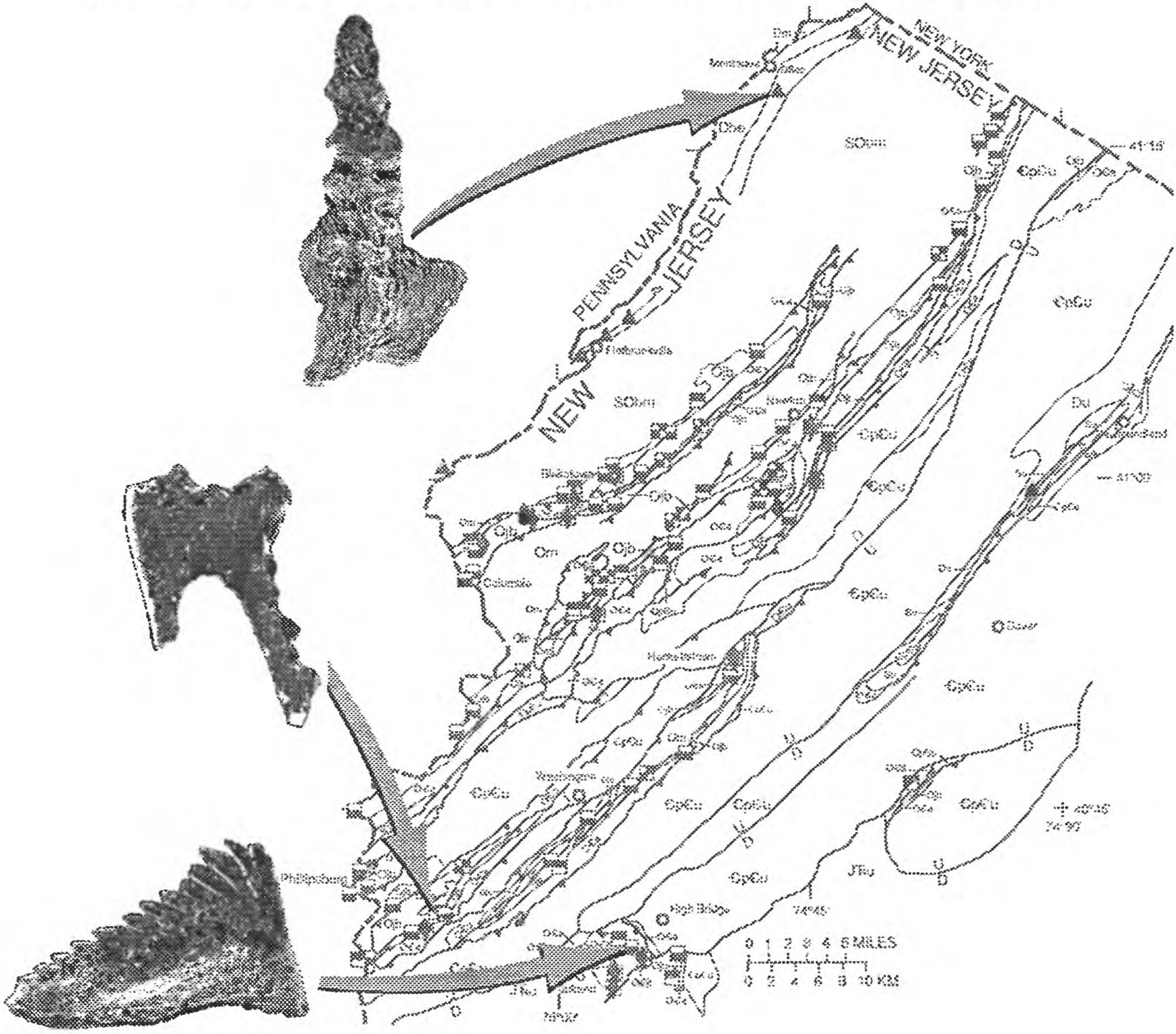
U. S. DEPARTMENT OF THE INTERIOR
U. S. GEOLOGICAL SURVEY

CONODONT AGE AND CAI DATA FOR NEW JERSEY



by

Anita G. Harris, John E. Repetski, Nancy R. Stamm, and David J. Weary
U.S. Geological Survey, MS 970, National Center, Reston, VA 22092

Open-File Report 95-557

1995

INTRODUCTION

Conodonts are the microscopic toothlike hard parts of an extinct group of marine vertebrates having affinities to the jawless fishes (e.g., hagfish). Since the first discovery of a nearly complete conodont animal from the Lower Carboniferous of Scotland (Briggs and others, 1983), several other animals have been found (Mikulic and others, 1985; Aldridge and Theron, 1993). The name conodont applies to the animal as well as its only known hard parts. These hard parts, conodont elements, generally range from 0.1 to 1 mm in length, are composed of calcium phosphate, occur in a variety of shapes, even within a single animal (like the variety of tooth shape in many other vertebrates), and formed part of a feeding apparatus. Conodonts range from the Cambrian through Triassic (an interval of ~300 million years), had worldwide distribution in most marine environments, and are one of the major groups of index fossils throughout their geologic range. An excellent summary of conodont taxonomy, biostratigraphy, and paleoecology is provided by Sweet (1988). Conodonts are also indices of thermal metamorphism (Epstein and others, 1977; Rejebian and others, 1987). The trace amount of organic matter sealed within these transparent skeletal elements visibly changes from pale yellow, to amber, light brown, dark brown, and black in the range of 50° to 300°C as a result of carbonization. Above 300°C, conodonts change from black, to gray, opaque white, and, finally, crystal clear as a result of carbon loss and recrystallization. These color changes, termed color alteration indices (CAI), have been reproduced and calibrated in the laboratory so that conodonts have become valuable geothermometers.

This report, exclusive of table 1, is virtually identical to the conodont chapter in a volume on the paleontology of New Jersey (Repetski and others, 1995) to be published by the Geological Association of New Jersey. Space restrictions in that volume do not allow inclusion of the database for our paper. This database is presented here as table 1 and provides detailed geographic, stratigraphic, and biostratigraphic information for every conodont collection from New Jersey reposited in the U.S. Geological Survey conodont laboratory, Reston, Va.

Previous Studies in New Jersey

Conodonts are known only from northwestern New Jersey including at least 180 collections from about 90 localities that could be plotted separately on figure 1 (table 1). Only a few publications describe conodonts from New Jersey. The first such report was by Ethington and others (1958) on conodonts from Middle Ordovician siltstone in the Jutland klippe sequence (fig. 1, locs. HB-6, CH-1). Subsequently, Barnett (1965) described Middle Ordovician conodonts from the Jacksonburg Limestone; all of Barnett's localities have been re-collected in the course of geologic mapping (Drake and others, in press) and are included on figures 1 and 2. Barnett (1966, 1971, 1972), Epstein (1970), and Denkler and Harris (1988) reported on conodonts from uppermost Silurian and lowermost Devonian rocks in northwesternmost New Jersey, and Barnett (1966, 1971) described latest Silurian conodonts from the Green Pond Mountain area (fig. 1, loc. DO-1). Harris and others (1978) mapped conodont CAI values in Paleozoic rocks in the Appalachian basin including New Jersey, and Karklins and Repetski (1989) showed the distribution of selected Ordovician conodont faunas and their CAI values in the state. In addition, several abstracts and two undergraduate theses on Ordovician conodonts in New Jersey contain important stratigraphic and distribution data (e.g., Savoy, 1981).

In the past 20 years, conodonts have been used more than any other fossil group for correlation and to refine the age of lower Paleozoic marine rocks in New Jersey. Conodonts have been recovered chiefly from carbonate-bearing Upper Cambrian to Middle Ordovician and Upper Silurian and Lower Devonian rocks (fig. 3). Conodonts have also been identified on bedding planes of fine-grained siliciclastic rocks in the Cambrian and Ordovician Jutland klippe sequence where they are locally very abundant. Conodonts have been particularly important for correlation and geologic mapping of the Beekmantown Group, a lithologically repetitious and complexly deformed unit that generally lacks other fossils. Conodonts from New Jersey have been relatively little studied because they are mostly deformed and fractured (pl. I:A-C,H; pl. II:Y; pl.

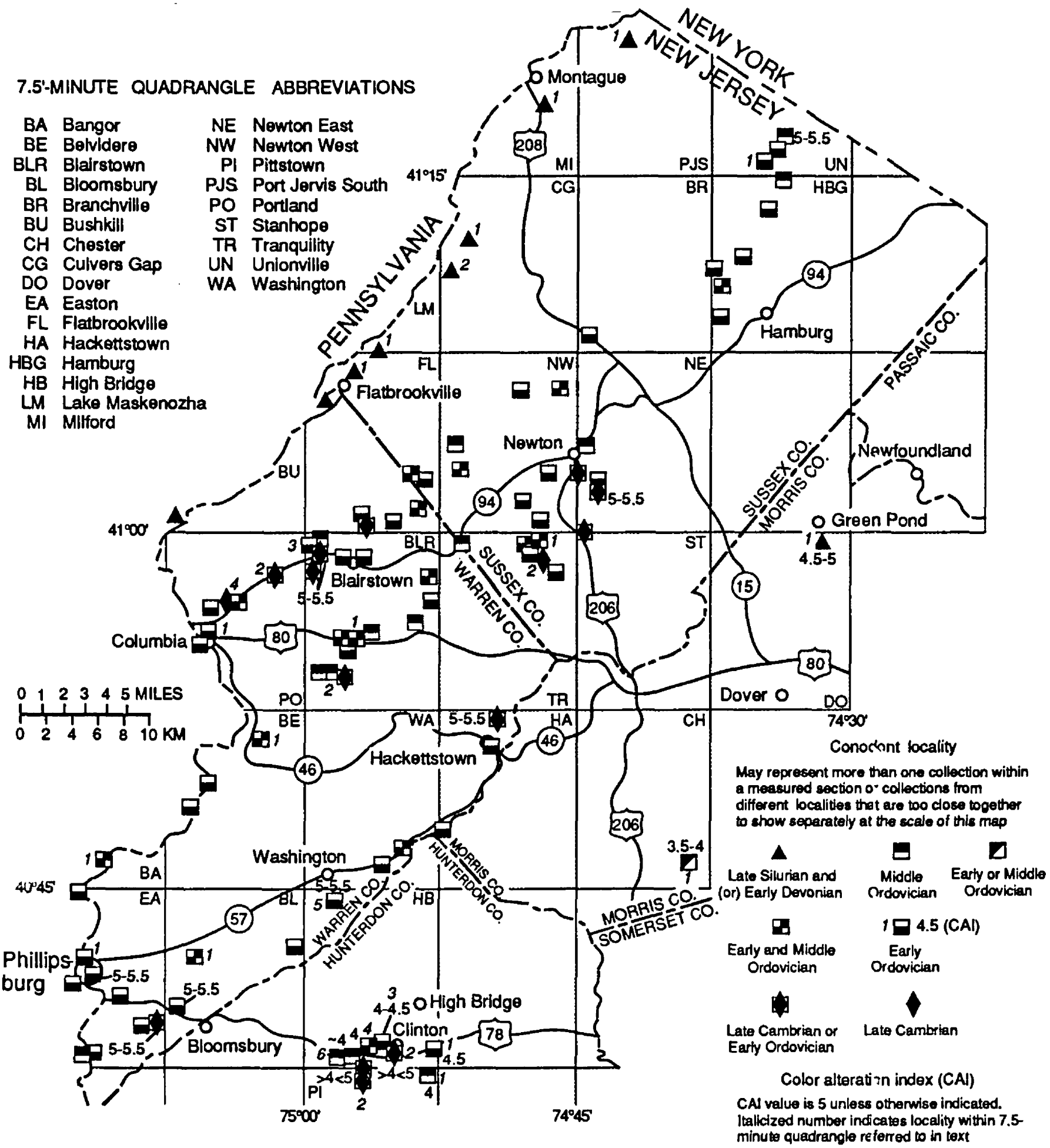


Figure 1. Index map of northwestern New Jersey showing conodont localities. See figure 2 for geologic setting.

III;V,X,Z). Most of the Paleozoic rocks in which they occur have undergone very low to low grade metamorphism, are complexly deformed, cleaved, and are relatively poorly exposed. Consequently, systematic collections from measured sections are difficult to obtain. In addition, most of the carbonate-bearing Paleozoic stratigraphic units in New Jersey, excluding the Stonehenge Formation and Jacksonburg Limestone, are poorly productive of conodonts (1-10 elements/kg). All of the above make biostratigraphic and taxonomic studies of conodonts in New

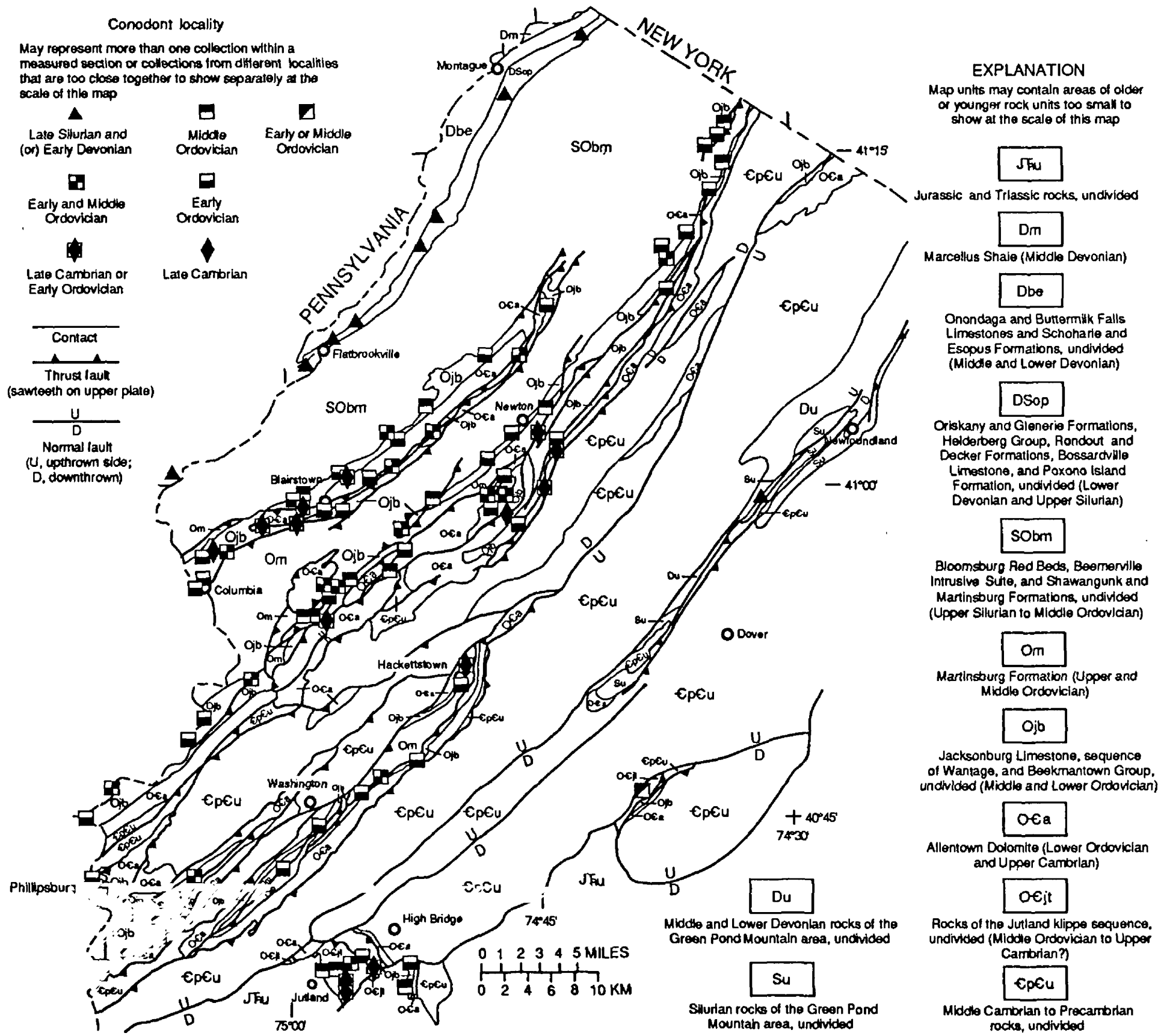


Figure 2. Generalized geologic map of northwestern New Jersey showing conodont localities (generalized from Drake and others, in press).

