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LATE SILURIAN CONODONTS UPDATE THE METAMORPHOSED FITCH FORMATION, LITTLETON AREA, NEW HAMPSHIRE

ANITA G. HARRIS,* NORMAN L. HATCH, JR.,** and J. THOMAS DUTRO, JR.*

ABSTRACT. Conodonts representing the *eosteinhornensis* Zone, one of the highest Silurian conodont zones, occur in part of the middle, the lower, and possibly the base of the Fitch Formation in its type area near Littleton, N.H. The conodonts were recovered from metagrainstone, metapackstone, and marble interbedded with chiefly chlorite-grade pelitic rocks. These conodonts date the Fitch as no older than latest Ludlovian and at least as young as early Pridolian, although the Fitch could possibly extend into the very earliest Early Devonian. Heretofore, the Fitch of the Littleton area was considered to be entirely of middle Ludlovian age (*siluricus* Zone). Brachiopods in a new collection from the base of the Fitch are preserved well enough to be identified as *Kirkidium* (*Pinguaella*) sp., a subgenus that ranges from the upper Wenlockian to Pridolian. These data also greatly reduce the possibility that any part of the overlying Littleton Formation is any older than Early Devonian.

INTRODUCTION

Southwest of the nonmetamorphic to low-grade metamorphic terrane of northern and eastern Maine, the crystalline rocks of the New England Appalachians have yielded discouragingly few fossils. Consequently, each additional find is greeted with great expectations and squeezed for every bit of significant new information. Our purpose in this paper is to describe conodonts and new brachiopod material recently recovered from the Fitch Formation near Littleton, N.H., and to discuss the significance of this find in terms of both regional geology and paleontology.

GEOLOGIC SETTING

The Fitch Formation is part of a sequence of Ordovician to Lower Devonian formations defined by Billings (1937) from the Littleton and Mount Moosilauke areas of western New Hampshire (fig. 1). Subsequently, this sequence of formations was recognized and mapped along the length of a chain of mantled gneiss domes known as the Bronson Hill anticlinorium that has been traced from northeastern New Hampshire southward across central Massachusetts and Connecticut (table 1).

The Albee Formation, Ammonoosuc Volcanics, and Partridge Formation have as yet yielded no fossils, and their Middle Ordovician or slightly older (for the Albee) age is based on very long range correlations with fossiliferous units in Quebec and Maine, a few isotopic ages on volcanic rocks, and relationships to plutonic rocks. Both the Clough Quartzite and Fitch Formation have long been known to contain Silurian fossils (Billings and Cleaves, 1934; Boucot and others, 1958), and the

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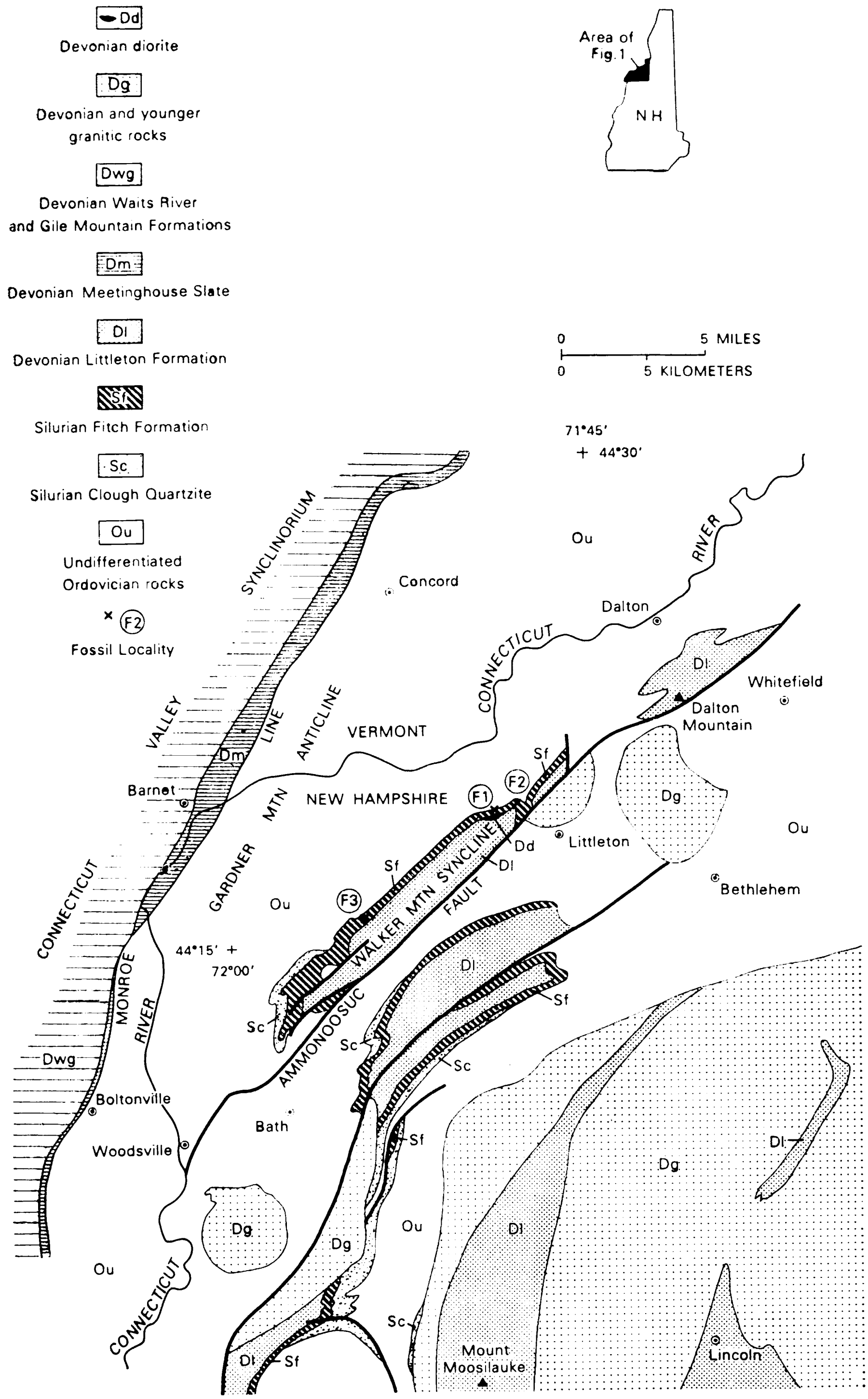


