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OSTRACODES OF THE HENRYHOUSE FORMATION (SILURIAN) IN OKLAHOMA

by

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OSTRACODES OF THE HENRYHOUSE FORMATION (SILURIAN) IN OKLAHOMA

ROBERT F. LUNDIN*

ABSTRACT

Thousands of specimens of ostracodes from the Henryhouse Formation which crops out in the Arbuckle Mountains region of south-central Oklahoma have been studied. Detailed studies of ontogeny and variation show that the fauna is distinctive and will serve to delimit this stratigraphic unit at the surface and in the subsurface. The late Middle or early Late Silurian age of the Henryhouse indicated by the presence of graptolites and brachiopods is supported by that of the ostracodes.

The stratigraphic and geographic distribution of ostracodes in the Henryhouse is constant throughout the outcrop area. No definite stratigraphic zonation of ostracodes exists. All species which are significantly abundant range throughout or almost throughout the Henryhouse Formation.

The fauna is large and diversified. Forty-six species (twenty-two new) represent twenty-eight genera (one new) and seventeen families. The Metacopina dominate in numbers of individuals, the Healdiidae, Bairdiocyprididae, Pachydomellidae, and Thlipsuridae being especially important. The Beyrichicopina dominate in number of taxa, the Aechminidae and Hollinidae being most numerous. In all, one leperditicopid, nine beyrichicopine, two kloedenellocopine, one podocopine, and four metacopine families are represented.

The occurrence of several genera in the Henryhouse is of special interest. A species of *Rakverella*? represents the first report of the Piretellidae in rocks younger than Ordovician. *Grammalomatella graffhami*, new species, is the first known occurrence of that genus in North America. *Eurychilina*, another typical Ordovician and Early Silurian genus, also occurs in the Henryhouse. *Hollinella*, *Healdia*, and *Amphissella*, previously known only from Devonian and younger rocks, are present.

The first report of dimorphism in the Thlipsuridae is presented. The possible significance of dimorphism as an aid in the classification of the Thlipsuridae is considered.

Detailed sampling has been carried out in all outcrop areas of the Henryhouse Formation. The ostracode fauna thereby obtained is readily identifiable and distinctive. Eleven ostracode species previously described as Haragan species are now known to have come from and to be restricted to the Henryhouse. All present evidence indicates that the Henryhouse ostracode fauna is distinctly different from that of the overlying Haragan Formation (Lower Devonian).

INTRODUCTION

General locality. — The Henryhouse Formation crops out in three areas of south-central Oklahoma (Amsden, 1960, fig. 27). The eastern belt extends southeastward from the Lawrence uplift, where the formation is well developed, to the Clarita, Oklahoma, area, where it is thin or absent. The western outcrop belt, in the Arbuckle Mountains, extends westward from Johnston County, where the Henryhouse is thin, through Murray County and into Carter County, where the formation is especially well developed in the westernmost exposures (245 feet thick; Amsden, 1960, p. 81). The third outcrop area is in the Criner Hills in the southern part of Carter County. Text-figure 1 shows the general outcrop areas of the Hunton Group, of which the Henryhouse Formation is a part.

Henryhouse Formation. — The Henryhouse Formation is the youngest Silurian unit in the Arbuckle Mountains (text-fig. 2). It is generally underlain by the Clarita Member (Niagaran) of the Chimneyhill Formation, from which it can easily be distinguished by its different lithology. The Chimneyhill-Henryhouse contact is unconformable (Amsden, 1960, p. 61).

The lithologic similarity of the Henryhouse and superjacent Haragan (Helderbergian) Formations has been recognized for some time. Reeds

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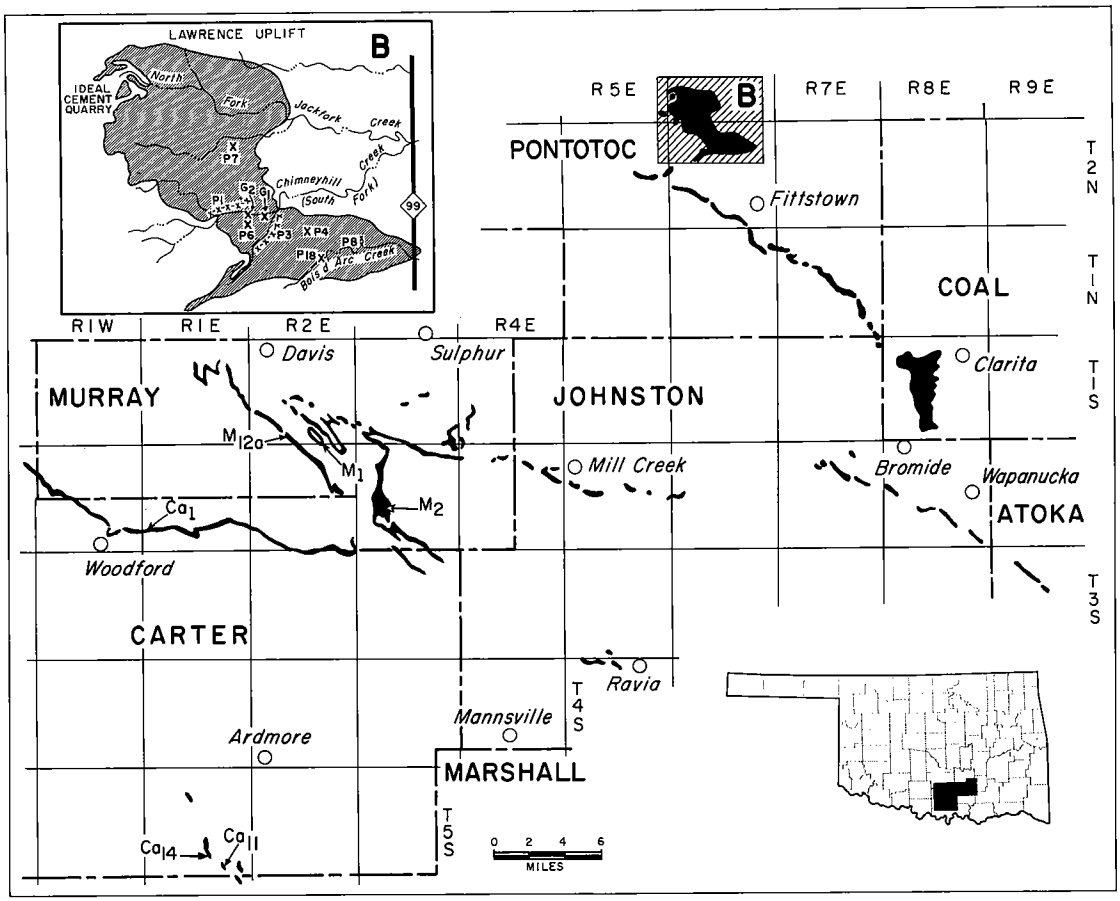


Text-figure 1. Generalized outcrop map of the Hunton Group showing location of sections (for example, M_2, P_3) referred to in text (modified from maps by Amsden, 1960).

(1911) proposed a fourfold subdivision of the Hunton Group, indicating a Silurian age for the Henryhouse and a Devonian age for the Haragan. He was the first to recognize the faunal difference between the Henryhouse and the Haragan and stated that where the two are found in contact "it will be difficult, without knowledge of the fossils, to separate one formation from the other." Subsequent work by Maxwell (1936) and Amsden (1951, 1957, 1958, 1960) substantiated the general interpretations given by Reeds, although minor modifications have been made. Amsden (1960, p. 74) indicated an unconformable Henryhouse-Haragan contact. A fundamental problem in understanding Hunton stratigraphy is the distinction between the Henryhouse and Haragan Formations.

Previous investigations. — No ostracodes have been described from the Henryhouse Formation as such. Roth (1929) erected three new genera, twenty-seven new species, and two new varieties in his study of ostracodes from the Haragan Formation. Amsden's study (1956, p. 48-57; 1960, maps) indicates that certainly in some cases, and probably in others, Roth's collections came from both the Henryhouse and the Haragan. Subsequent work by Warthin (1937-1945), Kesling (1957), and Sohn (1960) has consisted of redescription and introduction of minor taxonomic changes of ostracodes originally described by Roth (1929). The work of Coryell and Cuskley (1934) on ostracodes from White Mound, Murray County, Oklahoma, involves only Haragan ostracodes.

Purpose and scope of this study. — The purpose of this study is to (a) determine if all ostracode species previously described as Haragan actually occur in the Haragan, (b) determine whether the Henryhouse and Haragan Formations contain distinct ostracode faunas and, if so, to establish the faunal content of each, and (c) determine the stratigraphic and geographic distribution of ostracodes in the Henryhouse-Haragan sequence. The present report deals with the Henryhouse ostracode fauna, and a subsequent report,

now in preparation, will deal with the Haragan ostracode fauna and a comparison of the two.

Several ostracode species which are known from the Henryhouse Formation are not described or illustrated in this report. Most of these are smooth species which require special study. A few ornamented forms have been omitted from this study owing to lack of well-preserved material. These species cannot be adequately described until more material is available.

Materials studied. — Three-thousand Henryhouse ostracodes have been measured and studied in detail. In addition, thousands more have been studied and identified. Preservation of ostracodes in the Henryhouse generally is good. Ostracodes from all three outcrop areas of the Henryhouse Formation are included, although the Criner Hills area is poorly represented.

Roth's (1929) type collections have been studied. Although special remarks concerning the type specimens are given where necessary in the systematic descriptions, some general comments are necessary here. Roth's type collection is confused. Although he designated a holotype in the text for each new species he described, Roth apparently placed his entire collection of specimens for each species on one slide and made no attempt to designate which specimen was to be the holotype. No indication was given by Roth as to which figured specimen represents the holotype, and in many cases it is difficult, if not impossible, to be sure if the specimen he intended to be the holotype is even illustrated. Moreover, it is doubtful that some of the figured specimens are even in the type collections. The problem has been compounded by the fact that the collection of types has been tampered with, and in at least one case a specimen which is not even a Hunton ostracode has been placed on the type slide. Any attempt to match the specimens of Roth's collection with his illustrations will be based largely upon personal opinions and in the author's opinion will be largely unsuccessful.

Article 73 of the *International Code of Zoological Nomenclature* (Stoll and others, 1960) states the following concerning holotypes:

> (a) Single specimen.—If a new nominal species is based on a single specimen, that specimen is the "holotype."
>
> (b) Specified type.—If an author states in the description of a new nominal species that one specimen and only one is "the type" or uses some equivalent expression, that specimen is the holotype.
>
> Recommendation 73A. Original designation.—A zoologist when describing a new species should clearly designate a single specimen as its holotype.

Because identity of the specimens which Roth (1929) intended to be holotypes cannot be definitely and objectively established, lectotypes of Roth's (1929) species are designated herein except where the holotype is definitely known in accordance with (a) and (b) of article 73.

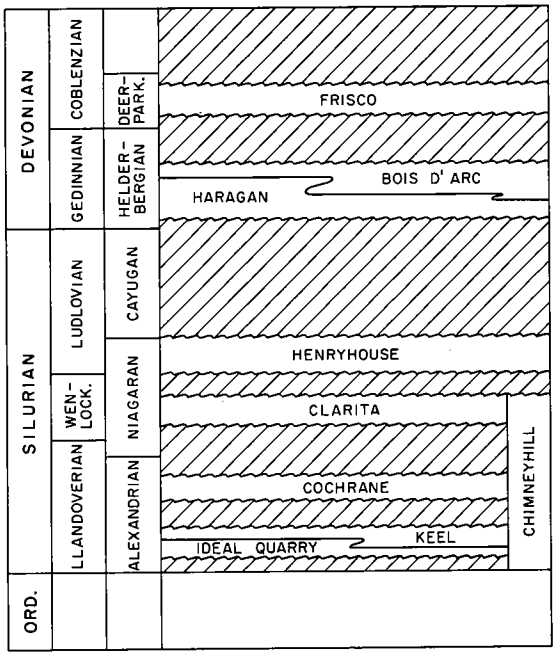
Acknowledgments. — Special gratitude is expressed to Dr. Thomas W. Amsden of the Oklahoma Geological Survey, who has given so freely of his time in aiding the author in the field and in providing various helpful information during this entire study. Professor Harold W. Scott of the University of Illinois directed the doctoral dissertation study which constitutes part of this report. Mr. John Lundin aided the author in the field, and Dr. Nicholas Salerno of Arizona State University helped in the formation of new names presented herein. Special thanks are due Dr. Carl C. Branson of the Oklahoma Geological Survey for the encouragement he has given for the completion of this study. Dr. G. Arthur Cooper of the U. S. National Museum, Dr. Norman Newell of the American Museum of Natural History, and Professor Robert V. Kesling of the University of Michigan have been especially cooperative in lending type specimens used in this study. Dr. William E. Ham gave helpful suggestions during preparation of the manuscript for which the author is especially grateful. Finally, appreciation is expressed to Professor Paul T. Miller and the Department of Geology at Arizona State University for providing time and technical assistance for the completion of the manuscript, and to the Petroleum Research Fund of the American Chemical Society (grant no. 1663-B) for providing funds without which this report could not have been completed.

HENRYHOUSE STRATIGRAPHY

The stratigraphy of the Henryhouse Formation has been discussed by Amsden (1957, 1960, 1962), and therefore only a brief review is presented here.

Previous work. — Reeds (1911) first recognized the Henryhouse Shale as a distinct unit of the Hunton limestone first described by Taff (1902, 1904). Reeds assigned the Henryhouse to the Niagaran and in 1926 elevated the Hunton limestone to group rank. Maxwell (1936) followed Reeds' (1926) assignment of the Henryhouse to the Niagaran and suggested it be called the Henryhouse Formation because of the lack of true shale in this unit. Ham (1955) presented measured sections and cross sections illustrating the regional stratigraphy of the various units of the Hunton Group in the Arbuckle Mountains region. He also referred the Henryhouse Formation to the Niagaran.

Amsden has done the most definitive recent work on the stratigraphy and paleontology of the Hunton Group in its outcrop area. He presented in his preliminary report (1957) and final report (1960) detailed information on stratigraphic relationships, lithology, thickness, distribution, and fossils of the Henryhouse Formation. Amsden's classification of the Hunton Group is shown in text-figure 2.



Text-figure 2. Chart showing stratigraphic relations and relative age of Henryhouse Formation and other Hunton strata (after Amsden, 1962, fig. 1).

Shannon (1962) studied the Hunton Group in the subsurface of Oklahoma. Upon the basis of electric-log, sample-description, and well-cutting studies, he chose to interpret the Henryhouse Formation as a facies of the Haragan or as a deposit which is transitional with the Haragan. Which of the two interpretations Shannon prefers is not altogether clear. Either interpretation is in marked contrast to that of the unconformable relationship indicated by Amsden (1957, 1960). Amsden (1962) summarized the evidence for his interpretation of the stratigraphic relationships of the Henryhouse Formation.

Lithology. — The general term of marlstone has been used to describe the Henryhouse lithology. The rock is a silty, argillaceous, fossiliferous calcilutite. It is thin bedded and generally yellowish gray to gray, although some beds are greenish gray and red-mottled beds are present at certain localities. The Henryhouse rocks commonly weather to produce rubble-covered slopes called glades, which make excellent exposures. Amsden (1960, p. 67-73) presented results of detailed chemical analyses of $MgCO_3$ content, HCl residue, acetic acid residue, and $CaCO_3$ content of the Henryhouse rocks. No purpose would be served in summarizing this information here.

Fossils and age. — The abundance of fossils in the Henryhouse beds is quite variable. Amsden (1960) summarized the geographic distribution of the Henryhouse megafauna and presented detailed information upon the brachiopods which dominate it. Geographic distribution of the ostracodes is discussed below. In addition to the large brachiopod fauna, corals, bryozoans, crinoids, gastropods, trilobites, graptolites, pelecypods, and sponges are represented. Conodonts are uncommon but arenaceous foraminifers are locally abundant.

Reeds (1911, 1926) and Maxwell (1936), both of whom presented extensive faunal lists for the Hunton Group, placed the Henryhouse in the Niagaran*.

Decker (1935) described a graptolite fauna from the Henryhouse. This includes *Monograptus*

* It must be emphasized, as indicated in text-figure 2, that Niagaran, as used in North America, includes strata ranging from late Llandoverian to early Ludlovian in age (Boucot, 1958, p. 1029).

nilssoni, M. vulgaris, and others indicating correlation with the lower Ludlow shales of Great Britian. Eight graptolite species are common to the two units.

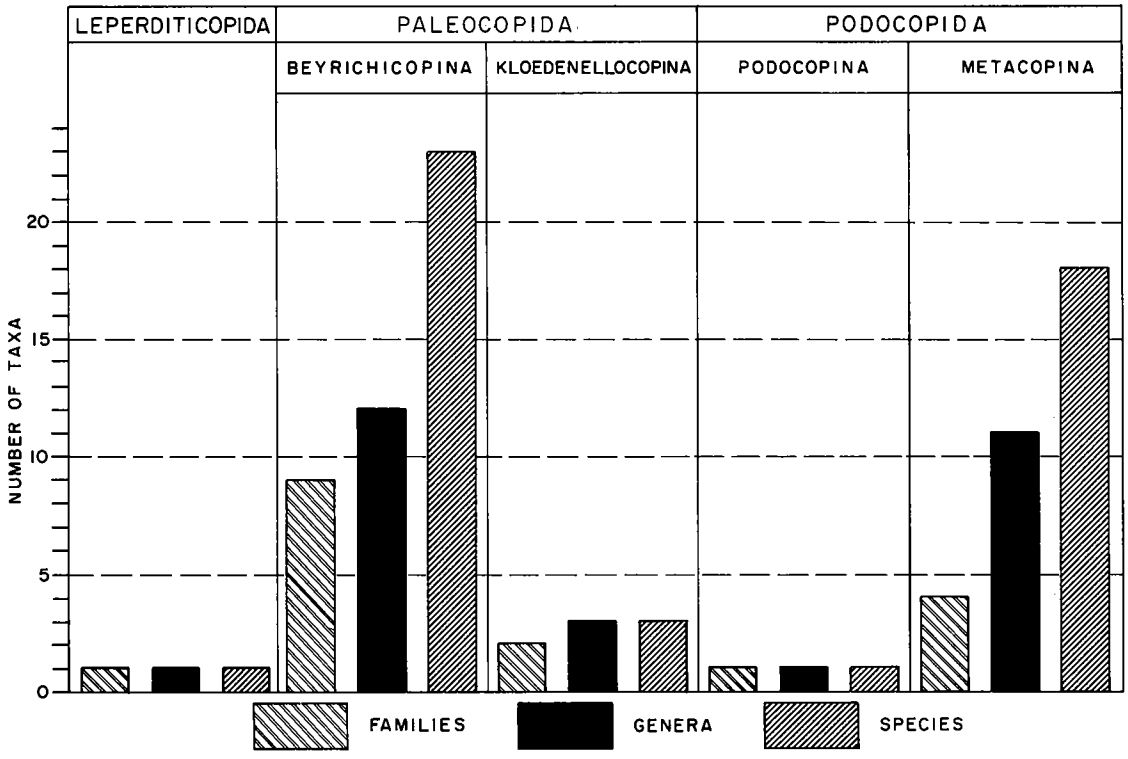
Amsden (1949), upon comparison of his own collections from the Brownsport Formation of western Tennessee and Reeds' Henryhouse collections, concluded that these two formations are closely related in age. The Brownsport was considered Niagaran in age. The similarity in age of the Brownsport and Henryhouse was restated by Amsden (1951) after a study of the Henryhouse brachiopods. He found twenty-three genera and sixteen species common to the two units.

Amsden (1958), in a definitive study of the Haragan articulate brachiopods and a supplement to the Henryhouse brachiopods, stated that a reexamination of the Henryhouse brachiopods indicated an early Late Silurian age as implied by Decker's (1935) graptolite study. Evidence for this early Ludlovian age was discussed by Amsden (1958, p. 15, 147). The early Ludlovian age of the Henryhouse was restated by Amsden (1960, 1962).

HENRYHOUSE OSTRACODA

Content of fauna. — The Henryhouse ostracode fauna is large and diversified. Forty-six species representing twenty-eight genera are described and illustrated herein. Several additional species are known, but sufficient material is not available to describe or illustrate them adequately.

Three orders and seventeen families are represented in this fauna. The number of families, genera, and species represented in each order and suborder is shown in text-figure 3. In numbers of individuals, the Healdiidae, Bairdiocyprididae, Pachydomellidae, and Thlipsuridae dominate. The Paleocopida are most abundantly represented by the kloedenellid *Dizygopleura landesi* Roth, but a number of other paleocopid families (eleven in all) are represented by fifteen genera. Notable among the paleocopid families is the Aechminidae. Although nowhere abundant in number of individuals, seven species of *Aechmina* and five species of *Aechminaria* are known from the Henryhouse strata. Among the Podocopida only one podocopine genus, *Spinobairdia,* is known.



Text-figure 3. Bar diagram showing the number of ostracode families, genera, and species in each order and suborder represented in the Henryhouse fauna.

However, the Metacopina are especially well represented in numbers of individuals and number of taxa. One healdiid genus, three bairdiocypridid genera, three pachydomellid genera, and four thlipsurid genera are common elements of the Henryhouse fauna. These numbers undoubtedly will change as more critical taxonomic work is done, especially upon such groups as the Thlipsuridae. The number of genera and species represented in each family is shown in text-figure 4.

Geographic distribution. — The abundance of ostracodes in the Henryhouse beds is extremely variable from one area to another. Of the three outcrop areas described (see Introduction) the collecting is poorest in the Criner Hills. However, sampling of the Henryhouse in this area has been limited in this study. The best collecting is in the Lawrence uplift (text-fig. 1). Here many samples yielded ostracodes in large numbers, and every sample contained at least some ostracodes. In the western outcrop belt of the Arbuckle Mountains (text-fig. 1) collecting generally is poor. Many samples contain only small numbers of ostracodes and they are nowhere abundant.

Amsden (1957, p. 32) recorded the same kind of geographic distribution for the Henryhouse megafauna. The significance of this erratic geographic distribution is uncertain. Certainly the attitude of the beds and lithology are part of the answer. If other things are equal, fossil collecting is better where the beds are horizontal or nearly horizontal because exposure to weathering is greater. Also, samples having a low clay content generally are poor because in many cases they do not break down as much as the highly argillaceous samples. Concentration by currents apparently is minimal. Ostracodes generally are well preserved, and evidence of abrasion is uncommon.

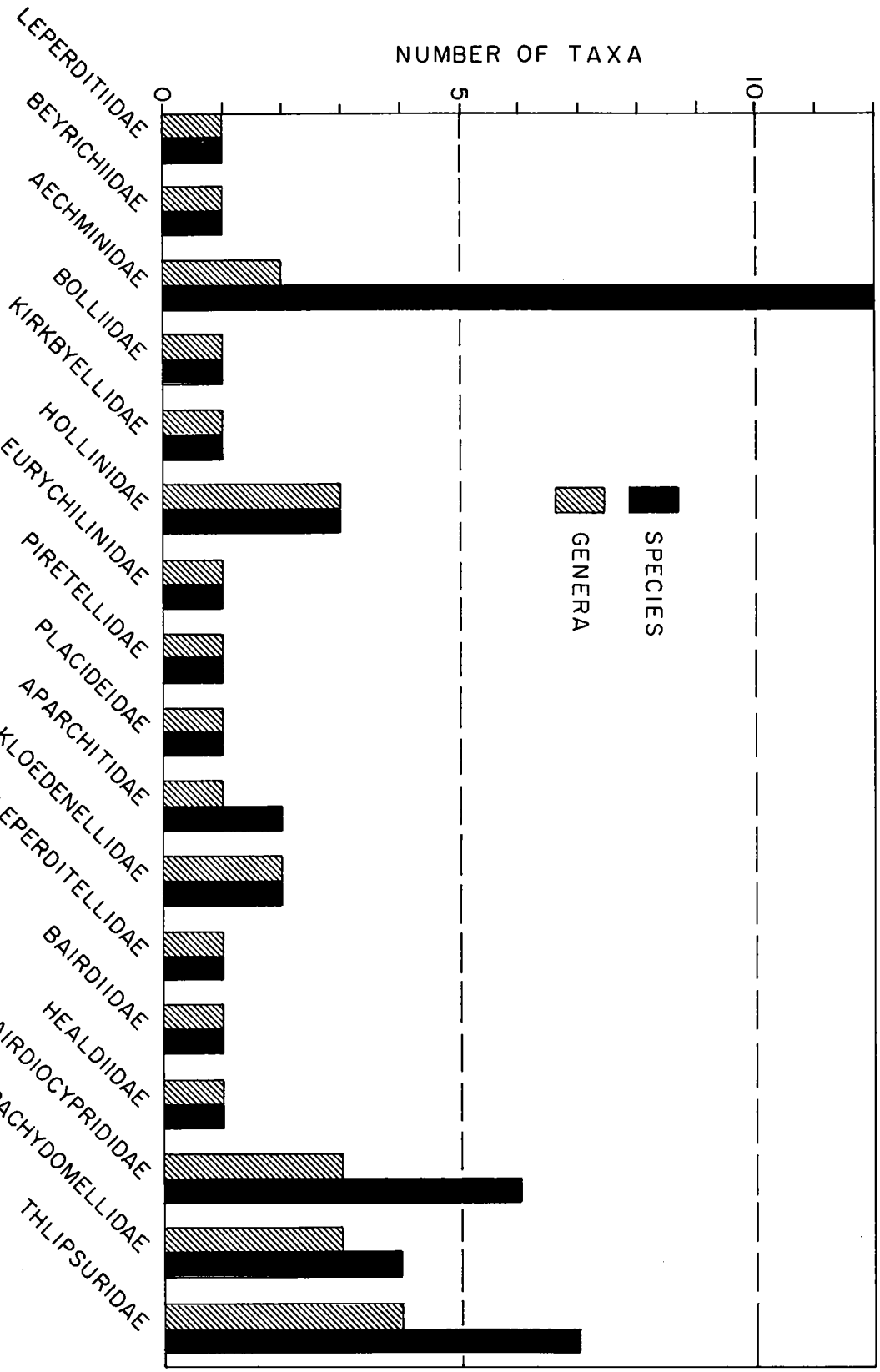
Primary distribution of ostracodes in the Henryhouse sea certainly is significant in explaining the erratic geographic distribution observed. Qualitative content of the ostracode collections from the various outcrop areas is the same. However, it appears that the smooth ostracode species are proportionately more abundant in the western outcrop belt than in the Lawrence uplift. No attempt has been made to make a precise mathematical analysis of this relationship, but, if it is true, it may indicate somewhat deeper water in the western area. More study is needed to substantiate this conclusion. In any case, the relative abundance of ostracodes in the Henryhouse sea differed from the eastern area to the western area.

Stratigraphic distribution. — Stratigraphic distribution of the Henryhouse ostracodes is shown in text-figure 5. The stratigraphic positions of those species which are known from fewer than five Henryhouse samples are indicated by X's. Stratigraphic ranges for those species known from five or more samples are represented by solid lines.

The apparently limited stratigraphic occurrence of some species is not considered significant. Those species which appear to have a limited stratigraphic range invariably are species which are known from only a few samples and in all but one instance (*Velibeyrichia fittsi*) are represented by only small numbers of specimens. Those species represented in more than just a few samples and by large numbers of individuals range throughout or almost throughout the Henryhouse Formation. The author believes that zonation of the Henryhouse beds based upon ostracodes is impossible. This conclusion supports that of Amsden (1962, p. 1506), who found the same to be true of the brachiopods. All evidence indicates that the Henryhouse Formation is a distinct stratigraphic unit which contains a single fauna devoid of recognizable faunal zones.

Abundance of ostracode species and individuals varies considerably from bed to bed throughout the Henryhouse sequence. Some beds are extremely rich and others are virtually barren of ostracodes. This variation has had an effect on the apparent stratigraphic range of some Henryhouse ostracodes. For example, section P_6 is the lowest exposure of Henryhouse beds which affords good ostracode collecting. Beds in this exposure are 15 to 27 feet above the base of the formation. Sample P_6-4 is especially rich and contains several species (especially aechminids) in small numbers not found elsewhere in the Henryhouse strata. Because this is the lowest sample that contains a large Henryhouse ostracode fauna, the lower limit of the range of a number of species is indicated at this stratigraphic level on the range chart (text-fig. 5). However, samples P_3-2 and P_3-3, both of which are from within seven feet of the base of the formation, contain many of the common species of the Henryhouse. The lower limit of the stratigraphic range of these species is indicated accordingly.

The apparent upper limit of the stratigraphic range of many Henryhouse ostracodes has also been restricted by availability of fossiliferous beds near the top of the Henryhouse section. The maximum thickness of the Henryhouse is 247 feet at section P_1 (Amsden, 1960, p. 81). The upper Henryhouse was not collected at this locality be-



Text-figure 4. Bar diagram showing the number of ostracode genera and species in each family represented in the Henryhouse fauna.

cause it was collected at section P_3 just east of section P_1. At section P_3 the Henryhouse Formation is 233 feet thick (Amsden, 1960, p. 274), but this is the thickest section which was sampled completely. Therefore, the highest stratigraphic position indicated on the range chart (text-fig. 5) is 233 feet above the base of the formation (and within 2 feet of the Devonian) even though the greatest thickness known in the outcrop area is 247 feet.

Age of the Henryhouse Ostracoda. — The age of the Henryhouse Formation has been discussed at length by Amsden (1949, 1957, 1958, 1960, 1962). A summary of the age assignments of the Henryhouse Formation is given above (see Fossils and Age under Henryhouse Stratigraphy).