Jersey a difficult as well as long-term undertaking. This report includes collections made by many geologists in the last three decades, chiefly related to geologic mapping. Foremost among these are A.A. Drake, Jr., J.B. Epstein, P.T. Lyttle, and ourselves, U.S. Geological Survey, and R. Dalton, G.C. Herman, and D.H. Monteverde, New Jersey Geological Survey.

STRATIGRAPHIC DISTRIBUTION OF CONODONTS IN NEW JERSEY

Upper Cambrian and Lower Ordovician Rocks

Allentown Dolomite (Upper Cambrian and Lower Ordovician?)

The oldest stratigraphic unit to produce conodonts in New Jersey is the Allentown Dolomite (fig. 3). A limestone within the Allentown (fig. 1, loc. TR-2) yielded a single element of *Proconodontus muelleri* (pl. I:Z), indicating a latest Cambrian age. A few other Allentown localities also have produced a very few conodonts, but all are taxa that range from the Late Cambrian into the Early Ordovician.

Beekmantown Group

Stonehenge Formation (Upper Cambrian? and Lower Ordovician, lower Ibexian)

The Stonehenge Formation has produced the largest number of Early Ordovician conodonts from the New Jersey carbonate platform succession because the Stonehenge interval was intensively examined during recent geologic mapping and its depositional setting was more favorable for conodonts than other Beekmantown Group rocks. Our use of Stonehenge Formation, as well as Rickenbach Dolomite and Epler Formation, generally follows that of Hobson's (1963) regional stratigraphic study of the Beekmantown Group in southeastern Pennsylvania, except that the Stonehenge is now recognized in New Jersey (Drake and others, in press). During deposition of the Allentown Dolomite and Beekmantown Group, much of North America, including New Jersey, was a shallow marine carbonate platform with predominantly shallow subtidal to supratidal depositional settings. Water temperature and salinity were undoubtedly elevated producing conditions unfavorable for abundant and diverse faunas. Some limestones (or dolomitized limestones) in the Stonehenge (and overlying Epler Formation) represent more "normal-marine" shallow subtidal conditions. These intervals generally produce indentifiable conodonts even though other organic remains are virtually absent. Other organisms may have once been present but their remains have not been preserved.

The lack of data near the gradational contact of the Stonehenge Formation with the underlying Allentown Dolomite, combined with the lack of agreement about the level for the Cambrian-Ordovician boundary, does not allow accurate placement of this contact; all assignable collections from the Stonehenge, however, are Ibexian (fig. 3). Collections from the earliest Ibexian *Cordylodus proavus* and *C. intermedius* Zones include both the name-bearing species as well as subzonal indicators such as *Clavohamulus elongatus* (pl. I:AF), *Hirsutodontus simplex* (pl. I:AC), and *Clavohamulus hintzei* (pl. I:AG).

Most limestones within the Stonehenge of New Jersey fall within the short interval of the *Cordylodus angulatus* Zone or the succeeding, geographically and stratigraphically extensive, *Rossodus manitouensis* Zone. Collections from limestones within the *R. manitouensis* Zone can contain diverse as well as common to abundant conodonts (~10-100 elements/kg). Besides the distinctive zonal index (pl. I:J-L), these collections usually include the tropical-cosmopolitan species *Variabiloconus bassleri* (pl. I:A-D), *"Oistodus" triangularis* (pl. I:M), and *Scolopodus sulcatus* (pl. I:H-I). Less common but important species within this zone are *Acanthodus uncinatus* (pl. I:E), *Chosonodina herfurthi* (pl. I:P), *Clavohamulus densus* (pl. I:R), *Loxodus bransoni* (pl. I:S), and *"Paltodus" spurius* (pl. I:T). The Stonehenge conodont faunas, like those in the rest of the Beekmantown Group, are shallow-water, tropical to low-temperate species associations typical of the North American Midcontinent Faunal Realm.

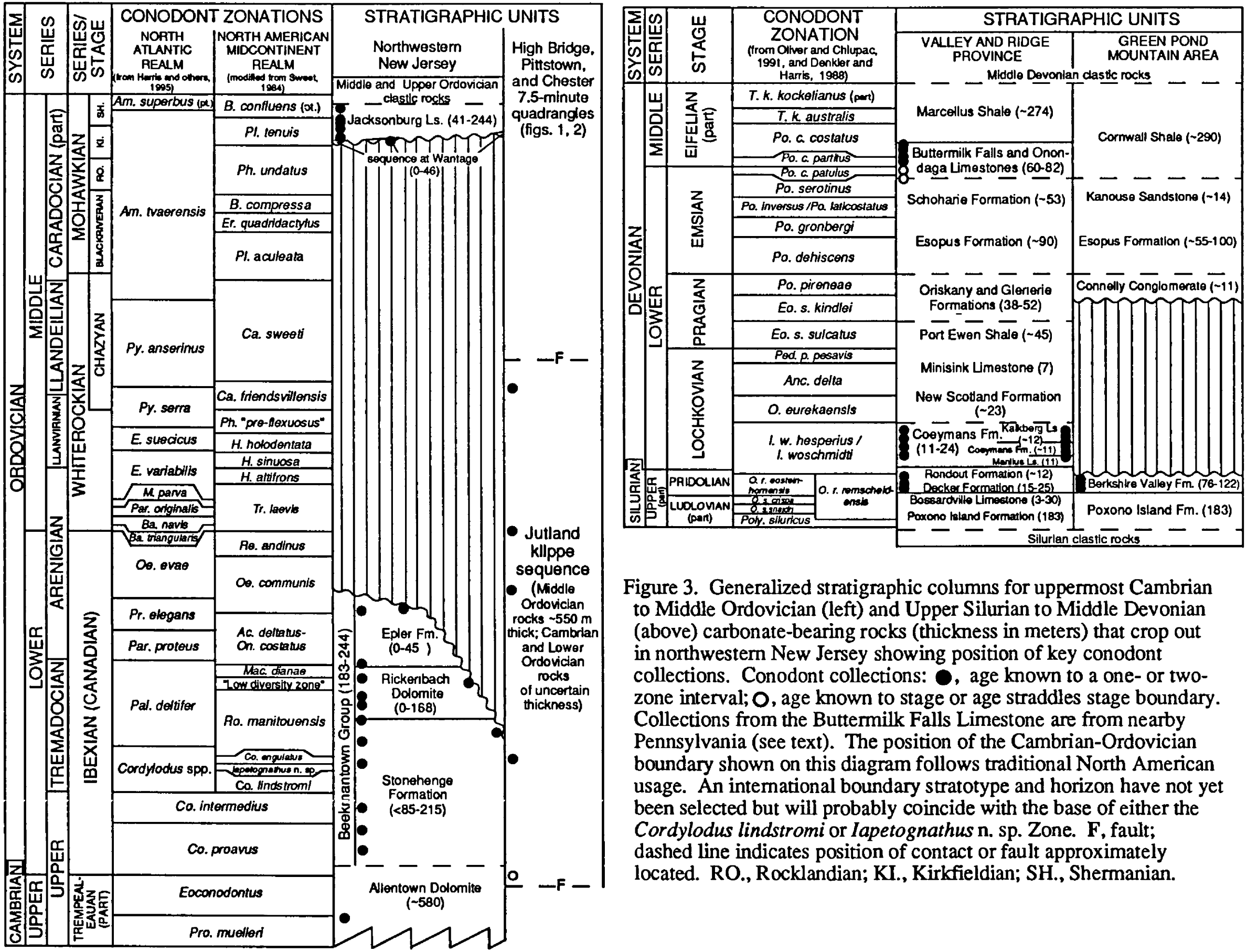


Figure 3. Generalized stratigraphic columns for uppermost Cambrian to Middle Ordovician (left) and Upper Silurian to Middle Devonian (above) carbonate-bearing rocks (thickness in meters) that crop out in northwestern New Jersey showing position of key conodont collections. Conodont collections: ●, age known to a one- or two-zone interval; ○, age known to stage or age straddles stage boundary. Collections from the Buttermilk Falls Limestone are from nearby Pennsylvania (see text). The position of the Cambrian-Ordovician boundary shown on this diagram follows traditional North American usage. An international boundary stratotype and horizon have not yet been selected but will probably coincide with the base of either the *Cordylodus lindstromi* or *Iapetognathus* n. sp. Zone. F, fault; dashed line indicates position of contact or fault approximately located. RO., Rocklandian; KI., Kirkfieldian; SH., Shermanian.

Rickenbach Dolomite (Lower Ordovician, lower and middle Ibexian)

The lower contact of the Rickenbach Dolomite is gradational with the Stonehenge Formation and occurs within the *R. manitouensis* Zone. Thus, it is difficult or impossible to distinguish isolated dolostone outcrops of most of the Rickenbach from much of the upper part of the Stonehenge either lithically or faunally. Generally, however, the dolostones of the Rickenbach represent more restricted depositional environments so that, if they yield conodonts, the faunas are less abundant and less diverse than those of the Stonehenge.

The upper part of the Rickenbach contains species of the "Low diversity zone" and the *Macerodus dianae* Zone (fig. 3). Other than rare elements of *M. dianae* (pl. II:X,Y), this relatively thin interval usually produces only rather morphologically generalized conodonts such as *Oneotodus simplex* and *Eucharodus* spp., as well as *Colaptoconus quadraplicatus* (pl. II:AG) and *Striatodontus? prolificus* (pl. II:AD,AE).

Epler Formation (Lower Ordovician, middle and upper Ibexian)

The Epler Formation, gradational upward from the Rickenbach Dolomite, is mostly dolostone, but does contain some limestones that help distinguish these formations. The contact is within the *M. dianae* Zone (fig. 3). Collections from limestones low in the formation may contain rather diverse faunas, but abundance is generally low. Characteristic species include *M. dianae* (pl. II:X,Y), *Protopanderodus leei* (pl. II:AB,AC), *Scolopodus floweri* (pl. II:U-W), as well as *Colaptoconus quadraplicatus* and *Eucharodus parallelus*.

Very little is known about the distribution of conodonts in the middle and upper parts of the Epler in New Jersey because these strata have not been systematically sampled. A few isolated samples containing *Diaphorodus delicatus* (pl. II:O) indicate the formation extends at least into the late Ibexian *Oepikodus communis* Zone. In addition, *O. communis* (pl. II:Q) was recovered from a redeposited cobble of Epler lithology within the Jacksonburg Limestone in an area from which the Epler was eroded (Savoy, 1981).

Middle Ordovician

Jacksonburg Limestone (late Middle Ordovician)

The Jacksonburg Limestone disconformably overlies all of the Beekmantown Group formations in northwestern New Jersey, as these rocks were exposed and eroded during the early Middle Ordovician. Savoy (1981) documented the presence of conodonts ranging in age from early to late Ibexian (to perhaps early Whiterockian) in carbonate cobbles incorporated within the basal and lower Jacksonburg. In addition, isolated exposures of dolomitic to shaly carbonate rocks lie immediately beneath the Jacksonburg in some areas. These rocks, mapped and termed the sequence at Wantage by Monteverde and Herman (1989) and Drake and others (in press), probably are remnants of a unit that filled topographic lows on the eroded Beekmantown surface during initial late Middle Ordovician transgression. Some samples from this unit have produced *Phragmodus undatus* among other species. This species and the position of the sequence at Wantage beneath the Jacksonburg indicate a Rocklandian or Kirkfieldian age.

The limestones of the Jacksonburg generally contain abundant and diverse shelly fossils and probably formed in normal-marine subtidal conditions. These limestones also produce the largest conodont yields of all New Jersey carbonate rocks. Most Jacksonburg samples contain the North American Midcontinent Faunal Realm species *Phragmodus undatus* (pl. III:V-Z), *Plectodina tenuis* (pl. III:R,S), *Aphelognathus politus* (pl. III:M-Q), as well as pandemic species such as *Panderodus gracilis* and *Drepanoistodus suberectus* (pl. III:AC). All these species are rather long-ranging, but some constrain the lower limit of the formation to an age no older than late Middle Ordovician (Kirkfieldian Stage) *Plectodina tenuis* Zone (fig. 3). As noted by Barnett (1965), at some localities the Jacksonburg faunas include species characteristic of the North Atlantic Faunal Realm together with North American Midcontinent species. This probably indicates a more offshore, open-marine setting for these more eastern localities (e.g., fig. 2, loc. PI-1). North Atlantic Realm species found in the Jacksonburg include *Icriodella superba* (pl. III:A-D), *Rhodesognathus elegans* (pl. III:L), and *Amorphognathus superbus* (pl. III:F,G). The presence of

A. superbus is significant because it ties the Jacksonburg into the cosmopolitan North Atlantic zonation (fig. 3). The age of the upper part of the Jacksonburg is not well constrained; graptolites in the lower part of the overlying Martinsburg Formation indicate an age no younger than early Edenian (Drake and others, in press).

Jutland klippe sequence

Very different conodont faunas occur sporadically in the mostly siliciclastic rocks of the Taconic-type klippen near Clinton (Jutland klippe) and near Chester (Peapack klippe, but included in the Jutland klippe sequence), New Jersey (figs. 2, 3). All faunas, both conodont and graptolite, known from these areas, as well as the sedimentology, point to deposition in continental slope to oceanic basin environments (see also Drake, 1969; Perissoratis and others, 1979). All conodonts known from the klippe sequence thus far are cosmopolitan North Atlantic Realm or pandemic species.

Conodonts are locally abundant on bedding surfaces of siltstone and fine-grained sandstone in the Jutland klippe sequence. These include mostly elements of *Periodon aculeatus* (pls. II:F, III:AB) and a few other long-ranging taxa that give an overall age of early to middle Middle Ordovician. However, two specimens of *Pygodus*, a biostratigraphically important genus, known from the sequence (Ethington and others, 1958, and this report, pl. III:AA), restrict the age to the Llanvirnian and (or) Llandeilian. Some new collections made by D.C. Parris (N.J. State Museum), from a lower stratigraphic level contain Early Ordovician graptolites and abundant conodont elements of *Paracordylodus gracilis* (fig. 1, loc. HB-3). These conodonts are best assigned an early or early middle Arenigian (early late Ibexian) age.

Some collections of calcareous rocks from the Jutland klippe sequence have yielded older conodonts. The oldest faunas span the Cambrian-Ordovician boundary (fig. 3), and include *Eoconodontus notchpeakensis* (pl. I:X), and species of the protoconodont *Phakelodus* (pl. I:V). Somewhat younger samples contain species of the cosmopolitan genus *Cordylodus* and are assignable to the lower Ibexian or lower Tremadocian (pl. II:G,H). A calcareous sample from the Peapack klippe (fig. 1, loc. CH-1) contains abundant *Periodon flabellum* (pl. II:A-E) and other species (pl. II:I-M), and is of latest Early or earliest Middle Ordovician age.