Fig. 1. Geologic map of northwestern New Hampshire showing location of fossil localities discussed in the text. Modified from Billings (1956).

Littleton Formation has long been known to contain Early Devonian fossils (Lahee, 1912; Billings and Cleaves, 1934, 1935; Boucot and Arndt, 1960; Boucot and Rumble, 1980). Although some fossils have been found in remarkably high-grade rocks (Boucot and Thompson, 1963; Boucot and Rumble, 1980), most of the Littleton and Fitch localities are from the northwest side of the Ammonoosuc fault which, in the Littleton area, separates chiefly chlorite-grade rocks on the northwest from staurolite-grade rocks on the southeast (fig. 1).

Although early described by Hitchcock (1871, 1874, 1877, 1904), Dale (1886), and Pumpelly (1888), the first comprehensive list and description of fossils from what is now known as the Fitch Formation was published by Billings and Cleaves (1934) as an offshoot of the detailed stratigraphic mapping of the Littleton-Moosilauke area by Billings (1937). The Silurian age assignment for the Fitch by earlier workers was confirmed by Billings and Cleaves (1934, p. 418) who concluded, largely on the basis of *Conchidium nettlerothi, Strophonella funiculata, Pterinea* cf. *P. emacerata,* and *Dalmanites limulurus,* that the Fitch was Middle Silurian (Niagaran) in age. Based on a reappraisal of the fauna described by Billings and Cleaves, Boucot (1968) and Berry and Boucot (1970, p. 147-148) assigned a Ludlovian Age to the Fitch in its type area. Berry and Boucot's (1970, pl. 2) accompanying correlation chart restricted the entire Fitch Formation, in its type area, to the *siluricus* Zone, even though the only biostratigraphically diagnostic fossils were found in the lower 13 m of a formation that ranges from 130 to 250 m in thickness (Billings, 1956).

THE CONODONT FAUNA AND ITS AGE

In the summer and fall of 1979, we sampled beds of light-medium bluish gray metagrainstone and metapackstone composed largely of skeletal debris (chiefly echinoderm ossicles) from two localities of the Fitch in the Littleton, New Hampshire-Vermont, and Lower Waterford, New Hampshire-Vermont, 7½-minute quadrangles, which constitute the southern half of the old Littleton 15-minute quadrangle, the New Hampshire part of which was mapped by Billings (1937). The two localities are shown as F2 and F3 on **figure 1.**

TABLE 1
Stratigraphic succession in northwest New Hampshire
(modified from Billings, 1937)

Age	Formation	Lithology
Early Devonian	Littleton	Gray schist and granofels
Late Silurian	Fitch	Gray slate, calcareous slate and sandstone, and marble
Silurian	Clough	Quartzite, conglomerate, and schist
Middle Ordovician	Partridge	Black sulfidic slate and quartzite
Middle Ordovician	Ammonoosuc	Mafic and felsic metavolcanic rocks
Middle and Early Ordovican	Albee	Light-green and gray quartzite and schist

Locality F2 is a roadcut on the southwest side of State Route 18 about 300 m northwest of the north terminus of Interstate Route I-93 and 2.5 km west-northwest of the center of the village of Littleton. This locality is estimated to be no more than 20 m from the contact with the subjacent Ordovician Highlandcroft Granodiorite as used by Billings (1937). Although this contact was mapped by Lahee (1912) and Billings (1937, pl. 1) as an unconformity, both the presence of large (+1 m) angular blocks of Highlandcroft Granodiorite within the Fitch outcrop and the apparent brecciation of the Fitch strata at the southeast end of the outcrop suggest faulting. Therefore, it is entirely possible, either that the Fitch-Highlandcroft contact near locality F2 is itself a splay off the nearby Ammonoosuc fault (fig. 1) or that an unconformable contact has been offset and complicated by Ammonoosuc faulting. In either case, the apparent position of F2 very near the base of the Fitch Formation may or may not be significant. Beds of nearly vertical calcareous to noncalcareous chlorite-grade slate with minor metagrainstone are exposed in the roadcut. At locality F2, six separate thin metagrainstone beds in a stratigraphic interval of about 12 m produced identifiable conodonts (table 2).