Although detailed comparisons of the Henryhouse ostracode fauna with other ostracode faunas are yet to be done, the early Late Silurian age assignment given by Amsden (1958, 1960, 1962) is supported here. The Henryhouse aechminids have a definite Middle and Late Silurian aspect, and several are similar to *Aechmina bovina* Jones, 1887, which occurs in the upper Wenlock shales (Tickwood beds) of England. *Aechminaria henryhousensis* Lundin, new species, appears to be related to *A. robusta* Coryell and Williamson, 1936, from the Waldron Shale (Niagaran) of Indiana. *Velibeyrichia fittsi* (Roth), *Eukloedenella pontotocensis* Lundin, new species, *Spinobairdia* sp., *Tubulibairdia* cf. *T. longula* (Ulrich and Bassler), 1913, and *Thlipsuropsis inaequalis* (Ulrich and Bassler), 1913, are ostracodes known from the Henryhouse which are related or identical to species described from Silurian rocks of the eastern United States ranging in age from Niagaran to Cayugan.

The occurrence of *Grammolomatella, Rakverella*?, and *Eurychilina* in the Henryhouse is of special interest. All are typical lower Paleozoic genera not known from rocks younger than Middle Silurian. On the other hand, *Hollinella, Healdia,* and *Amphissella* occur in the Henryhouse but have not been previously reported from rocks older than Devonian. Further work certainly will establish the geologic range of these genera more accurately.

Precise age determination of the Henryhouse ostracode fauna must be deferred until detailed comparisons with other faunas can be made. However, present evidence indicates that the assignment of the Henryhouse to the late Niagaran (early Ludlovian) is correct.

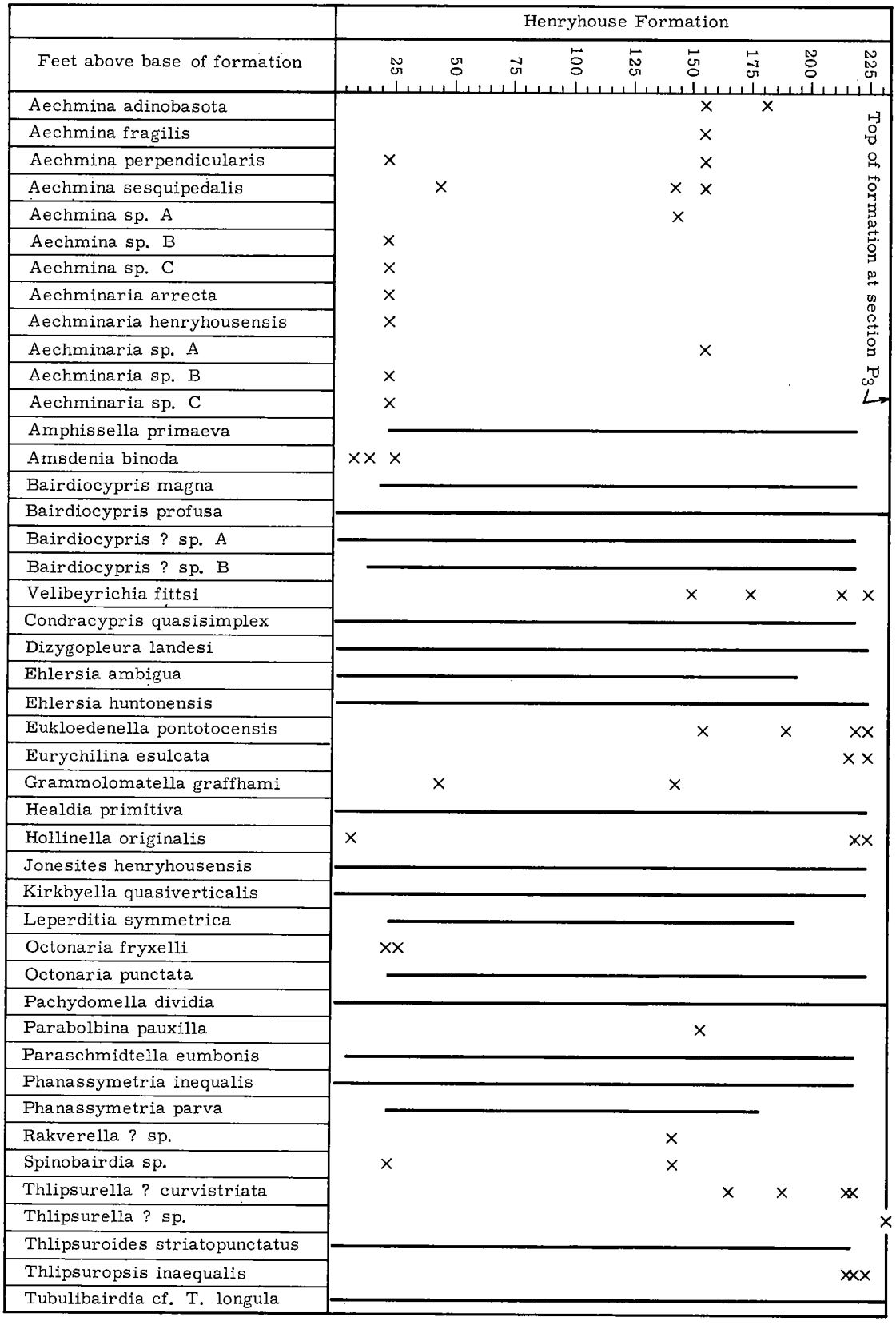
Although detailed comparison of the Henryhouse and Haragan ostracode faunas will be presented in a subsequent report, a brief statement can be made here. During the study of the Henryhouse ostracodes the author had large numbers of Haragan ostracodes available. These were used for comparison to similar species in the Henryhouse whenever necessary. Therefore the author obtained a knowledge of the Haragan ostracode fauna, which is unquestionably distinctly different from the Henryhouse ostracode fauna. Thus far the author has found no species common to both units. At present, evidence from the ostracode faunas supports Amsden's (1962) conclusions upon the stratigraphic and biostratigraphic relationships of the Hunton marlstone sequence.

PROCEDURES AND METHODS OF INVESTIGATION

Sample collecting. — Two methods of sample collecting were employed in this study. Some sections or partial sections were channel sampled, each sample including no more than 6 feet of strata. Where beds appeared especially fossiliferous, the sample interval was reduced to include thinner zones in each sample. The channel-sample method eliminates the possibility of missing thin, richly fossiliferous beds; however, it increases the possibility of including in a sample ostracode variations which are due to time. Other sections and localities were spot sampled, generally at 5- to 6-foot intervals. Again, the sample interval was reduced in places where the beds appeared especially fossiliferous. This method increases the possibility of missing rich zones but decreases the time factor in variation of ostracodes from each sample. At many places marl partings were sampled in this way and nowhere was more than 1 foot of strata included in each spot sample.

No attempt was made to control the size of each sample. All samples were taken in place. The entire formation in all outcrop areas was sampled systematically and in detail.

Sample preparation. — Each sample was soaked from sixteen to twenty-four hours in either Stoddard's solvent, Sinclair solvent, or Skellysolve. After the solvent was poured off, each sample was covered with water and boiled slowly for one to three hours. Repetition of the process was necessary in some instances. A few samples did not break down sufficiently for use.



Text-figure 5. Chart showing stratigraphic distribution of ostracodes in the Henryhouse Formation. Distributions indicated by X's are for species which are known from fewer than five samples.

Each disintegrated sample was wet sieved through 10- and 200-mesh sieves. The sediment which remained on the 200-mesh sieve was dried and dry sieved through 20-, 40-, 60-, 80-, and 100-mesh sieves. All material was saved, and each size fraction was bottled individually and labeled.

The ostracodes were picked, sorted, and mounted on cardboard microscope slides. Most of the ostracodes were found in the 40- and 60-mesh material, but some were found in the 20- and 80-mesh fractions.

Measurements. — Size-dispersion diagrams have been prepared for those species represented by large numbers of specimens in any one sample. Variation in size and form ratio can readily be seen on these diagrams. Generally maximum length and maximum height were measured. Some species have ornaments which affect these dimensions, and in these cases more constant dimensions, such as length and height of the domicilium, were measured. For species which are distinctly inequivalved, data for each valve are separated or data for only one valve are presented.

Measurements were made with a calibrated ocular set in a binocular microscope under 60 or 120 magnification. Measurements were made to the nearest whole unit on the ocular and are accurate to sixteen-hundreths of a millimeter. Only well-preserved undeformed specimens were measured.

In most cases the separation of instars of the various species measured is clear. In one case a histogram was made to aid in clarifying the division between instars. In a few cases, because of considerable size variation, the exact position of the line separating instars is uncertain. Average size of each instar has been calculated and growth factors determined. Generally, if only a limited number of specimens for a particular instar was available, average size and growth factors were not calculated.

Preparation of specimens. — Most illustrated specimens required some degree of cleaning before being photographed. In some cases a sonic resonator proved effective in cleaning the ostracodes. However, this method usually results in breakage if the specimens are fragile or slightly cracked. Therefore in some cases it was necessary to remove the matrix with a needle. This method is especially successful and not injurious to the specimen if the specimen is embedded in a thick paste of gum tragacanth. The portion of the specimen to be cleaned was daubed with water or some cleaning detergent. Generally the matrix could be easily removed. Some specimens, however, were so fragile that it was impossible to clean them sufficiently for good photography. In these cases drawings have been used for illustration.

The author has been successful at repairing good specimens which were broken during the cleaning process by the following method. The pieces were fitted together and temporarily glued with gum tragacanth. Then small amounts of Dupont Duco glue were applied to the fracture with a brush moistened with acetone, in which the glue is soluble. The glue was applied to the interior of the valves in all possible cases to avoid having glue on the exterior surface of the shell. This method allows for normal handling of specimens with a wet brush.

Photography. — Photographs in this report were made with a Leitz Labolux microscope equipped with a Lieberkuhn mirror, bellows, and Leica camera. The objective, a 63-mm photar lens, the six-power ocular, and the bellows extension, provided a magnification of 10x on the film. The negatives were enlarged for the finished plates. Kodak Panatomic X film and Kodabromide paper (N-2, N-3, and N-4) were used. None of the photographs was retouched.

Some ostracodes were coated with a film of brown washable ink before a coating of ammonium chloride was applied. The latter was used on all specimens. The brown ink aids in bringing out details of ornamentation in many cases. All drawings or reconstructions of ostracodes shown herein are traced from photographs.

REGISTER OF COLLECTING LOCALITIES

Fifteen localities and sections were sampled. Although many of these sections expose other Hunton units, the comments upon each of the localities given below refer only to the Henryhouse strata.

Amsden's (1960) method of designating sections has been, for the most part, retained in this study. For example, section P_3 of this study is identical to Amsden's section P3. Thus, detailed information on location, geology, and stratigraphic relationships can be easily secured by referring to Amsden (1960). Notation is made for those localities listed below which are not described by Amsden. In these cases the letter and number designation is of no special significance.

A map illustrating the location of sections is

text-figure 1. Table 1 gives the stratigraphic position of each sample used in this study. The positions of the samples are given in distances above the base of the Henryhouse Formation wherever the base of the Henryhouse section is known. However, at sections Ca_{14}, G_2, P_4, P_7, P_8, and P_{18} the positions of the samples are known only from the top of the Henryhouse section. Therefore the sample positions are indicated with a minus sign.

Section Ca_1 — Glade exposure 300 feet west of Henryhouse Creek, Carter County, Oklahoma (SE¼ sec. 30 T. 2 S., R. 1 E.). Thirty samples from this section contain ostracodes in small numbers. Three samples are barren. This is the type section of the Henryhouse Formation.

Section Ca_{11} — West bank of Hickory Creek,

TABLE 1.—STRATIGRAPHIC POSITIONS OF SAMPLES FROM HENRYHOUSE FORMATION

SECTION	SAMPLE NUMBER	DISTANCE ABOVE BASE (+) OR BELOW TOP (−) (FEET)	SECTION	SAMPLE NUMBER	DISTANCE ABOVE BASE (+) OR BELOW TOP (−) (FEET)
Ca_1	1	+1	P_1	9	+1
	2	+17		10	+4
	3	+20		11	+8-12
	4	+28		12	+14-15
	5	+33		13	+17-19
	6	+38		14	+26-32
	7	+40	P_3	2	+1-2
	8	+44		3	+2-7
	9	+47		4	+7-8
	10	+55		5	+8-16
	11	+60		6	+50 approx.
	12	+65		7	+82 approx.
	13	+71		8	+142-146
	14	+77		9	+147-152
	15	+83		10	+152-155
	16	+87-88		11	+155-159
	17	+94		12	+160-165
	18	+99		13	+166
	19	+104		14	+167-170
	20	+110		15	+170-174
	21	+116		16	+175-177
	22	+121		17	+175-181
	23	+127		18	+176-182
	24	+132		19	+182-186
	25	+139		20	+190-194
	26	+146		21	+214-219
	27	+152		22	+216-218
	28	+155-158		23	+225-227
	29	+164		24	+228-232
	30	+175	P_4	1	−8 approx.
Ca_{11}	1	+43	P_6	1	+15-21
Ca_{14}	1	−20		2	+21-23
G_1	1	+157 approx.		3	+24
G_2	1	−80		4	+23-25
M_1	2	+0-1		5	+25-27
	3	+33	P_7	1	−30-34
	4	+38-40		2	−28-30
	5	+44		3	−26-28
	6	+49		4	−23-26
	7	+50		5	−18-23
	8	+61		6	−16-18
	9	+61-64		7	−10-16
M_2	1	+2	P_8	1	−0-4
M_{12a}	1	+7	P_{18}	1	−90

Carter County, Oklahoma (NE¼ SW¼ sec. 35, T. 5 S., R. 1 E.). One sample shows ostracodes to be uncommon.

Section Ca_{14} — Northwest of Rock Crossing in Criner Hills, Carter County, Oklahoma (NE¼ NE¼ sec. 34, T. 5 S., R. 1 E.). One sample from this section is barren of ostracodes.

Section G_1 — South bank of Chimneyhill Creek between sections P_1 and P_3, Pontotoc County, Oklahoma (NW¼ SE¼ sec. 4, T. 2 N., R. 6 E.). One sample contains a good Henryhouse ostracode fauna. This locality is not described by Amsden but is indicated in text-figure 1. This sample is from a marl parting about eight feet above the bottom of the creek bed.

Section G_2 — South bank of Chimneyhill Creek about 200 yards east of section P_1, Pontotoc County, Oklahoma (SW¼ NW¼ SW¼ sec. 4, T. 2 N., R. 6 E.). This locality is not described by Amsden but is situated between Amsden's sections P1 and P3, as indicated in text-figure 1. Ostracodes are few.

Section M_1 — Vines Dome approximately one mile north of Dougherty, Murray County, Oklahoma (NW¼ NW¼ sec. 2, T. 2 S., R. 2 E.). Eight samples from this section show only a few ostracodes.

Section M_2 — About 1,000 feet southeast of White Mound, Murray County, Oklahoma (SE¼ NE¼ sec. 20, T. 2 S., R. 3 E.). One sample near the base of the Henryhouse contains only a few ostracodes.

Section M_{12a} — East side of Falls Creek at Price's Falls, Murray County, Oklahoma (SW¼ NW¼ sec. 33, T. 1 S., R. 2 E.). One sample is barren of ostracodes.

Section P_1 — Chimneyhill Creek about two miles southeast of Lawrence quarry, Pontotoc County, Oklahoma (NE¼ SE¼ sec. 5, T. 2 N., R. 6 E.). Six samples contain ostracodes in small numbers.

Section P_3 — Cedar Hill about three miles southeast of Lawrence quarry, Pontotoc County, Oklahoma (NW¼ NE¼ sec. 9, T. 2 N., R. 6 E., to SE¼ sec. 4, T. 2 N., R. 6 E.). Twenty-five samples show ostracodes to be common to abundant. Sample P_3-11 is the most fossiliferous of all Henryhouse samples. Many of the ontogenetic and variation studies included in this report are of populations from this sample.

Section P_4 — Small quarry southeast of Cedar Hill, Pontotoc County, Oklahoma (SW¼ SW¼ sec. 3, T. 2 N., R. 6 E.). Ostracodes are common in one sample from this locality.

Section P_6 — Small glade southwest of Cedar Hill, Pontotoc County, Oklahoma (SE¼ SW¼ sec. 4, T. 2 N., R. 6 E.). Five samples from this locality show ostracodes to be few to abundant. Sample P_6-4 contains an especially good fauna of Henryhouse ostracodes.

Section P_7 — Small roadside outcrop northwest of Cedar Hill, Pontotoc County, Oklahoma (NE¼ SE¼ sec. 32, T. 3 N., R. 6 E.). Ostracodes are uncommon in seven samples from this locality.

Section P_8 — North bank of Bois d'Arc Creek, Pontotoc County, Oklahoma (SW¼ NW¼ sec. 11, T. 2 N., R. 6 E.). One sample of the few feet of Henryhouse exposed at this locality contains only a few ostracodes.

Section P_{18} — East of Bois d'Arc Creek, Pontotoc County, Oklahoma (NE¼ NE¼ SW¼ sec. 10, T. 2 N., R. 6 E.). Ostracodes are abundant in one sample. This locality, approximately 1/2 mile southeast of Amsden's section P4 (1960, panel I, pl. A), was not described by him.

ONTOGENY, VARIATION, AND DIMORPHISM IN OSTRACODES

Details of ontogeny, variation, and dimorphism are given for each species wherever possible or necessary under the systematic descriptions. However, these phenomena should be discussed in a general manner here.

Ontogeny. — Ostracodes, like other crustaceans, grow by ecdysis. That is, at intervals the carapace is moulted, the soft parts of the animal increase in size, and a new carapace is secreted. Each stage between successive moults is called an instar.

Changes other than increase in size occur during the ontogeny of ostracodes. The nauplius stage has three pairs of cephalic appendages in the mature form. During successive moults the thoracic appendages, furca, and genital organs appear and develop. Any of these structures may appear first in an incipient form and mature during a subsequent moult or moults. Because the thoracic appendages, furca, and genital organs are situated in the medial and posterior portions of the animal, the posterior portion of the carapace may change more during ontogeny than may the anterior portion. Posterior lobes may not be developed in the early instars, whereas they may be quite prominent

in the adult instar. Indeed, an immature specimen may look quite different from an adult of the same species.

Dizygopleura landesi Roth of the Henryhouse Formation is a good example of this situation. As can be seen in figures 3a-q of plate X, L_4 is represented by two spines in the early instars and as a strong, rounded lobe in the late instars. Also, the posteroventral portion of the adult carapace is much better developed than that of the immature instars. Thus a change in shape can be seen through the ontogeny of this species.

In some species no distinct change in shape occurs during ontogeny, but progressive development of the posterior portion of the carapace can be seen. In *Kirkbyella quasiverticalis* Lundin, new species, the S_2 is situated approximately at midlength in the immature instars but is distinctly anterior to midlength in the adults. Such a change represents disproportionate development of the posterior portion of the carapace. However, the lateral outline of this species is unchanged during ontogeny.

Kesling (1952) discussed the size increase of ostracode carapaces from one instar to another. It was shown that the volume of ostracodes increases by a factor of two between successive moults. Upon this basis each dimension (length, width, and height) should increase by a factor of 1.26 if growth is isometric. Kesling (1952) illustrated sources of error and reasons for deviation from this ideal growth factor for linear dimensions. In the present study length, height, and, in one species, width of large numbers of ostracodes have been measured. Average size of various instars has been calculated, and growth factors generally are near 1.26. The significance of size-dispersion diagrams is discussed below (see Variation).

The number of instars in the complete ontogeny varies between six and eleven for various species of ostracodes. Generally all instars are not preserved in a particular population. Therefore the largest specimens normally are considered adults, the previous instar is called the adult −1 instar, etc. One Henryhouse ostracode, *Amphissella primaeva* (Roth), is believed to illustrate the phenomenon of postadult moulting. Specimens which have undergone postadult moulting are referred to as giants. Ostracodes are considered to have reached the adult stage when they attain sexual maturity. However, small numbers of unusually large specimens have been observed in some populations. These individuals are thought to have moulted after reaching sexual maturity. The difficulty in distinguishing giants from adults of a larger but closely related species is obvious. Evidence for postadult moulting in *Amphissella primaeva* (Roth) is discussed under the description of that species.

Variation. — Variation in ostracodes, especially variation in ornamentation, is discussed by Kesling (1954). Unfortunately few comments on variation of ostracode species occur in the literature. In this study an attempt has been made to describe and/or to illustrate morphological variation wherever possible.

Several kinds of variation may be present in a single ostracode species. One kind concerns variation between instars of the same species. This type of variation is discussed above (see Ontogeny). A second type of variation is due to differences between males and females of the same species and is discussed below (see Dimorphism). The third type of variation is between individuals of the same sex and instar. Several Henryhouse ostracodes illustrate this kind of variation, which may involve ornamentation, size, and shape. The number of pits which ornament the lateral surfaces of carapaces of *Octonaria punctata* Roth varies considerably, ranging from twenty to thirty on the adult left valve and from eight to twelve on the adult right valve. The arrangement of these pits is likewise variable. Similar, though less striking, variation occurs in *O. fryxelli* Lundin, new species. As indicated by Kesling (1952), preservation may account for variation in ornamentation. Abrasion certainly has affected the ornamentation of some specimens of *Ehlersia huntonensis* (Roth), *E. ambigua* Lundin, new species, and *Paraschmidtella eumbonis* Lundin, new species. Some specimens of each of these species are distinctly punctate, whereas some are only faintly punctate and others are smooth.

Variation in size and shape of various Henryhouse ostracodes has been illustrated wherever possible. Because growth of ostracodes is discontinuous, size-dispersion diagrams show clusters of individuals representing various instars. In many cases such diagrams are helpful in illustrating size variation within each instar. Also, if length and height are plotted, variation in length-height ratio of individuals of a single instar can readily be seen. Size-dispersion diagrams are presented for all Henryhouse ostracodes for which sufficient well-preserved material is available. It is apparent from these diagrams that some specimens are more elongate than others of the same instar.

Guber (1962) showed variation in shape of adult specimens of *Warthinia nodosa* (Ulrich), 1890, which could not be seen on a size-dispersion diagram. In addition to variation in height-length ratio, Guber recognized a variation in the position of maximum height. Thus he was able to distinguish eight groups of adults based upon height-length ratio and preplete, amplete, or postplete shape. Guber's observations are especially significant in that authors, in the past, have based orientation of nearly symmetrical valves upon the position of maximum height. Orientation of nearly symmetrical valves based upon the position of maximum height appears unacceptable. Characteristics which are less variable than shape should be used.

Observations upon variation of size, shape, and ornamentation of ostracodes should be made whenever possible. Such observations certainly will eliminate unnecessary erection of new taxa which represent a small percentage of variants of a single species and thus may aid in establishing trends which will lead to a clarification of phylogenetic lines.

Dimorphism. — Dimorphism in Ostracoda was discussed at length by Jaanusson (1957), Scott and Wainwright (1961a), and Martinsson (1962). Jaanusson's (1957) review of dimorphism in ostracodes is especially enlightening, and the terms introduced by him have been of major importance in clarifying and stabilizing the terminology applied to dimorphic features of paleocopid ostracodes. Modifications of Jaanusson's (1957) terminology were introduced by Scott and Wainwright (1961a); for example, "beyrichiid dimorphism" in place of "cruminal dimorphism." Martinsson's (1962) study of the Beyrichiidae from the Silurian of Gotland is a classic work and is the greatest single contribution to our knowledge of cruminal dimorphism and the Beyrichiidae. Differences of opinion between Martinsson (1962) and Scott and Wainwright (1961a) are discussed by Martinsson (1962, p. 355-359).

Various ostracodes of the Henryhouse Formation illustrate different kinds of dimorphism. *Velibeyrichia fittsi* (Roth) shows cruminal dimorphism; *Grammolomatella graffhami* Lundin, new species, shows histial dimorphism; *Eurychilina esulcata* Lundin, new species, shows velar dimorphism; and species of *Hollinella, Parabolbina,* and *Rakverella*? are present in which dimorphism is either indistinct or in which both dimorphs have not been found. The dimorphic characteristics of the species mentioned above are discussed under the descriptions of each. This is also done for *Dizygopleura landesi* Roth and *Eukloedenella pontotocensis* Lundin, new species, which illustrate domiciliar (kloedenellid) dimorphism. Dimorphism in these beyrichicopine and kloedenellocopine ostracodes has been known for some time and further discussion of it is not necessary here.

However, dimorphism is described herein for a thlipsurid ostracode. Because this is the first report of dimorphism in the Thlipsuridae, a few comments about it are in order. The thlipsurid ostracode for which dimorphism has been definitely established is *Thlipsuroides striatopunctatus* (Roth). This ostracode is distinctly dimorphic by domiciliar lengthening of the adult female. Associated with this domiciliar dimorphism is the presence of a well-developed posteroventral spine on each valve of the adult females. This feature is absent or only poorly developed on the adult males and immature instars. The significance of the posteroventral spines is uncertain. However, because they are well developed on the adult females and poorly developed or absent on other individuals, they may represent structures which aided the male in holding the female during copulation. Presence of poorly developed spines on some immature specimens may indicate preadult dimorphism. The immature forms which have spines may be those which became adult females. This conclusion is largely based upon conjecture because intra-instar variation and preservation may be important in this respect. However, all adult females have well-developed spines.

Domiciliar dimorphism has been given little, if any, taxonomic significance in podocopid ostracodes. This practice probably is justified in view of the fact that some species of recent ostracodes are known to reproduce both parthenogenetically and syngamically in different areas. However, the classification of Thlipsuridae presently in use is somewhat chaotic. This family appears to have become a "catch all" for any metocopine ostracode which cannot be conveniently classified elsewhere. As dimorphism is definitely known in one thlipsurid ostracode (see above) and indicated in others (see *Thlipsurella*? *curvistriata* (Roth) and *T.*? sp.), it is possible that further study along this line will aid in developing a more workable classification of thlipsurid ostracodes.

It is not surprising that domiciliar dimorphism has been overlooked in previous studies of ostracodes. In many cases it is difficult to detect domiciliar dimorphism, especially if size and shape variation in a species is considerable. The discovery of dimorphism in *Thlipsuroides stria-*

topunctatus (Roth) emphasizes the importance of detailed ontogenetic and variation studies of ostracodes. Certainly the phenomenon of dimorphism must be reckoned with in the classification of thlipsurids, just as it has been reckoned with in the classification of other taxonomic groups.

TAXONOMY

Scott (1961) reviewed the history of ostracode taxonomy and presented some of the problems involved in classification. It is not necessary to discuss these problems further here. The classification followed in this study generally is the one adopted in the *Treatise on Invertebrate Paleontology, Part Q* and discussed by Scott (1961). It is the most recent inclusive classification available and therefore it seems most logical to follow it. It should be emphasized, however, that taxonomic problems still exist and several Henryhouse ostracodes are classified in taxonomic categories, the relationships of which are quite unclear. It is not the purpose of this report to propose major taxonomic revisions, although observations made in this study indicate that such revisions will be necessary in the future. Perhaps this study will aid in clarifying some relationships, but until this clarification is more complete the use of tentative classification is to be expected.

Except where indicated otherwise, terminology used in this study follows that proposed by Moore (1961). Figured and type specimens have been deposited in the collections of the University of Illinois (abbreviated UI) Urbana, Illinois, and The University of Oklahoma (OU) Norman, Oklahoma. Roth's (1929) types, which have been refigured herein, are in the U. S. National Museum (USNM).

SUMMARY AND CONCLUSIONS

The Henryhouse ostracode fauna is large and diversified, consisting of at least twenty-eight genera and forty-six species representing seventeen families and three orders. The Metacopina (especially the Thlipsuridae, Bairdiocyprididae and Pachydomellidae) dominate in number of individuals, but the Beyrichiocopina dominate in number of genera and species. The content of the fauna supports the late Middle or early Late Silurian age previously assigned to the Henryhouse Formation.

Although geographic and stratigraphic distribution of ostracodes in the Henryhouse Formation is irregular, qualitatively the fauna is identical throughout the outcrop area. No certain stratigraphic zonation of ostracodes exists. All species which are significantly abundant range throughout or almost throughout the Henryhouse Formation. The ostracode fauna is essentially the same at the top as it is at the bottom of the unit. The Henryhouse Formation is a distinct stratigraphic unit with a single distinct ostracode fauna.

The occurrence of several genera in the Henryhouse is of special interest. A species of *Rakverella*? represents the first report of the Piretellidae in rocks younger than Ordovician. *Grammolomatella graffhami* Lundin, new species, represents the first report of that genus in North America, and *Eurychilina*, a genus previously not known from beds younger than Middle Silurian, is also present in the Henryhouse. *Hollinella*, *Healdia*, and *Amphissella*, all present in the Henryhouse, have not previously been reported from rocks older than Devonian.

Detailed ontogenetic and morphologic studies have shown that at least one thlipsurid species, *Thlipsuroides striatopunctatus* (Roth), is dimorphic. Dimorphism is indicated for other thlipsurids but more study is needed. Dimorphism may represent a characteristic which will aid in establishing a classification of the Thlipsuridae more critical than that now in use.

Finally, this study has shown what has long been suspected — that many ostracode species previously described as Haragan ostracodes are actually Henryhouse species. The following species are those previously described as Haragan species but are now known to have come from the Henryhouse Formation.

Amphissella primaeva (Roth)
Bairdiocypris magna (Roth)
Velibeyrichia fittsi (Roth)
Dizygopleura landesi Roth
Ehlersia huntonensis (Roth)
Healdia primitiva (Roth)
Octonaria punctata Roth
Phanassymetria inequalis (Roth)
Thlipsurella? *curvistriata* (Roth)
Thlipsuroides parallelus (Roth)*
Thlipsuroides striatopunctatus (Roth)

All present evidence indicates that these species are restricted to the Henryhouse and that the Henryhouse and Haragan ostracode faunas are distinctly different.

* See page 76 for discussion.

SYSTEMATIC DESCRIPTIONS

Subclass OSTRACODA Latreille, 1806

Order LEPERDITICOPIDA Scott, 1961

Family LEPERDITIIDAE Jones, 1856

Genus *Leperditia* Rouault, 1851

Leperditia symmetrica Lundin, new species

Pl. I, figs. la-d; pl. II, figs. la-d; pl. III, figs. la-e

Description. — The valves are subrectangular in lateral, dorsal, and ventral views and elliptical in end view. The dorsum is long and straight. The anterior and posterior borders are equally rounded. The ventral border is gently convex. The valves are amplete to slightly postplete. The cardinal angles are well defined and obtuse. The valves are unequal, the left overlapping the right. The surface is smooth. The contact margin of the left valve appears to be slightly thickened, especially along the anterdorsal and posterodorsal borders; this characteristic may be the best criterion for distinguishing the left valve from the right.