Upper Silurian and Lower Devonian Rocks

Valley and Ridge province

Decker Formation (Upper Silurian, upper Pridolian)

The Decker Formation is the oldest Silurian unit to produce conodonts (fig. 3). No conodonts have been recovered from the underlying Bossardville Limestone in New Jersey and samples from Pennsylvania have produced only indeterminate conodont fragments (Denkler, 1984). The Poxono Island Formation underlies the Bossardville and contains some carbonate beds, but it has not produced conodonts either in New Jersey or nearby Pennsylvania (Denkler, 1984 and A.G. Harris, unpublished data). Barnett (1971) showed the distribution of conodonts in samples from the Decker Formation at loc. PJS-1 (fig. 1). Barnett's data indicate conodonts are common (11 elements/kg) but diversity is low; *Ozarkodina remscheidensis* makes up more than 98% of the fauna and *Oulodus elegans* is the only other conodont on the basis of our multielement analysis of Barnett's form-element taxonomy. These two species also occur in the Decker in Pennsylvania (Denkler and Harris, 1988). The Decker contains a relatively diverse macrofauna including brachiopods, corals, mollusks, and pelmatozoans. Fossils and sedimentary structures indicate a high-energy, shoal-water depositional setting. The low diversity of conodonts suggests normal-marine conditions were intermittent or that physical and chemical barriers elsewhere in the Appalachian basin kept less eurytopic conodont species from reaching New Jersey.

Oulodus elegans indicates the Decker Formation is no older than late Ludlovian and no younger than latest Pridolian. Regional stratigraphic relationships indicate the Decker is late Pridolian.

Rondout Formation (Upper Silurian and Lower Devonian, upper Pridolian and lower Lochkovian)

The Rondout Formation consists of laminated, mud-cracked, argillaceous carbonate mudstone and dolostone containing one widespread, thin biostromal bed. The Rondout formed in a restricted lagoon setting (Epstein and others, 1967). Only one sample (fig. 1, loc. PJS-1) from the lower part of the formation in New Jersey produced conodonts (Barnett, 1971). Abundance and species composition is the same as in the Decker. *Oulodus elegans* restricts the lower part of the Rondout to the Late Silurian. The Silurian-Devonian boundary was placed in the middle of the Rondout Formation on the basis of sequence stratigraphy and regional conodont biostratigraphy and biofacies by Denkler and Harris (1988). Earlier, Barnett (1972) positioned this boundary at the base of the overlying Manlius Limestone in New Jersey using comparative morphometric analysis of Pa elements of *Ozarkodina remscheidensis* from New Jersey, Nevada, and Czechoslovakia. We believe changes in the shape of Pa elements of *O. remscheidensis*, a long-ranging and variable species, reflect recurrent environmental responses, are not evolutionary, and should not be used for long-distance correlation.

Manlius Limestone (Lower Devonian, *I. woschmidti* Zone, lower Lochkovian)

Conodonts are common (~10 elements/kg) in the Manlius Limestone in New Jersey (Barnett, 1966; Epstein, 1970; A.G. Harris, U.S. Geological Survey collections) and only slightly more diverse than in underlying Silurian rocks. *Ozarkodina remscheidensis* (pl. IV:E, G-I) continues to make up at least 98% of the collections indicating intermittently restricted conditions. *Oulodus cristagalli* and *Belodella devonica* are rare. One specimen of *Icriodus woschmidti*, an auxiliary guide to the base of the Devonian, was found 2.6 m below the top of the formation at loc. PJS-1 (Denkler and Harris, 1988) confirming the Devonian age based on regional relationships. Southwest of Montague, N.J., beds correlative to the Manlius become increasingly quartzose and are included in the more heterogeneous Coeymans Formation (fig. 3; Epstein and others, 1967).

Coeymans Formation (Lower Devonian, *I. woschmidti* Zone, lower Lochkovian)

The Coeymans Formation yields more abundant (~20 elements/kg) and possibly more diverse conodonts than any other uppermost Silurian or lowermost Devonian unit in New Jersey (Barnett, 1966, 1971; Epstein, 1970). The Coeymans includes bioclastic grainstone, packstone, and lesser wackestone that contain varying amounts of quartz silt and sand as well as biorudite and calcareous quartz-pebble conglomerate. The biorudites produce fewer conodonts than other facies in the formation. The conodont fauna of the Coeymans (using data in Barnett, 1966, and Epstein, 1970) consists of *Ozarkodina remscheidensis* (76%) (pl. IV:A-D, F), *Icriodus woschmidti* (12%) (pl. IV:Q-V), *Oulodus cristagalli* (9%) (pl. IV:K-O), *Belodella devonica* (2%) (pl. IV:P), *Pseudooneotodus beckmanni* (~1%) (pl. IV:J), and 1 specimen of *Panderodus unicostatus* (Branson and Mehl). Sedimentary structures and fossils indicate the Coeymans formed in a high- to moderate-energy depositional setting accounting for the increase in icriodids and oulodids.

Kalkberg Limestone (Lower Devonian, *I. woschmidti* Zone, lower Lochkovian)

The Kalkberg Limestone extends into New Jersey only as far southwest as the Lake Maskenozha quadrangle (fig. 3; Epstein and others, 1967). The Kalkberg is like the underlying Coeymans Formation, but is more argillaceous and contains more chert. Nevertheless, the Kalkberg produces nearly the same conodont species in the same order of abundance as the Coeymans (Epstein, 1970). The presence of *Icriodus woschmidti* restricts the formation to the earliest Lochkovian. The Kalkberg was deposited seaward of the Coeymans in slightly deeper water.

Post-Kalkberg Limestone Devonian rocks

No conodonts have been reported from Devonian rock units younger that the Kalkberg Limestone in northwestern New Jersey. Of these units (fig. 3), the Glenerie Formation and Buttermilk Falls Limestone have the best potential for conodonts. Common to abundant conodonts have been recovered from measured sections of the Buttermilk Falls in its type area near East Stroudsburg, Pa. (~lat. 41°00', long. 75°08'-11') (A.G. Harris, written communication, 1982, to

J.B. Epstein; U.S. Geological Survey collections 10635-SD to 10642-SD). The conodonts indicate the lower one-third of the formation is no older than the *serotinus* Zone and the remainder of the formation represents the *partitus* and *costatus* Zones. In the type area, the Tioga Ash Bed is 9 m below the top of the Buttermilk Falls Limestone. The Tioga is known to lie within the *costatus* Zone at many localities in the Appalachian basin (e.g., Klapper and Johnson, 1980).

Green Pond Mountain area

A narrow belt of Paleozoic rocks lies within the New Jersey Highlands, east of the Valley and Ridge province (fig. 2). Barnett (1966, 1971) described conodonts from carbonate-bearing uppermost Silurian and lowermost Devonian rocks at one locality in the Green Pond Mountain area of New Jersey (fig. 1, loc. DO-1). Three large samples from fossiliferous limestone beds in the Berkshire Valley Formation produced only *Ozarkodina remscheidensis* in low numbers (4 /kg). On the basis of regional stratigraphic relations, Barnett (1966, 1971) considered the Berkshire Valley correlative to the Decker and Rondout Formations of the Valley and Ridge province.

CONODONT COLOR AND TEXTURAL ALTERATION

Most conodonts from New Jersey have CAI values of 5 and, more rarely, higher (fig. 1 and table 1) indicating they reached at least 300°C and burial depths of at least 10 km. Values of 4.5 to as low as 3.5-4 are limited to the High Bridge, Pittstown, and Chester 7.5-minute quadrangles (fig. 1 and table 1), chiefly in the Jutland klippe sequence although conodonts from the Beekmantown Group and Jacksonburg Limestone in the same area have similarly low CAI values (fig. 1, locs. PI-1 and HB-1-3 and fig. 2). The data suggest that all these rocks lie structurally above and were never as deeply buried as nearby parautochthonous correlative strata with CAI values of 5 and 5-5.5 (e.g., fig. 1, loc. HB-5) as well as considerably younger Upper Silurian and Lower Devonian rocks with CAI values of 5 at least 40 km to the northwest.

Most conodonts from New Jersey are poorly preserved texturally, particularly specimens from dolostones in which saline pore waters probably promoted surface corrosion and recrystallization of conodonts during diagenesis. In limestones, recrystallization of conodonts generally begins at CAI 5. Because even the youngest conodonts from New Jersey have CAI values of 5, they too show varying degrees of recrystallization depending on the texture and composition of their host rock (see pls. I-IV). Conodonts from porous rocks such as grainstones may be more recrystallized than those from more poorly sorted rocks. For example, the specimen shown in plate IV:A is from a wackestone and is less recrystallized than the specimen shown in plate IV:K from a grainstone/packstone. At the temperatures associated with CAI values of 5 or higher, carbonate grains may anneal to the surface of conodonts. When such conodonts are freed from limestone by dissolving the rock in a weak acid solution, the conodonts often bear the imprint of annealed carbonate grains on their surface (e.g., pls. I:P, IV:R) even though these grains have dissolved. Conodonts extracted from dolomitic limestone, such as the Epler Formation, or quartzose carbonate rocks, such as the Coeymans Formation, generally retain the insoluble dolomite rhombs (e.g., pl. II:P,AH) or quartz grains on their surface (e.g., pl. IV:C, T).

Table 1. Geographic, stratigraphic, biostratigraphic, and CAI data for U.S. Geological Survey conodont collections from New Jersey
[See figures 1-3 for generalized location and biostratigraphic framework of collections. Scale constraints do not permit numeric identification of most collections shown on figures 1 and 2, so that many localities represent more than one collection. Individual collections can be located by their latitude/longitude and age]

FIELD NO. (USGS NO.)	7.5-MIN. QUAD.	COUNTY	LATITUDE/ LONGITUDE	AGE	FORMATION	CAI	REMARKS
BEL-3000 (10814-CO)	Belvidere	Warren	40°49.33'/ 75°05.08'	earliest Ordovician	probably Stonehenge Formation	5	Collected by A. A. Drake, Jr. Analyzed by J. E. Repetski.
BEL-1001 (10705-CO)	Belvidere	Warren	40°48.77'/ 75°05.93'	Early Ordovician (*R. manitouensis* Zone)	Stonehenge Formation	5-5+	Collected by A. A. Drake, Jr. Analyzed by J. E. Repetski.
BEL-1002 (10706-CO)	Belvidere	Warren	40°48.37'/ 75°05.95'	Early Ordovician (*R. manitouensis* Zone)	Stonehenge Formation	5-5+	Collected by A. A. Drake, Jr. Analyzed by J. E. Repetski.
Cono 3	Belvidere	Warren	40°51.22'/ 75°02.20'	Early Ordovician ("Low diversity" or *M. dianae* Zone)	Rickenbach Dolomite	5	(=loc. 45c, Karklins and Repetski, 1989).
(9636-CO)	Belvidere	Warren	40°51.22'/ 75°02.13'	Early Ordovician "Low diversity" or *M. dianae* Zone)	Rickenbach Dolomite	5	(=loc. 46 Karklins and Repetski, 1989).
(9637-CO)	Belvidere	Warren	40°51.38'/ 75°02.00'	Early Ordovician (*M. dianae* Zone)	Epler Formation	5	(=loc. 45a, Karklins and Repetski, 1989 and = BE-1, this report).
(10261-CO)	Belvidere	Warren	40°51.30'/ 75°01.98'	Early Ordovician (*M. dianae* Zone)	Epler Formation	5	(=loc. 45b, Karklins and Repetski, 1989).
(10523-CO)	Belvidere	Warren	40°51.20'/ 75°02.22'	Middle Ordovician (*Pl. tenuis* or *B. confluens* Zone)	Jacksonburg Limestone	5	(=loc. 47, Karklins and Repetski, 1989).
B-218 (9445-CO)	Blairstown	Warren	40°58.23'/ 74°59.63'	latest Cambrian or earliest Ordovician (*C. proavus* to *C. intermedius* Zone)	uppermost Allentown Dolomite or lower part Stonehenge Formation	5-5.5	Collected by P.T. Lyttle. (=loc. 22, Karklins and Repetski, 1989).
NJGS-95-2 (11236-CO)	Blairstown	Warren	40°55.45'/ 74°55.58'	Early Ordovician (*C. angulatus* or *R. manitouensis* Zone)	Stonehenge Formation	5	Collected by D. H. Monteverde. Analyzed by J. E. Repetski.
NJGS-95-3 (11237-CO)	Blairstown	Warren	40°55.45'/ 74°55.58'	Early Ordovician (*C. angulatus* or *R. manitouensis* Zone)	Stonehenge Formation	5	Collected by D. H. Monteverde. Analyzed by J. E. Repetski.
BLA-82 (9101-CO)	Blairstown	Warren	40°57.12'/ 74°52.68'	Early Ordovician (*R. manitouensis* Zone)	Stonehenge Formation	5	Collected by P.T. Lyttle. (=loc. 23, Karklins and Repetski, 1989).
8-5-80G (9378-CO)	Blairstown	Warren	40°58.10'/ 74°52.80'	Early Ordovician (*C. angulatus* to "Low diversity" Zone)	uppermost Stonehenge Fm. or lower Rickenbach Dolomite	5	(=loc. 4a, Savoy, 1981).
BLA-185B (10535-CO)	Blairstown	Warren	40°58.10'/ 74°53.20'	Early Ordovician (*R. manitouensis* Zone)	upper Stonehenge Formation or lower Rickenbach Dolomite	5	(=loc. 24, Karklins and Repetski, 1989).
B-170A (9444-CO)	Blairstown	Warren	40°58.80'/ 74°57.40'	Early Ordovician (*R. manitouensis* Zone)	upper Stonehenge Formation or lower Rickenbach Dolomite	5-5.5	(=loc. 25, Karklins and Repetski, 1989).
8-5-80I (9379-CO)	Blairstown	Warren	40°58.10'/ 74°52.80'	Early Ordovician (*R. manitouensis* Zone)	uppermost Stonehenge Fm. or lower Rickenbach Dolomite	5	(=loc. 4a, Savoy, 1981).

