus Harris and Hollingsworth, 1933

Plate 1, figures 17-33

Idiognathoides sinuata Harris and Hollingsworth, 1933, p. 201, Pl. 1, fig. 14.

Idiognathodus corrugata Harris and Hollingsworth, 1933, p. 202, Pl. 1, figs. 7, 8a, b.

Polygnathodella ouachitensis Harlton, 1933, p. 15, Pl. 4, fig. 14a-c.

Idiognathoides sinuatus Harris and Hollingsworth, Austin 1972, Pl. 2, figs. 19, 20, 26.

Idiognathoides corrugatus (Harris and Hollingsworth), Austin, 1972, Pl. 2, figs. 21, 25, 29.

Polygnathodella ouachitensis Harlton, Ellison, 1972, Pl. 1, figs. 5-7.

Idiognathoides sinuatus Harris and Hollingsworth, Lane and Straka, 1974, p. 88-90, Fig. 37: 14, 15, 18, 20, 23-26, 36, Fig. 41: 1-4, 20-27.

Idiognathoides sinuatus Harris and Hollingsworth, Higgins, 1975, p. 55, 56, Pl. 14, figs. 4-6, Pl. 15, figs. 11, 16, Pl. 16, figs. 1-7, 9-14.

Idiognathoides corrugatus (Harris and Hollingsworth), Higgins, 1975, p. 48, 49, Pl. 15, figs. 2-9.

Idiognathoides sinuatus Harris and Hollingsworth, Barskov and Aleksejev, 1975, Fig. 2: 3.

Idiognathoides corrugatus Harris and Hollingsworth, Barskov and Aleksejev, 1975, Fig. 2: 4.

Gnathodus ouachitensis (Harlton), Nassichuk, 1975, p. 179-181.

For additional synonymy and for diagnosis and description see Lane and Straka (1974).

*Material and occurrence.* 418 specimens (205 lefts, 213 rights) including GSC 49212-49222; uppermost part of Otto Fiord Formation, lowermost part of Hare Fiord Formation, Nansen Formation.

Genus Neognathodus Dunn, 1970a

*Type species.* Polygnathus bassleri Harris and Hollingsworth, 1933.

Neognathodus bassleri bassleri
(Harris and Hollingsworth, 1933)

Polygnathus bassleri Harris and Hollingsworth, 1933, p. 198, 199, Pl. 1, fig. 13a-e.

Neognathodus bassleri bassleri (Harris and Hollingsworth), Lane and Straka, 1974, p. 95, Fig. 37: 16, 17, 19, Fig. 42: 17-24.

Neognathodus bassleri (Harris and Hollingsworth), Higgins, 1975, p. 64, 65, Pl. 12, figs. 8, 10, 11, Pl. 17, figs. 12, 15.

Neognathodus bassleri (Harris and Hollingsworth), Sweet in Ziegler, 1975, p. 197-200, Neognathodus Pl. 1, figs. 3a, b.

For additional synonymy and description see Lane and Straka (1974).

*Material and occurrence.* 1 specimen, Nansen Formation.

Neognathodus bothrops Merrill, 1972

Neognathodus bothrops Merrill, 1972, p. 823, 824, Pl. 1, figs. 8-15.

Neognathodus bothrops Merrill, Barskov and Aleksejev, 1975, Fig. 2: 21.

Neognathodus bothrops Merrill, Sweet in Ziegler, 1975, p. 203, 204, Neognathodus Pl. 1, fig. 7.

For additional synonymy and description see Merrill (1972).

*Material and occurrence.* 1 specimen; Nansen Formation.

Neognathodus colombiensis (Stibane, 1967)

Plate 3, figures 24-27

Streptognathodus colombiensis Stibane, 1967, p. 336, Pl. 36, figs. 1-10.

*Remarks.* Neognathodus colombiensis differs from all other species of Neognathodus by its oblique anterior platform margin and by its asymmetrical basal cavity. The anterior end of the inner parapet is formed as a sharp edge which continues posteriorly to meet the carina with an angle of about 45°. In its continuation, the anterior end of the outer parapet extends posteriorly outward as an edge. The basal cavity is asymmetrical with subtriangular shape. The anterior margin of the basal cavity which forms one side of the triangle extends from the inner side posteriorly outward and crosses the long axis of the conodont with an angle of approximately 30°. The basal cavity extends anteriorly under the blade as a groove.

*Material and occurrence.* 5 specimens (2 lefts, 3 rights) including GSC 49258, 49259; lower part of Hare Fiord Formation.

Neognathodus medadultimus Merrill, 1972

Neognathodus medadultimus Merrill, 1972, p. 824, 825, Pl. 1, figs. 2-7, Pl. 2, fig. 19.

Neognathodus medadultimus Merrill, Barskov and Aleksejev, 1975, Fig. 2: 22.

Neognathodus medadultimus Merrill, Sweet in Ziegler 1975, p. 207, 208, Neognathodus Pl. 1, fig. 2.

For additional synonymy and description see Merrill (1972).

*Material and occurrence.* 1 specimen; Hare Fiord Formation.

Neognathodus medexultimus Merrill, 1972

Plate 3, figures 1-3, 12, 13, 32

Neognathodus medexultimus Merrill, 1972, p. 825, 826, Pl. 1, fig. 1, Pl. 2, figs. 20-26.

Neognathodus medexultimus Merrill, Sweet in Ziegler 1975, p. 209, 210, Neognathodus Pl. 1, fig. 1.

For additional synonymy and description see Merrill (1972).

*Material and occurrence.* 14 specimens (9 lefts, 5 rights) including GSC 49242, 49250, 49262; Hare Fiord and Nansen Formations.

Genus Streptognathodus Stauffer and Plummer, 1932

*Type species.* Streptognathodus excelsus Stauffer and Plummer, 1932.

Streptognathodus? sp. A

Plate 3, figures 20-23

*Remarks.* Two specimens each with a carina extending to the posterior end of the platform, with a flat to slightly concave platform surface and with only rudimentary transverse ridges have been recovered from the Hare Fiord Formation. The generic assignment of these specimens, which also might be pathological forms, is not certain.

*Material and occurrence.* 2 specimens including GSC 49256, 49257; Hare Fiord Formation.

Idiognathodus, Idiognathoides, Neognathodus, and/or Streptognathodus, ramiform elements of skeletal apparatus:

The ramiform elements described in the following are considered to be parts of the skeletal apparatuses of various species of Idiognathodus, Idiognathoides, Neognathodus, and Streptognathodus. If a distinction of the ramiform elements of these different species and genera is possible it would be based on insignificant morphologic characteristics. The material used for this report does not allow such a differentiation.

Tr element

(= form species Hibbardella acuta Murray and Chronic, 1965)

Plate 4, figures 35, 42

Hibbardella fragilis Higgins, 1961, p. 213, 214, Pl. 12, fig. 4, Text-fig. 2.

Hibbardella acuta Murray and Chronic, 1965, p. 598, Pl. 73, figs. 3-5.

Hibbardella acuta Murray and Chronic, Higgins and Bouckaert, 1968, p. 36, Pl. 1, fig. 9.

Hibbardella (Hibbardella) acuta Murray and Chronic, Rhodes et al., 1969, p. 112, Pl. 25, figs. 19a-20.

Hibbardella acuta Murray and Chronic, Reynolds, 1970, p. 10, Pl. 2, figs. 6, 7.

Streptognathodus and Idiognathodus Tr element, von Bitter, 1972, p. 71, Pl. 16, figs. 4a-d.

Idiognathodus delicatus Gunnell $A_3$ element (diplododellan), Baesemann, 1973, p. 702, 703, Pl. 1, fig. 20.

Hibbardella acuta Murray and Chronic, Higgins, 1975, p. 34, Pl. 1, figs. 7, 9, Pl. 6, fig. 13 (partim), Textfig. 7g.

Idiognathodus $A_3$ element, Perlmutter, 1975, p. 101, Pl. 2, figs. 12, 13.

Idiognathodus delicatus Gunnell, 1931, $A_3$ element, Sweet in Ziegler, 1975, Idiognathodus Pl. 1, fig. 1d.

For description see Higgins (1975).

*Material and occurrence.* 94 specimens including GSC 49286, 49292; Otto Fiord, Hare Fiord and Nansen Formations.