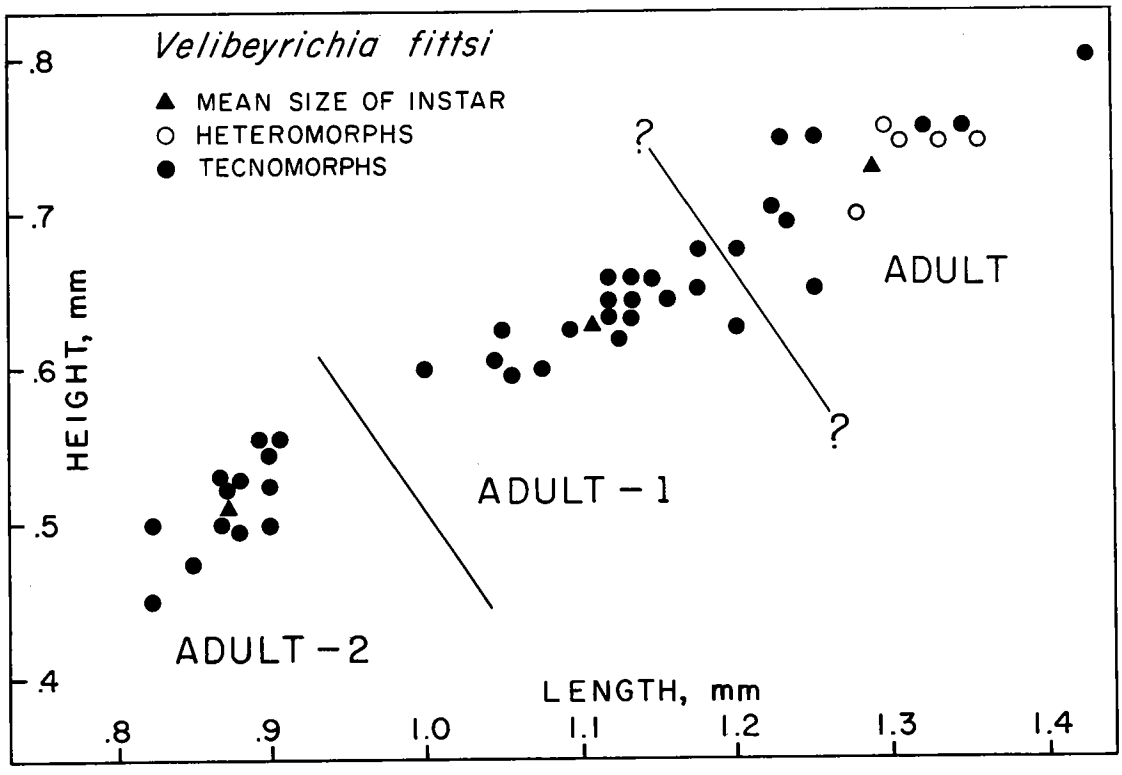
The hinge is straight and simple. It is approximately four-fifths as long as the valve. No evidence of grooves, denticles, or other hinge elements has been seen. The interior surface of the valve is smooth. No marginal structures are present. Muscle scars are not preserved.

Length (left valve of largest specimen available), 3.23 mm; height, 1.75 mm.

Ontogeny. — Sufficient material for detailed ontogenetic studies is not available at this time. At least two immature instars are represented in the material studied. No significant difference occurs between the immature forms and the adults. The shape is identical.

Variation. — The only variation seen in this species is the slight variation in shape. Some specimens are amplete, others slightly postplete. The paucity of specimens prohibits comments on size variation.

Remarks. — This species is questionably assigned to *Leperditia.* The general appearance of the ostracode indicates that it is a leperditiid, but



Text-figure 6. Size-dispersion diagram of *Velibeyrichia fittsi* (Roth) from sample P_3-21.

absence of muscle scars and eye tubercles casts doubt on the generic assignment made here. There is some question about orientation of this species. The orientation used above results in left-over-right overlap. The reverse orientation would result in the greatest height being anterior in specimens which are not amplete. The problem is compounded by the fact that in many specimens the venter is slightly deformed. In such a case it is difficult to know if the specimen were originally amplete, postplete, or preplete. As single valves of amplete specimens are perfectly symmetrical, the only way to orient them is by the arbitrary method mentioned in the description.

The specific name is from the Greek adjective symmetros, referring to the symmetrical form of the valves.

Distribution. — This species has been found in section P_6, samples 3, 4, and 5. It is most abundant in sample P_6-4. It has been found sparsely in section P_3, samples 14, 19, and 20. It has not been seen in the Haragan.

Materials studied. — Forty-four specimens from the above samples have been studied. Of these, only 30 valves are complete or nearly complete and many of these are deformed. Only four carapaces have been found, and all of these are either deformed or the valves have slipped on one another so that no perfect carapace is available.

Holotype. — OU 5069, sample P_3-14; plate I, figures 1a, b.

Figured specimens. — OU 5069-5072c, samples P_6-4, P_3-14, P_3-19, P_3-20.

Order PALEOCOPIDA Henningsmoen, 1953

Suborder BEYRICHICOPINA Scott, 1961

Superfamily BEYRICHIACEA Matthew, 1886

Family BEYRICHIIDAE Matthew, 1886

Genus *Velibeyrichia* Henningsmoen, 1954

Velibeyrichia fittsi (Roth), 1929

Pl. III, figs. 3a-e; pl. IV, figs. 7a-e; text-fig. 6

Beyrichia fittsi Roth, 1929, p. 340, pl. 35, figs. 6a-d; Warthin, 1937, card 18, figs. 6a, c, d; not Kesling, 1957, p. 78, pl. 5, figs. 7-9; not Levinson, Moore, and Berdan, 1961, p. Q112, fig. 48, 1j-l.

Description of female. — The valves are semicircular in lateral view and subrectangular in dorsal, ventral, and end views. The dorsum is straight, and the anterior and ventral borders are broadly convex. The posterior border is gently convex and meets the dorsal border at approximately 90 degrees. The anterior cardinal angle is obtuse. The valves are distinctly preplete and are trilobate. L_1 is developed as a small, low, vertically elongate node just behind the anterior cardinal corner. It is separated from the bulbous L_2 by a weak, slightly arcuate sulcus (S_1). L_2 extends from the dorsum to midheight and is teardrop shaped, being wider at the bottom than at the top. S_2 is elongate and curves anteriorly to join with S_1, thus somewhat isolating L_2. L_3 is a broad well-developed lobe, which curves anteriorly from a position just anterior to the posterior cardinal corner to a midventral position, where it faintly fuses with the crumina. L_3 is divided longitudinally in its dorsal portion by a shallow depression. This depression fades anteroventrally, and the transverse cross section of L_3 becomes gently convex. The portion of L_3 anterior to the depression may rise slightly above the hinge line. The surfaces of the lobes and sulci are finely granulose. A wide velum extends from the anterior cardinal corner to the posterior cardinal corner. It is widest along the venter and narrows uniformly along the anterior and posterior borders. The velum is constituted of radially arranged tubules, which are especially prominent just behind the crumina. The velum passes uninterruptedly over the crumina. The contact between the velum and the lateral surface of the valve is a deep groove due to the lateral flaring of the velum. Distal to this groove on the exterior surface of the velum is a ridge, which is most prominent along the posteroventral portion of the velum (border crest of Martinsson, 1962, p. 75). The crumina occupies an anteroventral position. It is a large bulbous pouch, subelliptical in outline. The surface of the crumina is smooth, but the faint striations along the distal edge of the inner surface of the velum are not interrupted as the velum crosses the crumina. A toric ridge (Martinsson, 1962, p. 75) arises on the inner surface of the velum anterodorsally to the crumina. This feature extends across the crumina (pl. III, fig. 3c) and fades gently into the velum in the posteroventral portion of the latter. The toric ridge varies in development, being prominent in some specimens but only poorly de-

veloped in others. The contact margin is essentially smooth except in the anterodorsal portion, where its distal limit is composed of a row of short spines. No marginal structures are evident, and apparently the valves met along a relatively simple contact margin. The contact margin of the left valve is just slightly rabbeted to receive the right valve. The adventral morphology is illustrated in plate III, figures 3c and 3e.

The hinge is relatively simple. A shallow groove in the hinge of the right valve is indicated, but more well-preserved material is necessary to substantiate its presence. The interior of one specimen is clean enough to show that the lobes and sulci are distinctly reflected interiorly. This is especially true of L_2, S_2, L_3, and the crumina.

Length (including velum), 1.50 mm; height (including velum), 1.08 mm.

Description of male. — The male is similar to the female in all respects but the following. The male has no crumina; as the crumina imparts the distinctly preplete shape to the female, the male is only slightly preplete to slightly postplete. L_1 and L_3 of the males join faintly with L_2. The connection of L_3 and L_2 in the males forms a faint zygal arch. The male velum is somewhat narrower than that of the female, but the velar tubules are generally more prominent in the male. The anteroventral depression is quite distinct.

Length (including velum), 1.38 mm; height (including velum), 1.00 mm.

Ontogeny. — Three instars have been found in the population studied (text-fig. 6). The size-dispersion diagram indicates that the adult and adult −1 instars are not clearly separated. The boundary between the adult −1 and adult −2 instars is distinct. Growth factors are within the range that might be expected for such an ornate species as *Velibeyrichia fittsi* (table 2).

Table 2 gives the average length and height for the last three instars. Length and height in this case do not include the velum. Length is the maximum distance from the anterior to the posterior contact margins parallel to the hinge. Height is the maximum distance from the hinge to the ventral contact margin. Growth factors and the number of specimens measured are included in the table.

Except for size, the adult −1 instar has the same features as the adult male. All features are proportionately less developed. On one specimen the velum and L_1 are less well developed than on the other specimens. The velum is present as a distinct feature on most specimens, although the posteroventral portion is commonly broken. No evidence of a crumina has been found in any specimen of the adult −1 instar. The only basic difference between the adult −1 and adult −2 instar is size. Again, two specimens show L_1 and the velum to be poorly developed compared to the other specimens. Generally the velum is prominent except along the posterior border.

Variation. — Variation is not a problem in identification of this species. The male dimorphs vary in the degree of flaring of the velum. The groove along the proximal border of the velum is much more pronounced in some than in others (compare figs. 7a and 7b, pl. IV). This may be due to preservation of the specimens. More material is needed to determine if this is a true morphological variation. The variation in the development of the velum in the immature instars may be an indication of preadult dimorphism. The specimens with the relatively poorly developed velum may represent immature forms destined to become adult males. More well-preserved material is needed to substantiate this supposition.

Remarks. — Considerable doubt has arisen concerning the type specimens and the content of the species. This problem should be reviewed here. Roth originally illustrated two specimens: one nearly complete male left valve and one fragmentary female left valve. He did not designate a holotype and apparently both specimens were placed on one type slide (USNM 80655).

Warthin's (1937) revised description of the species was based upon the male specimen. He considered the female valve to be a different species, stating that "there are pronounced differences in the two specimens, both in shape of the nodes, and in the surface ornamentation" (Warthin, 1937, card 18).

Kesling (1957) restudied the specimens which were still on one slide marked "Holotype." He noted that the female specimen was not the specimen which Roth originally illustrated. Kesling was of the opinion that Warthin had reillustrated Roth's specimens. This is not true. Warthin's illustrations are simply reproductions of Roth's original figures. Therefore there is no way to be sure that Warthin actually examined Roth's female specimen. It seems likely that Warthin did see Roth's female specimen because the female specimen Kesling studied is distinctly different from Roth's original figure, and Warthin made no such notation. Kesling concluded that the female and male specimens were probably conspecific and stated that the "differ-

ences in size and lobation are minor, and those in ornamentation can be attributed to preservation" (Kesling, 1957, p. 78). Kesling accordingly drew reconstructions of "*Velibeyrichia fittsi*" based largely upon the female specimen, which he acknowledged as being poorly preserved and "crushed and distorted in the posterior region" (Kesling, 1957, p. 78).

The two specimens which Kesling studied are now on separate slides. The female valve is USNM 80655 and the male valve is USNM 80655A. The female specimen is certainly not Roth's original specimen and is definitely the one studied by Kesling. The male valve is definitely Roth's type specimen and is here designated as the lectotype. The two are not conspecific. The male valve is well preserved and the surface is finely granulose. The female specimen is crushed and the surface is distinctly reticulate. The female specimen lacks the longitudinal depression in L_3 which is quite distinct in the male. Of the specimens in the author's collection, none is reticulate and all have the depression in L_3. Comparison of the female specimen on the type slide with all the beyrichiids collected from the Henryhouse and Haragan indicates that it is in all probability not from the Hunton marlstone. It apparently is a stray specimen placed on the type slide in place of Roth's original specimen. Therefore Kesling's drawings do not accurately illustrate *Velibeyrichia fittsi.*

As noted in the above description, the posteroventral portion of the velum tends to break along the border crest. This is true of Roth's male type specimen. The fracture commonly is so smooth that the velum appears to end in the posteroventral area. Actually the velum continues as a complete velum to the posterior cardinal corner. In this respect, Warthin's (1937) revised description of *V. fittsi* is misleading.

It should be noted that on page Q113 of the *Treatise on Invertebrate Paleontology* three views of "*Beyrichia*" *kiaeri* Henningsmoen are mislabeled as "*B.*" *fittsi* Roth (p. Q112). These illustrations are taken from Kesling (1957). Roth's species is not illustrated in the *Treatise on Invertebrate Paleontology.*

V. fittsi has a close relative in the Haragan Formation. The Haragan species differs from *V. fittsi* in having a velum which narrows abruptly in the posteroventral area, in lacking the depression in L_3, and in the males having no toric ridge. Warthin (1937) considered the two conspecific and listed a Haragan occurrence at White Mound (Murray County, Oklahoma). The writer has not seen *V. fittsi* in the Haragan.

V. fittsi is closely related to *V. tonolowayensis* (Ulrich and Bassler), 1923, which differs from it in having two distinct ridges on L_3. *V. tonolowayensis* is from the Tonoloway Formation (Silurian) of Maryland.

Undoubtedly Roth's type specimens came from the Henryhouse because no Haragan is present in the immediate area of his collecting locality.

According to Henningsmoen's (1954) classification of the Beyrichiidae, Roth's species belongs to the subgenus *Beyrichia* (*Velibeyrichia*) Henningsmoen. This subgenus was given generic rank by Martinsson (1962) in his definitive study of the Beyrichiidae. This procedure, although not followed by Levinson, Moore, and Berdan (1961), is used here.

Distribution. — *Velibeyrichia fittsi* has been found only in the upper two-thirds of the Henryhouse and in only moderate abundance in two samples (P_3-21, P_4-1). No significance is attached to its rather limited occurrence because it is generally scarce. This species has not been found in the Haragan Formation.

Materials studied. — The population studied consists of 45 measurable specimens. Many broken specimens were found in addition to these. No carapaces have been found. Generally, the material is not well preserved. The complete or nearly complete valves are in all cases caked with matrix. The difficulty of cleaning specimens without breaking them has limited detailed study of this species to a relatively few specimens. Procurement of more well-preserved material may result in slight modification of the observations presented above concerning morphology, ontogeny, and variation. Roth's type specimen, which is one male left valve, has been studied.

TABLE 2.—GROWTH FACTORS FOR VELIBEYRICHIA FITTSI

INSTAR	LENGTH (MM)	GROWTH FACTOR	HEIGHT (MM)	GROWTH FACTOR	NUMBER OF SPECIMENS
Adult	1.288		0.730		14
		1.156		1.155	
Adult —1	1.114		0.632		18
		1.273		1.232	
Adult —2	0.875		0.513		13

Lectotype. — USNM 80655A c; plate III, figure 3a.

Figured specimens. — OU 5073a-5073h, sample P_3-21.

Superfamily DREPANELLACEA Ulrich and Bassler, 1923

Family AECHMINIDAE Bouček, 1936

Remarks. — In addition to the species described below, several species of *Aechmina* and one species of *Aechminaria* have been found in Henryhouse samples ranging from near the bottom to near the top of the section. None of these aechminids is represented by sufficient well-preserved material to be described or illustrated at this time. However, comparison with the species described below indicates that most of them definitely are different species. Description of these species must be deferred until more material is available.

Genus *Aechmina* Jones and Holl, 1869

Aechmina adinobasota Lundin, new species

Pl. IV, figs. 1a,b

Description. — The valves are subquadarate in lateral view and elliptical in dorsal, ventral, and end views. The dorsal border is straight. The ends are broadly rounded, the posterior being more sharply rounded than the anterior. The ventral border is gently convex. The greatest length is at midheight, and the valves are amplete to slightly preplete. The cardinal angles are distinct and obtuse, the posterior angle being somewhat greater than the anterior. A spine arises from the dorsum just anterior to midlength. The spine has a stout base but tapers rapidly as it curves slightly to the posterior. The tip of the spine is commonly broken, but one perfect valve shows the length of the spine to be about three-fourths the height (hinge to venter) of the valve. The valves are finely granulose. No adventral or marginal structures are present.

The hinge is straight and about seven-tenths as long as the valve. No special hinge structures have been observed on the several specimens that are well enough preserved for a study of hingement. The interior of the valve is smooth. Muscle scars have not been seen.

Length, 0.72 mm; height (excluding spine), 0.41 mm.

Ontogeny and variation. — The small number of specimens available make ontogenetic studies impossible. Slight variation is present in the amount of curvature of the spine but is not significant in identification of this species.

Remarks. — *Aechmina adinobasota* is similar to *A. bovina* Jones from the Silurian of England. These species can be distinguished by the larger size of the latter and by the fact that the spine on *A. bovina* flares laterally more than does that of *A. adinobasota*. Also, the spine of the species described here is more delicate than is the spine of *A. bovina*.

The specific name is from the Greek adjective adinos, meaning thick, and basota, meaning base, having reference to the thick-based spine.

Distribution. — This species has been found in only two samples (P_3-11 and P_3-17).

Materials studied. — Eight specimens of this species have been found. Two are deformed carapaces, four are deformed or chipped valves, and two are well-preserved valves.

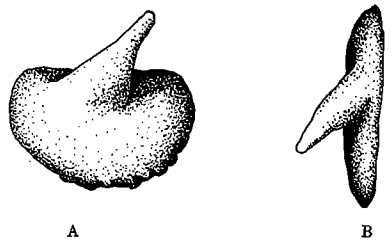
Holotype. — OU 5074, sample P_3-11; plate IV, figures 1a,b.

Aechmina fragilis Lundin, new species

Text-fig. 7

Description. — The valves are semicircular in lateral view and elliptical in dorsal, ventral, and end views. The dorsum is straight and the free border evenly rounded. The greatest length is approximately at midheight, and the valves are amplete to slightly preplete. The anterior cardinal angle is slightly obtuse, whereas the posterior cardinal angle is distinctly obtuse. At midlength on the dorsolateral surface is a thick-based posteriorly directed spine. The spine tapers rapidly to a sharp point, which is commonly broken. It is approximately as long as the valve is high. The surface of the valve is smooth. A row of extremely minute marginal spines is preserved on several specimens.

The hinge is straight and about nine-tenths the length of the valve. The extreme fragility of the shell makes it impossible to clean specimens well



Text-figure 7. ***Aechmina fragilis*** **Lundin, new species; holotype (OU 5075), x50.**
A. Left lateral view.
B. Dorsal view.

enough for study of the hinge and interior. However, no special hinge elements have been seen and the interior apparently is smooth. Muscle scars have not been seen.

Length, 0.52 mm; height (excluding spine), 0.29 mm.

Ontogeny and variation. — The paucity of material makes study of ontogeny and variation of this species impossible.

Remarks. — *Aechmina fragilis* is extremely thin shelled. Therefore, well-preserved specimens are uncommon. However, several specimens have been found which are preserved well enough for accurate description and comparison with published species. This species is similar to *A. simplex* Ulrich and Bassler and *A. bovina* var. *punctata* Krause. It can be distinguished from the former by its smaller size and its marginal spines. It differs from the latter in its smaller size and more posteriorly directed spine. *A. bovina* var. *punctata* Krause is from the Silurian of northern Europe, and *A. simplex* Ulrich and Bassler is from the Middle Silurian of Maryland.

The specific name is the Latin adjective fragilis and refers to the fragility of the valves.

Distribution. — This species has been identified from only one Hunton sample (P_3-11).

Materials studied. — Nine valves have been studied. No carapaces have been seen. Three valves are nearly perfect. All others are chipped or deformed, two of them to the extent that identification is uncertain.

Holotype. — OU 5075, sample P_3-11; text-figure 7.

Aechmina perpendicularis Lundin, new species

Pl. IV, figs. 2a-f

Description. — The valves are subquadrate in lateral view and subelliptical in dorsal, ventral, and end views. The dorsal border is straight, the ventral border gently convex, and the ends bluntly rounded. The greatest length is at midheight, and the greatest height is at or just in front of midlength. The cardinal angles are obtuse. The posterior cardinal angle is larger than the anterior cardinal angle. The only prominent ornamentation on the valves is a relatively short dorsocentral spine. The spine is perpendicular to the lateral surface of the valve, although its tip is curved slightly upward. The spine bears a sharp point but is stout and therefore commonly well preserved. A slight nodelike swelling is present in front of the spine on two of the well-preserved adult specimens. Two other well-preserved adults show no evidence of this feature. No depression which can qualify as a pit or sulcus is present. The surface of the valves appears smooth, but actually is faintly reticulate. No adventral or marginal features are present.

The hinge is straight and about seven-tenths as long as the valve. The only special hinge element seen is a small swelling at the anterior end of the hinge on the right valve. The single well-preserved left valve hinge available shows no special hinge elements. The interior of the valves probably is smooth. No features have been seen along the contact margin. Muscle scars have not been seen.

Length, 0.75 mm; height (excluding spine), 0.42 mm.

Ontogeny and variation. — Lack of well-preserved immature specimens precludes the possibility of ontogenetic studies. The only variation of note among the few adult specimens available for study concerns the small nodelike swelling anterior to the spine. This feature is absent on two well-preserved specimens and present on two others. In the latter case, the feature is so poorly developed that it is not considered significant in classification. The true significance of this variation cannot be determined until more specimens of this species are studied.

Remarks. — Of the described species of *Aechmina*, *A. aechmessa* Opik from the Silurian of Australia and *A. depressicornis* Jones from the Silurian of England are the most similar to *A. perpendicularis*. However, Opik's and Jones' species are distinctly preplete and have the spine relatively close to the anterior margin. *A. perpendicularis* is amplete to slightly preplete and has the spine at about midlength.

The specific name is the Latin adjective perpendicularis, meaning at right angles to, and refers to the orientation of the spine.

Distribution. — This species has been identified definitely in only one sample (P_3-11). It has been questionably identified in sample P_6-4.

Materials studied. — Twelve valves of this species have been found. Of these, only four are well preserved, and three are so poorly preserved that identification is questionable. The latter have not been used in the description. No carapaces are known. The specimens are too fragile to clean perfectly and therefore the interior of the valves has not been studied.

Holotype. — OU 5076, sample P_3-11; plate IV, figures 2a,b.

Figured specimens. — OU 5076-5077c, sample P_3-11.

Aechmina sesquipedalis Lundin, new species

Pl. IV, figs. 3a-e

Description. — The valves are subquadrate in lateral view and subelliptical in dorsal, ventral, and end views. The anterior border is straight to slightly convex, and the posterior border is gently rounded. The ventral border is broadly convex, and the dorsal border is straight. The greatest length is just above midheight. The greatest height (excluding the spine) is in front of midlength. The anterior cardinal angle is slightly obtuse, and the posterior cardinal angle is distinctly obtuse. The valves are distinctly preplete. The valves are completely void of ornamentation except for an extremely long spine which arises from the dorsolateral surface of the valve just anterior to midlength. The hollow spine tapers gradually from its base as it curves gently in a posterior direction. The tip of the spine invariably is broken. The surface of the valve and spine is smooth. No adventral or marginal structures are present.

The hingement apparently is simple. However, only a few specimens are available for study and more material may result in modification of this statement. Although completely clean interiors of this species are not available for study, the interior of the valves apparently is smooth. No features are present along the contact margin. Muscle scars have not been seen.

Length, 0.78 mm; height (excluding spine), 0.49 mm.

Ontogeny and variation. — The small number of specimens available prohibits ontogenetic and variation studies. Only one well-preserved immature specimen is known. It is similar to the adults except for size and the relative position of the spine. The spine is relatively closer to the anterior border on the immature specimen than on the adult. Only four well-preserved adult specimens have been found. No significant morphological variation has been seen.

Remarks. — The author knows of no species with which *A. sesquipedalis* can be confused. Of previously described species it seems most nearly related to *A. bovina* Jones. It can be distinguished from the latter by its longer and more erect spine, and by the fact that the spine curves posteriorly rather than anteriorly. *A. bovina* is from the Silurian of England.

The specific name is the Latin adjective sesquipedalis, meaning half a yard long, and refers to the unusually long spine on this species.

Distribution. — *A. sesquipedalis* has been found in only three samples (P_3-11, P_{18}-1, Ca_1-8). The paucity of this species limits the significance which can be attached to its limited stratigraphic occurrence. This species is not present in the Haragan Formation.

Materials studied. — Seven specimens from sample P_3-11, one specimen from sample Ca_1-8, and one specimen from sample P_{18}-1 have been studied. Six of these are complete or nearly complete valves, although the tip of the spine is invariably broken. The other three specimens are chipped valves.

Holotype. — OU 5078, sample P_3-11; plate IV, figures 3a,b.

Figured specimens. — OU 5078-5079b, sample P_3-11.

Aechmina sp. A

Pl. IV, figs. 4a-d

Description. — The valves are semicircular in lateral view and elliptical in dorsal, ventral, and end views. The dorsal border is straight and the free border is evenly rounded. The posterior border is somewhat more sharply rounded than is the anterior border. The greatest length is slightly above midheight and the greatest height is at or just anterior to midlength. The cardinal angles are slightly obtuse, the posterior being greater than the anterior. Anterior to midlength along the dorsum is a long, thick spine. The spine is inclined slightly toward the posterior and curves gently in the same direction. The tip of the spine is broken from both specimens available for study. However, the spine is approximately eight-tenths as long as the valve is high. The surface of the valve is smooth. No marginal structures are present.

The hinge is straight and about eight-tenths as long as the valve. No special hinge structures are present. The interior of the valves apparently is smooth. Muscle scars are not known.

Length, 0.91 mm; height (excluding spine), 0.55 mm.

Remarks. — Only three specimens of this species have been found, all from sample P_{18}-1. Although all three specimens are well preserved, it is thought that naming of this species should be deferred until more material can be studied. The relatively large size, the long, thick spine, and the lateral outline easily distinguish *A.* sp. A from other Henryhouse species of *Aechmina*. *A.* sp. A is similar to *A. longispina* Coryell and Cuskley but differs in that it is larger, has amplete or nearly amplete valves, and has a more inclined spine.

Figured specimens. — OU 5080a-5080c, sample P_{18}-1.

Aechmina sp. B

Pl. IV, figs. 5a,b

Description. — The valve is subquadrate in lateral view and elliptical in dorsal, ventral, and end views. The dorsal border is straight and the anterior border is bluntly rounded. The ventral border is broadly rounded and a definite swing is developed. The posterior border is sharply rounded. The greatest length is distinctly above midheight, and the valve is preplete. The cardinal angles are obtuse, the posterior being distinctly larger than the anterior cardinal angle. A straight erect spine is present at midlength along the dorsum. The spine is thick based and about half as long as the maximum height of the valve excluding the spine. The anterior portion of the valve is slightly swollen into a low lobe. However, no sulci can be distinguished. The surface of the valve is finely granulose. A row of small spines is present around most of the free margin.

The hinge apparently is simple, although more material should be studied. The hinge is straight and about two-thirds as long as the valve. The interior of the valve is smooth. Muscle scars are not known.

Length, 1.01 mm; height (excluding spine), 0.59 mm.

Remarks. — Only one specimen of this species is known. Although it is well preserved, more material should be studied before this species is named. The specimen is from sample P_6-3 and can be distinguished from other species by its lateral outline, marginal spines, and relatively large size. The author knows of no published species which is identical to *Aechmina* sp. B.

Figured specimen — OU 5081, sample P_6-3.

Aechmina sp. C

Pl. IV, figs. 6a,b

Description. — The valve is subquadrate in lateral view and subelliptical in dorsal, ventral, and end views. The dorsal margin is straight, the anterior margin bluntly rounded, the ventral margin broadly convex, and the posterior margin sharply rounded. The greatest length is about midheight, and the valve is slightly preplete. The cardinal angles are unequal, the anterior being slightly obtuse and the posterior being distinctly obtuse. A spine is present at midlength along the dorsum. It is straight and almost perpendicular to the dorsum. The spine tapers rapidly upward from its thick base and is about half as long as the height of the valve from hinge to venter. A low lobe is developed behind the anterior margin of the valve. Sulci are not distinguishable. The surface of the valve is granulose. No marginal structures are present.

The hinge is straight, simple, and about seven-tenths as long as the valve. The interior of the valve apparently is smooth. Muscle scars are unknown.

Length, 1.04 mm; height (excluding spine), 0.65 mm.

Remarks. — One well-preserved specimen of this species has been found in sample P_6-3. It is similar to *Aechmina* sp. B except for a slightly different lateral outline and the absence of marginal spines. *A.* sp. C is smiliar to *A. geneae* Roth, but the spine of the latter is inclined toward the posterior. Also, *A. geneae* has a distinctly smaller length-height ratio. Although it appears to be a new species, more material should be studied to determine definitely the specific characteristics of *A.* sp. C.

Figured specimen. — OU 5082, sample P_6-3.