Locality F3 is about 900 m southwest of the southwest shore of Ogantz Lake and 320 m southeast of Stickney Road in the southeast corner of the Lower Waterford quadrangle; it is on the ridge crest in an overgrown pasture about 260 m southwest of the house at the end of an "unimproved" dirt road. The locality is in the middle part of the Fitch, but its exact stratigraphic position is uncertain. It is at least 200 m (on the ground) southeast of and stratigraphically above the base and about 150 m below the top of the Fitch Formation as mapped by Billings (1937, pl. 1). Neither Billings' mapping nor our reconnaissance suggest faulting in this immediate area. Thus, although exact estimates of stratigraphic thickness, as frequently is the case in New England, are subject to modification due to widespread isoclinal folding, locality F3 is probably stratigraphically in the middle of the Fitch and is at least 100 m stratigraphically above the base of the formation in that area. The single bed of metagrainstone, about a quarter of a meter thick, sampled at F3 produced the highest yield of conodonts of all rocks sampled (table 2).

Although conodonts from both localities are generally poorly preserved, a few managed to escape the ravages of Acadian deformation. Most specimens are incomplete, stretched, corroded, and fractured and have mineral grains annealed to their surface (pls. 1 and 2). The conodonts have a color alteration index (CAI) of 5 to 5½ indicating the host rock reached at least 300°C (Epstein, Epstein, and Harris, 1977), a temperature consistent with mineral metamorphic indices in the same rock. Though most specimens are poorly preserved, conodonts from these localities are abundant enough so that a few representatives of each species have remained reasonably intact and easily identifiable. These better preserved specimens provide the basis for identification of other specimens whose preservation ranges from bad to worse. Both localities

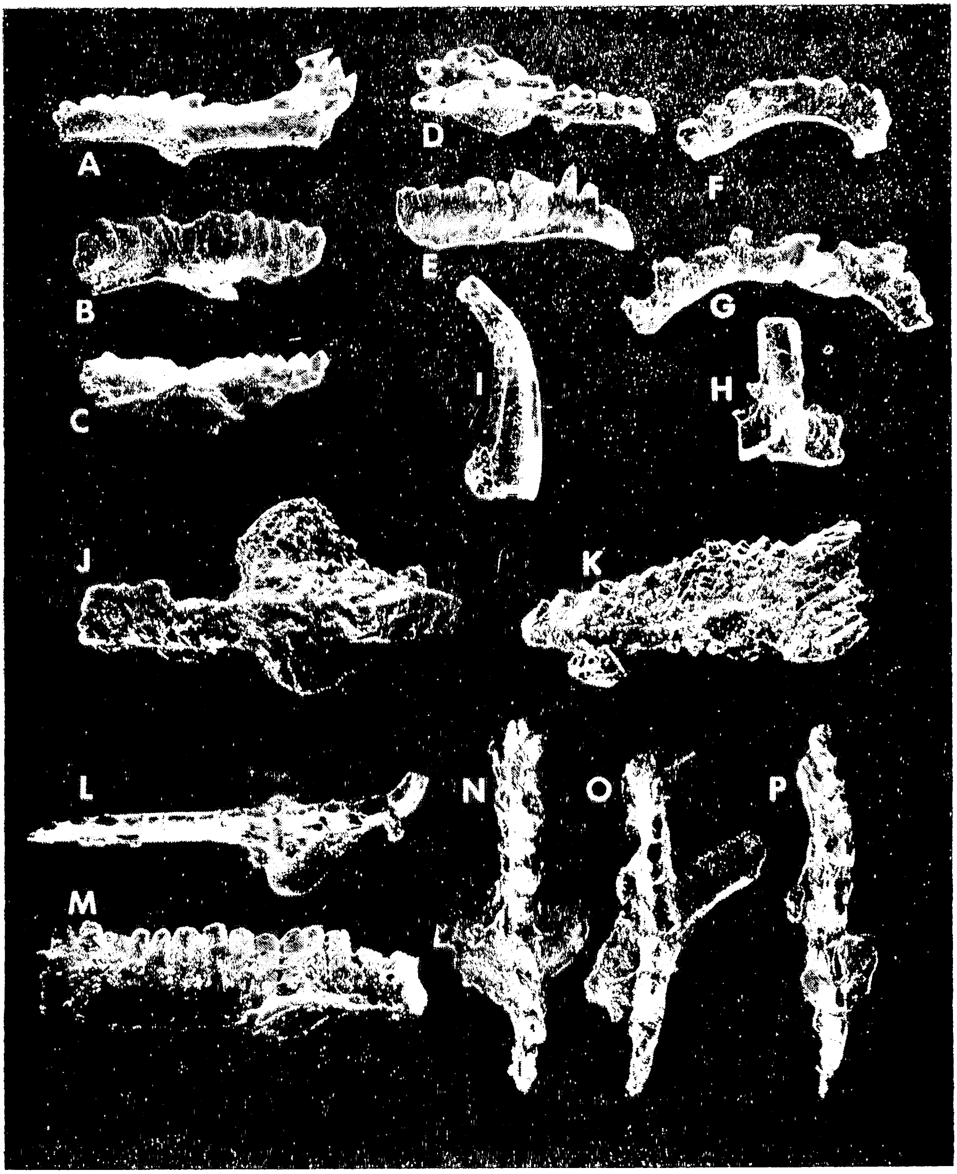
TABLE 2
Conodonts from the Fitch Formation