$Hi_1$ element

(= form species Hindeodella ibergensis Bischoff, 1957)

Plate 4, figures 46, 47

Hindeodella ibergensis Bischoff, 1957, p. 28, Pl. 6, figs. 33, 37, 39.

Streptognathodus and Idiognathodus Hi element, von Bitter, 1972, p. 60, 61, Pl. 11, fig. 3a-d.

Idiognathodus delicatus Gunnell, $A_1$ element (hindeodellan), Baesemann, 1973, p. 702, Pl. 1, fig. 13.

Idiognathodus delicatus Gunnell, $A_1$ element (hindeodellan), Baesemann, 1973, p. 702, Pl. 1, fig. 15.

Hindeodella ibergensis Bischoff, Higgins, 1975, p. 38-40, Pl. 4, figs. 10, 11, 14, 15, Pl. 6, fig. 13 (pars), Text-fig. 8a-f.

Idiognathodus $A_1$ element, Perlmutter, 1975, p. 100, 101, Pl. 2, figs. 10, 11.

Idiognathodus delicatus Gunnell, 1931, $A_1$ element, Sweet in Ziegler, 1975, Idiognathodus Pl. 1, figs. 1a, b.

For additional synonymy see Higgins (1975); for description see Bischoff (1957).

*Remarks.* Variations in the anterior end of this element similar to those illustrated by Higgins (1975, Text-fig. 9a-f) also can be observed in the faunas of this report. These variations also include transitions between specimens with a more inward-curved anterior lateral process (I. delicatus $A_{1b}$ element of Baesemann) and specimens with a less strongly inward curved anterior lateral process (I. delicatus $A_{1a}$ element of Baesemann).

*Material and occurrence.* 486 specimens including GSC 49296, 49297; Otto Fiord, Hare Fiord and Nansen Formations.

$Hi_2$ element

[= form-species Hindeodella simplex (Higgins and Bouckaert 1968)]

Plate 4, figures 43, 44

Angulodus simplex Higgins and Bouckaert, 1968, p. 28, 29, Pl. 1, fig. 7.

Idiognathodus delicatus Gunnell, $A_2$ element (angulodontan), Baesemann, 1973, p. 702, Pl. 1, fig. 12.

Hindeodella simplex (Higgins and Bouckaert), Higgins, 1975, p. 42, 43, Pl. 5, figs. 10, 12, 13.

Idiognathodus delicatus Gunnell, $A_2$ element, Sweet in Ziegler, 1975, Idiognathodus Pl. 1, fig. 1c.

For additional synonymy see Higgins (1975); for description see Baesemann (1973).

*Material and occurrence.* 304 specimens including GSC 49293, 49294; Otto Fiord, Hare Fiord, and Nansen Formation.

Ne element

Plate 4, figures 36-39

Streptognathodus and Idiognathodus Ne element, von Bitter, 1972, p. 60, Pl. 9, figs. 2a, b.

Idiognathodus delicatus Gunnell, N element (synprioniodinan), Baesemann, 1973, p. 701, 702, Pl. 1, fig. 14.

Synprioniodina microdenta Ellison, Higgins, 1975, p. 75, Pl. 3, figs. 10, 15, 16.

Idiognathodus N element, Perlmutter, 1975, p. 100, Pl. 2, figs. 8, 9.

Idiognathodus delicatus Gunnell, N element, Sweet in Ziegler, 1975, Idiognathodus Pl. 1, fig. 1e.

non Synprioniodina microdenta Ellison, 1941, p. 119, Pl. 20, figs. 43, 45, 46 (=Syn element of Gondolella, according to von Bitter, 1976, p. 20, 22), Pl. 20, fig. 44 (=Ne element of Gondolella, according to von Bitter, 1976, p. 20, 22).

For additional synonymy and description see Higgins (1975).

*Remarks.* The denticulation of the posterior bar is variable. Specimens with denticles of only one size have been observed as well as specimens with larger denticles alternating with up to three smaller denticles between the larger ones.

*Material and occurrence.* 275 specimens including GSC 49287, 49289; Otto Fiord, Hare Fiord, and Nansen Formations.

Oz element

[=form-species Ozarkodina delicatula (Stauffer and Plummer, 1932)]

Plate 4, figures 40, 41, 45

Bryantodus delicatulus Stauffer and Plummer, 1932, p. 29, Pl. 2, fig. 27.

Ozarkodina delicatula (Stauffer and Plummer), Ellison, 1941, p. 120, Pl. 20, figs. 40-42, 47.

Ozarkodina delicatula (Stauffer and Plummer), Webster, 1969, p. 42, 43, Pl. 7, fig. 11.

Streptognathodus and Idiognathodus Oz element, von Bitter, 1972, p. 60, Pl. 7, fig. 4a-h.

Idiognathodus delicatus Gunnell, $O_1$ element (ozarkodina), Baesemann, 1973, p. 700, Pl. 1, figs. 16, 17.

Ozarkodina delicatula (Stauffer and Plummer), Higgins, 1975, p. 69, Pl. 5, figs. 9, 11, 16, Pl. 6, figs. 15, 16 (pars).

Idiognathodus $O_1$ element, Perlmutter, 1975, p. 100, Pl. 2, figs. 1-7.

Idiognathodus delicatus Gunnell, O element, Sweet in Ziegler, 1975, Idiognathodus Pl. 1, fig. 1f.

For additional synonymy see Webster (1969); for description see von Bitter (1972).

*Remarks.* A small number of specimens have been observed with larger denticles on the posterior bar alternating with 2 to 3 smaller denticles between the larger ones.

*Material and occurrence.* 691 specimens including 49290, 49291, 49295; Otto Fiord, Hare Fiord, and Nansen Formation.

Unassigned Hindeodellan element

(=form-species Hindeodella parva Ellison, 1941)

Plate 4, figures 34, 37, 38

Hindeodella parva Ellison, 1941, p. 117, 118, Pl. 20, fig. 29.

?Hindeodina uncata Hass, 1959, p. 383, Pl. 47, fig. 6.

Hindeodella parva Ellison, von Bitter, 1972, p. 76, 77, Pl. 11, fig. 4a-d.

$A_1$ element (Hindeodella parva), Baesemann, 1973, p. 708, Pl. 1, fig. 8.

?Hindeodella uncata (Hass), Higgins, 1975, p. 44, Pl. 4, figs. 1-3.

For additional synonymy on Hindeodella uncata see Higgins, 1975; for description, see von Bitter, 1972.

*Remarks.* Von Bitter, 1972 has demonstrated, that the part of Hindeodella parva designated by Ellison (1941) as posterior bar actually should be considered an anterior bar.

This element seems to be exposed to breakage even more than other hindeodellan elements. No larger specimens with a complete posterior bar have been recovered from the conodont faunas of the Lower to Middle Pennsylvanian of the Arctic Islands. Several smaller specimens however, which were nearly complete, demonstrate that this element has a posterior bar, which in size and denticulation is very similar to the posterior bars of hindeodellan elements of Idiognathodus, Idiognathoides, Neognathodus and Streptognathodus.

*Material and occurrence.* 57 specimens including GSC 49285, 49288; Otto Fiord, Hare Fiord, and Nansen Formations.

Genus Idioprioniodus Gunnell, 1933

Idioprioniodus Gunnell 1933, p. 265.

Duboisella Rhodes 1952, p. 895.

Neoprioniodus Rhodes and Müller, 1956, von Bitter, 1972, p. 68.

Idioprioniodus Gunnell, Baesemann, 1973, p. 703.

*Type species.* Idioprioniodus typus Gunnell, 1933.

Idioprioniodus conjunctus (Gunnell, 1931)

Plate 4, figures 48-51, 53, 55-58

*Remarks.* For the taxonomic status of this multielement species, see Merrill and Merrill (1974, p. 119, 120). The Idioprioniodus apparatuses from the Lower to Middle Pennsylvanian of the Arctic Islands contain the Metalonchodina element, which is lacking in the Neoprioniodus conjunctus apparatus-species described by von Bitter (1972), and in the Idioprioniodus lexingtonensis apparatus-species described by Baesemann (1973).

Hibbardella element

Plate 4, figure 53

Prioniodus subacodus Gunnell, 1931, p. 246, Pl. 29, fig. 5.