8-5-80F (9377-CO)	Blairstown	Warren	40°54.00'/ 74°57.50'	Early Ordovician (*R. manitouensis* to *M. dianae* Zone)	probably Rickenbach Dolomite	5	(=loc. 5b, Savoy, 1981 and = BLR-2, this report).
GH-BL-307 (11238-CO)	Blairstown	Warren	40°59.12'/ 74°58.43'	Early Ordovician ("Low diversity" or *M. dianae* Zone)	Rickenbach Dolomite or Epler Formation	5	Collected by G.C. Herman. Analyzed by J. E. Repetski.
GH-BL-306-1 (11240-CO)	Blairstown	Warren	40°59.18'/ 74°58.38'	Early Ordovician ("Low diversity" or *M. dianae* Zone)	Rickenbach Dolomite or Epler Formation	5	Collected by G.C. Herman. Analyzed by J.E. Repetski.
8-5-80A-1 (9345-CO)	Blairstown	Warren	40°54.90'/ 74°57.40'	middle to late Early Ordovician	Rickenbach Dolomite or Epler Formation	5	(=loc. 5a of Savoy, 1981).
B-170 (9442-CO)	Blairstown	Warren	40°59.30'/ 74°59.37'	middle to late Early Ordovician	Epler Formation	5	Collected by P.T. Lyttle. (=loc. 27, Karklins and Repetski, 1989 and = BLR-3, this report).
B-168 (9440-CO)	Blairstown	Warren	40°59.62'/ 74°58.63'	Early Ordovician ("Low diversity" or *M. dianae* Zone, probably *M. dianae* Zone)	Epler Formation	5	Collected by P.T. Lyttle. (=loc. 28, Karklins and Repetski, 1989).
B-170A (9443-CO)	Blairstown	Warren	40°58.77'/ 74°56.60'	middle to late Early Ordovician	Epler Formation	5	Collected by P.T. Lyttle. (=loc. 26, Karklins and Repetski, 1989)
BLA-185A (9098-CO)	Blairstown	Warren	40°58.10'/ 74°53.20'	probably Lower Ordovician	Beekmantown Group	5	(=loc. 24, Karklins and Repetski, 1989).
8-5-80E-7 (9352-CO)	Blairstown	Warren	40°54.00'/ 74°57.50'	Middle Ordovician (*Pl. tenuis* or *B. confluens* Zone)	Base of Jacksonburg Limestone	5	(=loc. 5b, Savoy, 1981 and = BLR-2, this report).
8-5-80E-29 (9365-CO)	Blairstown	Warren	40°54.00'/ 74°57.50'	Middle Ordovician (*Pl. tenuis* or *B. confluens* Zone)	Base of Jacksonburg Limestone	5	(=loc. 5b, Savoy, 1981 and = BLR-2, this report).
8-5-80E-1 (9347-CO)	Blairstown	Warren	40°54.00'/ 74°57.50'	Middle Ordovician (*Pl. tenuis* or *B. confluens* Zone)	Base of Jacksonburg Limestone	5	(=loc. 5b, Savoy, 1981 and = BLR-2, this report).
8-5-80E-40, 41 (9375-CO, 9366-CO)	Blairstown	Warren	40°54.00'/ 74°57.50'	Middle Ordovician (*Pl. tenuis* or *B. confluens* Zone)	Base of Jacksonburg Limestone	5	(=loc. 5b, Savoy, 1981 and = BLR-2, this report).
BL-290 (11239-CO)	Blairstown	Warren	40°54.08'/ 74°57.72'	Middle Ordovician (*Pl. tenuis* or *B. confluens* Zone)	Jacksonburg Limestone	5	Collected by D.H. Monteverde. Analyzed by J.E. Repetski.
BLA-164 (9100-CO)	Blairstown	Warren	40°58.23'/ 74°53.02'	Middle Ordovician (*Pl. tenuis* or *B. confluens* Zone)	Jacksonburg Limestone	5	(=loc 4a, Savoy, 1981 and loc. 31, Karklins and Repetski, 1989).
BLA-291 (9099-CO)	Blairstown	Warren	40°59.65'/ 74°58.95'	Middle Ordovician (*Pl. tenuis* or *B. confluens* Zone)	Jacksonburg Limestone	5	Collected by P.T. Lyttle. (=loc. 30, Karklins and Repetski, 1989).
BLA-86 (9102-CO)	Blairstown	Warren	40°56.20'/ 74°53.48'	Middle Ordovician (*Pl. tenuis* or *B. confluens* Zone)	Jacksonburg Limestone	5	(=loc. 32, Karklins and Repetski, 1989).

FIELD NO. (USGS NO.)	7.5-MIN. QUAD.	COUNTY	LATITUDE/ LONGITUDE	AGE	FORMATION	CAI	REMARKS
BLA-76 (9103-CO; 10536-CO)	Blairstown	Warren	40°55.92'/ 74°56.00'	Middle Ordovician (*Pl. tenuis* or *B. confluens* Zone)	Jacksonburg Limestone	5	(=loc. 33, Karklins and Repetski, 1989).
L3-16-80 J21 (9333-CO)	Blairstown	Warren	40°55.40'/ 74°56.70'	latest Cambrian to earliest Ordovician	cobble from base of Jacksonburg Limestone	5	(=loc. 5c, Savoy, 1981 and = BLR-1, this report).
8-5-80E-33, 34 (9370-CO, 9371-CO)	Blairstown	Warren	40°54.00'/ 74°57.50'	latest Cambrian to earliest Ordovician	cobble (from Allentown Dolomite or Stonehenge Fm.) in base of Jacksonburg Ls.	5	(=loc. 5b, Savoy, 1981 and = BLR-2, this report).
8-5-80E-15 (9359-CO)	Blairstown	Warren	40°54.00'/ 74°57.50'	latest Cambrian to earliest Ordovician	cobble (from Stonehenge Formation) in base of Jacksonburg Limestone	5	(=loc. 5b, Savoy, 1981 and = BLR-2, this report).
8-5-80E-21 (9361-CO)	Blairstown	Warren	40°54.00'/ 74°57.50'	Early Ordovician (*C. lindstromi* to *R. manitouensis* Zone)	cobble (from Stonehenge Fm. or Rickenbach Dolomite) in base of Jacksonburg Ls.	5	(=loc. 5b, Savoy, 1981 and = BLR-2, this report).
L3-16-80 J31, J45 (9340-CO, 9343-CO)	Blairstown	Warren	40°55.40'/ 74°56.70'	Early Ordovician (*C. lindstromi* to *R. manitouensis* Zone)	cobbles (from Stonehenge Fm. or Rickenbach Dolomite) in base of Jacksonburg Ls.	5	(=loc. 5c, Savoy, 1981 and = BLR-1, this report).
8-5-80E-5,6 (9350-CO, 9351-CO)	Blairstown	Warren	40°54.00'/ 74°57.50'	Early Ordovician (*R. manitouensis* Zone)	cobbles (from Stonehenge Fm. or Rickenbach Dolomite) in base of Jacksonburg Ls.	5	(=loc. 5b, Savoy, 1981 and = BLR-2, this report).
8-5-80E-8 (9353-CO)	Blairstown	Warren	40°54.00'/ 74°57.50'	Early Ordovician (*R. manitouensis* Zone)	cobble (from Stonehenge Fm. or Rickenbach Dolomite) in base of Jacksonburg Ls.	5	(=loc. 5b, Savoy, 1981 and = BLR-2, this report).
8-5-80E-13 (9357-CO)	Blairstown	Warren	40°54.00'/ 74°57.50'	Early Ordovician (*R. manitouensis* Zone)	cobble (from Stonehenge Fm. or Rickenbach Dolomite) in base of Jacksonburg Ls.	5	(=loc. 5b, Savoy, 1981 and = BLR-2, this report).
8-5-80E-22 (9362-CO)	Blairstown	Warren	40°54.00'/ 74°57.50'	Early Ordovician (*R. manitouensis* Zone)	cobble (from Stonehenge Fm. or Rickenbach Dolomite) in base of Jacksonburg Ls.	5	(=loc. 5b, Savoy, 1981 and = BLR-2, this report).
8-5-80E-3 (9348-CO)	Blairstown	Warren	40°54.00'/ 74°57.50'	Early Ordovician (*R. manitouensis* Zone)	cobble (from upper part of Stonehenge Fm. or Rickenbach Dolomite) in base of Jacksonburg Ls.	5	(=loc. 5b, Savoy, 1981 and = BLR-2, this report).
8-5-80E-31, 32 (9368-CO, 9369-CO)	Blairstown	Warren	40°54.00'/ 74°57.50'	Early Ordovician (*R. manitouensis* Zone)	cobble (from Stonehenge Fm. or Rickenbach Dolomite) in base of Jacksonburg Ls.	5	(=loc. 5b, Savoy, 1981 and = BLR-2, this report).
8-5-80E-36 (9373-CO)	Blairstown	Warren	40°54.00'/ 74°57.50'	Early Ordovician (*R. manitouensis* Zone)	cobble (from Stonehenge Fm. or Rickenbach Dolomite) in base of Jacksonburg Ls.	5	(=loc. 5b, Savoy, 1981 and = BLR-2, this report).
8-5-80E-26, 27 (9363-CO, 9364-CO)	Blairstown	Warren	40°54.00'/ 74°57.50'	Early Ordovician (*R. manitouensis* or "Low diversity" Zone)	cobbles (from Stonehenge Fm. or Rickenbach Dolomite) in base of Jacksonburg Ls.	5	(=loc. 5b, Savoy, 1981 and = BLR-2, this report).
8-5-80E-4 (9349-CO)	Blairstown	Warren	40°54.00'/ 74°57.50'	Early Ordovician (*R. manitouensis* to *M. dianae* Zone)	cobble (from Stonehenge Fm. or Rickenbach Dolomite) in base of Jacksonburg Ls.	5	(=loc. 5b, Savoy, 1981 and = BLR-2, this report).

8-5-80E-35 (9372-CO)	Blairstown	Warren	40°54.00'/ 74°57.50'	early to middle Early Ordovician (*C. angulatus* to "Low-diversity" Zone)	cobble (from Stonehenge Fm. or Rickenbach Dolomite) in base of Jacksonburg Ls.	5	(=loc. 5b, Savoy, 1981 and = BLR-2, this report).
8-5-80E-42 (9376-CO)	Blairstown	Warren	40°54.00'/ 74°57.50'	early to middle Early Ordovician (*C. angulatus* to "Low-diversity" Zone)	cobble (from Stonehenge Fm. or Rickenbach Dolomite) in base of Jacksonburg Ls.	5	(=loc. 5b, Savoy, 1981 and = BLR-2, this report).
8-5-80E-17 (9360-CO)	Blairstown	Warren	40°54.00'/ 74°57.50'	early or middle Early Ordovician	cobble (from Stonehenge Fm. or Rickenbach Dolomite) in base of Jacksonburg Ls.	5	(=loc. 5b, Savoy, 1981 and = BLR-2, this report).
8-5-80E-14 (9358-CO)	Blairstown	Warren	40°54.00'/ 74°57.50'	middle to late Early Ordovician	cobble (from Rickenbach Dolomite or Epler Fm.) in base of Jacksonburg Limestone	5	(=loc. 5b, Savoy, 1981 and = BLR-2, this report).
8-5-80E-30 (9367-CO)	Blairstown	Warren	40°54.00'/ 74°57.50'	middle to late Early Ordovician	cobble (from Rickenbach Dolomite or Epler Fm.) in base of Jacksonburg Limestone	5	(=loc. 5b, Savoy, 1981 and = BLR-2, this report).
8-5-80E-9, 10 (9354-CO, 9355-CO)	Blairstown	Warren	40°54.00'/ 74°57.50'	Early Ordovician	cobble (from Beekmantown Group) in base of Jacksonburg Limestone	5	(=loc. 5b, Savoy, 1981 and = BLR-2, this report).
8-5-80E-12 (9356-CO)	Blairstown	Warren	40°54.00'/ 74°57.50'	Early Ordovician	cobble (from Beekmantown Group) in base of Jacksonburg Limestone	5	(=loc. 5b, Savoy, 1981 and = BLR-2, this report).
8-5-80E-38 (9374-CO)	Blairstown	Warren	40°54.00'/ 74°57.50'	Early Ordovician	cobble (from Beekmantown Group) in base of Jacksonburg Limestone	5	(=loc. 5b, Savoy, 1981 and = BLR-2, this report).
L3-16-80 J1 (9328-CO)	Blairstown	Warren	40°55.40'/ 74°56.70'	late Early to early Middle Ordovician	cobble from base of Jacksonburg Limestone	5	(=loc. 5c, Savoy, 1981 and = BLR-1, this report).
L3-16-80I (9344-CO)	Blairstown	Warren	40°55.40'/ 74°56.70'	Middle Ordovician	Jacksonburg Limestone (from above cobble bed)	5	(=loc. 5c, Savoy, 1981 and = BLR-1, this report).
BLA-1068 (9104-CO)	Blairstown	Warren	40°54.10'/ 74°58.27'	Middle Ordovician (*Pl. tenuis* or *B. confluens* Zone)	Jacksonburg Limestone	5	(=loc. 34, Karklins and Repetski, 1989).
B-169 (9441-CO)	Blairstown	Warren	40°59.25'/ 74°58.97'	Late Cambrian to Ordovician	Stratigraphic unit not identified	5	Collected by P.T. Lyttle. (=loc. 29, Karklins and Repetski, 1989).
BB-1 (10813-CO)	Bloomsbury	Warren	40°40.13'/ 75°06.32'	Early, but not earliest, Ordovician	Stonehenge Formation or Rickenbach Dolomite	5-5.5	Collected by A.A. Drake, Jr. Analyzed by J.E. Repetski.
8-5-80L (9381-CO)	Bloomsbury	Warren	40°42.13'/ 75°05.75'	middle to late Early Ordovician	uppermost Epler Formation	5	(=loc. 6, Savoy, 1981).
B-D-9-3 (7000-CO)	Bloomsbury	Warren	40°42.58'/ 75°00.08'	Early Ordovician	Epler Formation (lower part)	5	Collected by A. A. Drake, Jr. (Harris and others, 1978).
8-5-80K (9382-CO)	Bloomsbury	Warren	40°42.13'/ 75°05.75'	Middle Ordovician (*Pl. tenuis* or *B. confluens* Zone)	lowermost Jacksonburg Limestone	5	(=loc. 6, Savoy, 1981 and = BL-1, this report).
BR-493 (10343-CO)	Branchville	Sussex	41°08.63'/ 74°44.15'	Early Ordovician (*R. manitouensis* Zone)	Stonehenge Formation	5	(=loc. 63, Karklins and Repetski, 1989).