	Basal part of the Fitch Formation (loc. F1, fig. 1)			Lower(?) part of the Fitch Formation (loc. F2, fig. 1)						Middle part of the Fitch Formation (loc. F3, fig. 1)
	CAI=6-7		CAI=5½-6	CAI=5-5½						CAI=5-5½
Stratigraphic level (m)	2-3*	3½-4	4-5	0**	4	6	9	10	12½	
USGS colln. no.	10282-SD	10305-SD	10281-SD	10280-SD	10279-SD	10100-SD	10278-SD	10277-SD	10276-SD	10283-SD
Sample weight (kg)	20	1.7	19	7.5	8.7	26	7.6	7.6	7.6	6
Belodella sp.	—	—	—	—	—	—	—	—	—	1
Ozarkodina confluens (Branson and Mehl)										
P element	5	—	—	—	—	—	—	—	—	—
O. excavata excavata (Branson and Mehl)										
P element	12	—	1	—	—	—	—	—	—	—
N element	4	—	—	—	—	—	—	—	—	—
A_2 element	4	—	—	—	—	—	—	—	—	—
O. remscheidensis eosteinhornensis (Walliser)										
P element	?2	—	—	3	3	8	6	5	5	51
O element	—	—	—	1	—	1	1	—	—	14
N element	—	—	—	—	—	1	—	—	—	4
A_1 element	—	—	—	1	—	—	—	—	—	10
A_2 element	—	—	—	—	—	—	1	—	—	5
A_3 element	—	—	—	—	—	—	—	1	—	4

O. remscheidensis (Ziegler) transitional to *O. confluens* (Branson and Mehl)										
P element	—	—	—	—	—	—	—	—	—	1
Panderodus sp. elements	7	4	47	—	1	—	—	—	—	—
Pedavis cf. *P. thorsteinssoni* Uyeno										
I element	—	—	—	—	—	—	—	—	—	8
M_2 element	—	—	—	—	—	—	—	—	—	3
S_1 element	—	—	—	—	—	—	—	—	—	3
Pedavis sp.										
I element	—	—	—	—	2	—	—	—	—	28
Unassigned bar and blade elements										
lonchodiniform	—	—	—	—	—	2	—	—	—	—
neoprioniodiniform	—	—	—	—	—	—	—	—	1	—
ozarkodiniform	2	—	—	—	—	—	—	—	—	—
A_1 and A_2	9	—	2	—	—	—	—	2	—	—
Indeterminate fragments	139	4	16	9	15	40	8	17	9	115

* Measured from base of Fitch Formation.
** Measured from "lowest" bed sampled at southeast end of roadcut.

PLATE 1



contain, among other forms, abundant representatives of all elements of *Ozarkodina remscheidensis eosteinhornensis* (Walliser), the nominate subspecies of one of the highest Silurian conodont zones (fig. 2, table 2, and pls. 1 and 2). In the Barrandian area of Czechoslovakia, the area of the international Silurian/Devonian boundary stratotype and the type Pridolian, this zone whose base is marked by the first appearance of *O. r. eosteinhornensis* extends from the upper 3½ m of the Kopanina Formation (=uppermost Ludlovian) to very near the top of the Pridoli Formation (=Pridolian). The subspecies extends beyond the *eosteinhornensis* Zone into the very base of the Lower Devonian (earliest Lochkovian) in some sections in the Barrandian area (Chulpac and others, 1980); the composite worldwide range of *O. r. eosteinhornensis* is shown in figure 2. Other conodonts recovered from localities F2 and F3 are either longer ranging or have incompletely known ranges. Of the latter, only *Pedavis thorsteinssoni* Uyeno may hold some potential for future age refinement of this part of the Fitch (pl. 2, figs. A-F). This form is probably descended from *Pedavis latialata* (Walliser), an index species whose range thus far is known to be restricted to part of the *snajdri* Zone (fig. 2). *Pedavis thorsteinssoni* has only been reported from 239 m above the base of the Barlow Inlet Formation, eastern Cornwallis Island in the Canadian Arctic (Uyeno, 1977 and 1981; Thornsteinsson, 1981). In that area, it occurs 200 m above samples containing *Polygnathoides siluricus,* 160 m above *Pedavis latialata,* and 800 m below the first sample containing *Ozarkodina remscheidensis eosteinhornensis.* Unfortunately, no conodonts or other fossils were reported between the samples with *P. thorsteinssoni* and *O. r. eosteinhornensis.* Thus, at this time, the Barlow Inlet Formation collection with *P. thorsteinssoni* merely indicates an interval from the *latialata* Subzone to within the *eosteinhornensis* Zone. The conodont collections from localities F2 and F3 indicate that the lower(?) and middle