Neoprioniodus conjunctus (Gunnell), Tr element, von Bitter, 1972, p. 70, Pl. 16, figs. 2a, b.

Idioprioniodus lexingtonensis (Gunnell), $B_{3a}$ element, Baesemann, 1973, p. 704, Pl. 3, fig. 9.

For additional synonymy see von Bitter (1972).

*Material and occurrence.* 27 specimens including GSC 49303; Hare Fiord and Nansen Formation.

Ligonodina element

Plate 4, figure 57

Idioprioniodus typus Gunnell, 1933, p. 265, Pl. 31, fig. 47.

Neoprioniodus conjunctus (Gunnell), Hi element, von Bitter, 1972, p. 69, Pl. 12, fig. 3.

Idioprioniodus lexingtonensis (Gunnell), $B_{1a}$ element, Baesemann, 1973, p. 703, 704, Pl. 3, fig. 1.

Ligonodina typa (Gunnell), Higgins, 1975, p. 59, Pl. 6, fig. 4.

For additional synonymy see von Bitter (1972) and Higgins (1975).

*Material and occurrence.* 65 specimens including GSC 49306; Otto Fiord, Hare Fiord, and Nansen Formations.

Ligonodina element

Plate 4, figures 55, 56

Prioniodus lexingtonensis Gunnell, 1931, p. 246, Pl. 29, fig. 4.

Ligonodina lexingtonensis (Gunnell), von Bitter, 1972, p. 76, Pl. 12, fig. 2a, b.

Idioprioniodus lexingtonensis (Gunnell), $B_2$ element, Baesemann, 1973, p. 704, Pl. 3, figs. 3, 8.

Ligonodina lexingtonensis (Gunnell), Higgins, 1975, p. 58, Pl. 6, figs. 9, 10.

For additional synonymy see von Bitter (1972).

*Material and occurrence.* 31 specimens including GSC 49305; Otto Fiord, Hare Fiord, and Nansen Formations.

Lonchodina element

Prioniodus clarki Gunnell, 1931, p. 247, Pl. 29, fig. 8.

Neoprioniodus conjunctus (Gunnell), Pl element, von Bitter, 1972, p. 69, 70, Pl. 12, fig. 4a-c.

Idioprioniodus lexingtonensis (Gunnell), $B_{1b}$ element, Baesemann, 1973, p. 704, Pl. 3, fig. 2.

For additional synonymy see von Bitter (1972).

*Material and occurrence.* 64 specimens; Otto Fiord, Hare Fiord, and Nansen Formations.

Lonchodina element

Plate 4, figure 58

Lonchodina? ponderosa Ellison, 1941, p. 116, Pl. 20, figs. 37-39.

Lonchodina? ponderosa Ellison, von Bitter, 1972, p. 79, Pl. 12, fig. 5a-c.

Idioprioniodus lexingtonensis (Gunnell) $B_{3b}$ element, Baesemann, 1973, p. 704, Pl. 3, figs. 4, 5.

Lonchodina ponderosa Ellison, Higgins, 1975, p. 60, 61, Pl. 2, fig. 11.

*Material and occurrence.* 28 specimens including GSC 49307; Hare Fiord and Nansen Formations.

Metalonchodina element

Plate 4, figures 48-50

Prioniodus bidentatus Gunnell, 1931, p. 247, 248, Pl. 29, fig. 6.

Metalonchodina bidentata (Gunnell), Branson and Mehl, 1941, p. 106, Pl. 19, fig. 34.

Metalonchodina bidentata (Gunnell), Ellison, 1941, p. 116, Pl. 20, figs. 35, 36.

Metalonchodina bidentata (Gunnell), Higgins, 1975, p. 63, Pl. 1, fig. 13.

?Metalonchodina tenora Ellison, 1941, p. 117, Pl. 20, fig. 34.

For additional synonymy see Higgins (1975).

*Remarks.* The Metalonchodina bidentata element typically has one large denticle on the anterior bar and an angle of approximately 90° between both bars. In the conodont faunas of this report, transitions have been observed between typical M. bidentata elements and specimens with more than one large denticle on the anterior bar. The angle between both bars also seems to be relatively variable in these specimens.

*Material and occurrence.* 24 specimens including GSC 49298-49300; Hare Fiord and Nansen Formations.

Neoprioniodus element

Plate 4, figure 51

Prioniodus conjunctus Gunnell, 1931, p. 247, Pl. 29, fig. 7.

Neoprioniodus conjunctus (Gunnell), Ne element, von Bitter, 1972, p. 69, Pl. 9, fig. 6a, b.

Idioprioniodus lexingtonensis (Gunnell), N element, Baesemann, 1973, p. 703, Pl. 3, fig. 7.

Neoprioniodus conjunctus (Gunnell), Higgins, 1975, p. 66, 67, Pl. 3, fig. 7.

For additional synonymy see Higgins (1975).

*Material and occurrence.* 15 specimens including GSC 49301; Otto Fiord, Hare Fiord, and Nansen Formations.

Genus Stepanovites Kozur, 1975

*Type species.* Stepanovites meyeni Kozur and Movsovic, 1975.

Stepanovites conflexa (Ellison, 1941)

Plate 4, figure 52

Prioniodus? conflexus Ellison, 1941, p. 114, Pl. 20, fig. 25.

Delotaxis conflexa (Ellison), von Bitter, 1972, p. 72, Pl. 12, fig. 1a-c, Pl. 14, figs. 1a-c, b, 4a, b, Pl. 16, figs. 1a-d.

*Remarks.* For description see von Bitter (1972). Hi, Pl?, and Oz? elements of this multielement species have been recovered in the conodont faunas of the Lower and Middle Pennsylvanian of the Arctic Islands.

*Material and occurrence.* 18 specimens including GSC 49302; Nansen and Hare Fiord Formation.

Genus Aethotaxis Baesemann, 1973

*Type species.* Aethotaxis advena Baesemann, 1973.

Aethotaxis advena Baesemann, 1973

Plate 4, figure 54

Aethotaxis advena Baesemann, 1973, p. 697-699, Pl. 3, figs. 6, 10-21.

*Remarks.* One specimen which is considered to be an element of the multielement species Aethotaxis advena was recovered from the conodont faunas of the Lower to Middle Pennsylvanian of the Arctic Islands.

*Material and occurrence.* 1 specimen, GSC 49304; Hare Fiord Formation.

## REFERENCES


Austin, Ronald, L.
1972: Problems of conodont taxonomy with special reference to Upper Carboniferous forms; Geologica et Paleontologica, Sonderband 1, p. 115-126.

Baesemann, J.F.
1973: Missourian (Upper Pennsylvanian) conodonts of northeastern Kansas; Journal of Paleontology, v. 47, p. 689-710.

Barskov, I.S. and Aleksejev, A.S.
1975: Konodonti srednego i werchnego Karbona podmoskowia; Akademiia Nauk SSSR, Izvestiia, Seriia Geologicheskaia, v. 6, p. 84-99.

Bischoff, G.
1957: Die Conodonten-Stratigraphie des rhenoherzynischen Unterkarbons mit Berücksichtigung der Wocklumeria-Stufe und der Devon Karbon Grenze; Hessisches Landesamt fur Bodenforschung, Abhandlungen, v. 19.

Bonham-Carter, G.F.
1966: The geology of the Pennsylvanian sequence of the Blue Mountains, northern Ellesmere Island; University of Toronto, unpublished Ph.D. thesis.

Branson, E.B. and Mehl, M.G.
1941: New and little known Carboniferous conodont genera; Journal of Paleontology, v. 15, p. 97-106.

Dunn, D.L.
1966: New Pennsylvanian platform conodonts from southwestern United States; Journal of Paleontology, v. 40, p. 1294-1303.

Dunn, D.L.
1970a: Middle Carboniferous conodonts from western United States and phylogeny of the platform group; Journal of Paleontology, v. 44, p. 312-342.

1970b: Conodont zonation near the Mississippian-Pennsylvanian boundary in western United States; Geological Society of America, Bulletin, v. 81, p. 2959-2974.

1971: Considerations of the Idiognathoides-Declinognathodus-Neognathodus complex of Middle Carboniferous platform conodonts; Lethaia, v. 4, p. 15-19.