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(9105-CO)	Chester	Morris	40°46.33'/ 74°38.67'	late Early or early Middle Ordovician (*Oe. evae* to *Ba. navis* Zone)	Jutland klippe sequence	3.5-4	Collected by A.A. Drake, Jr. (= NJ-O-13, Harris and others, 1978, =loc. 52, Karklins and Repetski, 1989 and = CH-1, this report).
sec. 6-1(16-17) (12471-SD)	Culvers Gap	Sussex	41°10.50'/ 74°52.20'	early Early Devonian (early Lochkovian, *I. woschmidti* Zone)	Depue Limestone Member of Coeymans Formation	5	(=sec. 6, Epstein and others, 1967, =NJ-SmD-3, Harris and others, 1978, and loc. CG-2, this report).
sec. 5-3(0-1) (12472-SD)	Culvers Gap	Sussex	41°12.20'/ 74°50.80'	early Early Devonian (early Lochkovian, *I. woschmidti* Zone))	Shawnee Island Member of Coeymans Formation	5	(=sec. 5, Epstein and others, 1967, =NJ-SmD-2, Harris and others, 1978, and loc. CG-1, this report).
sec. 6	Dover	Morris	40°59.45'/ 74°31.56'	late Late Silurian (latest Pridolian)	Berkshire Valley Formation of Cayuga Group.	4.5-5	(=sec. 6, Barnett, 1971, =NJ-SmD-6, Harris and others, 1978 and = DO-1, this report).
East-30 (10999-CO)	Easton	Warren	40°39.60'/ 75°08.27'	Late Cambrian or early Early Ordovician	Stonehenge Formation	5-5.5	Collected by A.A. Drake, Jr. Analyzed by J.E. Repetski .
East-33 (11001-CO)	Easton	Warren	40°39.30'/ 75°08.82'	Early Ordovician (*Co. angulatus* or *R. manitouensis* Zone)	Stonehenge Formation	5-5.5	Collected by A.A. Drake, Jr. Analyzed by J.E. Repetski.
East-32 (11000-CO)	Easton	Warren	40°39.47'/ 75°08.57'	Early Ordovician (*R. manitouensis* Zone)	Stonehenge Formation	5-5.5	Collected by A.A. Drake, Jr. Analyzed by J.E. Repetski.
NJGS Cono-6 (10263-CO)	Easton	Warren	40°42.00'/ 75°11.70'	Early Ordovician (*R. manitouensis* Zone)	upper Stonehenge Formation or lower Rickenbach Dolomite	5	(=loc. 54b, Karklins and Repetski, 1989 and = EA-1, this report).
E-18 (10491-CO)	Easton	Warren	40°38.05'/ 75°11.30'	Early Ordovician (*R. manitouensis* Zone)	Rickenbach Dolomite	5-5.5	(=loc. 55, Karklins and Repetski, 1989).
E-20 (10492-CO)	Easton	Warren	40°38.00'/ 75°11.30'	Early Ordovician (*R. manitouensis* Zone)	Rickenbach Dolomite	5-5.5	(=loc. 56, Karklins and Repetski, 1989).
6-19-90G (10809-CO)	Easton	Warren	40°40.23'/ 75°09.82'	Early Ordovician (*M. dianae* Zone)	Rickenbach Dolomite (upper third)	5	Collected by A.G. Harris. Analyzed by J.E. Repetski.
6-19-90H (10810-CO)	Easton	Warren	40°40.23'/ 75°09.82'	middle Early Ordovician ("Low diversity" or *M. dianae* Zone)	Rickenbach Dolomite (upper third)	5	Collected by A.G. Harris. Analyzed by J.E. Repetski.
PB-RR-2 (9774-CO)	Easton	Warren	40°41.25'/ 75°11.27'	Early Ordovician (*Ac. deltatus-On. costatus* Zone)	Epler Formation	5-5.5	(=loc. 53, Karklins and Repetski, 1989).
PB-RR-1 (9773-CO)	Easton	Warren	40°41.27'/ 75°11.12'	middle to late Early Ordovician	Epler Formation	5	(=loc. 54a, Karklins and Repetski, 1989).
NJGS Cono-9 (10266-CO)	Easton	Warren	40°42.08'/ 75°11.72'	Ordovician	Beekmantown Group	5	(=loc. 54c, Karklins and Repetski, 1989).
FBV-127 (10529-CO)	Flatbrook-ville	Warren	41°00.30'/ 74°56.62'	latest Cambrian to middle Early Ordovician	Stonehenge Formation	5	(=loc. 4, Karklins and Repetski, 1989).

FBV-190 (10531-CO)	Flatbrook-ville	Sussex	41°02.15'/ 74°53.22'	Early Ordovician (*R. manitouensis* Zone)	upper Stonehenge Formation or lower Rickenbach Dolomite	5	(=loc. 6, Karklins and Repetski, 1989).
FBV-75A (10533-CO)	Flatbrook-ville	Sussex	41°02.22'/ 74°53.45'	Early Ordovician (*R. manitouensis* Zone)	upper Stonehenge Formation or lower Rickenbach Dolomite	5	(=loc. 7, Karklins and Repetski, 1989).
FBV-126 (10530-CO)	Flatbrook-ville	Warren	41°00.25'/ 74°56.70'	Early Ordovician (*R. manitouensis* Zone)	upper Stonehenge Formation or lower Rickenbach Dolomite	5	(=loc. 5, Karklins and Repetski, 1989).
FL-245 (11248-CO)	Flatbrook-ville	Warren	41°00.62'/ 74°53.88'	Early Ordovician (*R. manitouensis* Zone)	upper Stonehenge Formation or lower Rickenbach Dolomite	5	Collected by D.H. Monteverde. Analyzed by J.E. Repetski.
FBV-100 (10532-CO)	Flatbrook-ville	Warren	41°00.63'/ 74°56.80'	Early Ordovician ("Low diversity" or *M. dianae* Zone)	Rickenbach Dolomite	5	(=loc. 8, Karklins and Repetski, 1989).
FLT-7 (10812-CO)	Flatbrookv-ille	Warren	41°00.23'/ 74°54.75'	middle Early Ordovician	Rickenbach Dolomite or Epler Formation	5	Collected by A.A. Drake, Jr. Analyzed by J.E. Repetski.
FL-238 (11249-CO)	Flatbrook-ville	Warren	41°00.85'/ 74°53.37'	Early Ordovician	Beekmantown Group	5	Collected by D.H. Monteverde. Analyzed by J.E. Repetski.
FL-38 (11247-CO)	Flatbrook-ville	Warren	41°00.67'/ 74°53.95'	Middle Ordovician (*Pl. tenuis* or *B. confluens* Zone)	base of Jacksonburg Limestone	5	Collected by D.H. Monteverde. Analyzed by J.E. Repetski.
FBV-75B (10534-CO)	Flatbrook-ville	Sussex	41°02.22'/ 74°53.45'	Middle Ordovician (*Pl. tenuis* or *B. confluens* Zone)	Jacksonburg Limestone	5	(=loc. 7, Karklins and Repetski, 1989).
sec. 10-1(1-2) (12473-SD)	Flatbrook-ville	Sussex	41°06.70'/ 74°56.86'	early Early Devonian (early Lochkovian)	Depue Limestone Member of Coeymans Formation	5	(=sec. 10, Epstein and others, 1967, =NJ-SmD-5, Harris and others, 1978), =FL-1, this report).
HACK-28 (10524-CO)	Hacketts-town	Warren	40°51.75'/ 74°49.37'	latest Cambrian or earliest Ordovician	Stonehenge Formation	5-5.5	(=loc. 50, Karklins and Repetski, 1989).
HACK-11 (10525-CO)	Hacketts-town	Morris	40°47.85'/ 74°51.88'	Early Ordovician (*R. manitouensis* Zone)	Stonehenge Formation	5	(=loc. 51, Karklins and Repetski, 1989).
HK-25 (10787-CO)	Hacketts-town	Morris	40°50.70'/ 74°49.40'	Early Ordovician (*R. manitouensis* Zone)	upper Stonehenge Formation or lower Rickenbach Dolomite	5	Collected by D.H. Monteverde. Analyzed by J.E. Repetski.
H-13 (11269-CO)	Hacketts-town	Morris	40°48.00'/ 74°51.88'	Early Ordovician (*R. manitouensis* Zone)	upper Stonehenge Formation or lower Rickenbach Dolomite	5	Collected by P.T. Lyttle. Analyzed by J.E. Repetski. (=NJ-O-16, Harris and others, 1978).
HAM-33 (10493-CO)	Hamburg	Sussex	41°11.73'/ 74°35.42'	Early Ordovician (*R. manitouensis* Zone)	upper Stonehenge Formation or lower Rickenbach Dolomite	5	(=loc. 3a, Karklins and Repetski, 1989).
HAM-43 (10494-CO)	Hamburg	Sussex	41°13.40'/ 74°34.20'	Early Ordovician (*R. manitouensis* Zone)	upper Stonehenge Formation or lower Rickenbach Dolomite	5	(=loc. 3b, Karklins and Repetski, 1989).
HAM-7 (10342-CO)	Hamburg	Sussex	41°08.88'/ 74°36.83'	Early Ordovician (*R. manitouensis* Zone)	upper Stonehenge Formation or lower Rickenbach Dolomite	5	(=loc. 3c, Karklins and Repetski, 1989).
JR6-22-83F (9843-CO)	Hamburg	Sussex	41°10.23'/ 74°36.98'	Early Ordovician (*M. dianae* Zone)	uppermost Rickenbach Dolomite or lower Epler Formation	5	(=loc. 3d, Karklins and Repetski, 1989).

FIELD NO. (USGS NO.)	7.5-MIN. QUAD.	COUNTY	LATITUDE/ LONGITUDE	AGE	FORMATION	CAI	REMARKS
6-18-90I (10806-CO)	Hamburg	Sussex	41°08.87'/ 74°36.58'	early to middle Early Ordovician	Beekmantown Group	5	Collected by A.G. Harris. Analyzed by J. E. Repetski.
6-18-90A (10791-CO)	Hamburg	Sussex	41°14.17'/ 74°33.72'	Middle Ordovician (*Pl. tenuis* Zone)	sequence at Wantage	5	Collected and analyzed by A.G. Harris.
6-18-90B (10792-CO)	Hamburg	Sussex	41°14.17'/ 74°33.72'	late Middle Ordovician	sequence at Wantage	5	Collected and analyzed by A.G. Harris.
6-18-90C (10793-CO)	Hamburg	Sussex	41°14.17'/ 74°33.72'	Middle Ordovician (*Pl. tenuis* Zone)	sequence at Wantage	5	Collected and analyzed by A.G. Harris.
6-18-90G (10796-CO)	Hamburg	Sussex	41°08.87'/ 74°36.58'	late Middle Ordovician	sequence at Wantage	5	Collected and analyzed by A.G. Harris.
6-18-90F2 (10797-CO)	Hamburg	Sussex	41°08.87'/ 74°36.58'	Middle Ordovician (*Pl. tenuis* Zone)	sequence at Wantage	5	Collected and analyzed by A.G. Harris.
6-18-90D (10794-CO)	Hamburg	Sussex	41°14.17'/ 74°33.72'	late Middle Ordovician (*Pl. tenuis* or *B. confluens* Zone)	base of Jacksonburg Limestone	5	Collected and analyzed by A.G. Harris.
6-18-90E (10795-CO)	Hamburg	Sussex	41°14.17'/ 74°33.72'	late Middle Ordovician (*Pl. tenuis* or *B. confluens* Zone)	Jacksonburg Limestone	5	Collected and analyzed by A.G. Harris.
6-18-90F1 (10798-CO)	Hamburg	Sussex	41°08.87'/ 74°36.58'	late Middle Ordovician (*Pl. tenuis* or *B. confluens* Zone)	Jacksonburg Limestone	5	Collected and analyzed by A.G. Harris.
HB-337 (11280-CO)	High Bridge	Hunterdon	40°38.23'/ 74°53.87'	latest Cambrian	Jutland klippe sequence	~4	Collected by D.H. Monteverde. Analyzed by J.E. Repetski (= HB-2, this report).
CL-11 (10682-CO)	High Bridge	Hunterdon	40°38.13'/ 74°54.83'	latest Cambrian or earliest Ordovician	Stonehenge Formation	>4,<5	Collected by D.H. Monteverde. Analyzed by J.E. Repetski (= HB-2, this report).
CL-12 (10683-CO)	High Bridge	Hunterdon	40°38.10'/ 74°54.82'	latest Cambrian or earliest Ordovician	Stonehenge Formation	>4,<5	Collected by D.H. Monteverde. Analyzed by J.E. Repetski (= HB-2, this report).
JE-HB4 (9632-CO)	High Bridge	Hunterdon	40°38.17'/ 74°54.83'	latest Cambrian or earliest Ordovician	Stonehenge Formation	4.5	Collected by J.B. Epstein. Analyzed by J.E. Repetski (= loc. 57, Karklins and Repetski, 1989; =HB-2, this report).
HB-367 (11252-CO)	High Bridge	Hunterdon	40°38.25'/ 74°56.87'	Early Ordovician (*C. angulatus* or *R. manitouensis* Zone)	Jutland klippe sequence	4	Collected by D.H. Monteverde. Analyzed by J.E. Repetski (= HB-4, this report).
HBNJ-1 (10397-CO)	High Bridge	Hunterdon	40°38.50'/ 74°55.50'	Early Ordovician (*R. manitouensis* Zone)	Stonehenge Formation	4-4.5	(=loc. 58, Karklins and Repetski, 1989; =HB-3, this report).
JE-HB7 (9633-CO)	High Bridge	Warren	40°44.57'/ 74°58.15'	Early Ordovician (*R. manitouensis* Zone)	upper Stonehenge Formation or lower Rickenbach Dolomite	5-5.5	(=loc. 59, Karklins and Repetski, 1989; =HB-5, this report).
HBNJ-59 (11281-CO)	High Bridge	Hunterdon	40°39.57'/ 74°55.43'	Early Ordovician (*R. manitouensis* Zone)	upper Stonehenge Formation or lower Rickenbach Dolomite	4.5	Collected by D.H. Monteverde. Analyzed by J.E. Repetski (= HB-3, this report).
JE-HB2 (9630-CO)	High Bridge	Hunterdon	40°38.27'/ 74°52.93'	middle Early Ordovician	Epler Formation	4.5	(=loc. 60, Karklins and Repetski, 1989; =HB-1, this report).
HBNJ-469-2 (11278-CO)	High Bridge	Hunterdon	40°38.01'/ 74°58.24'	earliest Middle Ordovician	Jutland klippe sequence	4	Collected by D.H. Monteverde. Analyzed by J.E. Repetski.
4-23-74A (8675-CO)	High Bridge	Hunterdon	40°38.07'/ 74°57.07'	early Middle Ordovician	Jutland klippe sequence	4?	(=loc. 62 of Karklins and Repetski, 1989).