Genus *Aechminaria* Coryell and Williamson, 1936

Aechminaria arrecta Lundin, new species

Pl. V, figs. 5a-d

Description. — The valves are nearly semicircular in lateral view and elliptical in dorsal, ventral, and end views. The dorsal border is straight and the free border is broadly rounded. The posterior border is slightly sharper than the anterior. The greatest length is about midheight, and the valves are amplete. The cardinal angles are obtuse, the posterior angle being slightly larger than the anterior. Just in front of midlength along the dorsum, is a straight, thick spine. The length of the spine is almost perpendicular to the hinge line, slanting very slightly toward the posterior. The spine is about five-eights as long as the valve is high. A subcircular pit is developed at the anteroventral margin of the base of the spine. The anterior portion of the valve is slightly swollen into a small lobe. The valve surface is smooth. No adventral or marginal structures are present.

The hinge is straight and about three-fourths as long as the valve. Only left valves are available for study, but no evidence of special hinge elements is apparent. The interior is smooth. Muscle scars are not known.

Length, 0.95 mm; height (excluding spine), 0.52 mm.

Ontogeny and variation. — Because only a few adult specimens of this species have been found,

ontogenetic and variation studies are impossible.

Remarks. — This species is closely related to *Aechminaria henryhousensis* but differs from it in its more circular lateral outline and more erect spine.

The specific name is derived from the Latin adjective arrectus, meaning upright, and refers to the orientation of the spine.

Distribution. — *A. arrecta* is known from only one Hunton sample (P_6-4).

Materials studied. — This species is represented by three left valves. Two of these are nearly perfect and the third is chipped. However, preservation is good enough to allow accurate description.

Holotype. — OU 5087, sample P_6-4; plate V, figures 5a,b.

Figured specimens. — OU 5087, 5088, sample P_6-4.

Aechminaria henryhousensis Lundin, new species

Pl. V, figs. 4a-e

Description. — The valves are subquadrate in lateral view and elliptical in dorsal, ventral, and end views. The dorsal border is straight, the anterior border bluntly rounded, the posterior border sharply rounded, and the venter gently convex. The greatest length is about midheight, and the valves are distinctly preplete to almost amplete. The cardinal angles are distinctly obtuse, the posterior angle being somewhat greater than the anterior. A straight posteriorly directed spine arises from the dorsum just in front of midlength. It is about one-half as long as the valve is high and ends in a blunt point. The spine is generally well preserved. At the anteroventral margin of the base of the spine is a small but distinct pit. Just behind the anterior border the valves are slightly swollen into a faint lobe. The surface of the valves is smooth. No adventral or marginal structures are present.

The hinge is straight, simple, and about three-fourths as long as the valve. The interior has not been carefully studied because the matrix cannot be cleaned from it without danger of breakage. Apparently the interior is smooth. Muscle scars have not been seen.

Length, 0.91 mm; height (excluding spine), 0.49 mm.

Ontogeny and variation. — Only three adult specimens of this species are known. More material is necessary before ontogenetic studies are possible. Slight variation occurs in the development of the anterior lobe and length of the spine.

Remarks. — *Aechminaria henryhousensis* is similar to *A. robusta* Coryell and Williamson, 1936, from the Silurian of Indiana but differs from the latter in its greater length-height ratio and relatively longer spine. Also, the spine of *A. henryhousensis* is more erect than that of *A. robusta.*

The specific name refers to the occurrence of this species in the Henryhouse Formation.

Distribution. — This species is known from only one sample (P_6-4).

Materials studied. — *A. henryhousensis* is represented by three perfect right valves. Preservation is excellent.

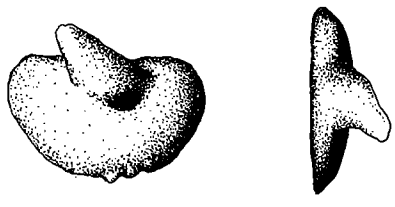
Holotype. — OU 5085, sample P_6-4; plate V, figures 4a,b.

Figured specimens. — OU 5085-5086b, sample P_6-4.

Aechminaria sp. A

Text-fig. 8

Description. — The valves are subsemicircular in lateral view and elliptical in dorsal, ventral, and end views. The dorsum is straight, the anterior border bluntly rounded, the posterior border gently rounded, and the ventral border broadly convex. The greatest length is at midheight, and the valves are slightly preplete. The anterior cardinal angle is slightly obtuse; the posterior cardinal angle is distinctly obtuse. A thick-based stout spine arises at midlength along the dorsal border. It is straight, posteriorly directed, and about seven-tenths as long as the valve is high. The spine tapers rapidly from its thick base to a blunt point. A small, poorly developed pit exists at the anteroventral margin of the spine. The surface of the valves is smooth. The free margin is ornamented with a row of small papillae.



A B

Text-figure 8. ***Aechminaria* sp. A (OU 5089), x50.**
A. Right lateral view.
B. Dorsal view.

The hinge is straight, simple, and about eight-tenths as long as the valve. The interior is smooth. Muscle scars are unknown for this species.

Length, 0.52 mm; height (excluding spine), 0.32 mm.

Remarks. — *Aechminaria* sp. A is distinct from other species of this genus described from the

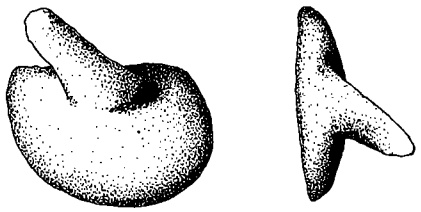
Hunton Group. However, it is known by only two valves (one right and one left), one of which is poorly preserved and the other of which is slightly chipped. It probably is new, but specific assignment of this species should be deferred until more material is available for study. The two specimens are from sample P_3-11.

Figured specimen. — OU 5089, sample P_3-11.

Aechminaria sp. B

Text-fig. 9

Description. — The valves are subquadrate in lateral view and elliptical in dorsal, ventral, and ends views. The dorsal border is straight, the ends are bluntly rounded, and the ventral border is distinctly convex. The greatest length is about midheight and the valves are amplete. The cardinal angles are almost equal and only slightly obtuse. An extremely long spine, which slants upward and backward, arises from the middle of the dorsum. Specimens with the entire spine preserved are not known, but the spine is straight and apparently nearly equals the length of the valve. A poorly developed pit is present at the base of the spine along its anteroventral margin. The surface of the valves is smooth. No marginal or adventral structures are present.



Text-figure 9. ***Aechminaria*** **sp. B (OU 5090), x50.**
A. Right lateral view.
B. Dorsal view.

The hinge is straight, simple, and almost equals the valve in length. The interior is smooth. Muscle scars have not been seen.

Length, 0.52 mm; height (excluding spine), 0.36 mm.

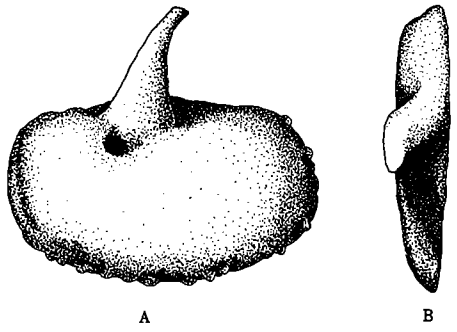
Remarks. — This species is distinguished from *Aechminaria* sp. A by its longer spine and absence of marginal spines. It is represented by one well-preserved (although the spine is broken) right valve and one broken left valve. Both specimens are from sample P_6-4. This also probably is a new species, but more material should be studied before definite specific assignment is made.

Figured specimen. — OU 5090, sample P_6-4.

Aechminaria sp. C

Text-fig. 10

Description. — The value is subquadrate in lateral view and elliptical in dorsal, ventral, and end views. The dorsal border is straight, the anterior border bluntly rounded, the posterior border sharply rounded, and the ventral border broadly convex. The greatest length is above midheight, and the valve is preplete. The cardinal angles are obtuse, the posterior angle being distinctly greater than the anterior. A well-developed spine, which curves gently toward the posterior, arises just in front of midlength on the dorsum. The spine is erect, sharp, and about two-thirds as long as the valve is high. A distinct pit is present at the anteroventral border of the spine. The anterior portion of the valve is swollen into a low lobe, which is best developed at the anterior cardinal corner. The valve is smooth. A row of spines is well preserved along the ventral border.



Text-figure 10. ***Aechminaria*** **sp. C (OU 5091), x50.**
A. Left lateral view.
B. Dorsal view.

The hinge is straight, simple, and about three-fourths the length of the valve. The interior is smooth. Muscle scars are not known.

Length, 0.91 mm; height (excluding spine), 0.52 mm.

Remarks. — *Aechminaria* sp. C is represented by one nearly perfect left valve from sample P_6-4. Its large size, marginal spines, deep pit, and erect but gently curved spine distinguish it from other species of this genus from the Henryhouse. More material is needed before specific assignment is made.

Figured specimen. — OU 5091, sample P_6-4.

Family BOLLIIDAE Bouček, 1936

Genus *Jonesites* Coryell, 1930

Jonesites henryhousensis Lundin, new species

Pl. V, figs. 1a-j; text-figs. 11, 12

Description. — The valves are subquadrate in lateral view and rectangular in dorsal, ventral, and end views. The dorsum is straight to slightly convex in the posterior two-thirds. The anterior border is sharply rounded, the ventral and posterior borders being broadly rounded. The valves are symmetrical and flattened laterally. Only a slight convexity of the lateral surface occurs in the posterior portion. The cardinal angles are obtuse. The lateral surface of the valves is reticulate and surrounded by a distinct velate ridge. The reticulations are crudely hexagonal and quite constant in size except that those adjacent to the velate ridge are noticeably larger than the others. The velate ridge extends around the entire free border of the valve and at the cardinal corners fuses with the delicate free edge to form a heavy rim on the dorsum. About one-third the length from the anterior this rim is partially interrupted by a distinct sulcus, S_2, which extends anteroventrally from the dorsum. The dorsal rim completely surrounds the sulcus as a loop from which a node arises anterior to the S_2. Anterior to this node the rim has incised in it another sulcus, S_1, which is poorly developed and seen best in dorsal view. On some specimens the S_1 is not visible. Posterior to the S_2 the dorsal rim swells slightly but has not been seen to develop into a distinct spine or node in adult specimens. The velate ridge is distinct and sharp in the posterior and ventral portions but becomes thick and rounded in the anterior. The free edge and hinge are delicate and often are chipped so as to appear scalloped. The loop around the S_2 is poorly developed in some specimens.

The hinge is straight and appears to have no complex elements. Slight swellings do occur at the cardinal corners of left valves where the hinge and contact margin meet. Hingement of right valves has not been observed. The marginal structure is reflected interiorly (text-fig. 11) and is therefore considered a velate ridge. A slight swelling, corresponding to the S_2, occurs on the interior surface.

Length, 0.68 mm; height, 0.44 mm.

Text-figure 11. Longitudinal cross section of adult left valve of *Jonesites henryhousensis* Lundin, new species (UI X-1600i), x50.

Ontogeny. — Four instars have been found in the population studied (text-fig. 12). Growth factors for length and height are less than 1.26 but are not unusually low (table 3).

Ontogenetic changes to note, other than size, are:

1. The swelling posterior to the S_2 in the adult is generally represented in the immature instars as a distinct spine.

2. The relative position of the S_2 shifts forward during ontogentic development. In the adult −3 and adult −4 instars the S_2 is at about midlength. In the adults it is distinctly anterior. The latter change undoubtedly results from the filling out of the posterior portion of the valves. This filling out is especially noticeable from the adult −1 to the adult instar.

Variation. — Variation is similar to that observed by Guber (1962) in *Warthinia nodosa.* Adults generally are amplete but some are distinctly postplete. Variation in development of the S_1 and the loop surrounding the S_2 has already been noted.

TABLE 3.—GROWTH FACTORS FOR JONESITES HENRYHOUSENSIS

INSTAR	LENGTH (MM)	GROWTH FACTOR	HEIGHT (MM)	GROWTH FACTOR	NUMBER OF SPECIMENS
Adult	0.685		0.436		8
		1.223		1.191	
Adult —1	0.560		0.366		25
		1.181		1.162	
Adult —2	0.474		0.315		32
		1.222		1.198	
Adult —3	0.388		0.263		2

The dorsal spine, posterior to the S_2 in the immature instars, varies in development and in at least one adult −1 specimen it is no more than a swelling as in the adults.

Remarks. — This species is closely related to *Ulrichia circa* and *U. reticulata* Coryell and Cuskley (considered the same species by Warthin, 1937-1945). These two species undoubtedly belong to the genus *Jonesites*. They are specifically different from the new species in that the adults have a dorsal spine which is bulbous at its base. Also, the new species is consistently more coarsely reticulate than *U. circa* and *U. reticulata*.

The new species differs from *Jonesites delicata* (= *Placentella delicata*) Wilson in shape and size, Wilson's species being more ovate and considerably smaller.

Jonesites has been questionably classified in the Bolliidae by Scott and Wainwright (1961b). Guber (1962) modified the familial description of the Bolliidae presented by Scott and Wainwright in order to accommodate two Cincinnatian ostracodes. The main change concerns the presence of a true velate ridge in the Ordovician forms discussed by Guber (1962). The new species described above has a true velate ridge as well as other basic features of the Bolliidae. The placement of *Jonesites* in the Bolliidae is supported here.

The specific name refers to the occurrence of this species in the Henryhouse Formation.

Distribution. — This species has been found, at least in small numbers, throughout the Henryhouse strata. It has not been seen in the Haragan.

Materials studied. — The population studied consists of 67 measurable valves and several deformed or chipped specimens. No complete carapaces were found. The population is from sample P_6-4.

Holotype. — UI X-1600a, sample P_6-4; plate V, figures 1a-c.

Figured specimens. — UI X-1600a to X-1600i, sample P_6-4.

Family KIRKBYELLIDAE Sohn, 1961

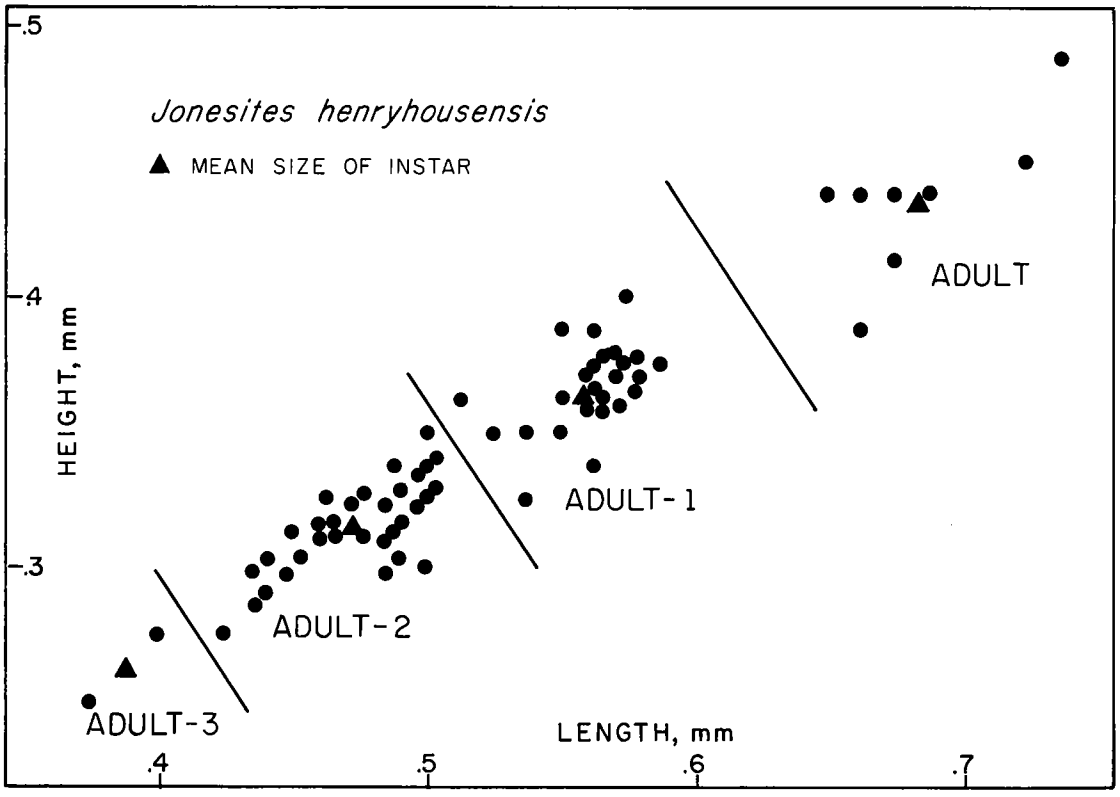
Genus *Kirkbyella* Coryell and Booth, 1933

*Kirkbyella quasiverticalis** Lundin, new species

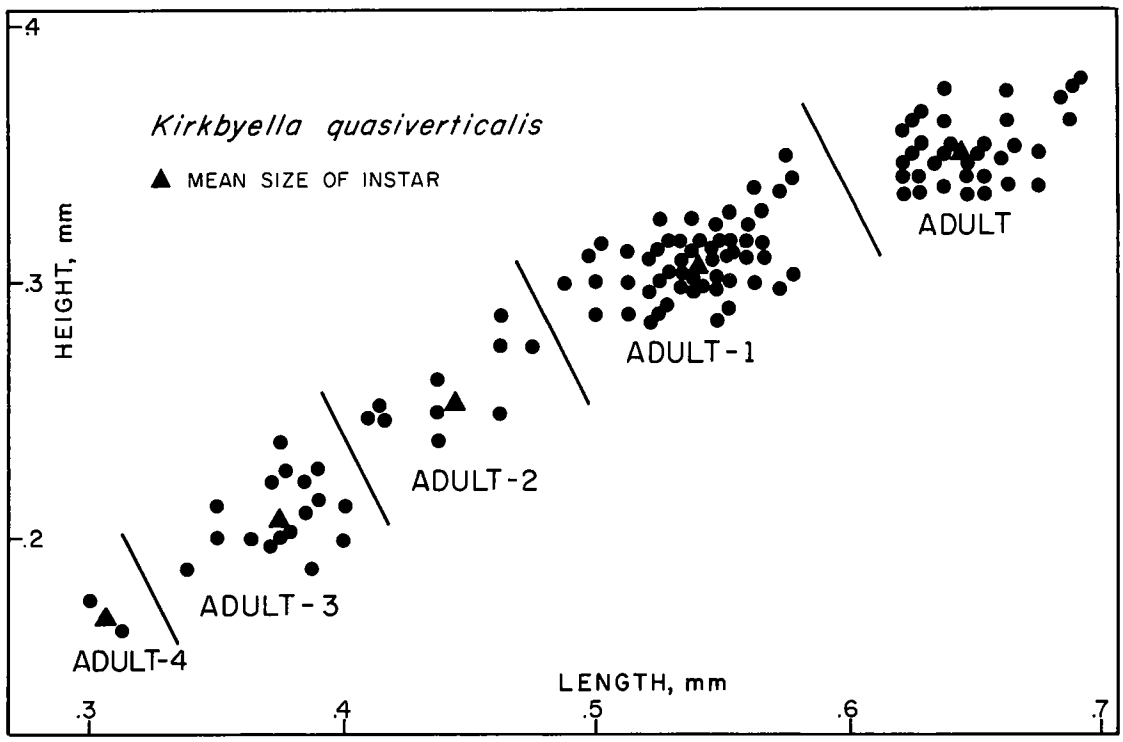
Pl. V, figs. 2a-h; text-fig. 13

Description. — The carapace is rectangular in lateral view and subrectangular in dorsal, ventral,

* According to Sohn (1961b), this species belongs in the subgenus *Kirkbyella (Berdanella)*.



Text-figure 12. Size-dispersion diagram of *Jonesites henryhousensis* Lundin, new species, from sample P_6-4.



Text-figure 13. Size-dispersion diagram of *Kirkbyella quasiverticalis* Lundin, new species, from sample P_3-11.

and end views. The dorsum is straight in the anterior half and very slightly convex in the posterior half. The posterior border is blunt and slants obliquely forward and downward to the straight ventral border. The anterior border is bluntly rounded. The cardinal angles are distinct and obtuse, the anterior cardinal angle being noticeably greater than the posterior cardinal angle. The valves are laterally flattened and equal in size. The lateral surface of the valves is ornamented with irregularly shaped reticulations. A broad, smooth marginal rim corresponds to the free border of the ostracode. This rim continues onto the dorsum to enclose the lateral surface of the valve. At about midlength of the dorsum a distinct S_2 extends vertically downward or obliquely backward, ending in a circular pit just above midheight. Just above the ventral portion of the marginal rim and in the posterior two-thirds of the valve, an elongate swelling parallel to the venter arises. This swelling is reticulate like the lateral surface. It becomes more prominent posteriorly, ending in a blunt but distinct spine.

The hinge is straight and simple. The hinge of the right valve is swollen at either end to form cardinal elements which pivoted on relatively broad flattened areas at the ends of the hinge of the left valve. No ridge-and-groove relationship exists along the length of the hinge. The S_2 is distinctly reflected interiorly as an elevated area. The marginal structure is reflected internally as a depressed zone interior to the free edge of the valve. Also, the ventral swelling which terminates in a spine has a slight internal reflection.

Length, 0.64 mm; height, 0.35 mm.

Ontogeny. — Five instars were found in the population studied (text-fig. 13). The growth factors for length and height do not deviate greatly from 1.26 (table 4).

No significant changes occur in shape, sulcation, or ornamentation in the last four instars. The reticulations, ventral swelling, and marginal rim are distinct in the adult −3 instar. In the adult −4 instar the ventral swelling and reticulations are indistinct, but the marginal rim is still quite prominent (as only two specimens of the adult −4 instar were found, it is possible that the above observations are due to preservation rather than ontogenetic change). The S_2 is weaker in the immature forms and becomes more pitlike in the earliest instars. Generally, it appears that the vertical attitude of the S_2 is more common in the immature forms than in the adults. This is a variable quality, but few of the adult −2 specimens have a distinctly oblique S_2.

Variation. — The only significant variation noted in addition to those mentioned above as being due to ontogenetic development is the

TABLE 4.—GROWTH FACTORS FOR KIRKBYELLA QUASIVERTICALIS

INSTAR	LENGTH (MM)	GROWTH FACTOR	HEIGHT (MM)	GROWTH FACTOR	NUMBER OF SPECIMENS
Adult	0.649		0.351		34
		1.202		1.136	
Adult —1	0.540		0.309		54
		1.224		1.193	
Adult —2	0.441		0.259		10
		1.173		1.233	
Adult —3	0.376		0.210		17
		1.229		1.243	
Adult —4	0.306		0.169		2

variation in attitude of the S_2 within a particular instar. Adults having a distinctly oblique S_2 have been found with adults having a distinctly vertical S_2. They are identical in all other respects. Variation in size is minor (text-fig. 13).

Remarks. — *K. quasiverticalis* is smilar to *K. verticalis* Coryell and Cuskley (1934) but differs from it in its smaller size, different ornamentation, and greater length-height ratio. *K. quasiverticalis* is distinguished from *K. perplexa* Wilson (1935) and *K. unicornis* Coryell and Malkin (1936) in having a smooth marginal rim.

The specific name refers to the similarity of this species and *Kirkbyella verticalis* Coryell and Cuskley.

Distribution. — *Kirkbyella quasiverticalis* has been found near the top as well as in the middle and near the bottom of the Henryhouse strata. It has not been seen in Haragan samples.

Materials studied. — The population studied (sample P_3-11) contained 117 specimens, only one of which was a carapace. Of these, thirty-four were adults. Preservation is good but many specimens are somewhat dirty.

Holotype. — UI X-1601a, sample P_3-11; plate V, figures 2a-c.

Figured specimens. — UI X-1601a to X-1601f, sample P_3-11.

Superfamily HOLLINACEA Swartz, 1936

Family HOLLINIDAE Swartz, 1936

Genus *Grammolomatella* Jaanusson, 1957

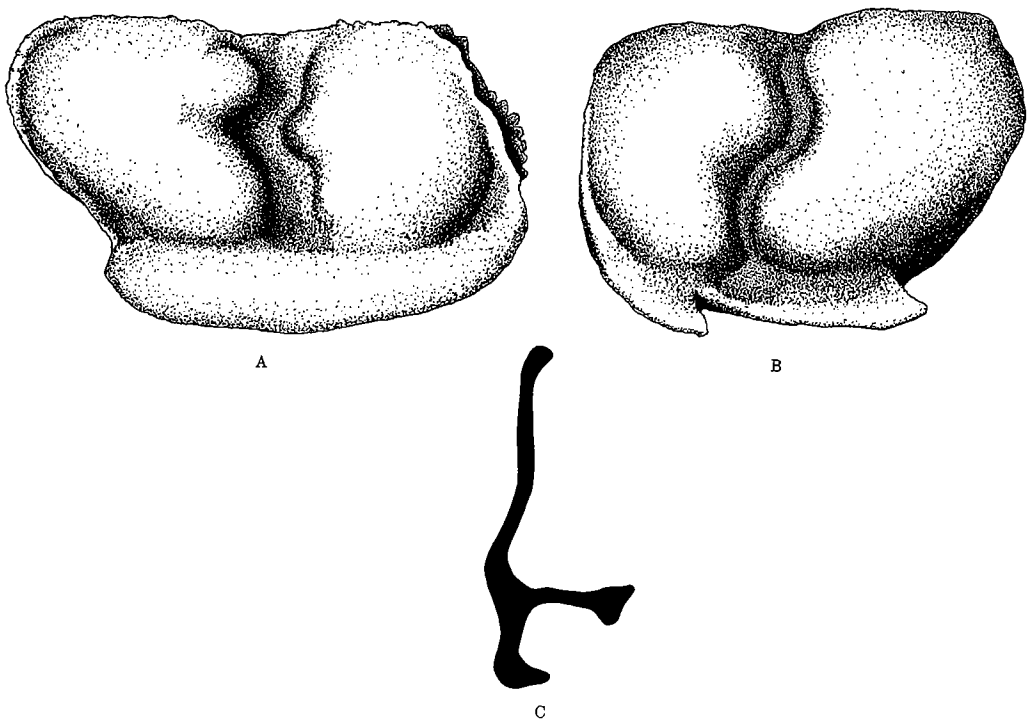
Grammolomatella graffhami Lundin, new species

Pl. VII, figs. 2a-l; text-fig. 14

Description of female. — The valves are subquadrate in lateral view and subrectangular in dorsal, ventral, and end views. The dorsum is straight. The ventral border is gently convex, the anterior border gently rounded, and the posterior border is more sharply convex than is the anterior border. The cardinal angles are obtuse. The valves are preplete and unisulcate. L_1 and L_2 are fused to form a single broad but well-defined lobe, which occupies most of the anterior two-fifths of the valve. It curves posteroventrally to a position just in front of S_2 along the ventral portion of the domicilium. S_2 is a long sigmoidal sulcus, wide in its dorsal portion but narrowing ventrally. The ventral end of S_2 reaches the histium. L_3 and L_4 are completely fused to form a broad but well-defined posterior lobe. The anterodorsal part of the posterior lobe is slightly swollen into a poorly defined node. The posterior lobe narrows as it curves anteroventrally and ends just behind the place where S_2 meets the histium. There is no trace of S_1 or S_3. The surface of the lobes and sulcus is smooth. A well-developed thick histial dolon extends from the anterior to the posteroventral border. It continues onto the anterolateral surface of the valve as a ridge which forms the anterior limit of the anterior lobe. The dolon is especially thick along its anteroventral and ventral borders. A shallow longitudinal depression occurs on the ventral side of the dolon. The posterior end of the dolon is bluntly pointed. The dolon is convex in cross section so that it partially surrounds an elongate curved "false pouch." The dolon is not striate. The contact margin is thickened and that of the left valve slightly grooved to receive the right valve. The only marginal structure seen is a row of extremely small tubercles along the anterior border.

The hinge is straight and of the edge-and-groove type, the groove being in the left valve. The hinge is slightly shorter than the maximum length of the domicilium. The lobes and sulcus are distinctly reflected interiorly. Muscle scars have not been seen.

Length (including dolon), 1.38 mm; height (including dolon), 0.95 mm.



Text-figure 14. ***Grammolomatella graffhami*** **Lundin, new species, x50. Specimens in A and B are illustrated on plate VII, figures 2c,e,f.**

A. Lateral view of female right valve (OU 5251a).
B. Lateral view of male left valve (OU 5251c).
C. Transverse cross section of female right valve (OU 5251j).

Description of male. — The male is like the female except in the following respects. The histium on the male is represented by two posteriorly directed spurs which are connected dorsally by a flange. The anterior spur is situated below the anterior lobe and the posterior spur below the posterior lobe. The histium is flared laterally and is straight in cross section. A dolon is not present.

Length (including histium), 1.35 mm; height (including histium), 0.93 mm.

Ontogeny. — Only a small number of immature specimens has been found. They represent the adult −1 and adult −3 instars. The immature individuals are like the adult males in all respects except size. More material is needed before the ontogeny of this species can be studied in detail.

Variation. — The small number of specimens available prohibits detailed variation studies at this time. Variation appears to be of minor significance in this species. The nodelike swelling of the anterodorsal portion of the posterior lobe is more pronounced in some specimens than in others.

Remarks. — To the author's knowledge this is the first report of *Grammolomatella* from North America. Previously it has been reported from the Ordovician of Scandinavia and the Silurian of Norway, England, and Australia. Of the species included in the genus by Jaanusson (1957), *G. dubitabilis* (Öpik), from the Silurian of Australia, is similar to *G. graffhami*. The latter differs from the former in having stouter tecnomorphic spurs and a better developed histial dolon on the female.

This species is named for Allen Graffham of Ardmore, Oklahoma, who directed the author to the locality which yielded this species.

Distribution. — This species has been found in two samples (Ca_1-8 and P_{18}-1). It has not been found in the Haragan.

Materials studied. — Twenty-three specimens, all isolated valves, have been found in sample P_{18}-1. Of these, seven are adult females, five are adult males, and the others are immature specimens. Preservation generally is good, although a few specimens are slightly deformed or chipped.

Holotype. — OU 5100, sample P_{18}-1, plate VII, figures 2a,b.