1976: Biostratigraphic problems of Morrowan and Derryan (Atokan) strata in the Pennsylvanian System of western United States; Geological Society of America, Bulletin, v. 87, p. 641-645.

Ellison, S.P., Jr.
1941: Revision of the Pennsylvanian conodonts; Journal of Paleontology, v. 15, p. 107-143.

1972: Conodont taxonomy in the Pennsylvanian; Geologica et Palaeontologica, Sonderband 1, p. 127-146.

Ellison, S.P., Jr. and Graves, R.W.
1941: Lower Pennsylvanian (Dimple Limestone) conodonts of the Marathon region, Texas; University of Missouri School of Mines and Metallury, Technical Series, v. 14, no. 3, p. 1-21.

Gunnell, F.H.
1931: Conodonts from the Fort Scott limestone of Missouri; Journal of Paleontology, v. 5, p. 244-252.

1933: Conodonts and fish remains from the Cherokee, Kansas City, and Wabaumsee groups of Missouri and Kansas; Journal of Paleontology, v. 7, p. 261-297.

Harlton, B.H.
1933: Micropaleontology of the Pennsylvanian Johns Valley Shale of the Ouachita Mountains, Oklahoma, and its relationship to the Mississippian Caney Shale, Journal of Paleontology, v. 7, p. 3-29.

Harris, R.W. and Hollingsworth, R.V.
1933: New Pennsylvanian conodonts from Oklahoma; American Journal of Science, v. 25, p. 193-204.

Hass, W.H.
1950: Conodonts from the Chappel Limestone of Texas; United States Geological Survey, Professional Paper 294-J.

Higgins, A.C.
1961: Some Namurian conodonts from North Staffordshire; Geological Magazine, v. 98, p. 210-224.

1962: Conodonts from the "Griotte" Limestone of Northwest Spain; Notas y comunicaciones, Instituto Geologico y Minero de España 65, p. 5-21, Pls. 1-3.

Higgins, A.C.
1975: Conodont zonation of the late Visean-early Westphalian strata of the south and central Pennines of northern England; Geological Survey of Great Britain, Bulletin 53, p. 90.

Higgins, A.C. and Bouckaert, J.
1968: Conodont stratigraphy and palaeontology of the Namurian of Belgium; Belgium, Service Géologique, Mémoire 10.

Huddle, J.W.
1964: Cavusgnathus, Idiognathoides and Polygnathodella: a conodont nomenclatural and biologic problem; Journal of Paleontology, v. 38, p. 400, 401.

Igo, H.
1974: Some Upper Carboniferous conodonts from the Akiyoshi Limestone, southwest Japan; Tokyo Gakygei University, Bulletin, Series 4: Mathematics and Natural Sciences., v. 26, p. 230-238.

Igo, H. and Koike, T.
1964: Carboniferous conodonts from the Omi Limestone, Niigata prefecture, central Japan (Studies of Asian conodonts, pt. I); Palaeontological Society of Japan, Transactions and Proceedings, n.s., no. 53, p. 179-193.

1965: Carboniferous conodonts from Yobara, Akiyoshi Limestone, Japan (Studies of Asiatic conodonts, pt. II); Palaeontological Society of Japan, Transactions and Proceedings, n.s., no. 59, p. 83-91.

Klapper, G. and Philip, G.M.
1971: Devonian conodont apparatuses and their various skeletal elements; Lethaia, v. 4, p. 429-452.

Koike, T.
1967: A Carboniferous succession of conodont faunas from Atetsu Limestone in southwest Japan (Studies of Asiatic conodonts, pt. VI); Science reports of the Tokyo Kyoiku Daigaku, v. 9, no. 53, p. 279-318.

Kozur, H.
1975: Beiträge zur Conodontenfauna des Perm; Geologisch-Paläontologische Mitteilungen, Innsbruck, v. 5, p. 1-44.

Lane, H.R.
1967: Uppermost Mississippian and lower Pennsylvanian conodonts from the type Morrowan region, Arkansas; Journal of Paleontology, v. 41, p. 920-942.

1968: Symmetry in conodont element-pairs; Journal of Paleontology, v. 42, p. 1258-1263.

Lane, H.R., Merrill,G., Straka, J. and Webster, G.D.
1971: North American Pennsylvanian conodont biostratigraphy in Symposium on conodont biostratigraphy; Geological Society of America; Memoir 127, p. 395-414.

Lane, H.R., Sanderson, G.A. and Verville, G.J.
1972: Uppermost Mississippian-basal Middle Pennsylvanian conodonts and fusulinids from several exposures in the south-central and southwestern United States; 24th International Geological Congress, Section 7, Paleontology, p. 549-555.

Lane, R.H. and Straka, J.J.
1974: Late Mississippian and Early Pennsylvanian conodonts, Arkansas and Oklahoma; Geological Society of America, Special Paper 152.

Mamet, B.L. and Skipp, B.
1970: Lower Carboniferous calcareous Foraminifera. Preliminary zonation and stratigraphic implications for the Mississippian of North America; 6th International Congress on Carboniferous Stratigraphy and Geology, v. 3, p. 1129-1146.

Meischner, K.D.
1970: Conodonten-Chronologie des deutschen Karbons; 6me Congress International de Stratigraphie et de Géologie du Carbonifère, Compte Rendu, v. III, p. 1169-1180.

Merrill, G.K.
1972: Taxonomy, phylogeny, and biostratigraphy of Neognathodus in Appalachian Pennsylvanian rocks; Journal of Paleontology, v. 46, p. 817-829.

1973: Pennsylvanian nonplatform conodont, genera, Spathognathodus; Journal of Paleontology, v. 47, p. 289-314.

Merrill, G.K. and King, C.W.
1971: Platform conodonts from the lowest Pennsylvanian rocks of northwestern Illinois; Journal of Paleontology, v. 45, p. 645-664.

Merrill, G.K. and Merrill, S.M.
1974: Pennsylvanian nonplatform conodonts, IIa: The dimorphic apparatus of Idioprioniodus; Geologica et Palaeontologica, v. 8, p. 119-130.

Merrill, G.K. and von Bitter, P.H.
1977: Apparatus of the Pennsylvanian conodont genus Neognathodus; Life Sciences Contributions, Royal Ontario Museum, Toronto, 22 p.

Murray, F.N. and Chronic, J.
1965: Pennsylvanian conodonts and other fossils from insoluble residues of the Minturn Formation (Desmoinesian), Colorado; Journal of Paleontology, v. 39, p. 594-610.

Nassichuk, W.W.
1975: Carboniferous ammonoids in the Canadian Arctic Archipelgo; Geological Survey of Canada, Bulletin 237.

Nemirovskaya, T.
1974: Stratigraphitscheskoje snascheue platformennich konodontov werchnich nischnego Karbona Donbassa; Geologicheskii Zhurnal, v. 34, p. 128-132.

Perlmutter, B.
1975: Conodonts from the uppermost Wabaunsee Group (Pennsylvanian) and the Admire and Concil Grove Groups (Permian) in Kansas; Geologica et Paleontologica, v. 9, p. 95-115.

Rexroad, C.B. and Furnish, W.M.
1964: Conodonts from the Pella Formation (Mississippian) South-Central Iowa; Journal of Paleontology, v. 38, p. 667-676.

Reynolds, M.J.
1970: A Lower Carboniferous conodont fauna from Flintshire, North Wales; Geological Survey of Great Britain, Bulletin 32, p. 1-19.

Rhodes, F.H.T.
1952: A classification of Pennsylvanian conodont assemblages; Journal of Paleontology, v. 26, p. 886-901.

Rhodes, F.H.T., Austin, R.L. and Druce, E.C.
1969: British Avonian (Carboniferous) conodont faunas, and their value in local and intercontinental correlation; British Museum (Natural History) Bulletin of Geology, Supplement, v. 5.

Rhodes, F.H.T. and Müller, K.J.
1956: The conodont genus Prioniodus and related forms; Journal of Paleontology, v. 30, p. 695-699.

Stauffer, C.R. and Plummer, H.J.
1932: Texas Pennsylvanian conodonts and their stratigraphic relations; University of Texas, Bulletin 3201, p. 13-50.

Stibane, F.R.
1967: Conodonten des Karbons aus den nördlichen Anden Südamerikas; Neues Jahrbuch für Geologie und Palaontologie, Abhandlungen v. 128, p. 329-340.