HB-359 (11235-CO)	High Bridge	Hunterdon	40°38.30'/ 74°57.67'	early Middle Ordovician	Jutland klippe sequence	~4	Collected by D.H. Monteverde. Analyzed by J.E. Repetski.
HBNJ-469-1 (11277-CO)	High Bridge	Hunterdon	40°37.99'/ 74°56.24'	early Middle Ordovician	Jutland klippe sequence	4	Collected by D.H. Monteverde. Analyzed by J.E. Repetski.
HBNJ-468 (11250-CO)	High Bridge	Hunterdon	40°38.03'/ 74°57.92'	early to middle Middle Ordovician (latest Arenigian or Llanvirnian)	Jutland klippe sequence	~4	Collected by D.H. Monteverde. Analyzed by J.E. Repetski (= HB-6, this report).
HBNJ-470 (11253-CO)	High Bridge	Hunterdon	40°38.18'/ 74°57.42'	early to middle Middle Ordovician (latest Arneigian to Llandeilan)	Jutland klippe sequence	~4	Collected by D.H. Monteverde. Analyzed by J.E. Repetski (= HB-6, this report).
(8674-CO)	High Bridge	Hunterdon	40°38.08'/ 74°58.17'	Middle Ordovician	unit B of the Jutland klippe sequence	Indet.	(=loc. 61, Karklins and Repetski, 1989; = HB-6, this report).
sec. 9-4(0-1; 1-2) (12474-SD; 12475-SD)	Lake Maskenozha	Sussex	41°07.70'/ 74°54.86'	early Early Devonian (early Lochkovian, *I. woschmidti* Zone)	Stormville Member of the Coeymans Formation and Kalkberg Fomation	5	(=sec. 9, Epstein and others, 1967, =NJ-SmD-4, Harris and others, 1978, and =LM-1, this report).
sec. 4-4(0-1) (12477-SD)	Milford	Sussex	41°17.66'/ 74°46.68'	early Early Devonian (early Lochkovian, *I. woschmidti* Zone)	Shawnee Island Member of Coeymans Formation	5	(=sec. 3, Epstein and others, 1967, =NJ-SmD-1, Harris and others, 1978, and =MI-1, this report).
sec. 4-1(4-5)	Milford	Sussex	41°17.66'/ 74°46.68'	early Early Devonian (early Lochkovian, *I. woschmidti* Zone)	Thacher Member of Manlius Limestone	5	(=sec. 3, Epstein and others, 1967, =NJ-SmD-1, Harris and others, 1978, and =MI-1, this report).
NE-13B (10527-CO)	Newton East	Sussex	41°02.58'/ 74°44.35'	latest Cambrian or earliest Ordovician)	upper Allentown Dolomite or Stonehenge Formation	5-5.5	(=loc. 15, Karklins and Repetski, 1989).
(9181-CO)	Newton East	Sussex	41°02.13'/ 74°43.48'	latest Cambrian or earliest Ordovician	upper Allentown Dolomite or Stonehenge Formation	5	(=loc. 16, Karklins and Repetski, 1989).
4-25-74A, NE-13A (8676-CO, 10528-CO)	Newton East	Sussex	41°02.58'/ 74°44.35'	Early Ordovician (*R. manitouensis* Zone)	upper Stonehenge Formation or lower Rickenbach Dolomite	5	(=loc. 15, Karklins and Repetski, 1989).
(9183-CO)	Newton East	Sussex	41°02.20'/ 74°43.40'	Early Ordovician (*R. manitouensis* Zone)	upper Stonehenge Formation or lower Rickenbach Dolomite	5	(=loc. 18, Karklins and Repetski, 1989).
(9182-CO)	Newton East	Sussex	41°02.17'/ 74°43.48'	Early Ordovician (*R. manitouensis* Zone)	Rickenbach Dolomite	5	Collected by P.T. Lyttle. (=NJ-O-12, Harris and others, 1978, =loc. 17, Karklins and Repetski, 1989).
(9184-CO)	Newton East	Sussex	41°02.23'/ 74°43.37'	early to middle Early Ordovician (*R. manitouensis* to *M. dianae* Zone)	upper Stonehenge Formation to Epler Formation	5	(=loc. 19, Karklins and Repetski, 1989).
NE-377 (10526- CO)	Newton East	Sussex	41°03.37'/ 74°43.95'	Middle Ordovician (*Pl. tenuis* or *P. confluens* Zone)	Jacksonburg Limestone	5	(=loc. 20, Karklins and Repetski, 1989).
NW-139 (10539-CO)	Newton West	Sussex	41°01.32'/ 74°47.78'	Early Ordovician (*R. manitouensis* Zone)	Stonehenge Formation	5	(=loc. 11, Karklins and Repetski, 1989).
NW-353 (10541-CO)	Newton West	Sussex	41°02.27'/ 74°46.30'	Early Ordovician (*R. manitouensis* Zone)	upper Stonehenge Formation or lower Rickenbach Dolomite	5	(=loc. 10, Karklins and Repetski, 1989).
NW-217 (10542-CO)	Newton West	Sussex	41°05.93'/ 74°47.77'	Early Ordovician) (*R. manitouensis* or "Low diversity" Zone)	upper Stonehenge Formation or Rickenbach Dolomite	5	(=loc. 12, Karklins and Repetski, 1989).

FIELD NO. (USGS NO.)	7.5-MIN. QUAD.	COUNTY	LATITUDE/ LONGITUDE	AGE	FORMATION	CAI	REMARKS
6-18-90K (10799-CO)	Newton West	Sussex	41°02.75'/ 74°51.17'	Early Ordovician (*R. manitouensis* Zone)	Rickenbach Dolomite	5	Collected by A.G. Harris; Analyzed by J.E. Repetski.
6-19-90D (10808-CO)	Newton West	Sussex	41°05.82'/ 74°46.22'	early to middle Early Ordovician	Rickenbach Dolomite(?)	5	Collected by A.G. Harris. Analyzed by J.E. Repetski.
6-19-90C (10807-CO)	Newton West	Sussex	41°05.92'/ 74°46.03'	Early Ordovician (*R. manitouensis* Zone)	cobble of Rickenbach Dolomite lithology In sequence at Wantage	5	Collected by A.G. Harris. Analyzed by J.E. Repetski.
JR6-22-83E 9803-CO)	Newton West	Sussex	41°02.75'/ 74°50.85'	middle to late Early Ordovician	Redeposited upper Beekmantown Group cono-donts in sequence at Wantage	5	(=loc. 13, Karklins and Repetski, 1989).
NW-129	Newton West	Sussex	41°00.37'/ 74°46.73'	Early Ordovician	probably Beekmantown Group	5	(=loc. 9, Karklins and Repetski, 1989).
6-18-90O (10800-CO)	Newton West	Sussex	41°02.75'/ 74°51.17'	Middle Ordovician	sequence at Wantage	5	Collected and analyzed by A.G. Harris.
6-19-90A (10801-CO)	Newton West	Sussex	41°05.97'/ 74°46.00'	Middle Ordovician (*Pl. tenuis* or *B. confluens* Zone)	base of Jacksonburg Limestone	5	Collected and analyzed by A.G. Harris.
NW-88 (10540- CO)	Newton West	Sussex	41°03.87'/ 74°51.20'	Middle Ordovician (*Pl. tenuis* or *B. confluens* Zone)	Jacksonburg Limestone	5	(=loc. 14, Karklins and Repetski, 1989).
PT-18 (11243-CO)	Pittstown	Hunterdon	40°37.35'/ 74°56.33'	latest Cambrian or earliest Ordovician	Jutland klippe sequence	~4-4.5	Collected by D.H. Monteverde. Analyzed by J.E. Repetski.
PT-NJ-98 (11246-CO)	Pittstown	Hunterdon	40°37.25'/ 74°56.63'	Late Cambrian or earliest Ordovician	Jutland klippe sequence	>4,<5	Collected by D.H. Monteverde. Analyzed by J.E. Repetski.
PT-NJ-35 (11244-CO)	Pittstown	Hunterdon	40°37.02'/ 74°56.22'	Cambrian or earliest Ordovician	Jutland klippe sequence	>4,<5	Collected by D.H. Monteverde. Analyzed by J.E. Repetski.
PT-NJ-44 (11245-CO)	Pittstown	Hunterdon	40°36.72'/ 74°56.58'	Cambrian or earliest Ordovician	Jutland klippe sequence	>4,<5	Collected by D.H. Monteverde. Analyzed by J.E. Repetski.
4-23-74B (11251-CO)	Pittstown	Hunterdon	40°37.33'/ 74°53.00'	latest Middle Ordovician (*Am. superbus* Zone)	Jacksonburg Limestone	~4	(=loc. 6 of Barnett, 1965; = PI-1, fig. 1, this report).
sec. 3-1(0-1) (12476-SD)	Port Jervis South	Sussex	41°20.10'/ 74°42.30'	early Early Devonian (early Lochkovian, *I. woschmidti* Zone)	Thacher Member of Manlius Limestone	5	(=sec. 3, Epstein and others, 1967, and =loc. PJS-1, this report).
sec. 3-2(2-2'4")	Port Jervis South	Sussex	41°20.10'/ 74°42.30'	early Early Devonian (early Lochkovian, *I. woschmidti* Zone)	Ravena Member of Coeymans Formation	5	(=sec. 3, Epstein and others, 1967, and =loc. PJS-1, this report).
NJGS Cono-7 (10264-CO)	Portland	Warren	40°58.37'/ 75°01.88'	latest Cambrian (*C. proavus* or *C. Intermedius* Zone)	Allentown Dolomite or Stonehenge Formation	5	(=loc. 21b, Karklins and Repetski, 1989).
NJGS Cono-8 (10265-CO)	Portland	Warren	40°58.38'/ 75°01.90'	latest Cambrian (upper *C. proavus* Zone)	Stonehenge Formation	5	(=loc. 21c, Karklins and Repetski, 1989).
PORT-46 (10823-CO)	Portland	Warren	40°57.42'/ 75°03.90'	latest Cambrian (*C. Intermedius* Zone)	Stonehenge Formation	5-	Collected by A.A. Drake, Jr. Analyzed by J.E. Repetski.

PORT-73 (10824-CO)	Portland	Warren	40°57.92'/ 75°01.58'	latest Cambrian (*C. intermedius* Zone)	Stonehenge Formation	5	Collected by A.A. Drake, Jr. Analyzed by J.E. Repetski (= PO-2, this report).
JR6-22-83C (9802-CO)	Portland	Warren	40°58.43'/ 75°01.95'	latest Cambrian (*C. intermedius* Zone)	Stonehenge Formation	5	(=loc. 21a, Karklins and Repetski, 1989).
4-25-74B (11274-CO)	Portland	Warren	40°57.00'/ 75°03.70'	Early Ordovician (*R. manitouensis* Zone)	Stonehenge Formation	5	Collected and analyzed by A.G. Harris (=PO-4, this report).
PORT-12 (10821-CO)	Portland	Warren	40°55.55'/ 75°05.17'	Early Ordovician (*R. manitouensis* Zone)	Stonehenge Formation	5	Collected by A.A. Drake, Jr. Analyzed by J.E. Repetski.
PORT-28 (10822-CO)	Portland	Warren	40°57.28'/ 75°05.38'	Early Ordovician (*R. manitouensis* Zone)	Stonehenge Formation	5	Collected by A.A. Drake, Jr. Analyzed by J.E. Repetski.
4-25-74C (11273-CO)	Portland	Warren	40°56.88'/ 75°03.67'	Middle Ordovician (*Pl. tenuis* to *B. confluens* Zone)	Jacksonburg Limestone	5	Collected and analyzed by A.G. Harris (=PO-4, this report).
NJGS Cono-11 (10267-CO)	Stanhope	Sussex	40°59.97'/ 74°44.87'	latest Cambrian or early Early Ordovician	upper Allentown Dolomite or lower Stonehenge Formation	5	(=loc. 64, Karklins and Repetski, 1989).
TR-382 (11242-CO)	Tranquility	Sussex	40°58.23'/ 74°47.00'	Late Cambrian	Allentown Dolomite	5	Collected by D.H. Monteverde. Analyzed by J.E. Repetski (= TR-2, this report).
TR-331A (11241-CO)	Tranquility	Sussex	40°58.92'/ 74°46.87'	latest Cambrian or earliest Ordovician	Allentown Dolomite	5	Collected by D.H. Monteverde. Analyzed by J.E. Repetski.
T-1049 (9565-CO)	Tranquility	Sussex	40°59.63'/ 74°46.77'	Early Ordovician (*R. manitouensis* Zone)	Stonehenge Formation	5	Collected by P.T. Lyttle. (=loc. 38, Karklins and Repetski, 1989; = TR-1, this report).
T-1109 (9566-CO)	Tranquility	Sussex	40°59.60'/ 74°47.72'	Early Ordovician (*R. manitouensis* Zone)	Stonehenge Formation	5	Collected by P.T. Lyttle. (=loc. 39, Karklins and Repetski, 1989).
T-1186 (9269-CO)	Tranquility	Sussex	40°59.20'/ 74°47.78'	Early Ordovician (*R. manitouensis* Zone)	Stonehenge Formation	5	Collected by P.T. Lyttle. (=loc. 36, Karklins and Repetski, 1989; = TR-1, this report).
T-1047 (9564-CO)	Tranquility	Sussex	40°58.97'/ 74°47.62'	Early Ordovician (*R. manitouensis* or "Low diversity" Zone)	Stonehenge Formation	5	Collected by P.T. Lyttle. (=loc. 37, Karklins and Repetski, 1989).
T-1153 (9266-CO)	Tranquility	Sussex	40°58.23'/ 74°45.53'	Early Ordovician (*R. manitouensis* Zone)	uppermost Stonehenge Formation or lower Rickenbach Dolomite	5	Collected by P.T. Lyttle. (=loc. 35, Karklins and Repetski, 1989).
8-5-80J (9380-CO)	Tranquility	Sussex	40°59.20'/ 74°47.80'	Early Ordovician (*R. manitouensis* Zone)	uppermost Stonehenge Formation or lower Rickenbach Dolomite	5	(=NJ-O-8, Harris and others, 1978; =loc. 4b, Savoy, 1981; = TR-1, this report).
T-1158 (9267-CO)	Tranquility	Sussex	40°59.98'/ 74°46.58'	Middle Ordovician (*Pl. tenuis* to *B. confluens* Zone)	Jacksonburg Limestone	5	(=loc. 41, Karklins and Repetski, 1989).

FIELD NO. (USGS NO.)	7.5-MIN. QUAD.	COUNTY	LATITUDE/ LONGITUDE	AGE	FORMATION	CAI	REMARKS
T-1182 (9268-CO)	Tranquility	Sussex	40°59.32'/ 74°47.97'	Middle Ordovician (*Pl. tenuis* to *B. confluens* Zone)	Jacksonburg Limestone	5	(=loc. 42, Karklins and Repetski, 1989).
T-1187 (9270-CO)	Tranquility	Sussex	40°59.77'/ 74°50.15'	Middle Ordovician (*Pl. tenuis* to *B. confluens* Zone)	Jacksonburg Limestone	5	Collected by P.T. Lyttle. (=NJ-O-7, Harris and others, 1978 and =loc. 43, Karklins and Repetski, 1989).
T-1193 (9271-CO)	Tranquility	Sussex	40°59.83'/ 74°50.15'	Middle Ordovician (*Pl. tenuis* to *B. confluens* Zone)	Jacksonburg Limestone	5	(=loc. 44, Karklins and Repetski, 1989).
T-1143 (9265-CO)	Tranquility	Sussex	40°59.73'/ 74°46.78'	Ordovician	stratigraphic unit not identified	4.5-5	(=loc. 40, Karklins and Repetski, 1989).
UN-19 (10522-CO)	Unionville	Sussex	41°15.75'/ 74°32.90'	Early Ordovician (*C. angulatus* or *R. manitouensis* Zone)	Stonehenge Formation	5	(=loc. 1, Karklins and Repetski, 1989).
UN-5 (10521-CO)	Unionville	Sussex	41°15.23'/ 74°34.57'	Early Ordovician (*R. manitouensis* Zone)	uppermost Stonehenge Formation or lower Rickenbach Dolomite	5	(=loc. 2a, Karklins and Repetski, 1989; = UN-1 this report).
UN-53 (10396-CO)	Unionville	Sussex	41°16.10'/ 74°33.50'	Middle Ordovician (*Pl. tenuis* to *B. confluens* Zone) containing redeposited *R. manitouensis* Zone conodonts	Jacksonburg Limestone containing minor redeposited Beekmantown Group conodonts	5-5.5	(=loc. 2b, Karklins and Repetski, 1989).
WASH-8 (10538-CO)	Washington	Warren	40°46.15'/ 74°55.48'	Early Ordovician (*R. manitouensis* or "Low diversity" Zone)	upper part of Stonehenge Formation or lower Rickenbach Dolomite	5	(=loc. 48, Karklins and Repetski, 1989).
WASH-6 (11275-CO)	Washington	Warren	40°46.15'/ 74°55.47'	Early Ordovician (*R. manitouensis* or "Low diversity"Zone)	upper part of Stonehenge Formation or lower Rickenbach Dolomite	5	Collected by P.T. Lyttle. (=NJ-O-11, Harris and others, 1978).
WASH-7 (11276-CO)	Washington	Warren	40°46.80/ 74°54.32'	Early Ordovician (*R. manitouensis* Zone)	lower Rickenbach Dolomite	5	(=loc. 49, Karklins and Repetski, 1989).
WASH-10 (10537-CO)	Washington	Warren	40°46.80'/ 74°54.33'	Early Ordovician (*R. manitouensis* Zone)	lower Rickenbach Dolomite	5	(=loc. 49, Karklins and Repetski, 1989).
WASH-14 (11268-CO)	Washington	Warren	40°46.85'/ 74°54.33'	Early Ordovician (*R. manitouensis* Zone)	lower Rickenbach Dolomite	5	Collected by A.A. Drake, Jr. Analyzed by J.E. Repetski.
WASH-13 (11267-CO)	Washington	Warren	40°46.85'/ 74°54.33'	Middle Ordovician (*Pl. tenuis* or *B. confluens*)	Jacksonburg Limestone	5	Collected by A.A. Drake, Jr. Analyzed by J.E. Repetski.