Figured specimens. — OU 5100, 5251a-5251j, sample P_{18}-1.

Genus *Hollinella* Coryell, 1928

Hollinella originalis Lundin, new species

Pl. V, figs. 7a-e; text-fig. 15

Description of female. — The valves are subquadrate in lateral view and subrectangular in dorsal, ventral, and end views. The dorsal border is straight and the free border is evenly convex. The cardinal angles are obtuse. The valves are slightly preplete and quadrilobate. L_1 is low and ill defined. It is confluent with the ventral extension of L_4. S_1 is poorly developed and separates only the dorsal parts of L_1 and L_2. L_2 is a distinct node but is confluent anteroventrally with L_1 and ventrally with the ventral extension of L_4. S_2 is well defined and curves anteroventrally from the dorsum. L_3 is a weak node and fuses posteriorly with L_4 so as to obscure S_3. L_4 is a low arcuate lobe, which is better developed along the ventral portion of the lateral surface than elsewhere. The surface is finely granulose. A well-developed frill extends from the middle of the anterior border to the posteroventral border, where it terminates in a velar spur. The frill is slightly flared, and two extremely faint scallops occur along its anteroventral portion. Marginal structures apparently are absent, although completely clean specimens are not available.

The hinge is straight and simple. It is slightly shorter than the maximum length of the domicilium. The lobes and sulci are reflected internally as depressions and elevations, respectively. The contact margin is simple. Muscle scars have not been seen.

Length (including frill), 0.98 mm; height (including frill), 0.63 mm.

Description of male. — The male is like the female except that the frill is narrower, does not end in a spur, and is slightly more flared. The scalloping of the frill is weak to nonexistent on the males. Most male specimens have a very small spinelike process at each cardinal corner.

Length (including frill), 0.98 mm; height (including frill), 0.58 mm.

Ontogeny. — No immature specimens of this species have been found.

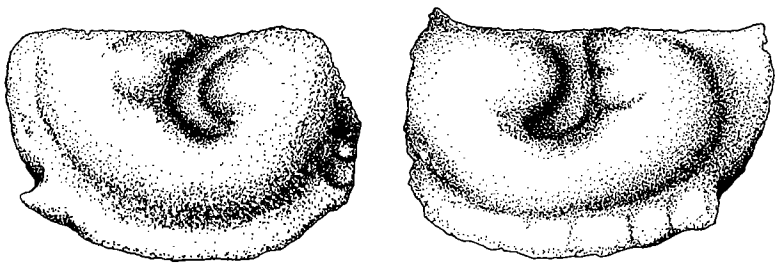
Variation. — Because only a small number of specimens is available, variation in this species cannot be studied at this time. The only variation noted at present concerns the development of spines at the cardinal corners of male specimens. On some they are noticeable at both cardinal corners, on others only at the anterior cardinal corner, and on still others these spines are absent. This variation appears to be normal and is not due to preservation. The slight scalloping of the anterior part of the frill is variable in the males. As only one female valve has been studied, it is not known whether the two faint scallops seen on this specimen represent a consistent morphological feature.

Remarks. — Dimorphism in this species is not well defined. If the velar spur is broken from a female valve, it is extremely difficult to distinguish it from a male valve. However, when well-preserved male and female specimens are seen together, the dimorphic differences are evident.

The generic designation of this species is questionable. The lobation and sulcation are definitely like those of other species of *Hollinella,* and the frill is nearly identical to that of the type species. This is, to the writer's knowledge, the first report of *Hollinella* from the Silurian. Thus the range of the longest lived hollinid ostracode is extended into the Silurian.

The specific name is derived from the Latin word originalis, meaning first, in reference to the fact that this is the earliest known species of the genus.

Distribution. — This species has been found in



Text-figure 15. ***Hollinella originalis*** **Lundin, new species, x50. These specimens are illustrated on plate V, figures 7a,b,d,e.**

A. Lateral view of female right valve; holotype (OU 5093a).
B. Lateral view of male left valve (OU 5093b).

small numbers in three samples (P_3-21, P_4-1, and a core sample 8 feet above the base of the Henryhouse Formation). It has not been seen in the Haragan.

Materials studied. — Eight complete or nearly complete valves and one broken valve of *H. originalis* have been found. Of these only one is definitely a female (the sex of the broken valve cannot be determined). Although preservation is generally good, the specimens are delicate and it has been impossible to clean them perfectly. However, through careful study of all specimens, it is thought that the morphology of this species has been accurately ascertained.

Holotype. — OU 5093a, sample P_3-21; plate V, figures 7a,b.

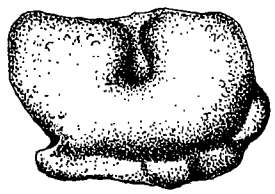
Figured specimens. — OU 5093a-5094, samples P_3-21 and P_4-1.

Genus *Parabolbina* Swartz, 1936

Parabolbina pauxilla Lundin, new species

Pl. V, fig. 6a; text-fig. 16

Description of female. — The valves are subquadrate in lateral view and subrectangular in dorsal, ventral, and end views. The greatest length is at midheight, and the greatest height is at or slightly in front of midlength. The valves are laterally compressed. The dorsal border is straight and the free border is gently convex. The cardinal angles are subequal and slightly obtuse. The valves are amplete to preplete and are unisulcate. S_2 is well developed and extends from the hinge to just below midheight of the domicilium. It is widened into a subcircular depression at its ventral end.



Text-figure 16. Lateral view of the holotype right valve of *Parabolbina pauxilla* Lundin, new species (OU 5092), x50. This specimen is illustrated on plate V, figure 6a.

Lobation or sulcation cannot be discerned on the remaining surface of the valves. The surface of the valves is finely granulose. A well-developed frill extends from the middle of the anterior border to the posteroventral border, where it ends in a blunt posteriorly directed spinelike process. The frill is scalloped into one poorly developed and three distinct scallops. The poorly developed scallop is the one just anterior to the terminal spinelike process and is hardly distinguishable on some specimens. The anteriormost scallop is invariably better developed than are the others. One sharp spine at each cardinal corner is preserved on some specimens.

The hinge is straight and simple. It is slightly shorter than the maximum length of the domicilium. The interior is smooth except where the S_2 is reflected internally. The contact margins are simple.

Length (including frill), 0.73 mm; height (including frill), 0.50 mm.

Description of male. — Male specimens of this species have not been found (see Remarks).

Ontogeny and variation. — The paucity of well-preserved material prohibits ontogenetic and variation studies at this time.

Remarks. — When Swartz (1936) erected the genus *Parabolbina,* he included in it *P. granosa* (Ulrich), 1900, as the type species and *P. limbata* and *P. ventrispinosa,* two new species from the Devonian of Pennsylvania. *P. limbata* is characterized by a scalloped frill, and *P. ventrispinosa* has two velar spurs rather than a frill.

Kesling (1961a) considered Swartz's species to be dimorphs of the same species. The frill is considered the dimorphic structure and is thought to belong to the female.

To the author's knowledge, no male dimorph of *P. granosa* is known. Therefore the true nature of dimorphism in *Parabolbina* is unknown, although it seems certain that this hollinid ostracode is dimorphic. Other species which illustrate the same kind of dimorphism as does *P. limbata* have been described and assigned to this genus (Henningsmoen, 1953).

Specimens similar to male dimorphs of *P. limbata* have not been found for the species described herein. No significance can be given to this situation because this species is uncommon. However, until a male dimorph to the type species is found, assignment of dimorphic species to this genus should be made with caution. Although it seems certain that *P. pauxilla* is dimorphic, description of the male dimorph must be deferred until specimens of it are found.

The species described here unquestionably belongs to *Parabolbina.* The author has not seen the genoholotype, but published illustrations indicate that it is closely related to *P. pauxilla.* The two can be distinguished by the fact that *P. granosa* has five distinct scallops in the frill and its anterior cardinal angle is somewhat greater than that of *P. pauxilla.*

Coryell and Cuskley (1934) referred a Haragan species of *Parabolbina* to *P. granosa* (Ulrich), 1900. The author has studied Coryell and Cuskley's plesiotype. The frill is poorly preserved, and comparison with the genoholotype must be made to establish definitely whether the two are conspecific. The author has studied collections of a Haragan *Parabolbina* which are thought to be conspecific with Coryell and Cuskley's specimen. At present, it is thought that these are not conspecific with *P. granosa,* although they are closely related. At any rate, Coryell and Cuskley's type, the author's Haragan specimens, and *P. granosa* (Ulrich) are not conspecific with *P. pauxilla.*

The specific name is derived from the Latin adjective paucus, meaning few, and refers to the paucity of specimens of this species.

Distribution. — *P. pauxilla* is extremely sparse in the Henryhouse, having been seen in only one sample (P_3-11). This species has not been seen in the Haragan Formation.

Materials studied. — Thirteen complete or nearly complete valves have been found in sample P_3-11. In addition, a number of identifiable fragments have been seen in the same sample. *P. pauxilla* is a delicate form and commonly is broken. Generally the specimens are covered with matrix, and their fragility makes them impossible to clean without breaking them. Four specimens are complete and relatively clean. The description and illustrations are largely based upon these specimens.

Holotype. — OU 5092, sample P_3-11; plate V, figure 6a; text-figure 16.

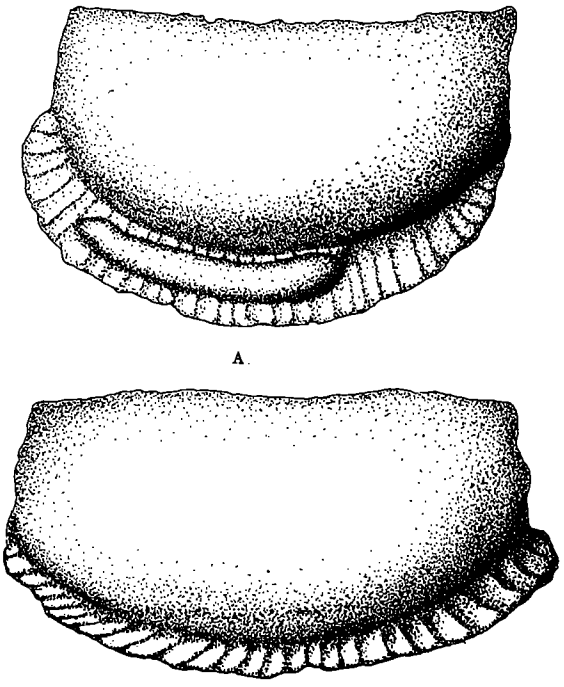
Family EURYCHILINIDAE Ulrich and Bassler, 1923

Genus *Eurychilina* Ulrich, 1889

Eurychilina esulcata Lundin, new species

Pl. VI, figs. 2a-e; text-fig. 17

Description of female. — The valves are subrectangular in lateral view and are laterally compressed so as to appear platelike in dorsal, ventral, and end views. The dorsal border is long and straight. The anterior and posterior contact margins are straight to gently convex. The ventral contact margin is gently convex. The domicilium has an amplete to slightly preplete outline. The anterior cardinal angle is slightly obtuse. The posterior cardinal angle is approximately 90 degrees. The valves are smooth. No sulcation or lobation is evident. A spinelike projection exists at the posterior cardinal corner where the hinge and posterior contact margin meet. A similar feature at the anterior cardinal corner has not been seen. However, only one female specimen with the anterior cardinal corner intact is available. A well-developed velum extends from the middle of the anterior border to the middle of the posterior border and does not reach the cardinal corners. The velum is striate and flares laterally. The anteroventral part of the velum is occupied by a long sausage-shaped dolon, which is restricted to the proximal portion of the velum and actually infringes on the domicilium. No opening exists between the domicilium and the dolon. The dolon is surrounded by a thickened edge, which has aided in preserving it. The contact margin is simple.



A

B

Text-figure 17. ***Eurychilina esulcata*** **Lundin, new species, x50. Drawn from specimens illustrated on plate VI, figures 2a,d,e.**

A. Reconstruction of female left valve (OU 5096a).

B. Reconstruction of male right valve (OU 5096b).

The hinge is straight, simple and almost as long as the maximum length of the domicilium. The interior of the valves is smooth. Muscle scars have not been seen.

Length (including velum), 1.53 mm; height (including velum), 0.93 mm.

Description of male. — The male is like the female except that the velum is flared laterally to a greater extent, the velum lacks a dolon, and a

row of small spines occurs along the ventral contact margin. Evidence of spinelike processes occurs at both cardinal corners of some male specimens. The velum is distinctly striate and extremely delicate.

Length (including velum), 1.53 mm; height (including velum), 0.78 mm.

Ontogeny and variation. — The small number of specimens available prohibits conclusive observations upon ontogeny and variation. Two immature specimens are similar to the adult males except that the velum is poorly developed. The velum is represented by a ridge of spines.

Some variation occurs in the development of the spinelike processes at the cardinal corners of the adult specimens. More material is needed to determine how much variation is due to preservation.

Remarks. — Jaanusson (1957) divided the Eurychilinidae into three subfamilies, based upon the construction of the dolon in the females and the nature of the velum in the males. These seem to be natural and workable subdivisions of this family. The species described herein certainly belongs to the subfamily Eurychilininae. The dolon is restricted to the proximal part of the velum just as shown by Ulrich (1897, pl. 44, figs. 3-4a) in *E. subradiata.* Ulrich (1897), Henningsmoen (1953), and Jaanusson (1957) indicated that the restriction of the dolon to the proximal part of the velum is of major importance in the diagnosis of *Eurychilina.* If this is true, a number of North American species must be restudied and reclassified.

The dolon of *E. esulcata* is similar to that of *E. subradiata* Ulrich. However, it is more restricted longitudinally. Also, *E. esulcata* has no sulcus, a feature which seems to be typical of *Eurychilina,* and the velum is not entire as in most *Eurychilina.* It is possible that *E. esulcata* represents a new genus. The author does not consider it proper to establish a new genus based upon the limited material available and therefore tentatively classifies this species under *Eurychilina* at this time.

The specific name refers to the absence of a sulcus in this species.

Distribution. — This species is extremely sparse, being found in only two Henryhouse samples. Both samples (P_4-1 and P_7-6) are within the upper 20 feet of the formation. This species has not been seen in the Haragan.

Materials studied. — Only thirteen valves of this species are available at this time. Three are females, eight are males, and two are immature forms. *E. esulcata* is extremely delicate and therefore commonly broken. Only one complete female valve has been found, and it was broken during cleaning. Three complete or nearly complete male valves are available. The illustrations of this species are based upon complete and broken valves.

Holotype. — OU 5095, sample P_7-6; plate VI, figures 2b,c.

Figured specimens. — OU 5095-5096b, samples P_4-1, P_7-6.

Family PIRETELLIDAE Öpik, 1937

Genus *Rakverella* Öpik, 1937

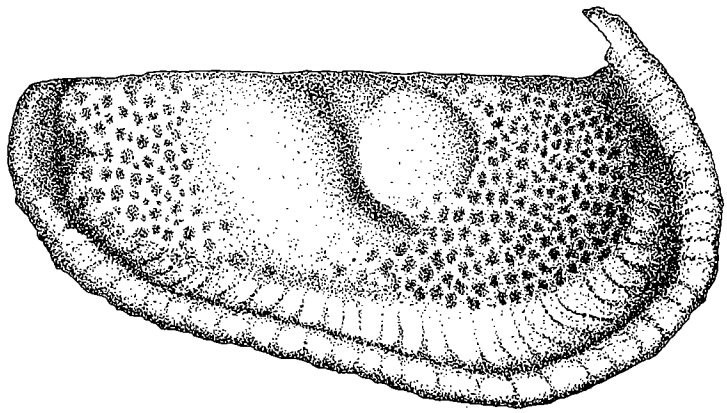
Rakverella? sp.

Pl. VI, figs. 3a,b; text-fig. 18

Description. — The valve is subtriangular in lateral view and subrectangular in dorsal, ventral, and end views. The dorsal border is straight, the anterior border is broadly rounded, and the ventral border is straight to gently convex. The posterior border is rounded but is not distinctly separated from the ventral border. The valve is distinctly preplete. The anterior cardinal angle is slightly obtuse; the posterior cardinal angle is distinctly acute. The valve is bilobate, the two lobes being separated by a well-developed S_2. The anterior lobe is a prominent presulcal node just below the dorsal border and about four-tenths the length of the valve from the anterior border. S_2 is wide and shallow near the dorsal border but narrows and deepens as it curves in an anteroventral direction. The posterior lobe occupies most of the posterior portion of the valve. It is higher and wider in its dorsal portion but narrows and fades out as it curves below S_2. The two lobes are not quite connected. The surface of the valve not occupied by the lobes or sulcus is reticulate. A wide velum extends from the anterior cardinal corner, where it protrudes above the dorsum as a spine, to the posterior cardinal corner. The velum is composed of radially arranged tubules, which extend throughout the width of the velum. The velum flares laterally throughout its length. Although the distal edge of the velate structure is thickened, no special features are present on it. The contact margin of the valve is simple.

The hinge is straight, simple, and almost equal in length to the length of the domicilium. The lobes and the sulcus are reflected interiorly. Muscle scars are not known.

Length (including velum), 1.92 mm; height (including velum), 0.91 mm.



Text-figure 18. Reconstruction of right valve of *Rakverella*? sp. (OU 5097), x50. This specimen is illustrated on plate VI, figures 3a,b.

Remarks. — Although *Rakverella*? sp. likely is a new piretellid genus, this species is tentatively classified with *Rakverella* because only one valve is known. The lobes of the type species are represented only as ridges, designated C_1, C_2, etc. The species described here has no evidence of features analogous to C_2 and C_4 of the type species, *R. spinosa* Öpik, 1937. C_1 and C_3 are true lobes separated by a true S_2 in *Rakverella*? sp.

Because only one valve is known of *Rakverella*? sp. (sample P_{18}-1), the nature of dimorphism cannot be determined. Also, the author knows of no piretellid genus from rocks younger than Ordovician. However, the general shape, lobation, and velate structure of this species have the piretellid aspect. Definite classification of this form must be deferred until more material is available.

Figured specimen. — OU 5097, sample P_{18}-1.

Superfamily KIRKBYACEA Ulrich and Bassler, 1906

Family PLACIDEIDAE Schneider, 1956

Genus *Amphissella* Stover, 1956

*Amphissella primaeva** (Roth), 1929

Pl. VI, figs. 1a-j; text-fig. 19

Amphissites primaevus Roth, 1929, p. 346, pl. 36, fig. 10a; Wilson, 1935, p. 638.

Description. — The carapace is subquadrate in lateral view and subelliptical in dorsal, ventral, and end views. The dorsum is straight to slightly concave. The anterior and posterior borders are gently convex and the ventral border is straight. The lateral surface is moderately convex and can be divided into two broad lobes separated dorsally by a faint sulcus. Either one or both of these lobes may rise slightly above the hinge at the cardinal corners, imparting the slight concavity to the dorsum. The cardinal angles are obtuse. The carapace is equivalved. The surface is ornamented by coarse reticulations, which are arranged in a pattern roughly paralleling the free border. The outermost row of ridges of this reticulate pattern is expanded into a marginal ridge. This structure is best developed around the anterior, anteroventral, posterior, and posteroventral borders. It is reduced along the ventral border. The marginal ridge is best seen in ventral or interior views. In lateral view it may hardly be noticed. At about mid-height and distinctly in front of midlength is a moderately well-developed to indistinct pit. In most specimens the area above this pit is slightly depressed into a faint sulcus.

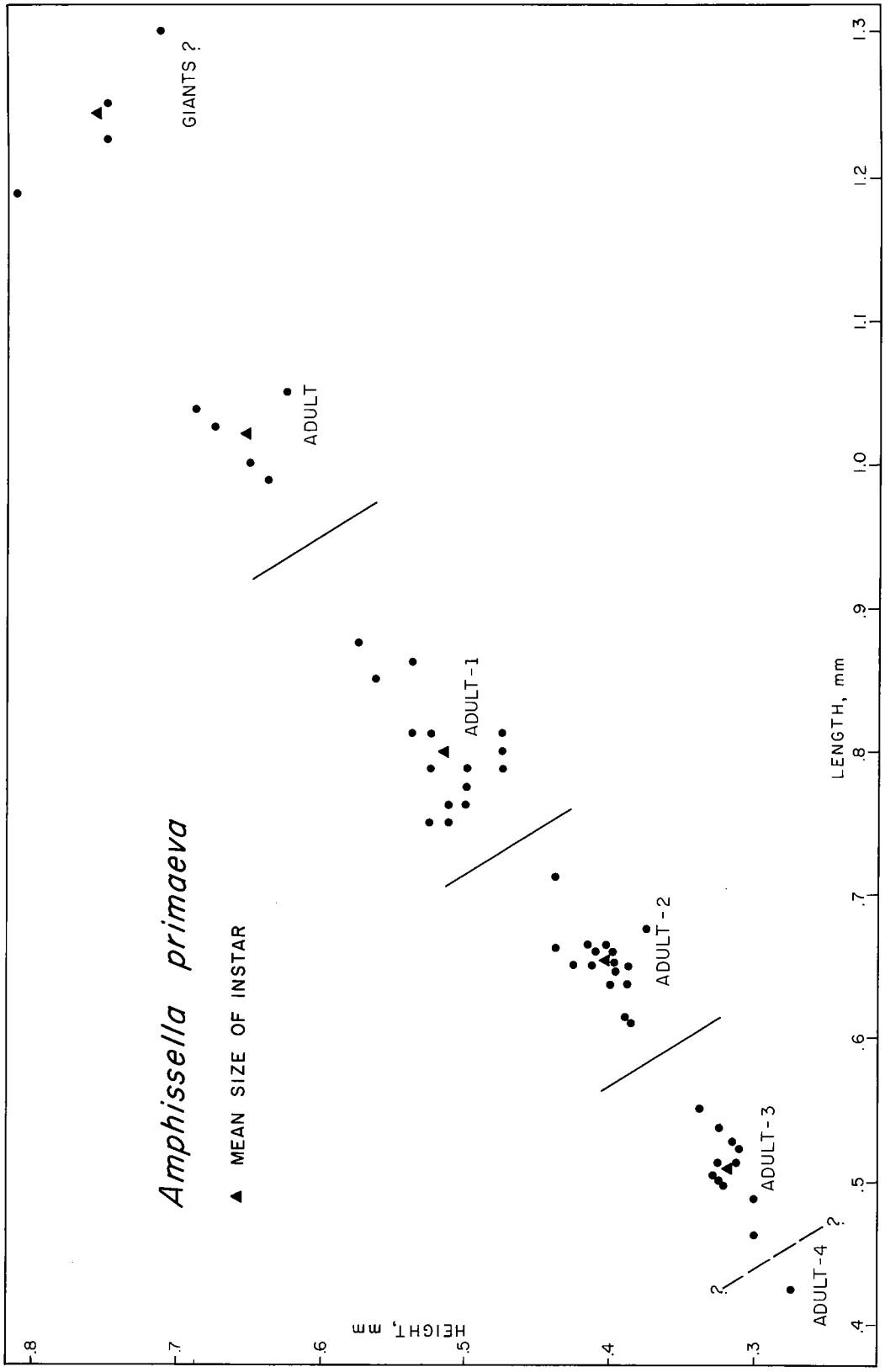
The hinge is straight and has no complex elements. The hinge of each valve consists of a fairly sharp ridge which continues around the entire free edge as the contact margin of the valves. The pit is reflected interiorly as a circular elevated area. Anterior and posterior to this area the interior is concave, the posterior concavity being especially distinct. The reticulate pattern of the exterior shows through distinctly on clean portions of the interior surface.

Length, 1.02 mm; height, 0.66 mm.

Ontogeny. — Five instars in addition to some giants have been found in this population (text-fig. 19). Growth factors do not deviate greatly from the theoretical value (table 5).

The only consistent differences between the mature and immature instars concern the lobation and sulcation. The anterior and posterior lobes are relatively better developed in the immature instars so that a swelling commonly occurs above the hinge at both cardinal corners. This develop-

* See Addendum (p. 79) for remarks.



Text-figure 19. Size-dispersion diagram of *Amphissella primaeva* (Roth) from sample P_6-4.

ment is less common in adult specimens, and in many cases the anterior lobe does not protrude above the hinge at all. On the other hand, few, if any, specimens of immature forms show a moderately well-developed pit, although the faint sulcus generally can be seen. The development of the pit is variable in the adults, being indistinct in some but quite pronounced in others. Generally, some indication of the pit is noticeable in adult specimens.

distinct, but in others it can hardly be seen (this may be due, in part, to preservation). Slight variation in shape within any particular instar may be seen. This variation is concerned mainly with the configuration of the posterior border. Commonly it is bluntly rounded. However, in a number of specimens it swings backward in a straight line from the posterior cardinal corner. The posteroventral border then is sharply rounded to meet the ventral border.

TABLE 5.—GROWTH FACTORS FOR AMPHISSELLA PRIMAEVA

INSTAR	LENGTH (MM)	GROWTH FACTOR	HEIGHT (MM)	GROWTH FACTOR	NUMBER OF SPECIMENS
Giants	1.241		0.756		4
		1.217		1.154	
Adult	1.020		0.655		5
		1.277		1.269	
Adult —1	0.799		0.516		15
		1.222		1.277	
Adult —2	0.654		0.404		16
		1.285		1.270	
Adult —3	0.509		0.318		12

Some specimens in this population apparently underwent one postadult moulting, although the number of giants compared to the number of adults does not seem significantly different to support this conclusion (text-fig. 19). However, a population of the same species from another sample (P_3-11) contained no specimens nearly so large as those considered giants in this population (P_6-4). Furthermore, the largest specimens of the population from P_3-11 compare favorably in size with those considered adults from sample P_6-4. Also, the largest specimens of *Amphissella primaeva* were measured from several other samples. All were near the size range of the adults of P_6-4. No specimens as large as the giants of P_6-4 were found in other samples. It seems improbable that the largest specimens of P_6-4 are adults and that none of the other samples examined contained adults at all. Therefore these large specimens are considered postadults, and the group of next largest ostracodes are considered adults.

Variation. — Perhaps not enough specimens have been found to give a true indication of variation in this species. It has already been noted that the development of the lobes, sulcus, and pit are variable within a particular instar. Also worthy of note is the variation in development of the marginal ridge. In some adult specimens it is quite

Remarks. — According to recent classification (Sohn, 1961a), this species cannot be placed in *Amphissites* because it lacks a median node and carinae, and has only one marginal structure. This species most likely is congeneric with *Amphissella* Stover, differing from Stover's species only in the external expression of the adductor muscle attachment. Whereas *A. primaeva* has a pit, *A. papillosa* Stover (1956) has a smooth circular spot. This difference is not considered significant enough to warrant a different generic designation.

Roth's locality most likely was Cedar Hill (section P_3). There can be little doubt that his collection came from the Henryhouse.

Distribution. — *A. primaeva* occurs throughout the Henryhouse unit. Wilson (1935) reported it from the Birdsong Shale (Devonian) of Tennessee, but it has not been seen in the Haragan.

Materials studied. — Sample P_6-4 yielded 52 specimens of *A. primaeva*. Sample P_3-11 yielded 24 specimens which were measured and graphed (not presented in this study) for comparison. Several other samples contained small numbers of this species. Preservation is good.

Holotype. — USNM 80658 H; plate VI, figure 1i.

Figured specimens. — UI X-1602a to X-1602h, sample P_6-4.

Superfamily OEPIKELLACEA Jaanusson, 1957

Family APARCHITIDAE Jones, 1901

Genus *Ehlersia* Kesling et al., 1960

Ehlersia ambigua Lundin, new species

Pl. IX, figs. 2a-t; text-figs. 20, 21

Description. — The carapace is ovate in lateral view and elliptical in dorsal, ventral, and end views. The dorsal border is straight and the free border is evenly rounded. Greatest width is central. The valves are amplete. The cardinal angles are obtuse and generally more distinct on left valves than on right valves. The valves are subequal, the left being slightly larger than the right and overlapping it along the free margin. The surface of the valves is ornamented with medium-sized punctae except for a smooth area along the free border and a central smooth spot. The marginal structure of the right valve is variable. A marginal rim is more or less developed along the ventral border of all right valves. This rim is modified into a small striate "frill" along the posteroventral border of most specimens. On a few specimens the posteroventral portion of the marginal rim is only slightly better developed than is the ventral portion, and the structure hardly qualifies as a frill. Development of the rim into a small frill-like structure along the anteroventral border is apparent in a few specimens. The marginal rim and frill-like structures are distinctly separated from the contact margin of the valve. The marginal structure of the left valve is less complex and less variable than is that of the right valve. A shallow groove parallel to the free border is situated just outside the proximal edge of the smooth border area. A distinct marginal rim is thus formed along the free border of the left valves. Modification of this rim into an extremely small frill-like feature in the posteroventral area has been seen on only one specimen.

The hinge is straight and of the edge-and-groove type. The groove is in the right valve along the entire length of the hinge. The hinge is approximately one-half as long as the valve. The interior is smooth except for a small ridge (corresponding to the external groove) along the contact margin of the left valve. Apparently the ridge stopped the smaller right valve when the valves were closed. Muscle scars have not been seen.

Length (largest specimen available), 1.00 mm; height, 0.85 mm.

Ontogeny. — Text-figures 20 and 21 show that three instars have been found in the population studied. The boundaries between some instars are uncertain. Therefore the average size of the various instars has not been calculated. The immature individuals are morphologically the same as the adults. The marginal structures are as equally well developed on the immature specimens as on the adult specimens. Ornamentation and shape are basically the same. The only basic difference between the young and adult specimens is size.

Variation. — The only variation of note is that concerned with the development of the marginal rim and "frill" explained above (see Description). Some variation in the shape of the valves occurs but is not significant.

Remarks. — Orientation of this species follows that used for *Ehlersia huntonensis* (Roth). This species generally is easier to orient because the hinge is generally set distinctly forward.