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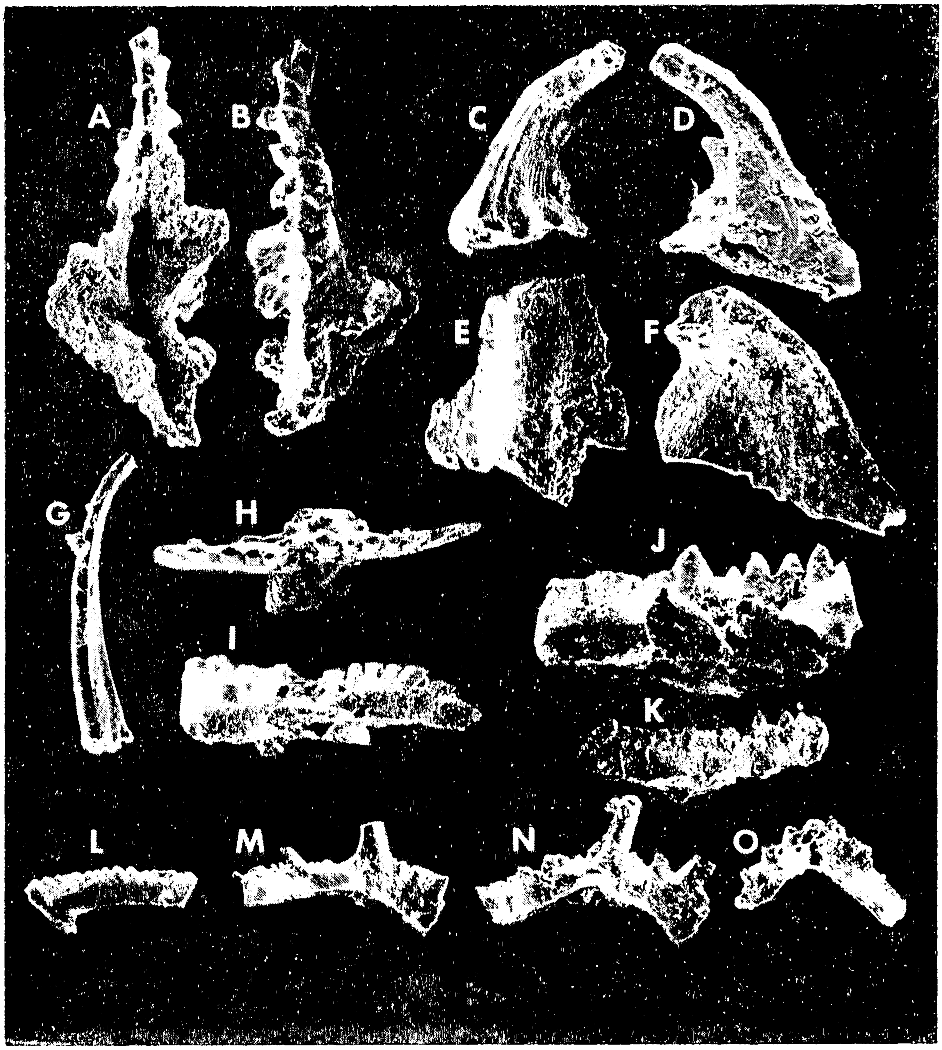
← SEM photomicrographs of conodonts from the Fitch Formation. All figured specimens are reposited in the U.S. National Museum of Natural History, Washington, D.C. (USNM).

A-I. Locality F1 (fig. 1), USGS colln. 10282-SD, 2 to 3 m above base of Fitch Formation at Fitch Farm. (A). *Ozarkodina confluens* (Branson and Mehl), P element, stretched but intact, oblique lateral view, USNM 307756, × 25. (B, C). *Ozarkodina ?remscheidensis eosteinhornensis* (Walliser), P element, posterior end missing, lateral and oblique lateral views, specimen lost during photography, × 50. Species identification is queried because specimen is incomplete and deformed and the other elements of the apparatus of *O. r. eosteinhornensis* were not found in the sample. This may not be significant as only P elements of *O. confluens* were also found in the sample. D-H. *Ozarkodina excavata excavata* (Branson and Mehl), × 50. (D, E). P elements, upper and lateral views, USNM 307757, 307758. (F). N element, inner view, specimen lost during photography. (G). A_2 element, inner view, USNM 307759. (H). A_3(?) element, incomplete, oblique posterior view, USNM 307760. (I). *Panderodus* sp., outer lateral view, USNM 307761, × 50.

(J, K). Locality F2 (fig. 1), lower(?) part of Fitch Formation, *Ozarkodina remscheidensis eosteinhornensis* (Walliser), × 50. (J). P element, upper view, USGS colln. 10277-SD, USNM 307762. (K). O element, inner lateral view, USGS colln. 10280-SD, USNM 307763.

L-P. Locality F3 (fig. 1), middle part of Fitch Formation, USGS colln. 10283-SD, *Ozarkodina remscheidensis eosteinhornensis* (Walliser), P elements. These specimens show the range in preservation quality of the same morphotype in a single sample. The well-preserved specimens are keys to the identification of other "metamorphotypes." (L, M). Upper and lateral views of nearly complete specimen, USNM 307764, × 50. (N). Upper view of nearly complete and virtually undeformed specimen showing diagnostic shape and position of lobes for P elements of *O. r. eosteinhornensis,* USNM 307765, × 45. (O). Upper view of specimen with spaced-out lobes, USNM 307766, × 60. (P). Upper view of specimen with broken and corroded lobes, USNM 307767, × 40.

PLATE 2



SEM photomicrographs of conodonts from the middle part of the Fitch Formation (USGS colln. 10283-SD, loc. F3, fig. 1).

A-F. *Pedavis* cf. *P. thorsteinssoni* Uyeno. We believe the *Pedavis* in this part of the Fitch Formation is identical to *P. thorsteinssoni* from the lower part of the Barlow Inlet Formation, eastern Cornwallis Island (Uyeno, 1977 and 1981) but hesitate to identify them as such with certainty because even the best of our specimens (shown here) are incomplete and (or) partly deformed. (A, B). I element, lower and upper views, USNM 307768, × 30. Undeformed I elements in our collection have short lateral processes of equal to slightly unequal length that are perpendicular to the axis of the platform or slightly anteriorly directed. These processes are shorter and less ornamented than those of *P. latialata*, the species that may be ancestral to *P. thorsteinssoni*. (C, D). M_2 element, opposite latereal views, USNM 307769, × 75. These M_2 and S_1 elements (figs. E and F) conform to the same components of *P. thorsteinssoni* figured by Uyeno (1981, pl. 6). (E, F). S_1 elements, opposite lateral views, specimens lost during photography, × 75.

(G). *Panderodus* sp., inner lateral view, USNM 307770, × 75.

(H, I). *Ozarkodina remscheidensis* (Ziegler) transitional to *O. confluens* (Branson and Mehl), P element, upper and lateral views, USNM 307771, × 30. This specimen has the upper margin profile of *O. confluens* and the lobes of *O. remscheidensis*. It is possible that the specimen is a P element of *O. confluens* whose lobes have been deformed to resemble those of *O. remscheidensis*.