Straka, J.J.
1972: Conodont evidence of age of Goddard and Springer Formations, Ardmore Basin, Oklahoma; American Association of Petroleum Geologists, Bulletin, v. 56, p. 1087-1099.

Straka, J.J. and Lane, H.R.
1970: Evolution of some Lower Pennsylvanian conodont species; Lethaia, v. 3, p. 41-49.

Sweet, W.C.
1970a: Permian and Triassic conodonts from a section at Guryul ravine, Vihi District, Kashmir; University of Kansas, Paleontology Contributions, Paper 49.

1970b: Uppermost Permian and Lower Triassic conodonts of the Salt Range and Trans-Indus Ranges, West Pakistan in Stratigraphic boundary problems: Permian and Triassic of West Pakistan, Kummer, K. and Teichert, C., eds.; University of Kansas, Special Publication 4, p. 207-275.

Thompson, T.L.
1970: Lower Pennsylvanian conodonts from McDonald County, Missouri; Journal of Paleontology, v. 44, p. 1041-1048.

Thorsteinsson, R.
1970: Precambrian and Paleozoic in Geology and economic minerals of Canada; Geological Survey of Canada, Economic Geology Report No. 1, 5th Edition, p. 548-590.

1974: Carboniferous and Permian stratigraphy of Axel Heiberg Island and western Ellesmere Island, Canadian Arctic Archipelago; Geological Survey of Canada, Bulletin 224.

Thorsteinsson, R., Tozer, E.T. and Trettin, H.P.
1972: Geology, Otto Fiord, District of Franklin; Geological Survey of Canada, Map 1309A.

Toomey, D.F., Baesemann, J.F. and Lane, H.R.
1974: The biota of the Pennsylvanian (Virgilian) Leavenworth Limestone, midcontinent region. Part 5: Distribution of miscellaneous microfossils; Journal of Paleontology, v. 48, p. 1156-1165.

von Bitter, P.H.
1972: Environmental control of conodont distribution in the Shawnee Group (Upper Pennsylvanian) of eastern Kansas; University of Kansas, Paleontology Contributions, Article 59.

1976: The Apparatus of Gondolella sublanceolata Gunnell (Conodontophorida, Upper Pennsylvanian) and its Relationship to Illinella typica Rhodes; Life Science Contribution, Royal Ontario Museum, v. 109.

Webster, G.D.
1969: Chester through Derry conodonts and stratigraphy of northern Clark and southern Lincoln Counties, Nevada; University of California Publications in Geological Sciences, v. 79.

Wirth, M.
1967: Zur Gliederung des höheren Paläozoikums (Givet-Namur) in Gebiet des Quinto Real (Westpyrenäen) mit Hilfe von Conodonten, Neues Jahrbuch für Geologie und Pälaontologie, Abhandlungen 127, p. 179-244.

Youngquist, W. and Heezen, B.
1948: Some Pennsylvanian conodonts from Iowa; Journal of Paleontology, v. 22, p. 767-773.

Youngquist, W.L. and Miller, A.K.
1949: Conodonts from the Late Mississippian Pella beds of South-Central Iowa; Journal of Paleontology, v. 23, p. 617-622.

Ziegler, W., ed.
1973: Catalogue of conodonts; E. Schweizerbart'sche Verlagsbuchhandlung, v. 1.

1975: Catalogue of conodonts; E. Schweizerbart'sche Verlagsbuchhandlung, v. 2.

1977: Catalogue of conodonts; E. Schweizerbart'sche Verlagsbuchhandlung, v. 3.

PLATES 1-4

## PLATE 1

(Figures 8, 9, 17, 18 x65; all other figures x40)

Figures 1, 2, 4-7. Idiognathoides lateralis (Higgins and Bouckaert) platform element:

1, 2. Left elements, upper view, GSC 49198, 49199 from GSC loc. C-23881.

4. Right element, upper view, GSC 49201 from same locality.

5, 6, 7. Right element, upper, lower and outer lateral view, GSC 49202 from same locality.

Figures 3, 8-16. Idiognathoides noduliferus (Ellison and Graves) platform element:

3. Left element, upper view, GSC 49200 from GSC loc. C-23881, type section Otto Fiord Formation.

8. Left element, juvenile, upper view GSC 49203 from GSC loc. C-23881.

9. Right element, juvenile, upper view GSC 49204 from GSC loc. C-23881.

10. Right element, upper view, GSC 49205, from GSC loc. C-20460, locality 4, Otto Fiord Formation.

11. Right element, gerontic, upper view, GSC 49206, from GSC loc. C-10684, locality 2, Otto Fiord Formation.

12. Left element, upper view, GSC 49207, GSC loc. C-23886, type section Otto Fiord Formation.

13. Right element, upper view, GSC 49208, GSC loc. C-23886.

14. Left element, upper view, GSC 49209, GSC loc. C-23881, type section Otto Fiord Formation.

15. Left element, upper view, GSC 49210, GSC loc. C-23896, type section Hare Fiord Formation.

16. Left element, upper view, GSC 49211, from GSC loc. C-23886, type section Otto Fiord Formation.

Figures 17-33. Idiognathoides sinuatus Harris and Hollingsworth, platform element:

17. Left element, juvenile, upper view, GSC 49212, from GSC loc. C-23894, type section Otto Fiord Formation.

18. Right element, juvenile, upper view, GSC 49213, from GSC loc. C-23894.

19. Left element, upper view, GSC 49214, from GSC loc. C-29269, locality 8, "Tellevak Limestone".

20. Right element, upper view, GSC 49215, from GSC loc. C-29269.

21, 22. Left element, upper and outer lateral view, GSC 49216, from GSC loc. C-4085, locality 7, "Tellevak Limestone".

23, 24. Right element, upper and outer lateral view, GSC 49217, from GSC loc. C-4085.

25. Right element, upper view, GSC 49218, from GSC loc. C-23895, type section Otto Fiord Formation.

26, 27, 28. Left element, upper, lower, and outer lateral view, GSC 49219, from GSC loc. C-23896, type section Hare Fiord Formation.

29, 30. Right element, upper, and inner lateral view, GSC 49220, from GSC loc. C-23896.

31. Left element, upper view, GSC 49221 from GSC loc. C-23894, type section Otto Fiord Formation.

32, 33. Right element, upper, and lower view, GSC 49222, from GSC loc. C-23896, type section Hare Fiord Formation.