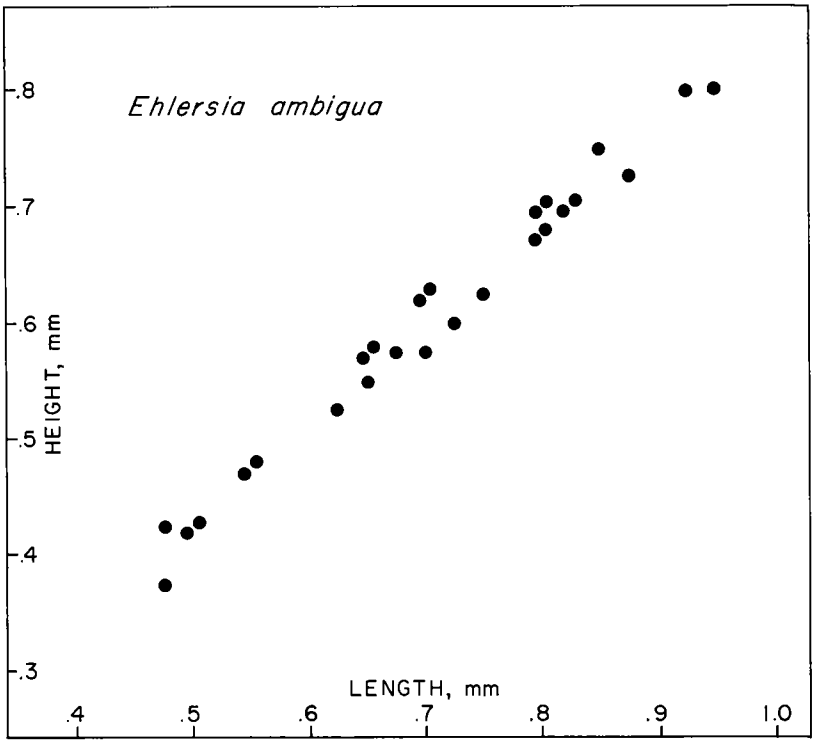
The placement of this species in *Ehlersia* is subject to question. *E. ambigua* is similar to *E. huntonensis* (Roth) in all respects except the coarseness of ornamentation and the development of the small posteroventral "frill" on the right valve. The latter is ornamented with smaller pits than is the former. The posteroventral part of the marginal rim of the right valve of *E. ambigua* is consistently developed into a small striate "frill." This feature is represented at best as a serrate ridge on *E. huntonensis*.

The small striate "frill" on *E. ambigua* is not a dimorphic feature. It is equally well developed on immature and mature right valves. It has been seen on only one left valve. For this reason, no great significance has been attached to the occurrence of this small frill-like structure. Until more is known about the development of the "frill" and until the relationships of various aparchitid genera are clarified, this species is questionably placed in *Ehlersia*.

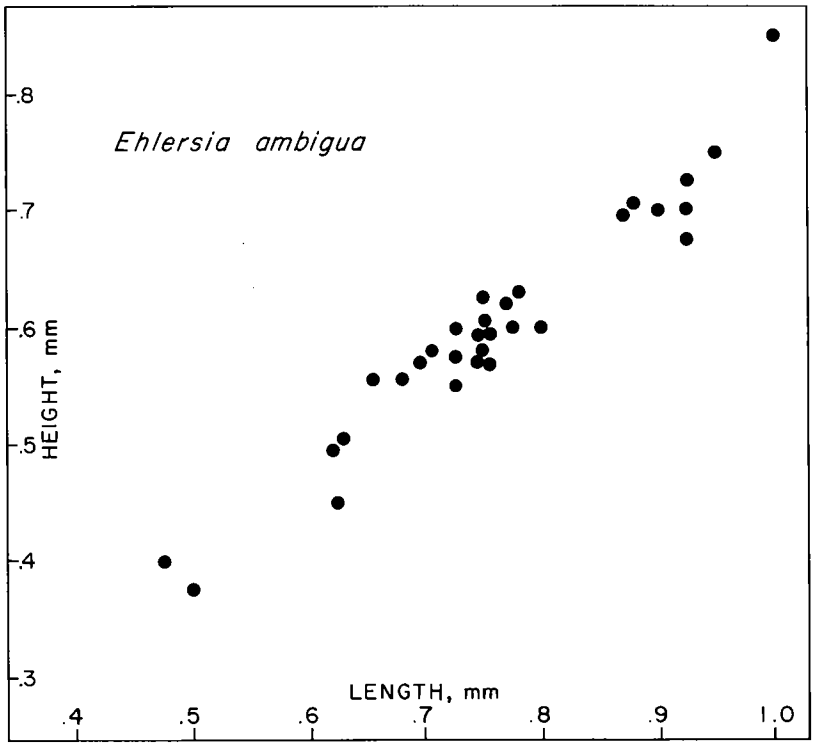
The specific name is derived from the Latin adjective ambiguus, meaning doubtful, and refers to the questionable placement of the species in the genus *Ehlersia*.

Distribution. — This species has been found throughout the Henryhouse Formation. It is nowhere abundant and has been seen in moderate abundance in only two samples (P_6-4, P_3-11). *E. ambigua* has not been found in the Haragan.

Materials studied. — Sample P_3-11 yielded the largest population of this species. Fifty-seven measurable specimens were found in this sample (30 left valves, 1 carapace, 26 right valves).



Text-figure 20. Size-dispersion diagram of right valves of *Ehlersia ambigua* Lundin, new species, from sample P_3-11.



Text-figure 21. Size-dispersion diagram of left valves of *Ehlersia ambigua* Lundin, new species, from sample P_3-11.

Fourteen other specimens were broken or deformed. Twenty-seven specimens were picked from sample P_6-4, and small numbers of specimens were found in several other samples.

Preservation generally is good, although this species also, apparently owing to its elliptical shape, has been subject to abrasion so that many specimens have, to a greater or lesser extent, lost their ornamentation. Some specimens are almost smooth. The variation seen in development of the marginal structures does not appear to be due to preservation. In fact, many of the specimens which have been most severely abraded have the delicate frill preserved better than have other specimens.

Holotype. — OU 5256, sample P_{18}-1; plate IX, figures 2a,b.

Figured specimens. — OU 5256-5259, samples P_3-4, P_3-11, P_3-20, P_{18}-1.

Ehlersia huntonensis (Roth), 1929

Pl. VIII, figs. 2a-o

Aparchites variolatus var. *huntonensis* Roth, 1929, p. 332, pl. 35, figs. 1a,b.

Description. — The valves are subovate in lateral view, and the carapace is elliptical in dorsal, ventral, and end views. The dorsal border is straight and the free border is evenly convex. The valves are amplete to slightly preplete. The cardinal angles are obtuse but indistinct. The valves are nearly equal, the left being slightly larger than the right. The surface of the valves is coarsely punctate except along the smooth border and at a smooth central spot. The punctae are randomly arranged and constant in size. The marginal features of this species are quite variable. Some right valves have a faint groove along the proximal edge of the smooth border. This feature is especially noticeable along the posteroventral border. The marginal rim thus formed is developed into a serrate ridge in the posteroventral area on a few specimens. A distinct groove occurs along the proximal edge of the smooth border of most left valves. The free edge of the left valve is thickened, and a narrow marginal rim is thus formed. Nothing resembling a "frill" has been seen on any left valve. Specimens with variable marginal structures are identical in all other respects.

The hinge is straight and of the edge-and-groove type. The groove is the entire length of the hinge and is in the right valve. The hinge is about one-half the length of the valve. The interior is smooth except for a small ridge along the contact margin of the left valve. Muscle scars have not been seen.

Length (largest specimen available), 1.10 mm; height, 0.83 mm; width, 0.60 mm.

Ontogeny. — The paucity of well-preserved specimens from any one sample has prohibited the construction of a size-dispersion diagram for this species. However, three instars have been found in one population and two in another. The only significant difference between the immature and mature individuals is that of size. Marginal structures vary as much in the immature forms as described above for the adults. Ornamentation is the same, but generally the immature forms seem to be somewhat more circular in lateral outline than the adults.

Variation. — The only significant variation in this species concerns the marginal features (see Description). Some variation occuring in shape is well illustrated by Roth (1929, pl. 35, figs. 1a,b). Some specimens are more elongate than others.

Remarks. — The orientation of this genus is questionable. Some valves are so nearly symmetrical that some criterion other than shape is needed to orient them. The central smooth spot is thought to represent the position of the adductor muscle. However, it generally is situated in the center of the valve and therefore is useless for orienting most specimens. Kesling and others (1960, p. 308) and Kesling and Kilgore (1952) considered the plenate end in assymmetrical valves of *Ehlersia hypercala* to be posterior. Guber (1962) showed that a single species may range in shape from preplete to amplete to postplete. Shape alone does not appear to be a good criterion for orienting even asymmetrical valves. The orientation used by Kesling and Kilgore (1952) results in left-over-right overlap. *Ehlersia huntonensis* (Roth) is oriented herein upon this basis. Commonly, left valves can be distinguished from right valves by the nature of the marginal features. Also, in many cases, the hinge is closer to one end of the valve than to the other. This end is considered anterior.

Roth considered this species to be a variety of *Aparchites variolatus* Ulrich and Bassler. The latter is about half the size, more coarsely pitted, and has a more convex dorsum than has the former. Warthin (1937, card 105) gave Roth's variety specific rank and placed the species in *Macronotella* Ulrich, 1897. Warthin also placed *Aparchites punctinellus* Wilson (1935) in synonymy with Roth's species. I have not seen the types of *A. punctinellus* Wilson, but published illustrations indicate that Wilson's and Roth's

species are not conspecific. *A. punctinellus* is more circular, has finer pits, and lacks the marginal structures of *E. huntonensis* (Roth).

Kesling and others (1960) illustrated that the type species of *Macronotella, M. scofieldi* Ulrich, is distinctly dimorphic. The female has a wide frill. They proposed a new genus, *Ehlersia,* for nondimorphic forms superficially similar to *Macronotella. E. huntonensis* is not dimorphic and is similar to *E. hypercala* Kesling and Kilgore in other respects. Roth's species, therefore, is assigned to the genus *Ehlersia.*

Kesling and others (1960) emphasized the significance of marginal structures in the classification of oepikelacean ostracodes and described the margin of *Ehlersia* as a simple bend (1960, p. 307). The marginal structure of *E. huntonensis* is more than a simple bend on some specimens. The small serrate edge along the posteroventral margin of some specimens may be a variation resulting from the overlapping relationships of the valves. It is possible that this structure is a result of the left valve's "rubbing" the right valve as the valves were closed. This feature cannot be considered a rudimentary frill because it exists only on the right valve and is not a dimorphic structure. Mature and immature specimens have this feature. Whatever the case may be, the marginal morphology of *E. huntonensis* is not considered different enough from the type species of the genus to warrant a new or different generic designation.

Distribution. — *E. huntonensis* has been found in three samples (P_3-21, P_4-1, P_7-4). All of these samples are from the upper 25 feet of the Henryhouse Formation. This species has not been found in the Haragan.

Material studied. — Sizable collections of this species have been made from samples P_3-21 and P_4-1. However, many specimens are somewhat deformed. Nineteen good specimens have been found in sample P_4-1; only one of these is a carapace. Twenty-one good specimens have been obtained from sample P_3-21; none is a carapace. This species is represented in sample P_7-4 by a single valve.

Of the unbroken undeformed specimens listed above, a number are abraded so that the surface ornamentation has more or less disappeared. As this species is distinguished from other species in part by the coarseness of the ornamentation, identification of abraded specimens is subject to question. The above description is based upon well-preserved specimens. However, all ostracodes of this kind in the samples mentioned above have been considered conspecific for the purpose of counting the number of specimens in the collection. I have seen no specimens in these samples which certainly belong to another species.

Roth's type specimens of this species have been studied. The type collection consists of four specimens: one well-preserved left valve, one broken left valve, one deformed immature left valve, and one carapace. They are all conspecific. Roth's collecting localities are in Henryhouse rocks and therefore his report of this species from the Haragan is incorrect.

Lectotype. — USNM 80654 c; plate VIII, figure 2a.

Figured specimens. — OU 5252a-5253d, samples P_3-21, P_4-1.

Suborder KLOEDENELLOCOPINA Scott, 1961

Superfamily KLOEDENELLACEA Ulrich and Bassler, 1908

Family KLOEDENELLIDAE Ulrich and Bassler, 1908

Genus *Dizygopleura* Ulrich and Bassler, 1923

Dizygopleura landesi Roth, 1929

Pl. X, figs. 3a-q; text-figs. 22-24

Dizygopleura landesi Roth, 1929, p. 341, pl. 35, figs. 7a-i.

Description of female. — The carapace is subquadrate in lateral and end views, and cuneate in dorsal and ventral views. The dorsum is straight except at the anterior cardinal corner, where a toothlike process of the left valve reaches over onto the right valve. The anterior border is distinctly rounded, the venter is slightly sinuate, and the posterior border is straight to gently curved, truncate, and not distinctly separate from the ventral border. The posterior border has a distinctly forward swing. The anterior cardinal angle is obtuse and the posterior cardinal angle acute. The carapace is distinctly asymmetrical, the left valve overlapping the right around the entire free margin. The carapace is distinctly preplete. The cara-

pace is quadrilobate and trisulcate. L_1 is parallel to the anterior border. It arises beneath the anterior cardinal corner and curves ventrally to end just above the venter. S_1 is adjacent to L_1, having a curved anterior border but relatively straight posterior border. It has the same vertical extent as L_1. L_2 arises just below the dorsal border behind S_1 and passes ventrally around S_2, where it is connected with L_3, which slopes anteroventrally from the dorsum. S_2 is a broad, short sulcus ending at about midheight. L_3 and L_4 are connected dorsally over S_3, which is faint, being almost obliterated in some specimens by the bulbous L_4. S_3 opens ventrally onto the venter. At the posterior cardinal corner a small swelling occurs. The left valve is thickened around the entire free edge. This edge is rabbeted to receive the smaller right valve. This thickening ends at the anterior cardinal corner in a heavy bulbous toothlike process which fits into a notch in the right valve. In front of this notch is a small swelling resembling a cardinal tooth. This swelling corresponds in position to a slight indentation along the anteroventral part of the large bulbous process on the left valve. Around the anterior border of both valves a flange is present. It fades out along the venter.

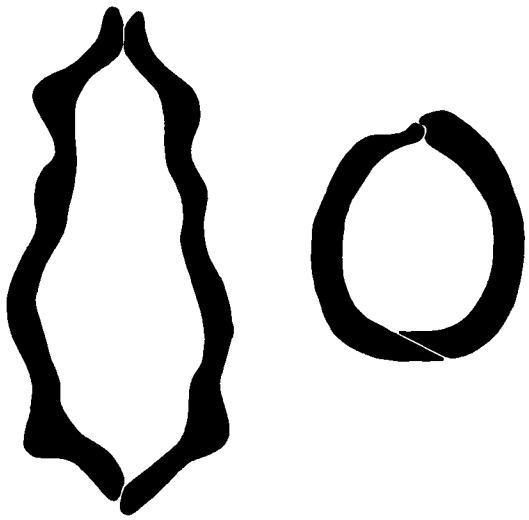
Hingement is of the edge-and-groove type, an edge on the left valve fitting into a groove on the right valve (text-fig. 22). The hinge is straight. At the posterior termination of the right valve hinge is a slight socket, beneath which is a swelling which fits into a socket in the left valve hinge. All the lobes and sulci are reflected internally (text-fig. 22), especially the L_2, S_2, and L_3.

Length, 1.20 mm; height, 0.68 mm; width, 0.60 mm.

Description of male. — The male is like the female except that the posteroventral portion is filled out more in the male. This makes the male more quadrate in lateral view and makes the venter more sinuate. The female is distinctly widest at L_4, whereas L_3 and L_4 are subequal in width in the male. This makes the male more quadrate in dorsal and ventral views. Because the L_4 of the females is more swollen, S_3 is generally less distinct than in the males. Generally, the females are larger than the males.

Length, 1.14 mm; height, 0.61 mm; width, 0.50 mm.

The above differences often are not distinct enough so that any particular adult can be classified as a male or female. The best method of distinguishing males from females is in dorsal or ventral view, where the position of the maximum width can be observed. If the greatest width is distinctly at L_4, the specimen is a female.



Text-figure 22. Adult female carapaces of *Dizygopleura landesi* Roth, x50.
A. Longitudinal cross section (UI X-1604l).
B. Transverse cross section (UI X-1604m).

Ontogeny. — Six instars have been found in the population studied (text-fig. 23). Growth factors for length and height are listed in table 6. Males and females were not differentiated in the calculation of average length and average height because, as seen in text-figure 23, males and females are not distinctly separated in the adult instar. The same type of pattern results when length is plotted against maximum width. No distinct separation of males and females can be detected. However, when length is plotted against the width at L_4 of carapaces of *D. landesi,* the separation of males and females becomes apparent (text-fig. 24).

In addition to change in size during ontogenetic development, other morphological changes occur.

Adult −1 instar: The valves are essentially like those of the adult male except that L_4 is less bulbous and more flangelike.

Adult −2 instar: The L_4 is even more reduced, developing into a spine dorsally in some specimens and into a small ventral spine in a few specimens. The valves are distinctly truncate in the posteroventral area. The other lobes and sulci are well developed.

Adult −3 instar: The L_4 is distinctly spinose, especially on the right valve. The S_3 is represented as only a slight depression because L_3 and L_4 have almost completely fused. The other lobes and

TABLE 6.—GROWTH FACTORS FOR DIZYGOPLEURA LANDESI

INSTAR	LENGTH (MM)	GROWTH FACTOR	HEIGHT (MM)	GROWTH FACTOR	NUMBER OF SPECIMENS
Adult	1.183		0.668		53
		1.291		1.166	
Adult —1	0.916		0.573		94
		1.270		1.257	
Adult —2	0.721		0.456		51
		1.267		1.249	
Adult —3	0.569		0.365		28
		1.251		1.221	
Adult —4	0.455		0.299		10
		1.253		1.215	
Adult —5	0.363		0.246		6

sulci are well developed, but the S_2 is relatively broader than in the adult. The anterior flange on the right valve and the thickened flange around the free edge of the left valve are considerably more distinct than in the later instars.

Adult −4 instar: Although well-preserved right valves of this instar have not been seen, the L_4 and L_3 on the left valve are completely fused, with no S_3 apparent. Projecting backward from the dorsal and ventral portions of this lobe are two distinct spines. L_1, L_2, S_1, and S_2 are still prominent.

Adult −5 instar: The lobe represented by the fused L_3 and L_4 in the adult −4 instar is weak, being represented by two small spines or a weak swelling. The L_1 and S_1 are distinct, but the S_2 is weak.

Variation. — The significant variation in the adult instar can be ascribed to dimorphism. Variation in sulcation, lobation, and shape within the adult dimorph groups is minor and does not confuse classification of this species.

The only noticeable variation in the immature instars concerns the spinosity of L_4. Within any particular instar, L_4 and the fused L_3 and L_4 may be distinctly spinose or may be flangelike without developed spines. Generally, the lobe on the right valve is more spinose than that on the left.

Remarks. — The specific homogeneity of the material studied is unquestionable. No species has been found in the literature which might be confused with *D. landesi.*

Haragan rocks do not occur in the area of one of Roth's localities, and his other locality probably is Cedar Hill (section P_3), which is also Henryhouse. I have nowhere seen this species in the Haragan. Roth's report of *D. landesi* in the Haragan is erroneous.

Distribution. — *D. landesi* is present throughout the Henryhouse strata. It has not been reported from other units and it has not been seen in the Haragan.

Materials studied. — The population studied (sample P_3-11) consisted of 428 specimens of which 35 were carapaces, 186 were right valves, and 207 were left valves. All of these are undeformed specimens. A number of deformed specimens were also found.

Lectotype. — USNM 80645 C; plate X, figure 3a.

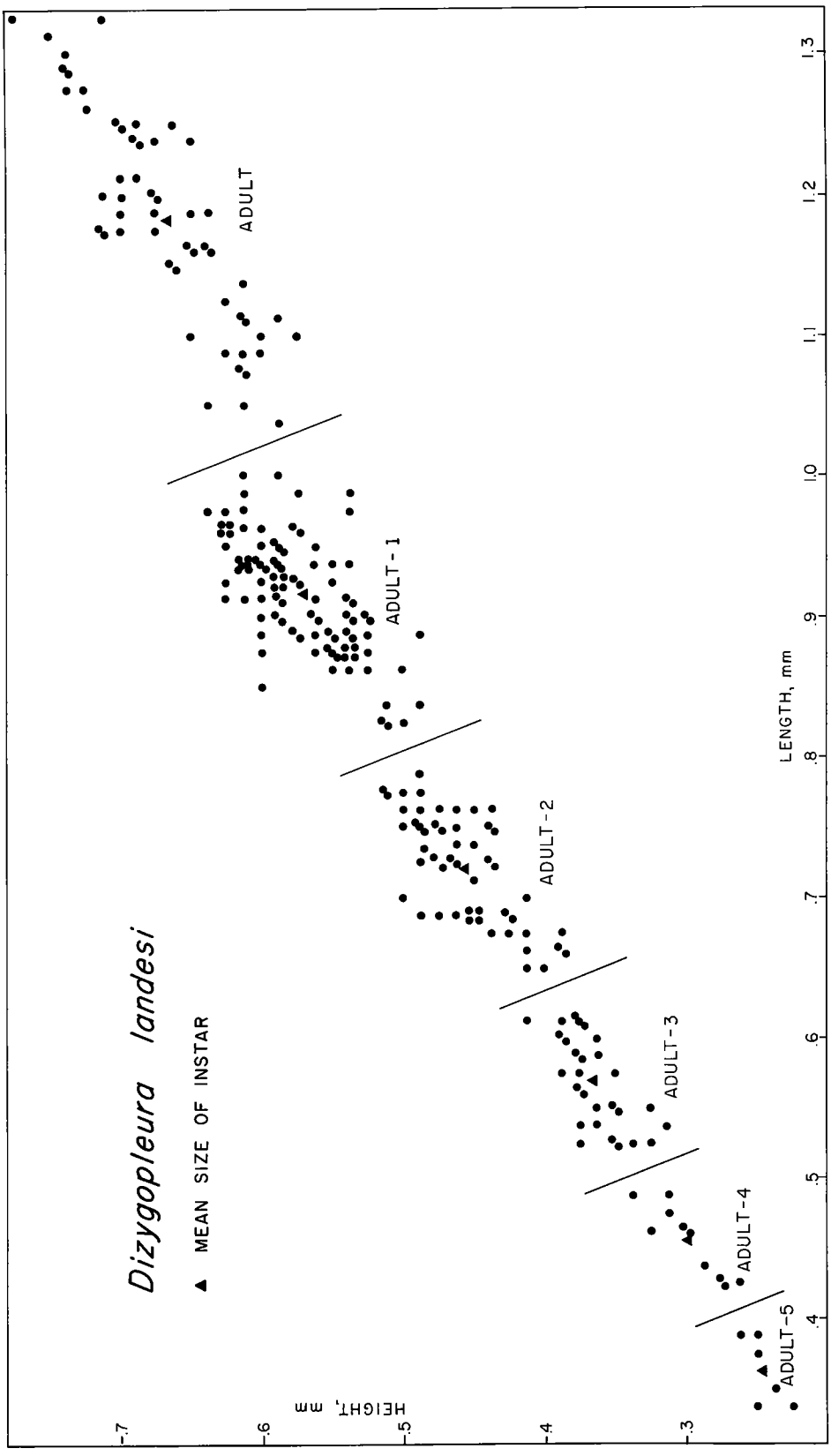
Figured specimens. — UI X-1604a to X-1604 m), sample P_3-11.

Genus *Eukloedenella* Ulrich and Bassler, 1923

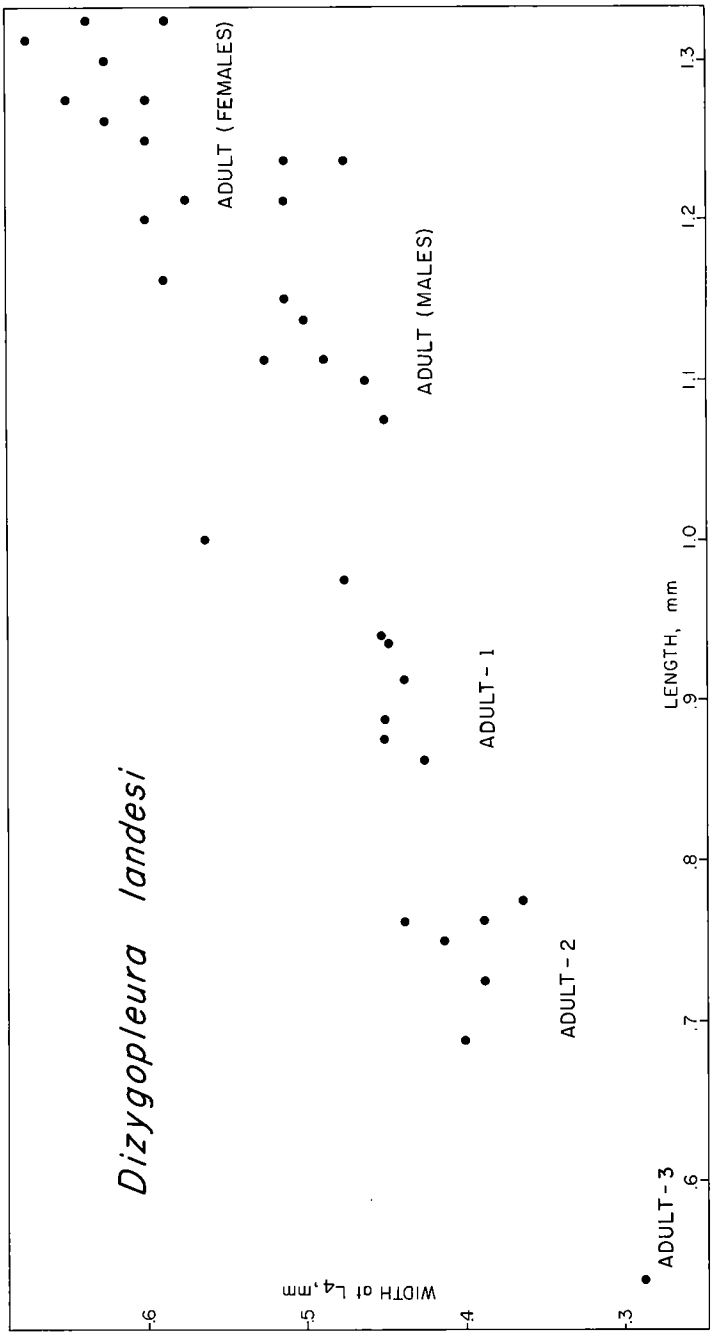
Eukloedenella pontotocensis Lundin, new species

Pl. V, figs. 3a-i

Description. — The valves are subquadrate in lateral and end views, and elliptical to cuneate in dorsal and ventral views. The straight dorsum is interrupted by a small process at the anterior cardinal corner on some specimens and behind midlength by the dorsal swelling of the posterior lobe. The anterior border is broadly rounded and the posterior border is gently rounded to almost straight. The venter is gently convex to slightly sinuate. The anterior cardinal angle is slightly obtuse and the posterior cardinal angle varies from slightly obtuse to slightly acute. The valves are preplete or amplete. Only one poorly preserved carapace is known, but apparently the left valve overlaps the right valve around the free margin. Two lobes separated by a poorly developed S_2 can be distinguished. The anterior lobe is present in the form of a presulcal node just below the dorsal border. The node is distinct but not large. Behind



Text-figure 23. Size-dispersion diagram of left valves of *Dizygopleura landesi* Roth from sample P_3-11.



Text-figure 24. Size-dispersion diagram of carapaces of *Dizygopleura landesi* Roth from sample P_3-11.

the presulcal node is the short, weak S_2. This sulcus is hardly more than a pit on some specimens. The posterior portion of the valve is occupied by a broad but well-developed lobe. It fades gradually in an anteroventral direction into the general surface of the valve. No marginal features are present.

It has not been possible to study the hingement carefully owing to poor preservation, but an edge-and-groove relationship is evident. The lobes and sulcus are reflected on the interior surface of the valves. Muscle scars are not known.

Length, 0.91 mm; height (hinge line to venter), 0.49 mm.

Dimorphism. — Dimorphism is not distinct in this species. Some specimens are more swollen in the posterior part than are others, and these are considered to be the females. Enough specimens are not available for measurement to illustrate graphically any difference in posterior width. Males and females may best be distinguished in dorsal or ventral views.

Ontogeny. — As only three immature specimens representing two different immature instars are known, little can be said about the ontogeny of *E. pontotocensis*. However, all immature specimens are more distinctly preplete than are most of the adults. No other difference except size can be distinguished.

Variation. — Variation in this species is not of major significance. Some variation exists in lateral outline of the valves, and the posterior lobe is better developed and protrudes higher above the hinge line in some specimens than in others. The latter variation probably is dimorphic.

Remarks. — *E. pontotocensis* is similar to several species of *Eukloedenella* described by Ulrich and Bassler (1923) from the Silurian of Maryland. It differs from *E. sulcifrons* Ulrich and Bassler of the McKenzie Formation in its much smaller size and more preplete shape. It can be distinguished from *E. similis* Ulrich and Bassler from the same formation by its more preplete outline and the absence of a posterior flange.

The name refers to the occurrence of this species in Pontotoc County, Oklahoma.

Distribution. — *E. pontotocensis* is known from samples P_3-11, P_3-20, P_3-21, and P_4-1 in Pontotoc County, Oklahoma. The restriction of this species to the upper part of the Henryhouse probably is not significant because it is sparse even in these samples.

Materials studied. — Eleven well-preserved isolated valves were studied from sample P_3-21. Six of these are adult females, three are adult males, and two are immature instars. Five poorly preserved adults were identified from sample P_4-1, one steinkern of an adult carapace was found in sample P_3-20, and one immature valve was present in sample P_3-11.

Holotype. — OU 5083, sample P_3-21; plate V, figures 3b,c.

Figured specimens. — OU 5083-5084f, sample P_3-21.