J-O. *Ozarkodina remscheidensis eosteinhornensis* (Walliser), K × 30, all others × 50. (J, K). P elements, lateral and oblique lateral views, USNM 307772, 307773. (L). N element, inner lateral view, USNM 307774. (M). A_1 element, inner lateral view, USNM 307775. (N). A_2 element, inner lateral view, USNM 307776. (O). A_3 element, oblique posterior view, USNM 307777.

parts of the Fitch can be no older than latest Ludlovian (=base of the *eosteinhornensis* Zone) and probably no younger than the middle Pridolian but could extend to the basalmost Lochkovian (=basalmost *woschmidti* Zone, the youngest known occurrence of *O. r. eosteinhornensis*).

Boucot's (1968) Ludlovian Age assignment for the Fitch Formation in the Littleton area and Berry and Boucot's (1970) subsequent assignment to the *siluricus* Zone of the Ludlow were based on megafossils from the stratigraphically lowest beds now exposed at their Fitch Farm locality west of Littleton. Seeking to resolve the apparent discrepancy between *siluricus* Zone equivalent megafossils from the base of the Fitch and *eosteinhornensis* Zone conodonts from only slightly higher to midway through the Fitch, we returned to Littleton in the summer of 1980 and collected three samples from the Fitch farm locality (fig. 1, loc. F1) on which Billings and Cleaves (1934), Boucot (1968), and Berry and Boucot

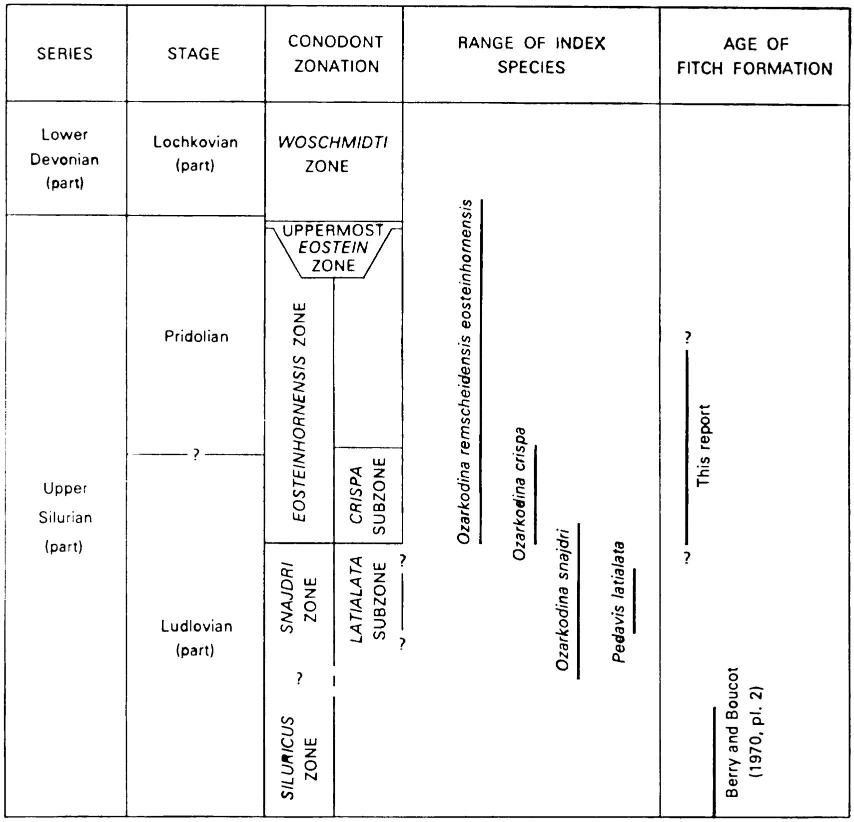


Fig. 2. Conodont-based age of Fitch Formation. Conodont zones and subzones and range of selected index species are based on published worldwide occurrences. The most significant of these are: Walliser (1964), Rexroad and Craig (1971), Pollock and Rexroad (1973), Klapper and Murphy (1975), Ebner (1976 and 1980), Mehrtens and Barnett (1976), and Chulpac, Kriz, and Schönlaub (1980).

high in the *eosteinhornensis* Zone. The presence of poorly preserved specimens that resemble *O. r. eosteinhornensis* near the base of the formation and the occurrence of abundant *O. r. eosteinhornensis* in the lower(?) and middle parts of the formation at other localities in the Littleton area tend to favor a latest Ludlovian or younger Pridolian Age for the base of the Fitch.

BRACHIOPODS

One of our collections from the Fitch Formation at Fitch Farm (loc. F1, USGS colln. 10305-SD) contains several relatively good specimens of a large pentameroid brachiopod which previously was identified by Cleaves (*in* Billings and Cleaves, 1934) as *Conchidium nettelrothi* Hall and Clarke, by Boucot and Thompson (1963) as *Conchidium* sp., and by Boucot (*in* Berry and Boucot, 1970) as *"Conchidium,"* as *Kirkidium* had not been published in time for inclusion in the correlation chart. The new material is preserved well enough to answer several questions about the taxonomic position of these shells, and there is little question that they can be assigned to *Kirkidium (Pinguaella)* a subgenus established by Boucot and Johnson in 1979. Although this subgenus has a stratigraphic range from upper Wenlockian to Pridolian, most of the assigned species are Ludlovian forms. Because of distortion and poor preservation in the marble near the base of the Fitch Formation at Fitch Farm, we hesitate to describe these shells as a new species, but their size, shape, and costation suggest close relationship to the type species *Kirkidium (Pinguaella) pingue* (Amsden) which occurs in the uppermost Brownsport Formation in western Tennessee. The Brownsport is Ludlovian, as it contains conodonts of the *siluricus* Zone (Berry and Boucot, 1970). Thus, the recovery of specimens identifiable as *Kirkidium (Pinguaella)* sp. from the base of the Fitch and the known range of this subgenus do not conflict with the age assignment of the formation based on conodonts.