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PLATES 1-4

[Specimens on all plates are scanning electron photomicrographs. Specimens are reposited in the U.S. National Museum of Natural History (USNM), Washington, D.C. All figures X 80, unless specified otherwise; all specimens are shown in lateral view unless noted otherwise; localities shown on figure 1]

PLATE I

Late Cambrian and Early Ordovician conodonts from northwestern New Jersey

A-D. *Variabiloconus bassleri* (Furnish). A-C: tectonically deformed elements; from Stonehenge Fm. at loc. TR-1, USGS colln. 9269-CO, USNM 486915-17. D: non-deformed element from dolostone cobble in Jacksonburg Ls. (see text) at loc. BLR-1, USGS 9343-CO, X120, USNM 486918.

E. *Acanthodus uncinatus* Furnish. Stonehenge Fm. near loc. PO-1, USGS 10825-CO, USNM 486919.

F, N. "*Acanthodus*" *lineatus* (Furnish). Tall-based element (F), from uppermost Stonehenge Formation or lower part of the Rickenbach Dolomite, loc. TR-1, USGS 9380-CO, and short-based element (N), from Stonehenge Formation, loc. PO-1, USGS 10825-CO, USNM 486920, 21.

G. *Rossodus*? n. sp. Posterolateral view of coniform element; Stonehenge Formation same loc. as fig. N, USNM 486922.

H, I. *Scolopodus sulcatus* Furnish. H: deformed element from Stonehenge Fm., same loc. as figs. A-C. I: non-deformed element from cobble in base of Jacksonburg Ls., loc. BLR-2, USGS 9350-CO, USNM 486923, 24.

J-L. *Rossodus manitouensis* Repetski & Ethington. J: posterolateral view of deformed coniform element from loc. TR-1; K, L: posterolateral and inner lateral views of non-deformed coniform and oistodontiform elements from loc. PO-1. All from Stonehenge Fm., USNM 486925-27.

M. "*Oistodus*" *triangularis* Furnish. From cobble in base of Jacksonburg Limestone at loc. BLR-2, USGS 9351-CO, USNM 486928.

O. "*Drepanodus*" *pseudoconcavus* Repetski. From Stonehenge Fm. at loc. PO-1, USNM 486929.

P. *Chosonodina herfurthi* Müller. Posterior view; Stonehenge Formation or Rickenbach Dolomite at loc. UN-1, USGS 10521-CO, USNM 486930.

Q. *Clavohamulus*? n. sp. A. Postero-basal view; from Stonehenge Formation or Rickenbach Dolomite at loc. EA-1, USGS 10263-CO, USNM 486931.

R. *Clavohamulus densus* Furnish. Posterior view; Stonehenge Formation at loc. TR-1, USNM 486932.

S. *Loxodus bransoni* Furnish. From Stonehenge Fm. at loc. HB-3, USGS 10397-CO, USNM 486933.

T. "*Paltodus*" *spurius* Ethington & Clark. From Stonehenge Formation at loc. TR-1, USGS 9565-CO, USNM 486934.

U. *Aloxoconus iowensis* (Furnish). From cobble in base of Jacksonburg Limestone at loc. BLR-2, USGS 9351-CO, USNM 486935.

V. *Phakelodus* cf. *P. elongatus* An. Nearly complete fused cluster of grasping apparatus of protoconodont; from limestone bed in Jutland klippe sequence at loc. PI-2, USGS 11244-CO, X160, USNM 486936.

W. *Teridontus nakamurai* (Nogami). From cobble in base of Jacksonburg Limestone at loc. BLR-1, USGS 9333-CO, X160, USNM 486937.

X, Y. *Eoconodontus notchpeakensis* (Miller). X: rounded element from limestone bed in Jutland klippe sequence at loc. PI-2, USGS 11243-CO, Y: compressed element, from cobble in base of Jacksonburg Limestone at loc. BLR-2, USGS 9359-CO; both X120, USNM 486938, 39.

Z. *Proconodontus muelleri* Miller. From limestone within Allentown Dolomite at loc. TR-2, USGS 11242-CO, X125, USNM 486940.

AA. *Hirsutodontus hirsutus* Miller. Limestone in lower part of Stonehenge Formation at loc. PO-2, USGS 10824-CO, X125, USNM 486941.

AB. *Cordylodus angulatus* Pander. Stonehenge Fm. at loc. HB-3, USGS 10397-CO, USNM 486942.

AC. *Hirsutodontus simplex* Miller. Same loc. as fig. AA, X125, USNM 486943.

AD. *Hirsutodontus rarus* Miller. Basal margin of element slightly stretched tectonically. Same loc. as fig. AA, X120, USNM 486944.

AE. *Cordylodus proavus* Müller. Cusp of element broken, displaced posteriorly, and annealed during deformation and diagenesis. From cobble in base of Jacksonburg Limestone at loc. BLR-1, USGS 9333-CO, X160, USNM 486945.

AF. *Clavohamulus elongatus* Miller. Posterolateral view of advanced morphotype. Same loc. as fig. AA, X120, USNM 486946.

AG. *Clavohamulus hintzei* Miller. Posterior view of very slightly deformed element. Same loc. as fig. AA, X120, USNM 486947.

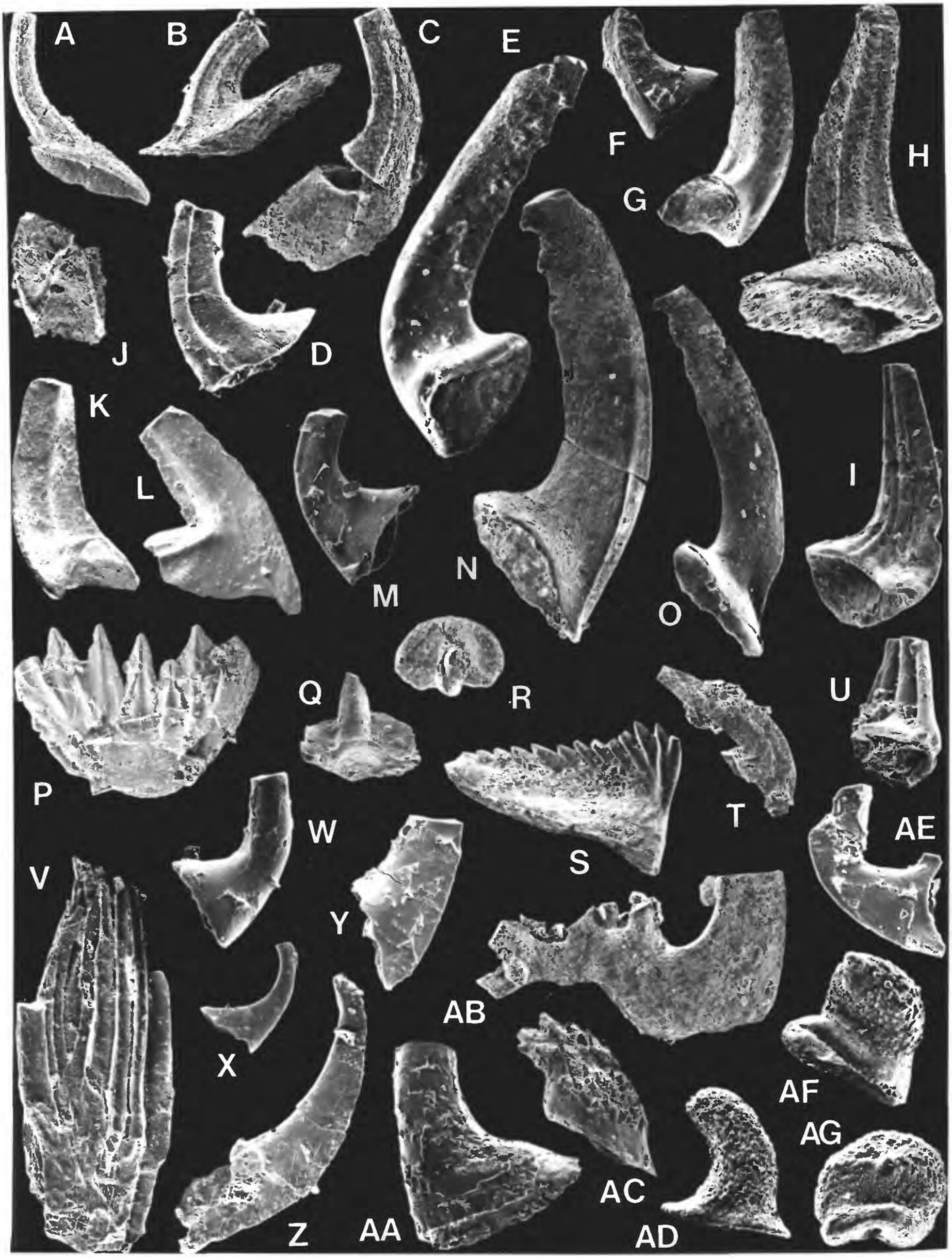
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PLATE II

Early and Middle Ordovician conodonts from northwestern New Jersey

A-E. *Periodon flabellum* (Lindström). Pa, Sb, Pb, Sc, and M elements; from a limestone in the Jutland klippe sequence at loc. CH-1, USGS 9105-CO, USNM 486948-52.

F. *Periodon aculeatus* Hadding (right) and two other ramiform conodont elements on bedding surface of siltstone from Jutland klippe, loc. HB-6, USGS 11250-CO, X50, USNM 486953.

G. *Cordylodus intermedius* Furnish. This species is an index for the lower Ibexian. From a limestone in the Jutland klippe sequence at loc. HB-4, USGS 11252-CO, USNM 486954.

H. *Cordylodus lindstromi* Druce & Jones. This is a key index species in the lower Ibexian. Same loc. as fig. G, USNM 486955.

I,J. *Protoprioniodus* sp. Oistodontiform (M) and "elongatiform" elements. Same loc. as figs. A-E, USNM 486956, 57.

K,L. *Paroistodus parallelus* (Pander). Oistodontiform and drepanodontiform elements. Same loc. as figs. A-E, USNM 486958, 59.

M. *Protopanderodus* cf. *P. rectus* (Lindström). Same loc. as figs. A-E, USNM 486960.

N. *Oneotodus costatus* Ethington & Brand. Posterolateral view of poorly preserved element. From Epler Formation at loc. BLR-3, USGS 9442-CO, USNM 486961.

O. *Diaphorodus delicatus* (Branson & Mehl). Sc element. Species is an auxiliary guide for the *Oepikodus communis* Zone in warm, restricted, shallow-water facies. Epler Formation, same loc. as fig. N, USNM 486962.

P. *Tropodus comptus* (Branson & Mehl). Specimen shows traces of annealed dolomite rhombs. Epler Formation, same loc. as fig. N, USNM 486963.

Q. *Oepikodus communis* (Ethington & Clark). Ramiform (S) element. From cobble in base of Jacksonburg Limestone at loc. BLR-1, X160, USNM 486964.

R. *Protoprioniodus aranda* Cooper. Anterolateral view. Epler Formation, same loc. as fig. N, USNM 486965.

S. *"Scolopodus" emarginatus* Barnes & Tuke. Posterolateral view. Epler Formation, same loc. as fig. N, USNM 486966.

T. *Chionoconus avangna* Smith. Epler Formation, same loc. as fig. N, USNM 486967.

U-W. *Scolopodus floweri* Repetski. Scandodontiform (V) and two multicostate elements. Species is an index in the middle Ibexian. Limestone in the Epler Formation, loc. BE-1, USGS 9637-CO, USNM 486968-70.

X,Y. *Macerodus dianae* Fåhraeus & Nowlan. A key species in the middle Ibexian. Element Y stretched and broken. Epler Formation, same loc. as figs. U-W, X120, USNM 486971,72.

Z,AA. *Clavohamulus*? new species B. Anterior and posterior views. Epler Formation, same loc. as figs. U-W, X160, USNM 486973,74.

AB,AC. *Protopanderodus leei* Repetski. Posterolateral views of symmetrical (AB) and asymmetrical (AC) elements. Fig. AB from Epler Formation at loc. BE-1, USGS 9637-CO; fig. AC from loc. BA-1, Epler Formation on Pennsylvania side of Delaware River; both X120, USNM 486975, 76.

AD,AE. *Striatodontus*? *prolificus* Ji & Barnes. Posterolateral (AD) and posterior (AE) views. Epler Formation, same loc. as figs. U-W, USNM 486977, 78.

AF. *Parapanderodus striatus* (Graves & Ellison). Upper view, showing cross-section of cusp. Epler Formation, same loc. as fig. AC, X240, USNM 486979.

AG. *Colaptoconus quadraplicatus* (Branson & Mehl). This is one of the most common species in the upper Ibexian rocks of the North American Midcontinent Faunal Realm. Epler Formation, same loc. as fig. N, USNM 486980.

AH. *Rossodus*? n. sp. Posterior view of coniform element. From redeposited cobble of Epler Formation or Rickenbach Dolomite lithology, in Jacksonburg Limestone at loc. BLP-1, USGS 9340-CO, X160, USNM 486981.