Superfamily LEPERDITELLACEA Ulrich and Bassler, 1906

Family LEPERDITELLIDAE Ulrich and Bassler, 1906

Genus *Paraschmidtella* Swartz, 1936

Paraschmidtella eumbonis Lundin, new species

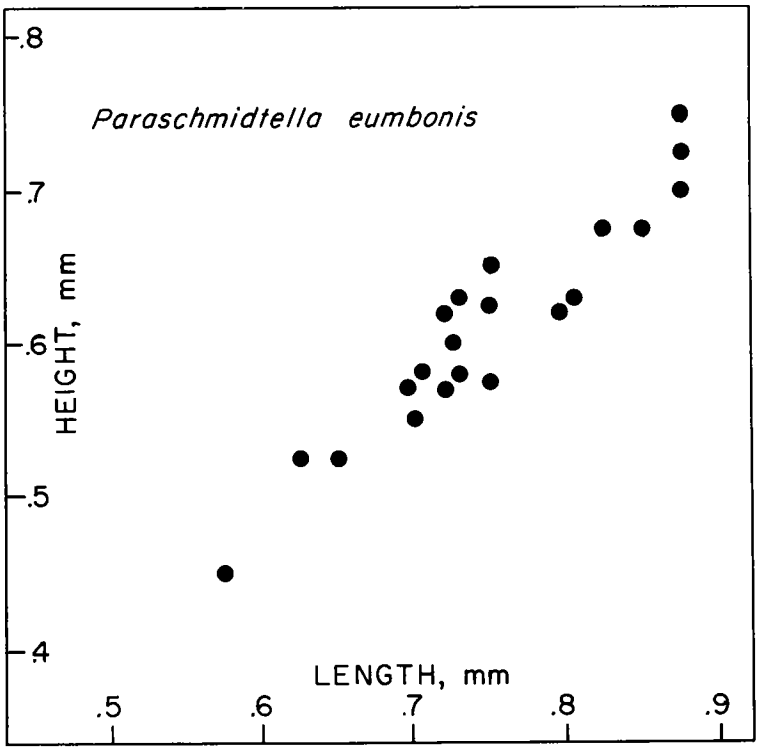
Pl. VII, figs. 1a-h; text-figs. 25, 26

Description. — The carapace is subcircular in lateral view and elliptical in dorsal, ventral, and end views. The dorsal border is straight and the free border is evenly rounded. The valves are amplete to slightly preplete. The cardinal angles are obtuse. The valves are unequal, the left being larger than the right and overlapping it around the entire free margin. The surface is ornamented by medium-sized pits, which are randomly arranged and constant in size. The border is smooth and confluent with the lateral surface of the valve. No marginal structures are present.

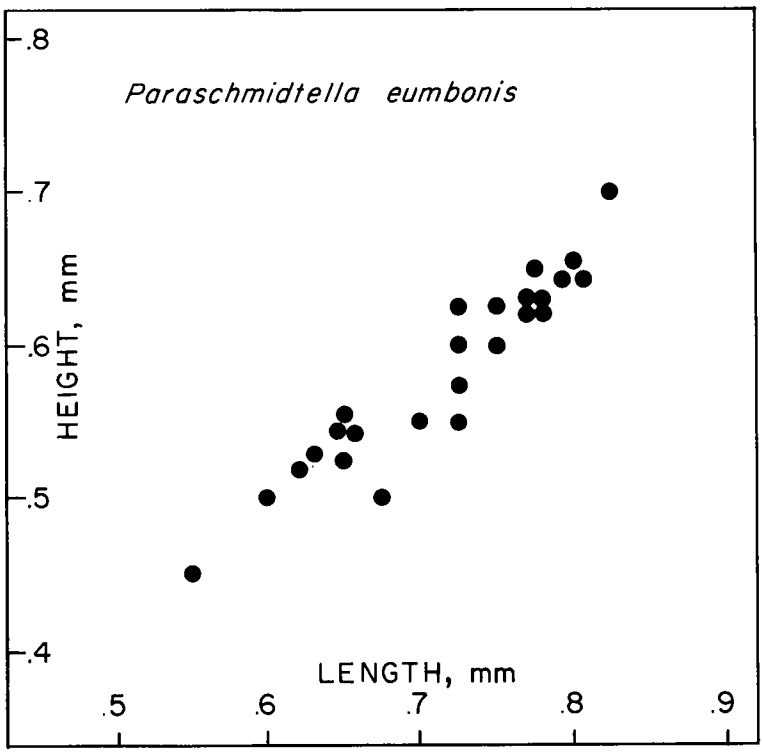
The hinge is straight and of the edge-and-groove type. The groove is in the right valve but is poorly developed. The hinge is about one-half the length of the valve and closer to the anterior end. The interior of the valves is smooth. Muscle scars have not been seen.

Length (largest specimen available), 0.88 mm; height, 0.75 mm.

Ontogeny. — Text-figures 25 and 26 show that several instars have been found in the population studied. However, boundaries between instars are not clear, and therefore growth factors have not been calculated. The author believes that three instars are represented in each size-dispersion diagram. Because the left valve is larger than the right, the two are plotted on separate diagrams. It perhaps is significant that the size-dispersion pattern is practically identical for the left and right valves. The fact that this pattern is different from that shown for a superficially similar species, *Ehlersia ambigua* Lundin, new species (text-figs. 20, 21), supports the conclusion that the two



Text-figure 25. Size-dispersion diagram of left valves of *Paraschmidtella eumbonis* Lundin, new species, from sample P_3-11.



Text-figure 26. Size-dispersion diagram of right valves of *Paraschmidtella eumbonis* Lundin, new species, from sample P_3-11.

species are distinct and that isolated valves of the two species have not been mixed.

Immature individuals differ from adults only in size.

Variation. — Variation in this species is insignificant. Slight variation occurs in shape, some valves being more nearly symmetrical than others.

Remarks. — Orientation of this species has been based mainly upon the valve relationships. As this species has no marginal structures which distinguish right and left valves, the author has relied largely on the position of the hinge to determine orientation. In most cases the hinge is nearer one end than the other. This end is taken to be anterior.

The consistent absence of marginal structures has made this species easier to identify than others similar to it. This is true despite the fact that the ornamentation is poorly preserved on many specimens.

The generic designation of this species is doubtful. Superficially this species is similar to species of *Ehlersia,* a genus which Kesling and others (1960) have questionably placed in the Aparchitidae. Hessland (1961) contended that the aparchitids are characterized by a velar structure which *Ehlersia* does not have according to Kesling and others (1960). The species described here is not classified with *Ehlersia* or the Aparchitidae because of its lack of velar structures and marginal ridges. It is placed in *Paraschmidtella* because it is nonsulcate, pitted, and distinctly inequivalved. The lateral outline and ornamentation is similar to that of *Paraschmidtella.* However, it lacks the umbones which characterize other species of this genus, and the generic designation is therefore provisional.

The specific name refers to the absence of umbones on this species.

Distribution. — This species has been found throughout the Henryhouse strata in the Lawrence uplift and in the Arbuckle Mountains. It is most abundant in samples P_6-4 and P_3-11. Several poorly preserved specimens have been found in two samples of basal Haragan. Speciation of these specimens is questionable. It is likely that, if they are conspecific with *P. eumbonis,* they represent reworked specimens from Henryhouse rocks. This species has not been seen in any other Haragan samples.

Materials studied. — Sample P_3-11 yielded 46 measurable specimens. Many others are slightly deformed or broken. Thirty-five specimens from sample P_6-4 were studied. Some of these also were deformed or broken. Small numbers of specimens from eight other samples were studied, and specimens of this species from several additional samples were identified. Preservation generally is good, although the ornamentation has been more or less abraded on many specimens. Few carapaces are present.

Holotype. — OU 5098, sample P_3-11; plate VII, figures 1a-c.

Figured specimens. — OU 5098-5099e, sample P_3-11.

Order PODOCOPIDA Muller, 1894

Suborder PODOCOPINA Sars, 1866

Superfamily BAIRDIACEA Sars, 1888

Family BAIRDIIDAE Sars, 1888

Genus *Spinobairdia* Morris and Hill, 1952

Spinobairdia sp.

Pl. IX, figs. 1a-c

Remarks. — Four specimens of *Spinobairdia* sp. are known from Henryhouse strata, two from sample P_6-3, and two from sample P_{18}-1. The most nearly perfect specimen is a complete right valve from which the spine is broken. The other three specimens have the spine preserved but are broken at one end or the other or are partially covered with matrix. S. sp is closely related to S. *kellettae* Morris and Hill (1952) from the Middle Silurian Newsom Formation of Tennessee. The one complete valve known from the Henryhouse compares favorably in size and shape with S. *kellettae.* The spine is in approximately the same relative position on both forms. More material is needed to establish the specific identification of the Henryhouse form.

Figured specimens. — OU 5254, 5255, samples P_6-3, P_{18}-1.

Suborder METACOPINA Sylvester-Bradley, 1961

Superfamily HEALDIACEA Harlton, 1933

Family HEALDIIDAE Harlton, 1933

Genus *Healdia* Roundy, 1926

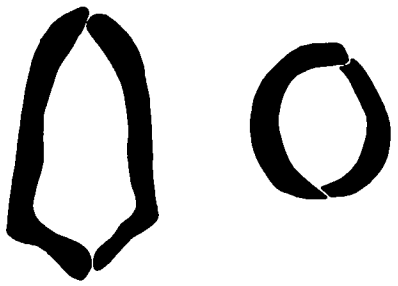
Healdia primitiva (Roth), 1929

Pl. VIII, figs. 1a-n; text-figs. 27, 28

Thlipsura primitiva Roth, 1929, p. 358, pl. 37, figs. 19a-c.

Description. — The carapace is subtriangular in lateral view, subcircular in end view, and cuneate in dorsal and ventral views. The dorsum is gently arched, becoming straight in its posterior portion in most specimens. The straight portion of the dorsum is more distinct in the right valve than in the left. The anterior border is sharply rounded, the posterior border broadly rounded, and the ventral border is straight on the left valve but sinuate on the right valve. The left valve is slightly larger than the right, overlapping it around the entire free margin. Overlap is especially distinct along the ventral, anterior, and anterodorsal margins. In many specimens the anterodorsal border of the right valve is slightly concave. The cardinal angles are indistinct. The lateral surfaces are distinctly convex and are smooth except for a ridge just in front of the posterior border. This ridge is generally straight and vertical. In a number of specimens this ridge is straight and inclined slightly backward from the dorsum, but in some specimens it is distinctly curved, paralleling the posterior border. The greatest width of the carapace is at the position of this ridge, imparting the distinctive wedge-shaped appearance to the carapace in dorsal and ventral views. There is a slight thickening of the free margin of the left valve, which is rabbeted to receive the right. A distinct flange occurs around the anterior margin of the right valve of some specimens.

The hinge is straight and situated along the posterodorsal portion of the margin. It is inclined gently backward. The hingement appears to be simple in most specimens, but evidence of edge-and-groove relationships can be seen in some valves. The groove is in the left valve into which the edge of the right valve fits. The interior is smooth and deepest in the posterior portion (text-fig. 27). Anterior to the deepest portion of the valve the shell thickens slightly to produce a slight swelling on the interior surface. Little, if any, evidence of this feature is seen on the exterior of the valve.



Text-figure 27. Adult carapaces of *Healdia primitiva* (Roth), x50.
A. Longitudinal cross section (UI X-1603m).
B. Transverse cross section (UI X-1603n).

Length, 0.66 mm; height, 0.42 mm.

Ontogeny. — Four instars have been found in this population but only the last two are represented by a significant number of specimens (text-fig. 28). Although growth factors for length and height are low (table 7), adult and adult −1 instars are definitely indicated by the data plotted on text-figure 28. A histogram of length has aided in determining the division between the last two instars. At best, the exact position of this division is questionable.

More variation occurs within each instar than from one instar to the next. No consistent significant ontogenetic changes other than size have been observed.

Variation. — Considerable variation within the adult and adult −1 instars occurs. This variation is mainly in shape, size, and orientation of the posterior ridge. The typical forms and variants are shown in plate VIII, figures 1a-n. The same type of variation occurs in both the adult and adult −1 instars.

Size variation is considerable as can be seen in text-figure 28. Because of this variation in size, it is difficult to distinguish the adult −1 and the adult instars. Although both right and left valves have been plotted together, it is unlikely that this is the cause of the size variation seen on the size-dispersion diagram. In terms of the accuracy of the measurements, the left and right valves are not significantly different in size.

Attendant with this size variation is considerable variation in shape. Some specimens are elongate, and others are foreshortened, taking on a stubby appearance. The dorsum of some is

straight and inclined anteriorly, imparting a distinctly triangular outline to the ostracode.

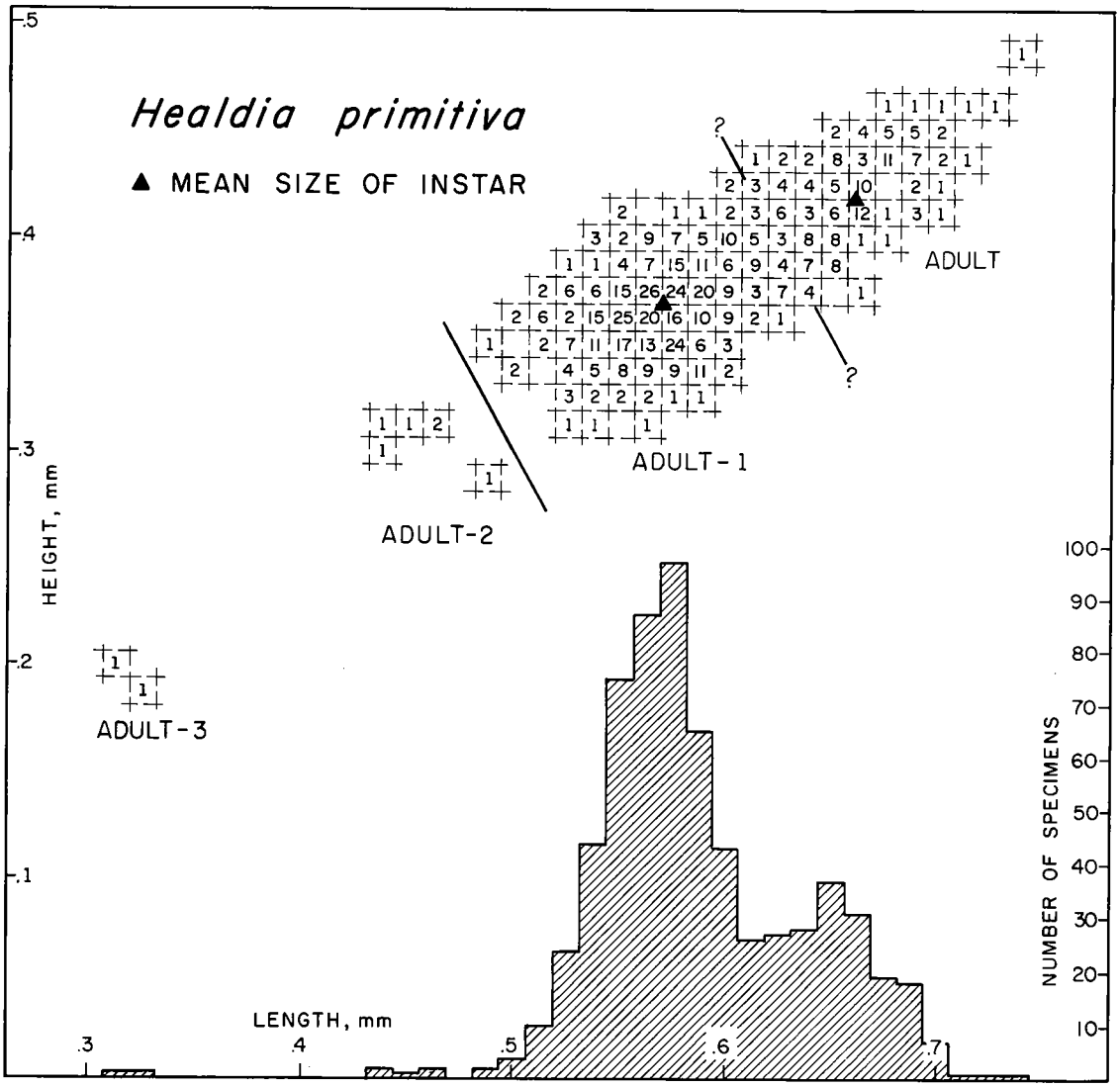
The orientation of the posterior ridge is subject to variation, as stated above. Typically it is vertical, but commonly it is inclined backward and in a few cases it is curved. The same variations occur in the adult —1 instar.

Remarks. — This species definitely belongs to *Healdia.* It has the typical shape, valve relationships, hingement, and ornamentation of this genus. On the other hand, it does not have the typical thlipsurid shape and ornamentation of *Thlipsura.*

To the author's knowledge, this is the first report of *Healdia* from rocks as old as Silurian.

TABLE 7.—GROWTH FACTORS FOR HEALDIA PRIMITIVA

INSTAR	LENGTH (MM)	GROWTH FACTOR	HEIGHT (MM)	GROWTH FACTOR	NUMBER OF SPECIMENS
Adult	0.658		0.421		162
		1.159		1.144	
Adult —1	0.568		0.368		484



Text-figure 28. Size-dispersion diagram and histogram of a population of *Healdia primitiva* (Roth) from sample P_3-11. The number in each square represents the number of specimens of that size.

Roth's type collection includes nine specimens which are on one slide (USNM 80661). Of these, one specimen is an immature pachydomellid. The other eight specimens illustrate the same range of variation as does the population described above.

Healdia primitiva has not been seen in the Haragan. Roth's localities are in Henryhouse rocks, and therefore his report of this species in the Haragan is incorrect.

Distribution. — This species is found from near the bottom to near the top of the Henryhouse. Although closely related forms are present in the Haragan, the same species has not been seen there.

Materials studied. — The population from sample P_3-11 is represented by 654 specimens. Of these, 162 are considered adults and 484 are considered to belong to the adult −1 instar. Preservation is good. Carapaces are common.

Lectotype. — USNM 80661 C; plate VIII, figures 1a,b.

Figured specimens. — UI X-1603a to X-1603n, sample P_3-11.

Family BAIRDIOCYPRIDIDAE Shaver, 1961

Genus *Bairdiocypris* Kegel, 1932

Bairdiocypris magna (Roth), 1929

Pl. XII, figs. 1a-f; pl. XIII, figs. 1a,b

Pontocypris smithi var. *magna,* Roth, 1929, p. 366, pl. 38, figs. 26a,b; not *Rishona magna* (Roth), 1929, of Sohn, 1960, p. 80, pl. 4, figs. 18-21.

Description. — The carapace is subreniform in lateral view and elliptical in dorsal, ventral, and end views. The dorsal border is slightly angulate, and the posterior and anterior borders are sharply rounded. The venter is gently convex in the posterior one-half and slightly sinuate in the anterior portion. The sinuation of the venter of the right valve is more marked than that of the left. No lobes, nodes, sulci, or other ornaments are present. The left valve overlaps the right along the entire free border and overreaches it along the hinge line. The surface of the valves is smooth.

The hinge is simple. The only left valve available for study is attached to a right valve, but several right valves show evidence of a faint groove in the hinge. The hinge is straight and is only about one-third of the length of the carapace. Perfectly clean interiors are not present in the material studied, but the cleanest specimens indicate that the interior is smooth. No marginal structures are present. Muscle scars have not been observed.

Length (largest right valve available), 2.44 mm; height, 1.37 mm.

Ontogeny. — At least two immature instars are represented in the material studied. Generally, there appears to be no significant difference between the immature specimens and the adults. Because of the simplicity of this species, more material and extremely detailed studies will be necessary to develop any conclusive evidence on the ontogentic changes in this species.

Variation. — Lack of large numbers of specimens prohibits the study of variation in this species. The specimens studied do not show significant variation in morphology, although the dorsal border is more strongly arched on some specimens than on others.

Remarks. — This species has been misunderstood largely because of the inadequacy of Roth's collection, which includes only right valves. Roth collected his three specimens from two localities (Roth, 1929, p. 367). No Haragan rocks are exposed in the vicinity of one of these localities (SW¼ NE¼ sec. 28, T. 3 N., R. 6 E., Pontotoc County, Oklahoma). The other locality (sec. 4, T. 2 N., R. 6 E., Pontotoc County, Oklahoma) has Haragan rocks which contain few ostracodes. The author has examined four samples of Haragan-Bois d'Arc strata from this locality but has not seen any ostracodes which resemble Roth's specimens. However, much of the strata exposed in the latter locality belong to the Henryhouse Formation. The author has found ten specimens in this part of the section which compare favorably with Roth's specimens. It seems certain that Roth's collections are from the Henryhouse and not the Haragan.

Sohn (1960, p. 80, pl. 4, figs. 18-21) commented upon Roth's types and illustrated a single carapace from the Haragan Formation of Murray (not Murphy) County, Oklahoma. Sohn's specimen (USNM 133208) is certainly from the Haragan Formation. He stated (p. 80) that Roth's holotype (USNM 80643) and two paratypes are left valves. They are right valves. Also, Sohn stated that "Roth's specimens differ from *Pontocypris smithi* Jones, 1887, in size, lateral outline, and relative width," and therefore raised Roth's variety *Pontocypris smithi* var. *magna* Roth (1929) to specific rank. Furthermore, Sohn classified this species, once questionably and once apparently without question, in the genus *Rishona* Sohn (1960).

The author has studied Sohn's (1960, pl. 4, figs. 18-21) specimen and believes it to be differ-

ent from Roth's specimens. Although the right valve of the former has the same general lateral outline as that of Roth's species (which is based upon right valves only), the dorsal border of Sohn's specimen is more arched and more angulate than that of Roth's holotype. In end view the dorsal area of the two are quite different. A shallow concavity exists beneath the dorsal border of the right valve of Sohn's specimen, whereas Roth's holotype and the author's specimens are evenly convex in transverse outline. Sohn's specimen appears to be perfectly preserved, and so this difference is not attributed to preservation.

As indicated in the description above, one well-preserved carapace, the right valve of which is identical to Roth's holotype, shows that the left valve overlaps the right around the free edge and overreaches it along the hinge. According to Sohn's definition of *Rishona,* this species cannot be placed in that genus because of the valve relationships described.

The author, like Sohn (1960, p. 79) and others, believes that Roth's and other Paleozoic species do not belong to *Pontocypris* Sars, 1866. The species in question here is provisionally included in *Bairdiocypris* Kegel, 1932. *Bairdiocypris magna* (Roth), 1929, has the convex somewhat angulate dorsum, the same valve relationships, and the same outline in lateral view as has the type species, *B. gerolsteinensis* Kegel, 1932. The type species is, however, distinctly more elliptical in dorsal view.

Distribution. — *B. magna* is known from samples throughout the Henryhouse Formation. It is nowhere abundant, a maximum of four specimens having been found in any one sample. The author has not seen this species in the Haragan strata.

Materials studied. — Thirteen specimens (one carapace and twelve right valves) have been studied and definitely assigned to this species. Several other right valves are thought to belong to this species, but definite identification of these specimens is uncertain. Preservation is fair.

Lectotype. — USNM 80643 C; plate XII, figure 1e.

Figured specimens. — OU 5265a-5268, samples P_3-15, P_3-16, P_3-21, P_6-3.

Bairdiocypris profusa Lundin, new species

Pl. XI, figs. 1a-h; text-fig. 29

Description. — The carapace is subreniform in lateral view, subquadrate in dorsal and ventral views, and elliptical in end view. The dorsum is gently convex and merges imperceptibly with the sharply rounded anterior border and broadly rounded posterior border. The venter is straight, although the ventral border of the right valve is slightly sinuate. The left valve is slightly larger than the right, but overlap is distinct only along the venter and anterodorsal border. Overlap is slight elsewhere. The ends of the right valve are more sharply rounded than are those of the left valve, and the dorsal border of the right valve is straight in the medial portion. Cardinal angles are indistinct. The lateral surfaces are distinctly convex in transverse cross section. In longitudinal cross section the lateral surfaces are convex except in some specimens which have a slight medial depression (not a sulcus). This depression perhaps is mainly a result of a swelling of the posterior portion of the carapace. The surface of the carapace is smooth.

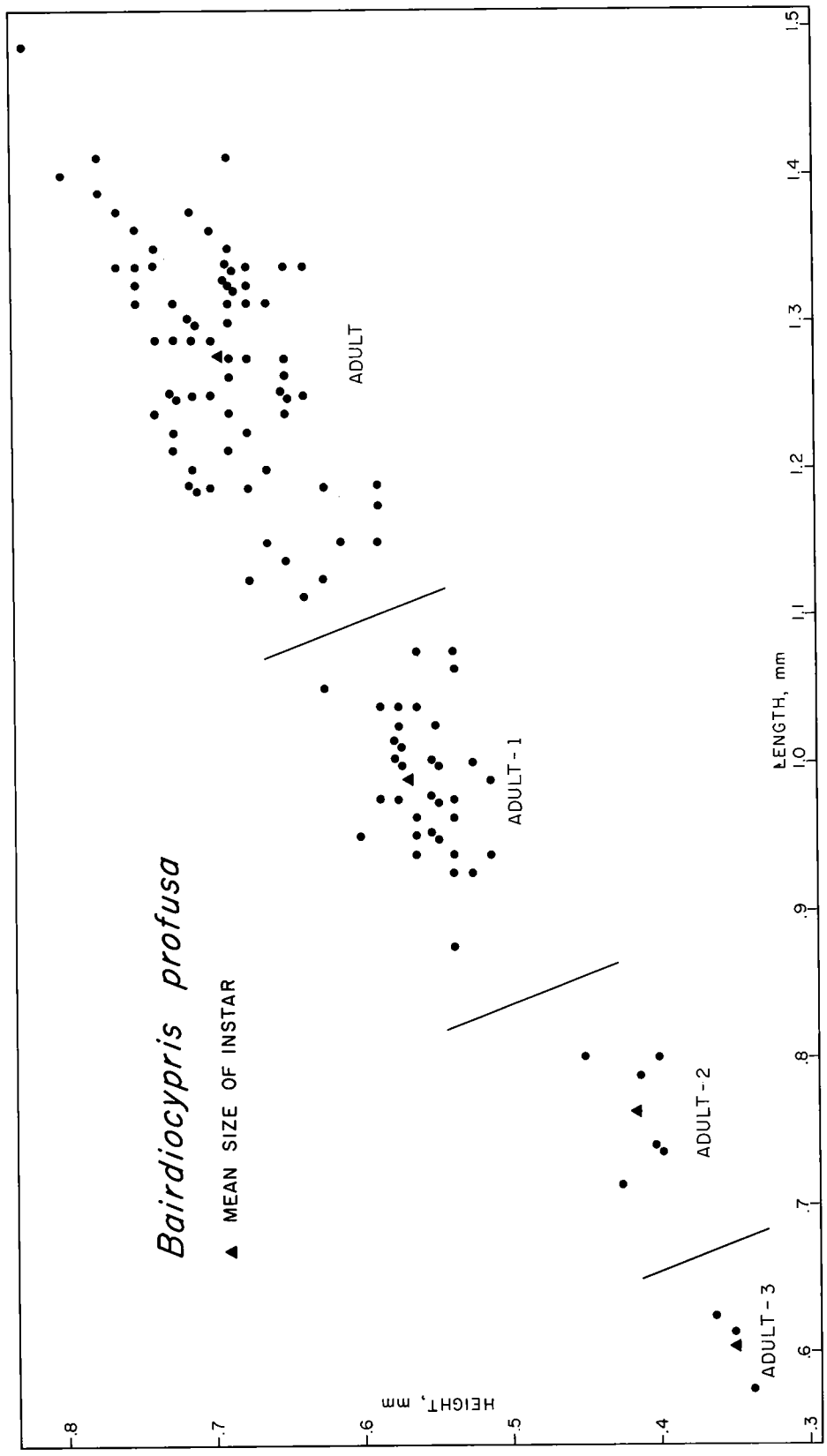
No special hingement can be seen. Apparently the valves were held in place by the musculature and overlapping valve relationships. The interior is smooth and gently concave. The concavity is interrupted only by a slight swelling corresponding to the exterior depression seen on some specimens. An inner lamella is lacking. Muscle scars have not been observed.

Length, 1.28 mm; height, 0.69 mm.

Ontogeny. — Four instars have been found (text-fig. 29). Other than size, no significant

TABLE 8.—GROWTH FACTORS FOR BAIRDIOCYPRIS PROFUSA

INSTAR	LENGTH (MM)	GROWTH FACTOR	HEIGHT (MM)	GROWTH FACTOR	NUMBER OF SPECIMENS
Adult	1.275		0.694		71
		1.290		1.220	
Adult —1	0.988		0.569		34
		1.295		1.371	
Adult —2	0.763		0.415		6
		1.263		1.186	
Adult —3	0.604		0.350		3



Text-figure 29. Size-dispersion diagram of left valves of *Bairdiocypris profusa* Lundin, new species, from sample P_3-11.

ontogenetic changes can be seen. Generally, the left valve is more elliptical in lateral view in the immature forms. Also, the venter of the right valve loses its sinuosity in the early instars.

Variation. — Variation in size is significant (text-fig. 29). Also, it is easily seen that height-length ratio is quite variable. However, distinguishing this species from others in the last four instars is generally no problem. The posterior swelling of some specimens is likely a dimorphic variation, but the width of large numbers of adult carapaces should be measured to substantiate this.

Remarks. — This species seems to fit best in *Bairdiocypris*. The lateral outline and valve relationships are identical to those of the type species, *Bythocypris* (*Bairdiocypris*) *gerolsteinensis* Kegel (1932). In dorsal view *Bairdiocypris profusa* is more rectangular than is the type species.

More instars are probably present in the sample, but owing to the great similarity of the earliest instars to early instars of other smooth species, only those specimens which definitely are conspecific with the adults have been measured.

The specific name is derived from the Latin adjective profusus, meaning abundant, and refers to the abundance of this species in the Henryhouse Formation.

Distribution. — This species is common to abundant throughout the Henryhouse strata. It is not known from the Haragan Formation.