Kirkidium (Pinguaella) sp.

Plate 3, figures A to G

Conchidium nettelrothi Hall and Clarke. Billings and Cleaves, 1934, p. 424.

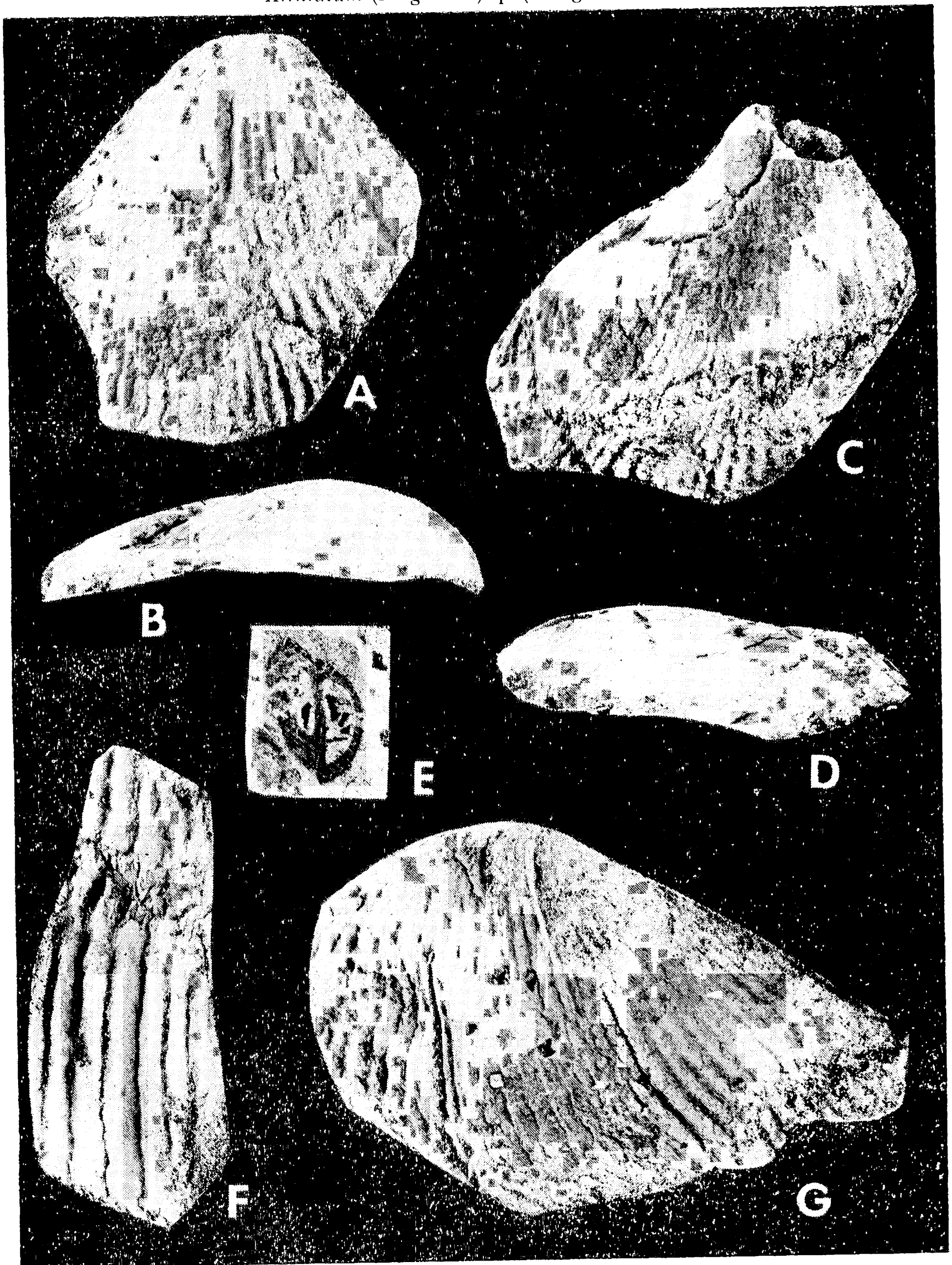
Conchidium sp. Boucot and Thompson, 1963, p. 1319.

Description: Large, multicostate, biconvex pentamerinids; brachial and pedicle valves approximately equal convexity; spondylium in pedicle valve with median septum reaching about halfway to anterior margin; two long, subparallel plates in the brachial valve; costae coarse with angular crests and troughs; anterior rectimarginate; pedicle beak extending only slightly over brachial posterior margin.

Discussion: Several nearly complete valves indicate that this species is about 6 cm long and 4 to 6 cm wide in the adult stage. One small brachial valve is about 2.5 by 2.5 cm with the widest part of the shell about two-thirds of the distance from the beak to the anterior margin. In the large shells, there are 28 to 30 costae on each valve. The sum

PLATE 3

Kirkidium (*Pinguaella*) sp. (all figures × 1).



A, B. Pedicle valve; pedicle and right lateral views, former showing trace of septum. USNM 312601.