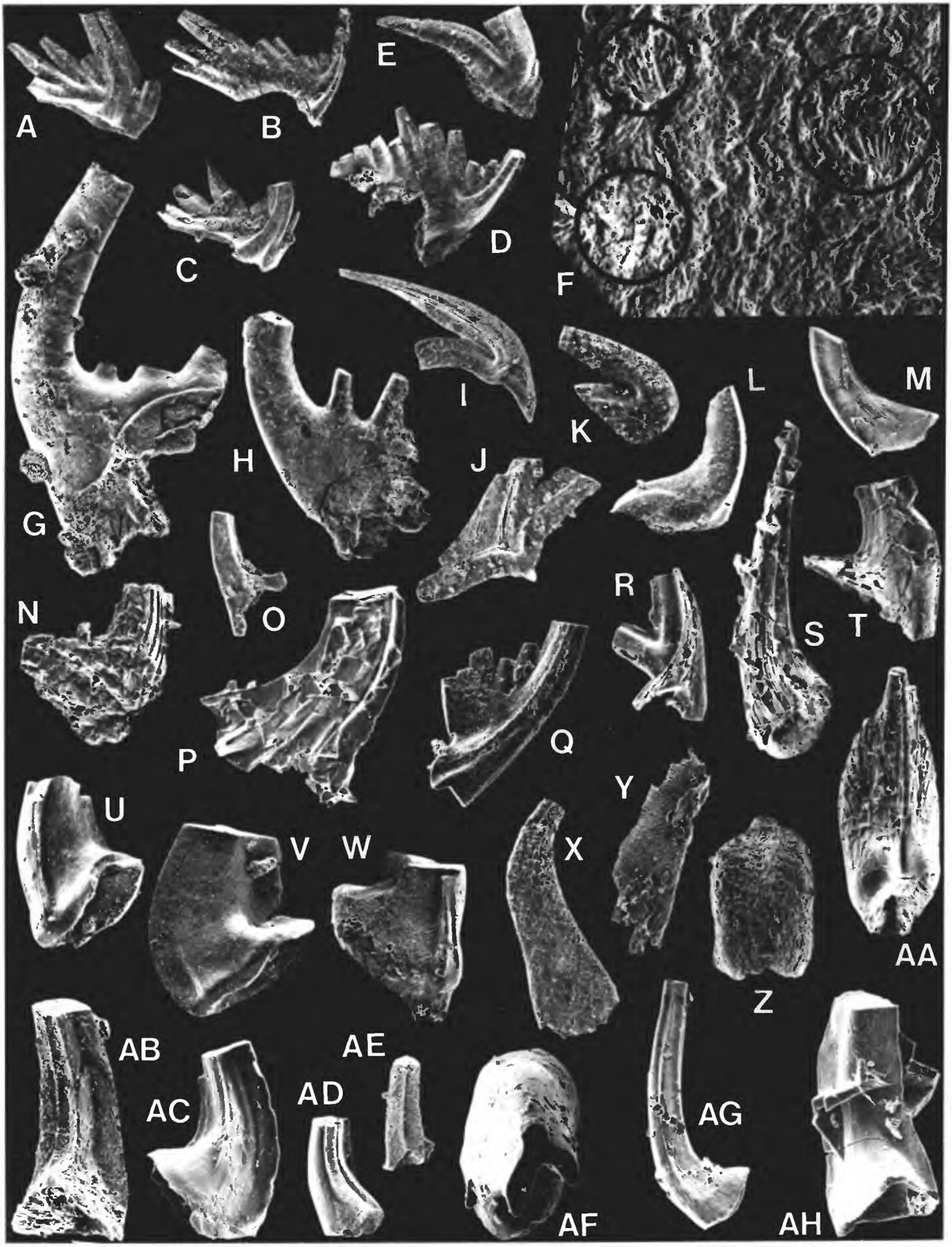
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PLATE III

Middle Ordovician conodonts from northwestern New Jersey and immediately adjacent New York [All specimens from Jacksonburg Limestone or correlative Balmville Limestone (nearby in New York), except figs. H, AA, and AB.]

A-D. *Icriodella superba* Rhodes. Pa (lateral and upper views), Sa (posterolateral view), and Pb elements, respectively. Loc. PI-1, USGS 11251-CO, USNM 486982-85.

E. *Polyplacognathus ramosus* Stauffer. Upper view of Pa element. Lower part of Balmville Limestone, at loc. 3B of Savoy, (1981), at approx. 4 mi. E of SE corner of Unionville quadrangle, in adjacent New York, USGS 9386-CO, USNM 486986.

F-H. *Amorphognathus superbus* (Rhodes). Pb (holodontiform) elements. F and G from Jacksonburg Limestone at same loc. as figs. A-D (= loc. 6 of Barnett, 1965); H, for comparison, from Upper Ordovician Kope Formation, northern Kentucky, USGS 8538-CO, USNM 486987-89.

I. *Paroistodus? venustus* (Stauffer). Oistodontiform element, from basal meter of Balmville Limestone at loc. 2 of Savoy (1981), Goshen quadrangle, NY, USGS 9390-CO, X120, USNM 486990.

J, K. Ramiform elements (Sd and Sa) of either *Amorphognathus superbus* or *Rhodesognathus elegans*. Jacksonburg Limestone, same loc. as figs. A-D, USNM 486991, 92.

L. *Rhodesognathus elegans* (Rhodes). P element. Same loc. as figs. A-D, USNM 486993.

M-Q. *Aphelognathus politus* (Hinde). Pa, and posterolateral views of Sb, Pb, M, and Sa elements, respectively; figs. M, P, Q from Jacksonburg Limestone above basal cobble-bearing beds at loc. BLR-1; figs. N and O from lower part of Balmville Limestone at same loc. as fig. E (loc. 3B of Savoy, 1981), USGS 9384-CO and 9385-CO, USNM 486994, 98.

R, S. *Plectodina tenuis* (Branson & Mehl). Pa and posterolateral view of Sb element. Same loc. as figs. A-D, USNM 486999, 487000.

T, U. *Plectodina?* sp. Pb (X120) and Pa elements; lower part of Balmville Limestone, same loc. as fig. E, USNM 487001, 02.

V-Z. *Phragmodus undatus* Branson & Mehl. P (figs. V-X) and S (figs. Y, Z) elements from deformed (V, X, Z) and non-deformed (W, Y) strata. Elements V, X, Z from loc. BL-1, USGS 9382-CO; W and Y from loc. BLR-1; USNM 487003-07.

AA. *Pygodus* sp. Stereo-pair showing broken Pa element, partially exposed on bedding surface of fine-grained sandstone from Jutland klippe sequence, loc. HB-6, USGS 11253-CO, USNM 487008.

AB. *Periodon aculeatus* Hadding. Two ramiform (S) elements on bedding surface of siltstone from Jutland klippe, loc. HB-6, USGS 11250-CO, X60, USNM 487009.

AC. *Drepanoistodus suberectus* (Branson & Mehl). Drepanodontiform element; same loc. as fig. E, X120, USNM 487010.

AD. *Pseudooneotodus mitratus* (Moskalenko). Upper view of this cap-shaped element. Same loc. as figs. A-D, USNM 487011.

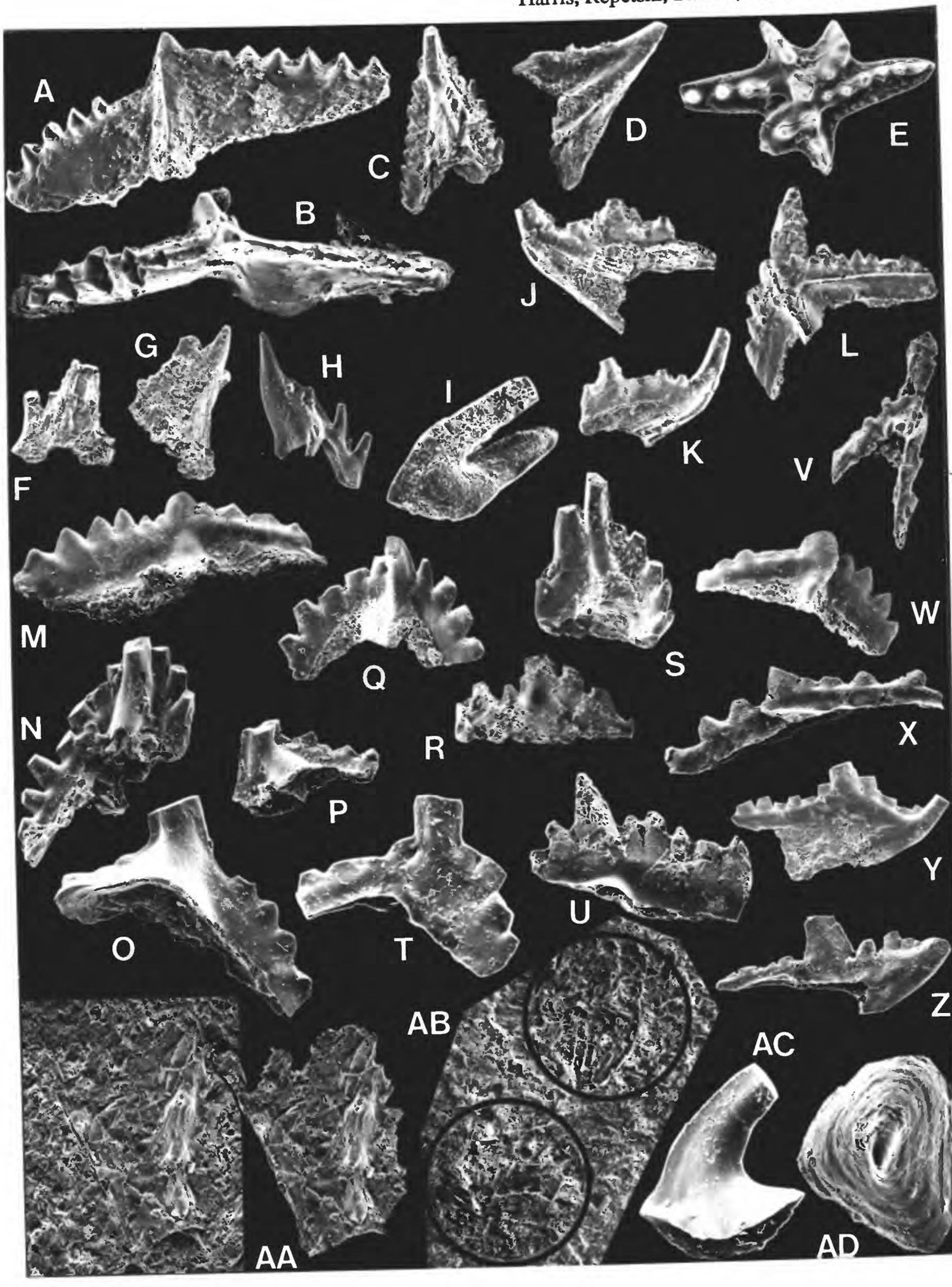
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PLATE IV

Early Devonian conodonts from northwesternmost New Jersey

A-I. *Ozarkodina remscheidensis* (Ziegler), the most abundant species in collections from Upper Silurian rocks and in most collections from lowermost Devonian rocks in New Jersey.

A, C, D. From 1 m below top of Depue Limestone Member of the Coeymans Formation, loc. CG-2, USGS colln. 12471-SD. A, C, Pa elements, inner lateral and upper views, USNM 486876, 78. D, Pb element, outer lateral view, USNM 486879.

B. Pa element, inner lateral view, 2 m below top of Depue Limestone Member of the Coeymans Formation, loc. FL-1, USGS colln. 12473-SD, USNM 486877.

E, H. M and Sb_2 elements, inner lateral views, 4 m below top of Thacher Member of the Manlius Limestone, loc. PJS-1, USGS colln. 12476-SD, USNM 486880, 83.

F. Sa element, posterior view, 0.3 m above base of Shawnee Island Member of the Coeymans Formation, loc. CG-1, USGS colln. 12472-SD, USNM 486881.

G, I. Sb_1 and Sc elements, inner lateral views, 3 m below top of Thacher Member of Manlius Limestone, loc. MI-1, USNM 486882, 84.

J, P. From Stormville Member of the Coeymans Formation, loc. LM-1.

J, *Pseudooneotodus beckmanni* (Bischoff & Sannemann), upper view, 0.3 m above base of member, USGS colln. 12474-SD, USNM 486885. P, *Belodella devonica* (Stauffer), S element, outer lateral view, 0.6 m above base of member, USGS colln. 12475-SD, USNM 486886.

K-O. *Oulodus cristagalli* (Ziegler) from the Coeymans Formation. This species first appears in the very latest Pridolian and is an auxiliary guide to the base of the Devonian.

K, M-O. Pb_1 (lateral view), Sa (posterior view), Sb, and Sc (lateral views) elements, 0.6 m above base of Ravena Member, loc. PJS-1, USNM 486887-90.

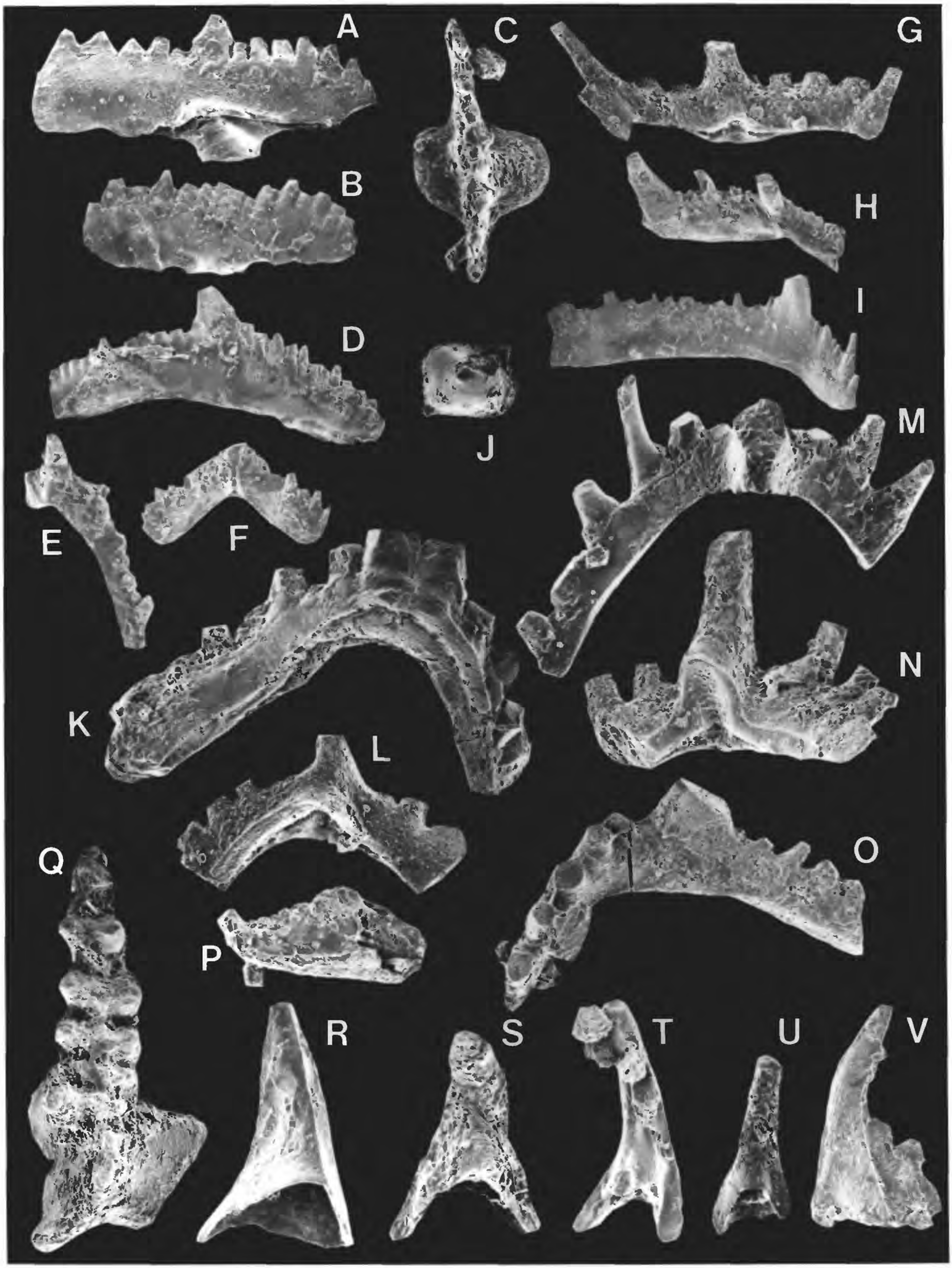
L, Pb_2, lateral view, 8 m above base of Shawnee Island Member, loc. MI-1, USNM 486891.

Q-V. *Icriodus woschmidti* Ziegler from the Coeymans Formation. This species is a guide to the base of the Devonian.

Q, R, U. Pa (upper view), Pb (postero-lateral view), and an adenticulate Sc element (inner lateral view), Shawnee Island Member (Q and U, 1 m above base, USGS colln. 12477-SD; R, 0.6 m above base), loc. MI-1, USNM 486892-94.

S. M element, inner lateral view, same collection as P, USNM 486895.

T, V. Adenticulate and denticulate Sb elements, inner and outer lateral views, same collection as F, USNM 486896, 97.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