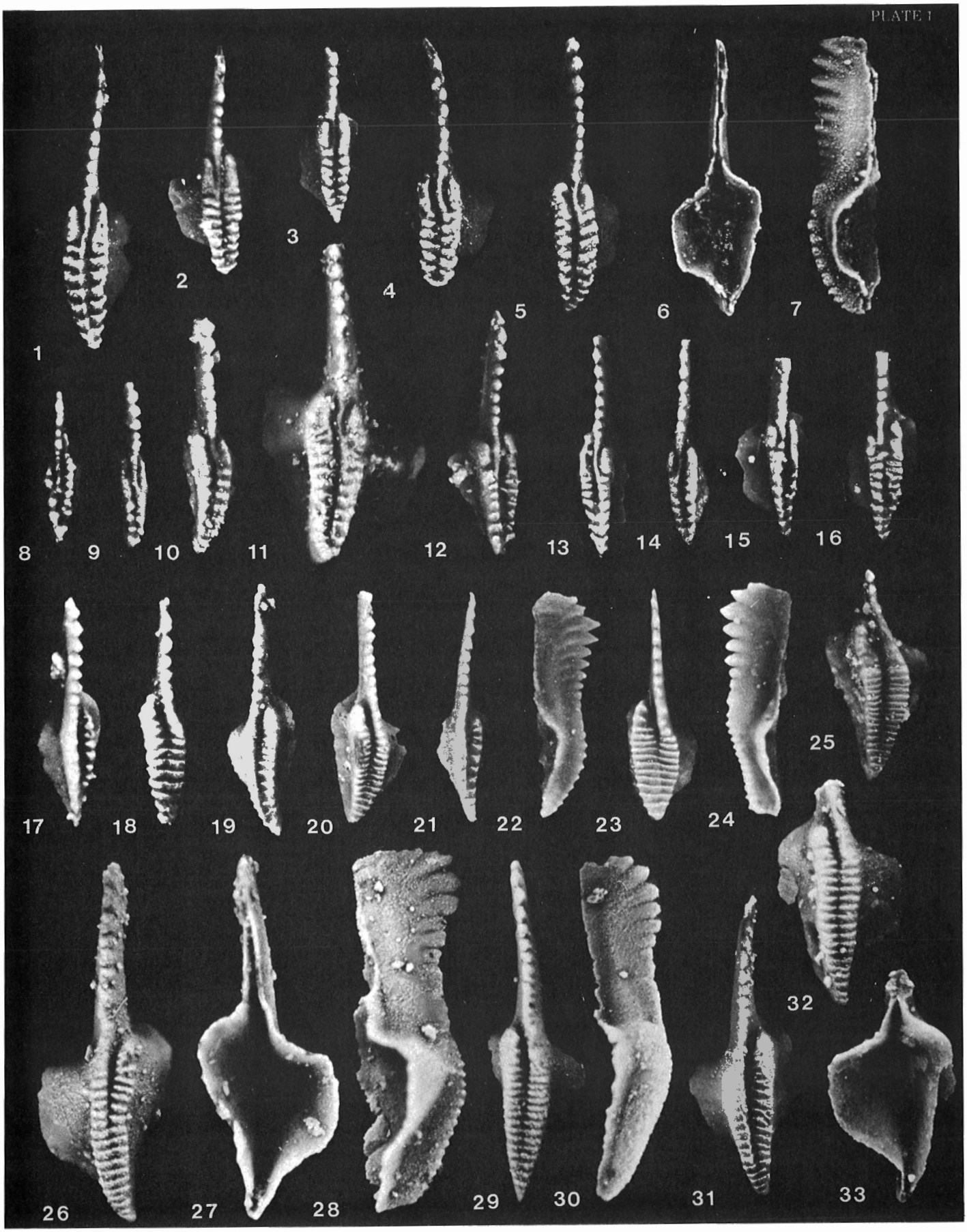
PLATE 1
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33

## PLATE 2

(Figure 12 x65; all other figures x40)

Figures 1-38. Idiognathoides opimus (Igo and Kokie)

1, 2. Morphotype 2, right element, upper, and outer lateral view, GSC 49223, from GSC loc. C-4013, locality 11, Hare Fiord Formation.

3, 4. Morphotype 4, left element, upper, and outer lateral view, GSC 49224, from GSC loc. C-4013.

5, 6, 7. Morphotype 4, left element, upper, outer and inner lateral view, GSC 49225, from GSC loc. C-4013.

8, 9. Morphotype 1, left element, upper and outer lateral view, GSC 49226, from GSC loc. C-4013.

10, 11. Morphotype 2, right element, upper, and outer lateral view, GSC 49227, from GSC loc. C-4013.

12. Juvenile, right element, upper view, GSC 49228, from GSC loc. C-4085, locality 7, "Tellevak Limestone".

13, 14. Morphotype 3, left element, upper, and outer lateral view, GSC 49229, from GSC loc. C-4013.

15, 16. Morphotype 1, right element, upper, and outer lateral view, GSC 49230, from GSC loc. C-4013.

17, 18. Morphotype 4, right element upper, and outer lateral view, GSC 49231, from GSC loc. C-4013.

19, 20. Morphotype 2, left element, upper, and outer lateral view, GSC 49232, from GSC loc. C-4013.

21, 22. Morphotype 2, right element, upper, and outer lateral view, GSC 49233, from GSC loc. C-4013.

23, 24. Morphotype 1, right element, upper, and outer lateral view, GSC 49234, from GSC loc. C-23789, locality 3, type section Nansen Formation.

25, 26. Morphotype 3, left element, upper, and outer lateral view, GSC 49235, from GSC loc. C-23789.

27, 28. Morphotype 1, right element, upper, and outer lateral view, GSC 49236, from GSC loc. C-4013.

29, 30, 31. Morphotype 1, right element, upper, lower, and outer lateral view, GSC 49237, from GSC loc. C-4085, locality 7, "Tellevak Limestone".

32, 33. Morphotype 2, left element, upper, and inner lateral view, GSC 49238, from GSC loc. C-23898, type section Hare Fiord Formation.

34. Morphotype 1, right element, upper view, GSC 49239, from GSC loc. C-23898.

35, 36, 37. Morphotype 3, right element, upper, lower, and outer lateral view, GSC 49240, from GSC loc. C-4013.

38. Morphotype 1, left element, upper view, GSC 49241, from GSC loc. C-23898, type section Hare Fiord Formation.

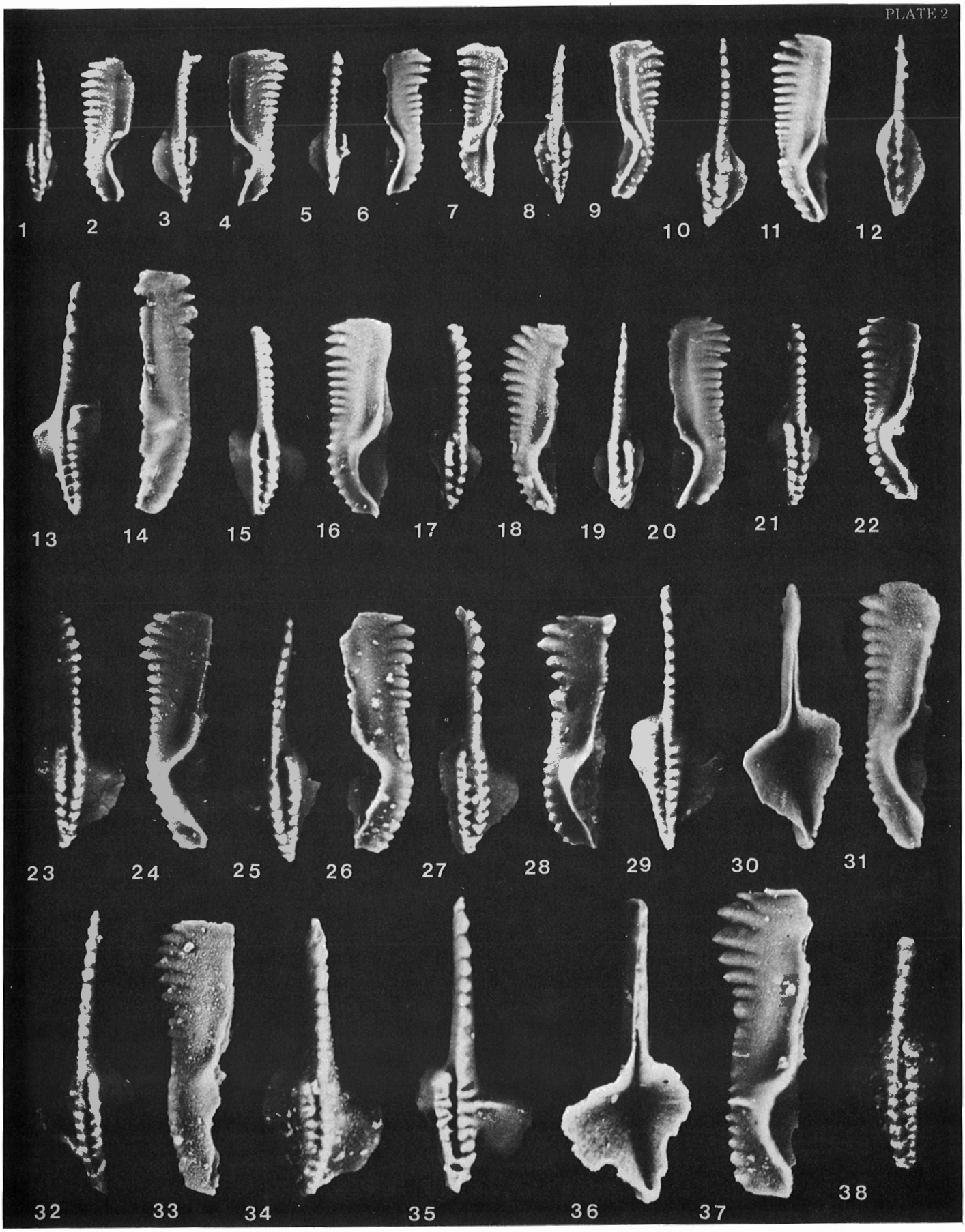
PLATE 2
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38

## PLATE 3

(Figures 8, 9 x65; all other figures x40)

Figures 1-3, 12, 13, 32. Neognathodus medexultimus Merrill, platform element:

1, 2, 3. Left element, upper, lower, and outer lateral view, GSC 49242, from GSC loc. C-4013, locality 11, Hare Fiord Formation.