C, D. Pedicle valve; pedicle and left lateral views. USNM 312602.

E. Section of pedicle valve, very close to beak, showing median septum and initial stage of spondylium. USNM 312603.

F. Fragment of valve showing coarse, angular costae. USNM 312604.

G. Large brachial valve showing traces of the long plates, emphasized by minor shearing. Shell shape distorted by metamorphism. USNM 312605.

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The larger fossils from this locality clearly are assignable to Boucot's Benthic Assemblage 3, the pentamerinid community (see Boucot, 1975, fig. 4 and related discussion). This assemblage is a low-diversity one, apparently reflecting a high-energy, relatively near-shore environment. Other fossils in the new collection include comminuted echinodermal debris and small, recrystallized favositid colonies. The collections reported by Billings and Cleaves (1934) contain these additional forms: indeterminate solitary rugose corals, halysitids, stromatoporids, "*Atrypa*," and "*Spirifer*." These fossils and the conodont species associated with them, as well as the coarse clastic fabric of the limestone, reinforce the environmental interpretation.

Material: Illustrated specimens include two pedicle valves, USNM 312601, 312602; a section of the beak of a pedicle valve showing the median septum and the initial state of the spondylium, USNM 312603; a fragment showing the coarse angular costation, USNM 312604; and a large brachial valve, USNM 312605. In addition, there are several fragments of pedicle valves showing the spondylium and a subdued costation pattern produced by metamorphism.

Locality: USGS 10305-SD (field no. L-782) Fitch Formation; metacarbonate with megafossils from within 3½ to 4 m of the base of the Fitch Formation at Fitch Farm, Littleton 7½-minute quadrangle, Grafton County, N.H.

Collector: Norman L. Hatch, Jr., 10/9/80.

AGE OF THE FITCH FORMATION

The *eosteinhornensis* Zone occurs in part of the middle, the lower, and possibly the base of the Fitch Formation. Reevaluation of the brachiopod date does not conflict with the conodont age determination. We thereby extend Berry and Boucot's (1970) age assignment of the Fitch in its type area upward to include the latest Ludlovian and at least the early Pridolian and question a pre-*eosteinhornensis* Ludlovian Age assignment for any part of the Fitch in the Littleton area.

REGIONAL STRATIGRAPHIC IMPLICATIONS

The latest Ludlovian to Pridolian Age of the Fitch conodonts has some implications for the geology along the Bronson Hill anticlinorium. About 95 km southwestward along the anticlinorium from the Littleton area, in the vicinity of Croydon Mountain, N.H., Boucot and Thompson (1963) described late Llandoverian brachiopods from several localities in the Clough Quartzite. No biostratigraphically diagnostic fossils have yet been discovered in the overlying Fitch Formation in that area. The apparently gradational nature of the contact between the Clough Quartzite and the Fitch Formation led Boucot (1968) and Berry and Boucot

(1970) to assign a Wenlockian to Ludlovian Age to the unfossiliferous Fitch in the Croydon Mountain area, where it overlies fossiliferous late Llandoverian Clough Quartzite, and likewise to assign an early Ludlovian Age to the unfossiliferous Clough in the Littleton area where it underlies fossiliferous middle Ludlovian (their designation) Fitch. We prefer not to extrapolate relationships of these units between the Croydon Mountain, and Littleton areas, because there are several stratigraphic possibilities (that is, time transgressions, unconformities, and conformities). All that can safely be said at this time is: (1) the Fitch Formation in the Littleton area is of latest Ludlovian to Pridolian Age; the nature of its contact with and the age of the underlying Clough is uncertain; and (2) the Clough Quartzite in the Croydon Mountain area is of late Llandoverian Age. The nature of its contact with the overlying Fitch, although reported as gradational (Berry and Boucot, 1970), is still uncertain because of the lack of geologic and paleontologic control.

The discontinuous outcrop of both the Clough Quartzite and Fitch Formation between Middle Ordovician strata and the Lower Devonian Littleton Formation (see Billings, 1956) may be most reasonably explained as resulting from post-Fitch, pre-Littleton erosion. An alternative explanation that the present distribution is the result of highly discontinuous deposition is possible, especially as the late Llandoverian age of the Clough (Boucot and Thompson, 1963) suggests to us the possibility of a considerable time gap at the Clough-Fitch boundary. In either event, but particularly by the former model, a latest Ludlovian to Pridolian, rather than middle Ludlovian Age for the Fitch, decreases the possibility that any part of the overlying Littleton Formation can be older than Early Devonian. Although all the fossils reported from the Littleton are of late Early Devonian age, it has been pointed out (Boucot and Arndt, 1960, p. 45) that those in the Walker Mountain syncline directly overlying the belt of Fitch from which we collected conodonts (see fig. 1) are 800 to 1000 m above the base of the Littleton (Billings and Cleaves, 1934, p. 422). This led Boucot and Arndt (1960, p. 45) to state "Although older Lower Devonian fossils have not been found in the 2500 feet of beds underlying those that contain fossils of Camden age in the Littleton quadrangle, there is no a priori reason to conclude that these barren beds are of the same age as those that contain fossils (Billings and Cleaves, 1934, p. 422)." We feel that the latest Ludlovian to Pridolian Age of the conodonts described here, while certainly not ruling out a somewhat older (than Camden) Early Devonian age for the basal 800 m of the Littleton in the Walker Mountain syncline, makes a pre-Devonian age for any part of that Littleton section highly unlikely. Thus, there is still no evidence of the earliest Devonian in the Fitch-Littleton sequence.

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