12, 13. Left element, upper, and lower view, GSC 49250, from GSC loc. C-23898, type section Hare Fiord Formation.

32. Right element, upper view, GSC 49262, from GSC loc. C-23898.

Figures 4-8, 10, 11, 16, 28-31, 33-38. Idiognathodus delicatus Gunnell, platform element:

4. Left element, upper view, GSC 49243, from GSC loc. C-4013, Hare Fiord Formation.

5. Right element, upper view, GSC 49244, from GSC loc. C-4013.

6, 7. Right element, upper and inner lateral view, GSC 49245, from GSC loc. C-4013.

8. Juvenile, right element, upper view, GSC 49246, from C-23884, type section Otto Fiord Formation.

10. Left element, upper view, GSC 49248, from GSC loc. C-23792, type section Nansen Formation.

11. Right element, upper view, GSC 49249, from GSC loc. C-23789, type section Nansen Formation.

16. Right element, upper view, GSC 49252, from GSC loc. C-23892, type section Otto Fiord Formation.

28, 29, 30. Right element, upper, outer lateral, and lower view, GSC 49260, from GSC loc. C-23892.

31. Left element, upper view, GSC 49261, from GSC loc. C-4013.

33, 34, 35. Left element, upper, lower, and outer lateral view, GSC 49263, from GSC loc. C-56430, locality 5, Hare Fiord Formation.

36, 37, 38. Left element, upper, lower, and outer lateral view, GSC 49264, from GSC loc. C-57137, "Tellevak Limestone".

Figure 9. Idiognathodus sp. indet., platform element: juvenile, upper view, GSC 49247, from GSC loc. C-4013.

Figures 14, 15. Idiognathodus claviformis Gunnell, platform element, right element, upper, and lower view, GSC 49251, from GSC loc. C-23896, type section Hare Fiord Formation.

Figures 17-19. Idiognathodus sinuosus Ellison and Graves, platform element:

17. Right element, upper view, GSC 49253, from GSC loc. C-23789, type section Nansen Formation.

18. Left element, upper view, GSC 49254, from GSC loc. C-4013.

19. Right element, upper view, GSC 49255, from GSC loc. C-4013.

Figures 20-23. Streptognathodus? sp. A, platform element:

20, 21. Right element, upper, and inner lateral view, GSC 49256, from GSC loc. C-4013.

22, 23. Left element, upper, and outer lateral view, GSC 49257, from GSC loc. C-4013.

Figures 24-27. Neognathodus colombiensis (Stibane) platform element:

24, 25, 26. Right element, upper, lower, and outer lateral view, GSC 49258, from GSC loc. C-56430, locality 5, Hare Fiord Formation.

27. Right element, upper view, GSC 49259, from GSC loc. C-4013, locality 11, Hare Fiord Formation.

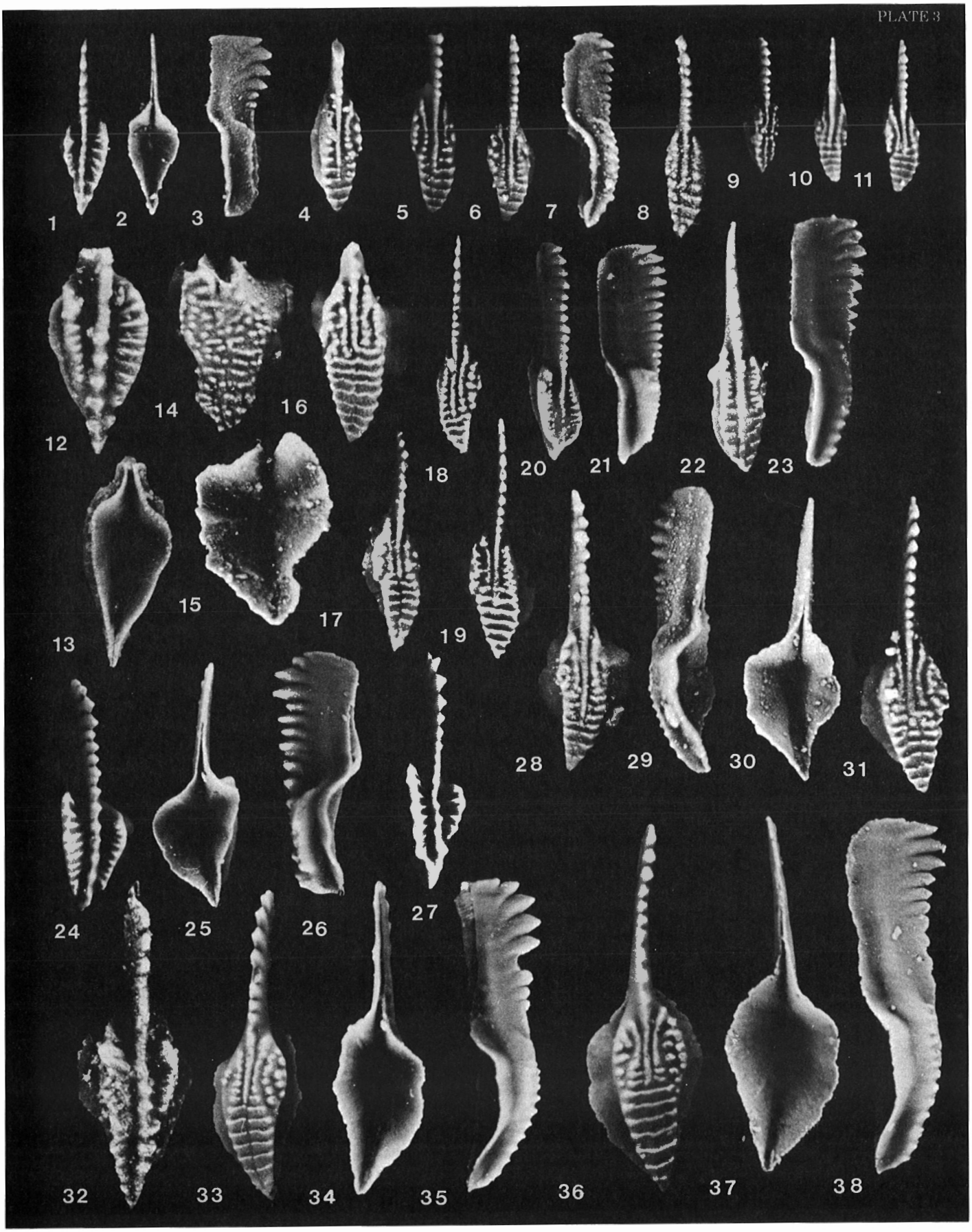
PLATE 3
1
2
3
4
5
6
7
8
9
10
11
12
14
16
18
20
21
22
23
13
15
17
19
28
29
30
31
24
25
26
27
32
33
34
35
36
37
38

## PLATE 4

(Figures 1-33 x65, Figures 34-58 x40)

Figures 1-4. Diplognathodus n. sp. A:

1, 2. Lateral outer, and upper view, GSC 49265, from GSC loc. C-23787, type section Nansen Formation.

3. Lateral view, GSC 49266, from GSC loc. C-23781, type section Nansen Formation.

4. Lateral view, GSC 49267, from GSC loc. C-23785, type section Nansen Formation.

Figures 5-7, 11, 15-21, 23-25. Diplognathodus ellesmerensis n. sp.

5. Lateral view, GSC 49268, from GSC loc. C-23789, type section Nansen Formation.

6, 7. Outer lateral, and upper view, GSC 49269, from GSC loc. C-4013, locality 11, Hare Fiord Formation.

11. Lateral view, GSC 49271, from GSC loc. C-23789, type section Nansen Formation.

15. Lateral view, GSC 49275, from GSC loc. C-23893, type Otto Fiord Formation.

16, 17. Outer lateral, and upper view, GSC 49276, from GSC loc. C-4013.

18, 19. Outer lateral, and upper view, GSC 49277, from GSC loc. 56430, locality 5, Hare Fiord Formation.

20, 21. Outer lateral, and upper view, GSC 49278, from GSC loc. C-23789.

23, 24, 25. Outer lateral, upper, and lower view of holotype, GSC 49280, from GSC loc. C-23789, type section Hare Fiord Formation.

Figures 8-10, 12-14. Diplognathodus coloradoensis (Murray and Chronic):

8, 9, 10. Lateral, upper, and lower view, GSC 49270, from GSC loc. C-23889, type section Otto Fiord Formation.

12. Lateral view, GSC 49272, from GSC loc. C-23886, type section Otto Fiord Formation.

13. Lateral view, GSC 49273, from GSC loc. C-23886.

14. Lateral view, GSC 49274, from GSC loc. C-23893, type section Otto Fiord Formation.

Figure 22. Hindeodus ex. pr. Hindeodus minutus (Ellison: lateral view, GSC 49279, from GSC loc. C-23896, type section Hare Fiord Formation.

Figures 26-33. Adetognathus lautus (Gunnell) left platform element:

26. Upper view, GSC 49281, from GSC loc. C-23772, type section Nansen Formation.

27, 28. Upper, and inner lateral view, GSC 49282, from GSC loc. C-23773, type section Nansen Formation.

29, 30. Upper and outer lateral view, GSC 49283, from GSC loc. C-23773.

31, 32, 33. Upper, inner lateral, and lower view, GSC 49284, from GSC loc. C-23777, type section Nansen Formation.

Figures 34, 37, 38. Hindeodella parva Ellison:

34. Upper view, GSC 49285, from GSC loc. C-4013, locality 11, Hare Fiord Formation.

37, 38. Lateral and upper view of anterior bar, GSC 49288, from GSC loc. C-4085, locality 7, Hare Fiord Formation.

Figures 35, 36, 39-47. Idiognathodus, Idiognathoides, and/or Neognathodus, ramiform elements of skeletal apparatus:

35. Tr element, oblique lateral view, GSC 49286 from GSC loc. C-10817, locality 9, "Tellevak Limestone".

36. Ne element, lateral view, GSC 49287, from GSC loc. C-10817.

39. Ne element, lateral view, GSC 49289, from GSC loc. C-4013.

40. Oz element, with alternating denticulation posterior bar, lateral view, GSC 49290, from GSC loc. C-4013.

41. Oz element, lateral view, GSC 49291, from GSC loc. C-4013.

42. Tr element, posterior view, GSC 49292, from GSC 49292, from GSC loc. C-4085.

43, 44. $Hi_2$ elements, GSC 49293, 49294, from GSC loc. C-4013.

45. Oz element, lateral view, GSC 49295, from GSC loc. C-23789, type section Nansen Formation.

46, 47. $Hi_1$ elements, GSC 49296, 49297, from GSC loc. C-4013.

Figures 48-51, 53, 55-58. Idioprioniodus conjunctus (Gunnell):

48. Metalonchodina element, GSC 49298, from GSC loc. C-4013, locality 11, Hare Fiord Formation.

49. Metalonchodina element, GSC 49299, from GSC loc. C-23896, type section Hare Fiord Formation.

50. Metalonchodina element, GSC 49300, from GSC loc. C-4013.

51. Neoprioniodina element, GSC 49301, from GSC loc. C-4085, locality 7, "Tellevak Limestone".

53. Hibbardella element, GSC 49303, from GSC loc. C-4085.

55, 56. Ligonodina element, outer and inner lateral view, GSC 49305, from GSC loc. C-4013.

57. Ligonodina element, inner lateral view, GSC 49306, from GSC loc. C-4013.

58. Lonchodina element, outer lateral view, GSC 49307, from GSC loc. C-4013.

Figure 52. Stepanovites conflexa (Ellison), Oz? element, GSC 49302, from GSC loc. C-23789.

Figure 54. Aethotaxis advena Baesemann, Az? element, GSC 49304, from GSC loc. C-57137, "Tellevak Limestone".

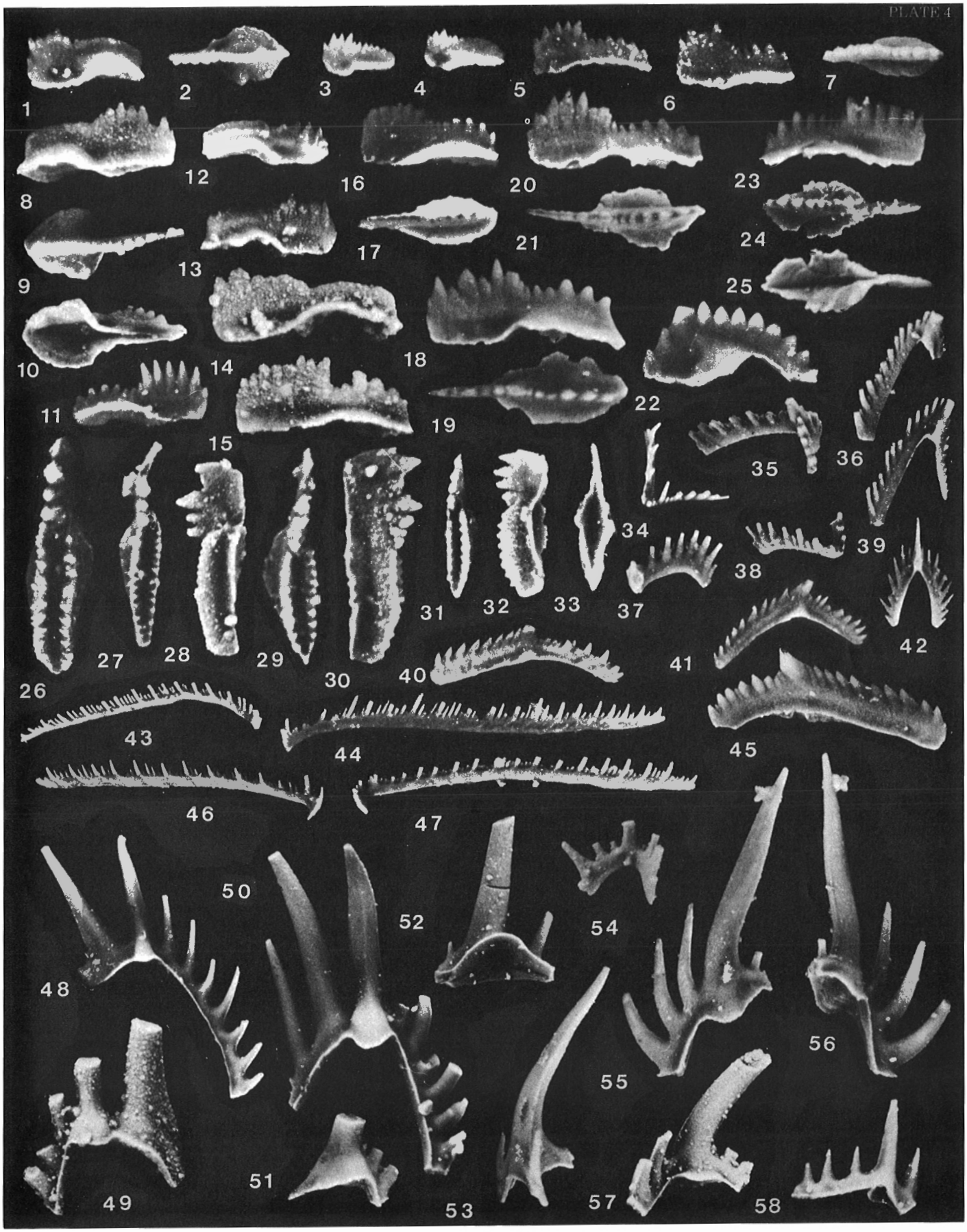
PLATE 4
1
2
3
4
5
6
7
8
12
16
20
23
9
13
17
21
24
10
14
18
25
11
15
19
22
35
36
26
27
28
29
30
31
32
33
34
37
38
39
40
41
42
43
44
45
46
47
48
50
52
54
49
51
53
55
56
57
58