Materials studied. — A population from sample P_3-11 contained 114 measureable left valves and 127 measurable right valves. Carapaces are uncommon.

Holotype. — UI X-1605a, sample P_3-11; plate XI, figure 1a.

Figured specimens. — UI X-1605a to X-1605h, sample P_3-11.

Bairdiocypris? sp. A

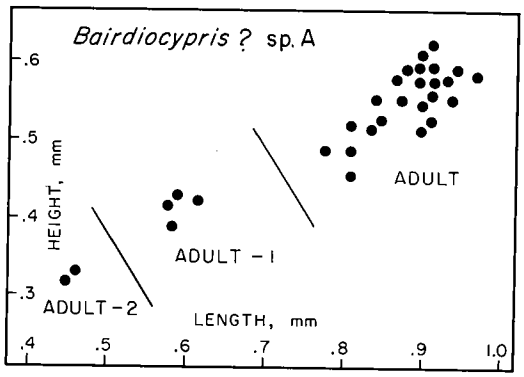
Pl. X, figs. 1a-h; text-fig. 30

Description. — The carapace is subreniform in lateral view and elliptical in dorsal, ventral, and end views. The dorsum is strongly arched, the ends are sharply rounded, and the venter is sinuate. The lateral surfaces of the carapace are evenly convex in dorsal, ventral, and end views. The left valve overlaps the right along its entire margin. The carapace is smooth.

No special hingement has been observed, although the left valve is rabbeted along the dorsal and ventral margins to receive the right valve. An inner lamella is especially well developed along the anterior and posterior margin. The interior is smooth. Muscle scars are not known.

Length, 0.85 mm; height, 0.55 mm; width, 0.39 mm.

Ontogeny. — The size dispersion of three instars from sample P_3-11 is shown in text-figure 30. Average length and height and growth factors have not been calculated because of the paucity of immature individuals. The only significant difference between the adult and immature forms is that the dorsum is generally more strongly arched on the latter.



Text-figure 30. Size-dispersion diagram of *Bairdiocypris*? sp. A from sample P_3-11.

Variation. — Only slight variation in shape occurs among the adult individuals. The dorsum is more arched on some specimens than on others, and the venter is less sinuate on some than on others.

Remarks. — *Bythocypris transversa* Roth (1929) was questionably placed in *Bairdiocypris* by Sohn (1960). *B.*? sp. A appears to be ancestral to *B.*? *transversa* (Roth), being similar in all respects except in smaller size and in the absence of the dorsal angulation of the left valve as seen in end view. *B.*? sp. A is distinguished from *B.*? sp. B by its more ovate lateral outline. The length-height ratio of *B.*? sp. B is distinctly greater than that of *B.*? sp. A.

Distribution. — *B.*? sp. A has been found in samples throughout the Henryhouse Formation. It is common in samples P_6-4, P_3-11, and P_{18}-1 and has been found in small numbers in samples P_3-3, P_3-4, P_3-5, P_3-17, P_3-21, P_6-1, and P_6-3.

Materials studied. — Thirty specimens representing three instars from sample P_3-11 have been measured and studied in detail. Forty-two specimens from other samples listed above have been identified and studied. Preservation is good. Carapaces are sparse.

Figured specimens. — OU 5260a-5260d, sample P_3-11.

Bairdiocypris? sp. B

Pl. X, figs. 2a-e

Description. — The carapace is subreniform in lateral view and elliptical in dorsal, ventral, and end views. The dorsal border is broadly arched, the ends are sharply rounded, and the ventral border is sinuate. The lateral surfaces of the carapace are evenly convex in dorsal, ventral, and end views. The left valve overlaps the right around the entire margin. The carapace is smooth.

No special hingement is present but the contact margin of the left valve is rabbeted to accommodate the right valve. The inner lamella is especially wide along the anterior and posterior margins. The interior is smooth. Muscle scars are not known.

Length, 0.98 mm; height, 0.52 mm; width, 0.39 mm.

Ontogeny. — Only two immature individuals of this species have been found. Both are like the adults except for size.

Variation. — One population of twenty-six adult specimens from sample P_3-11 indicates only minor variation in shape occurs.

Remarks. — *B.*? sp. B is closely related to *B.*? sp. A, but can be distinguished from it by its distinctly greater length-height ratio. The two species are similar in all other respects.

Distribution. — This species is known from samples P_3-11, P_6-1, P_6-3 and P_{18}-1, although it is common only in sample P_3-11.

Materials studied. — This species is represented by thirty-one specimens from the samples listed above. Preservation is good. Carapaces are sparse.

Figured specimens. — OU 5261a-5261c, sample P_3-11.

Genus *Condracypris* Roth, 1929

Condracypris quasisimplex Lundin, new species

Pl. XI, figs. 2a-n; text-fig. 31

Description. — The carapace is subreniform in lateral view and subquadrate in dorsal, ventral, and end views. The greatest length is below midheight, the greatest height anterior, and the greatest width central. The dorsum is distinctly arched and flattened for a short distance at its crest. The anterior border is bluntly rounded and the posterior border is sharply rounded. The venter is sinuate. The valves are unequal, the left slightly overlapping the right around the entire free border. The anterior and posterior borders are flangelike on some specimens. A small flangelike ridge is developed on the anterior surface of some valves. The surface of the valves is smooth.

The hinge is straight to slightly convex. The right valve hingement consists of a groove between two edges. The left valve hinge generally appears to be a simple edge, but one or two specimens show some evidence of a groove in it also. An inner lamella is especially well developed along the anteroventral and posteroventral contact margins. It is fused to the shell so that no vestibule is present (pl. XI, fig. 2n). The inner lamella apparently narrows over the sinuation of the venter and fades rapidly in a dorsal direction from the anteroventral and posteroventral margins. The contact margin of the valves is simple. The interior of the valves is featureless except for a subcircular depression situated just in front of midlength. The depression is about 0.13 mm in diameter. It is not reflected on the exterior of the valve. This depression certainly marks the position of the adductor muscle. Muscle scars have not been seen.

Length, 1.25 mm; height, 0.71 mm; width 0.90 mm.

Ontogeny. — Five instars have been found in the population studied (text-fig. 31). The mean length and height and growth factors for the left valves are given in table 9.

The significance of the distinct increase in the growth factors between the third from the last and the second from the last moults is unknown. It is possible that the sex organs appeared between the adult −2 and the adult −1 instars and matured during the last moult.

No significant changes occur in morphology through the ontogenetic sequence. The inner lamella of the immature individuals has not been studied in thin sections, but examination of interiors indicates that it is present in at least the later immature instars.

Variation. — Text-figure 31 shows that considerable variation occurs in size within each instar. Shape variation is insignificant, and, although this species lacks ornamentation, its shape easily distinguishes it from other smooth ostracodes in the Henryhouse. Some variations occur in the anteroventral and posteroventral borders. On some specimens these are flangelike; on others they are not. A flangelike ridge occurs on the anteroventral surface of some valves.

Dimorphism has not been detected in this species.

Remarks. — Unquestionably this species belongs in *Condracypris* Roth (1929). The type species, *Condracypris binoda,* has two vertically elongate nodes on the lateral surface of each valve. These

TABLE 9.—GROWTH FACTORS FOR CONDRACYPRIS QUASISIMPLEX

INSTAR	LENGTH (MM)	GROWTH FACTOR	HEIGHT (MM)	GROWTH FACTOR	NUMBER OF SPECIMENS
Adult	1.245		0.707		19
		1.316		1.289	
Adult —1	0.946		0.548		55
		1.321		1.330	
Adult —2	0.716		0.412		47
		1.241		1.231	
Adult —3	0.577		0.335		22
		1.236		1.219	
Adult —4	0.467		0.275		3

nodes lose their significance in the late immature instars and probably are not present in the early ontogeny of the species. Also, Roth (1929) included in the genus *Condracypris simplex*, a species which does not have the nodes. The interior of one of the types in the type-species collection indicates that the marginal features of *C. binoda* and *C. quasisimplex* are the same.

C. quasisimplex and *C. simplex* are closely related. The latter is distinguished by its small posteroventral spine, its larger size, and the well-developed lip along the anterior border.

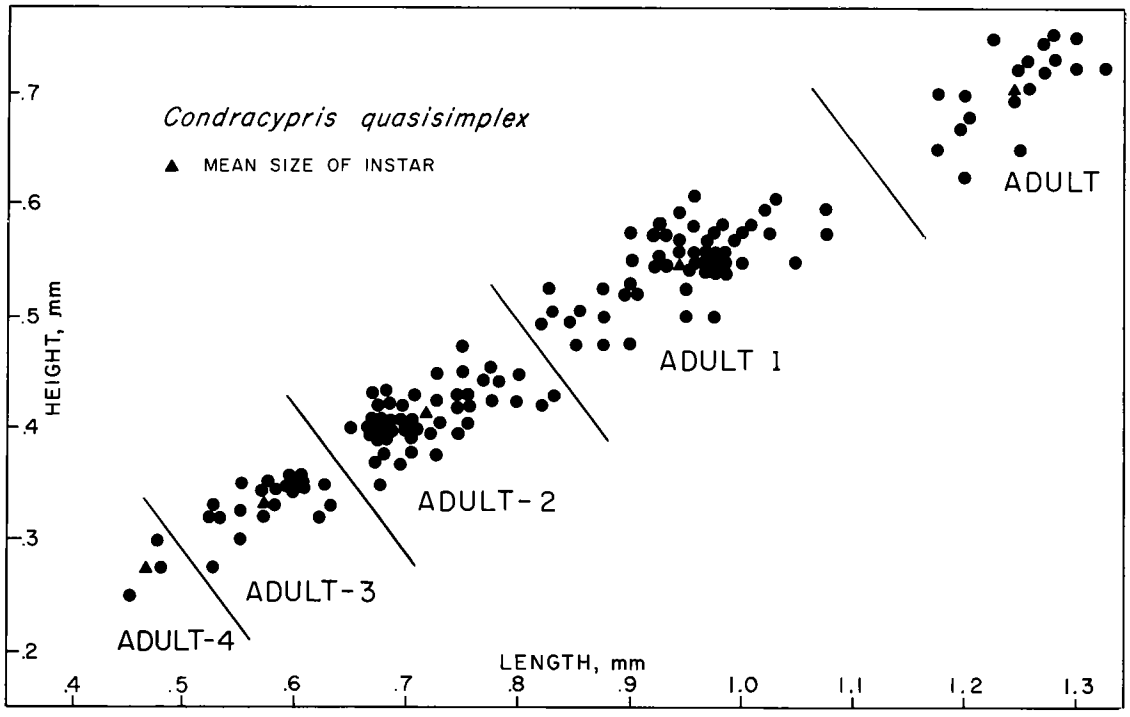
The name refers to the similarity of this species and *Condracypris simplex* Roth.

Distribution. — This species is one of the more common Henryhouse ostracodes. It has been found in almost all of the Henryhouse samples and is moderately common in samples which contain only a few other species. This species ranges throughout the Henryhouse strata. It has not been seen in the Haragan Formation.

Materials studied. — The population studied (sample P_6-4) in detail contains 281 measurable specimens (146 of which are left valves). Twenty-five of these are carapaces. Approximately 450 other specimens of this species have been found. As this species is thick shelled, preservation is excellent.

Holotype. — OU 5262, sample P_6-4; plate XI, figures 2a-d.

Figured specimens. — OU 5262-5264h, samples P_6-4, P_{18}-1.



Text-figure 31. Size-dispersion diagram of left valves of *Condracypris quasisimplex* Lundin, new species, from sample P_6-4.

Genus *Amsdenia* Lundin, new genus

Type species. — *Amsdenia binoda* Lundin, new species.

Diagnosis. — Bairdiocyprididae with evenly convex dorsal margin on left valve and angulate dorsal margin on right valve, with a well-developed node along the posterior border of each valve. The node is reflected interiorly.

Remarks. — This genus is believed to be related to *Bairdiocypris,* from which it is distinguished by the posterior node. The genus is named in honor of Dr. Thomas W. Amsden of the Oklahoma Geological Survey, who has contributed so much to the knowledge of Silurian-Devonian geology of Oklahoma.

Amsdenia binoda Lundin, new species

Pl. XIII, figs. 2a-f; pl. XIV, figs. 1a-e; text-fig. 32

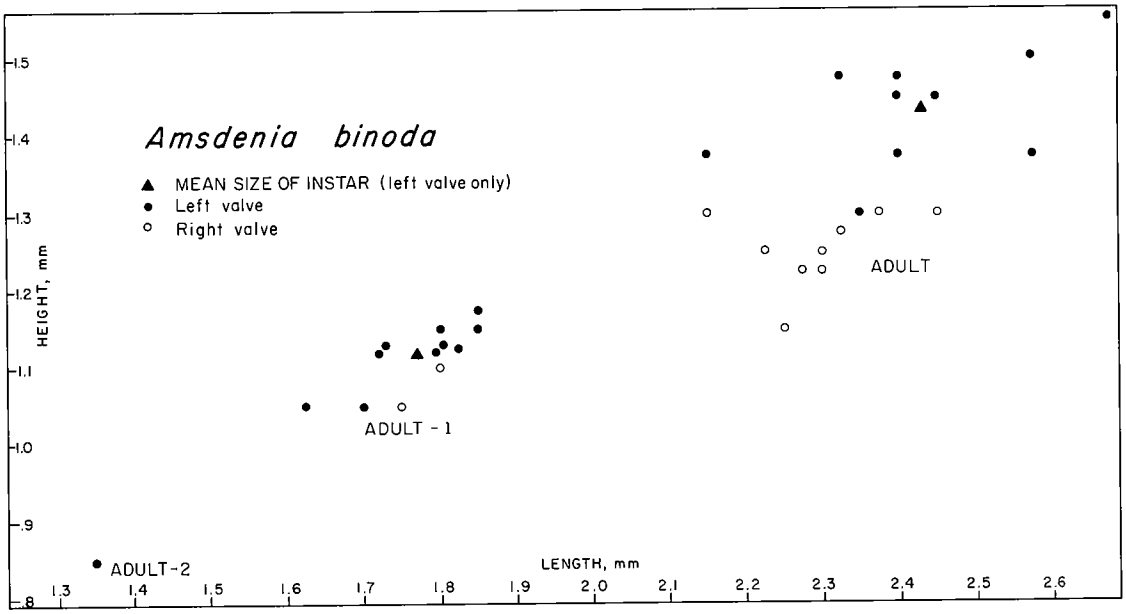
Description. — The valves are subreniform in lateral view and carapaces are elliptical in dorsal, ventral, and end views. The dorsal border of the left valve is uniformly arched, that of the right valve is slightly angulate. The anterior and posterior borders of the left valve are broadly rounded, those of the right valve are more sharply rounded. The venter of the left valve is straight to slightly sinuate, that of the right valve is distinctly sinuate. Ornamentation consists of a single node on each valve which is situated along the posterior border just below midheight. The node is circular in cross section and slightly affects the curvature of the posterior border. Only one carapace has been found. It indicates that the left valve overlaps the right valve along the entire free border. Overlap is greater along the ventral and anterodorsal borders than elsewhere. The surface of the valves is smooth.

The hinge is straight and simple. A weak groove is in the hinge of the right valve. The hinge is approximately one-third the length of the valves. The node is reflected interiorly. The shell is thickened along the contact margin, but thin sections show no evidence of a duplicature. Muscle scars have not been seen.

Length, 2.43 mm; height, 1.43 mm.

Ontogeny. — Three instars have been found in a population from sample P_6-4 (text-fig. 32). Only one specimen of the adult —2 instar has been definitely identified. A few immature specimens lacking the posterior node were found but not included in the measurements because they cannot be distinguished from immature specimens of some other species. Only specimens which certainly belong to this species have been used. The growth factor for length of the last moult is quite large. This large growth factor may indicate unusual lengthening of the carapace owing to maturation of the sex organs, or it may be due to the fact that only a relatively few specimens have been measured. As only two immature right valves have been found, growth factors for only the left valves are given in table 10.

The immature specimens differ from the adults only in size. The length-height ratio for the



Text-figure 32. Size-dispersion diagram of left and right valves of *Amsdenia binoda* Lundin, new species, from sample P_6-4. Triangles represent the mean size of each instar based upon left valves only.

adults is slightly larger than for the adult −1 instars, but the morphology of the adults and immature instars is not significantly different. The relatively poor development of the node in a few immature specimens may be an indication that this feature is not present in the early ontogeny of this species.

Variation. — The size-dispersion diagram (text-fig. 32) shows that variation in the size of adult specimens is great. Two adult left valves have a relatively high length-height ratio. This may be a normal variation or may be an indication of dimorphism. More material is necessary to determine which interpretation is correct.

The only variation of note in the immature specimens is the development of the posterior node. On most specimens it is distinct, but on a few specimens it is no more than a weak swelling. The node is always well developed in the adults.

Remarks. — As this is the first and only known species of this genus, it serves as the type species.

The specific name is derived from the Latin prefix bi, meaning two, and the Latin noun nodus, meaning swelling, and refers to the postero-ventral nodes on the carapace of this species.

Distribution. — *Amsdenia binoda* Lundin, new species, is known from three Henryhouse samples (P_6-1, P_6-4, P_3-5), all of which are in the lower part of the Henryhouse section. This species has not been seen in the Haragan Formation.

Materials studied. — Forty-eight specimens, mostly adult and adult −1 individuals, have been studied. Preservation is good, although some specimens are cracked or deformed. Carapaces are sparse.

Holotype. — OU 5269, sample P_6-4; plate XIII, figures 2a,b.

Figured specimens. — OU 5269-5271, samples P_3-5, P_6-4.

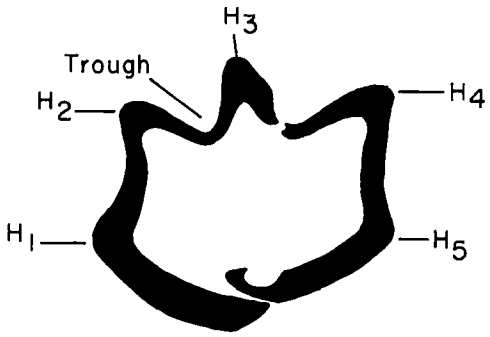
Family PACHYDOMELLIDAE Berdan and Sohn, 1961

Remarks. — The Hunton Group contains a large complex of species belonging to this family of ostracodes. There is question in the mind of this author concerning the generic significance of the characteristics upon which the three pachydomellid genera are distinguished (Sohn, 1960; Berdan and Sohn, 1961). Sohn (1960) indicated that *Phanassymetria* Roth (1929) differs from *Tubulibairdia* Swartz (1936) and *Pachydomella* Ulrich (1891) in that it has an angular transverse cross-sectional outline, although it may or may not have a groove (trough) on the larger valve. Ontogentic studies of *Phanassymetria triserrata* Roth, 1929, and *P. quadrupla* Roth, 1929, by Lundin and Scott (1963) indicate a close relationship between these two species, the former of which has a distinct trough and the latter of which lacks a trough. Furthermore, the trough is shown to be a feature which may not appear until late in the ontogeny. Also, the angular transverse outline of *P. quadrupla* does not exist until the adult −1 instar. The angular transverse outline of *Phanassymetria* is a result of the development of shoulders (ridges) which are subparallel to the hinge. The development of the shoulders, as well as the trough, is quite variable in some species of this genus. This variation is especially true of the shoulders in the ventral half of the carapace. Yet *Pachydomella* is distinguished from *Phanassymetria* upon the basis of the absence of shoulders below midheight. The type material of *Tubulibairdia* Swartz consists of molds and casts. Type material of this genus, which was generously supplied by Professor F. M. Swartz, leaves doubt that the true external appearance of this genus is known. The ventral shoulders of some pachydomellid species may result merely from a thickening of the shell and not be noticeable on the interior. In short, the author has observed enough variation in large populations of some pachydomellids that separating species is difficult. In view of this difficulty it seems unreasonable to place these species in different genera.

More variation and ontogenetic studies of the Pachydomellidae are needed to secure a better understanding of specific and generic relationships. As it is not the purpose of the present study to propose major taxonomic changes, the classification of the Pachydomellidae presented by Sohn (1960) and Berdan and Sohn (1961) is followed here.

TABLE 10.—GROWTH FACTORS FOR AMSDENIA BINODA

INSTAR	LENGTH (MM)	GROWTH FACTOR	HEIGHT (MM)	GROWTH FACTOR	NUMBER OF SPECIMENS
Adult	2.431		1.433		10
		1.373		1.279	
Adult —1	1.770		1.120		10



Text-figure 33. Transverse cross section of an adult carapace of *Phanassymetria triserrata* Roth illustrating terminology used in description of Pachydomellidae. The left valve is on the left, x50.

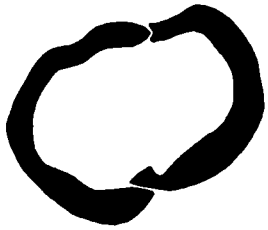
Terminology. — It is convenient for the purposes of description to number the shoulders which parallel the hinge on the carapace. The shoulders are numbered H_1, H_2, H_3, H_4, and H_5, beginning with the ventral lateral shoulder on the left valve and progressing clockwise around the ostracode as viewed from the posterior. The trough, if present, is ventral to H_3 (see text-fig. 33).

Genus *Pachydomella* Ulrich, 1891

Pachydomella dividia Lundin, new species

Pl. XV, figs. 1a-p; text-figs. 34, 35

Description. — The carapace is subreniform in lateral view, cuneate in dorsal and ventral views, and subovate in end views. The dorsal border of each valve is straight to gently convex. The anterior border of each valve is broadly rounded. The ventral border of the left valve is straight to gently convex, that of the right valve being straight or slightly sinuate. The posterior margin of each valve is bluntly pointed, but the point is higher on the left valve than on the right. The valves are asymmetrical, the left valve overlapping the right around the entire free margin and overreaching it along the hinge. The greatest width is posterior. The cardinal angles are indistinct. Distinct shoulders are not present in the ventral half of the carapace. The lateral surface of the left valve is swollen on most adult specimens so that a weak trough exists between the lateral surface of the valve and H_3. H_3 is moderately well developed just behind midlength so that a hinge channel is produced. H_4 is present but only moderately well developed. The lateral surface of the right valve is gently to sharply convex. Although nothing qualifies as an H_5 on the right valve, on many specimens a distinct change in the convexity of the right valve separates the ventral and lateral surfaces of the valve. The surface of the carapace is smooth.



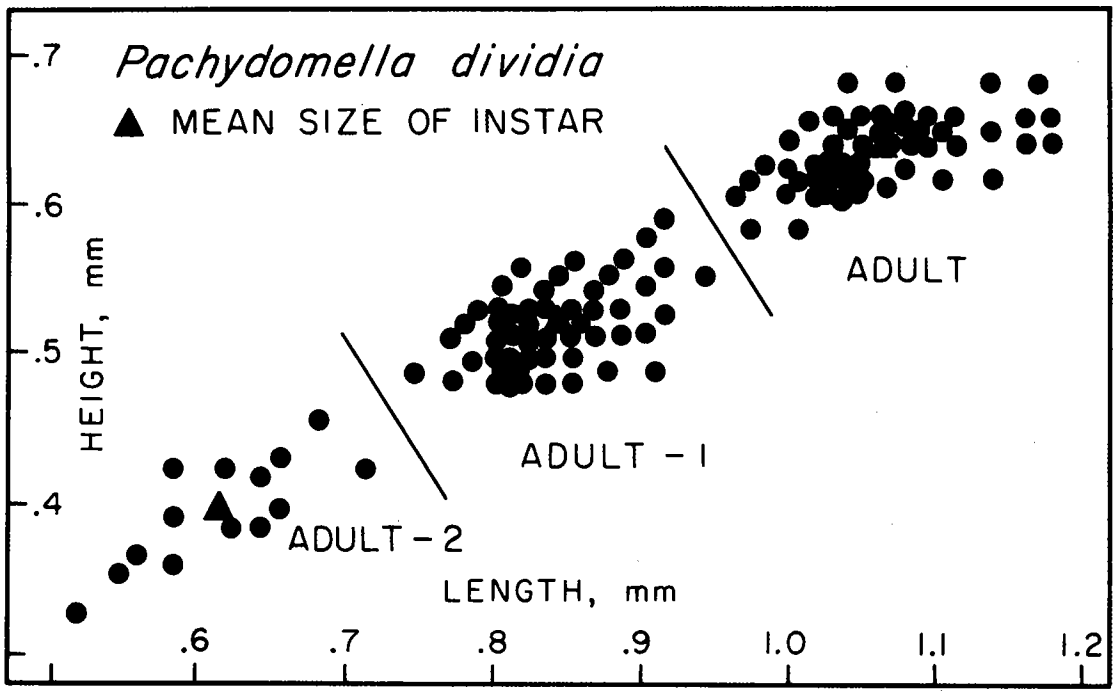
Text-figure 34. Transverse cross section through the widest part of an adult carapace of *Pachydomella dividia* Lundin, new species (OU 5398i). The left valve is on the left, x50.

The hinge is straight and about two-thirds as long as the carapace. The anterior end of the right valve hinge is swollen. This swelling fits into a depression in the left valve hinge. A flattened area at the posterior end of the right valve hinge accommodates a small posterior swelling of the left valve hinge. The edge of the left valve hinge fits into a shallow groove in the right valve. The interior surface of the valves is punctate as a result of the openings of randomly arranged tubules which do not open to the exterior. The tubules can be seen exteriorly only on especially well-preserved specimens. They are best seen when the specimen is immersed in water. H_4 is reflected interiorly, but H_3 is largely the result of the thickening of the shell. The exterior trough is only slightly noticeable as a low ridge on the interior of the valve. A transverse cross section through the widest part of the carapace is shown in text-figure 34. A duplicaturelike structure is especially well developed on the right valve. This structure is not believed to be a true duplicature because a plane of concrescence has not been seen. Muscle scars are not known.

Length, 1.07 mm; height, 0.65 mm; width, 0.75 mm.

Ontogeny. — Two immature instars are known for this species (text-fig. 35). Average length and height and growth factors are given for the left valves of the last three instars of this species in table 11. The left valves were measured rather than the right valves because they are more easily distinguished from similar species.

The adult −1 instar is like the adult in lateral outline. In transverse outline the valves of the adult −1 instar are less convex than are those of the typical adult individual. The trough is distinct on some and completely absent on others. The same variation exists in the adult −2 instar, although individuals of this instar are identical



Text-figure 35. Size-dispersion diagram of left valves of *Pachydomella dividia* Lundin, new species, from sample P_{18}-1.

in all other respects except size to the adult and adult −1 individuals. Several specimens of the adult −2 instar have a trough so sharply defined that an H_2 is developed. These specimens look remarkably similar to adults of *Phanassymetria parva,* new species, but differ in having a more elongate lateral outline. The convexity of the lateral surface of the adult −2 individuals is proportionately reduced, as are H_3 and H_4. In general, the same variation occurs in all three known instars. No major difference in morphology is found between the last two immature instars and the adult instar. The trough and H_2 are well developed only in several specimens of the adult −2 instar. Perhaps reduction in development of the trough occurred through the ontogeny of this species. More immature instars must be found to substantiate this supposition.

Variation. — The main variations in this species are in the convexity of the valves, the development of the trough, and accordingly the transverse outline of the carapace. Posterior views of two adult left valves are shown on plate XV, figures 1g and 1i, to illustrate this variation. Size variation of each instar can be seen in text-figure 35. The lateral shape of this species is remarkably constant, and it is this quality which has made it possible to distinguish this species from related pachydomellids.

Remarks. — This species is similar to *Pachydomella dorsoclefta* Swain (1953) but differs in its smaller size, shallower and shorter trough, and more bluntly rounded anterior margin.

The specific name is the Latin noun dividia used in apposition, meaning dissension, and refers to the variability in the tranverse outline of different specimens of this species.

Distribution. — *P. dividia* Lundin, new species, is common throughout the Henryhouse Formation. It is especially abundant in samples P_3-21,

TABLE 11.—GROWTH FACTORS FOR PACHYDOMELLA DIVIDIA

INSTAR	LENGTH (MM)	GROWTH FACTOR	HEIGHT (MM)	GROWTH FACTOR	NUMBER OF SPECIMENS
Adult	1.062		0.637		53
		1.263		1.227	
Adult —1	0.841		0.519		52
		1.367		1.314	
Adult —2	0.615		0.395		14

P_6-4, and P_{18}-1. However, it has been found in almost all Henryhouse samples which contain ostracodes.

Materials studied. — One-hundred and nineteen carapaces and left valves from sample P_{18}-1 have been measured and studied in detail. Right valves are equally abundant. In addition, hundreds of specimens from samples throughout the Henryhouse have been identified and studied. Preservation is excellent and carapaces are common.

Holotype. — OU 5397, sample P_{18}-1; plate XV, figures 1a-e.

Figured specimens. — OU 5397-5398i, sample P_{18}-1.

Genus *Tubulibairdia* Swartz, 1936

Tubulibairdia cf. *T. longula* (Ulrich and Bassler), 1913

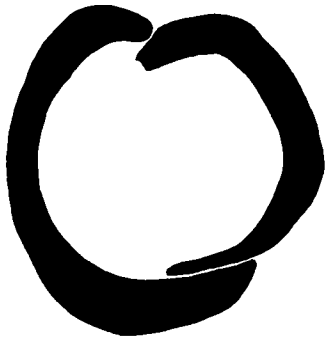
Pl. XV, figs. 2a-k; text-figs. 36, 37

Pachydomella longula Ulrich and Bassler, 1913, p. 542, pl. 98, figs. 29-31.

Tubulibairdia longula (Ulrich and Bassler), Sohn, 1960, p. 75.

Description. — The carapace is subelliptical in lateral view, cuneate in dorsal and ventral views, and subovate in end view. The dorsal border of each valve is gently to strongly arched. The anterior end of each valve is distinctly rounded, whereas the posterior border of the right valve is sharply rounded and that of the left valve is broadly rounded. The venter of the left valve is gently convex, that of the right valve straight to slightly sinuate. The valves are asymmetrical, the left overlapping the right around the entire free border and overreaching it along the hinge. The greatest width is posterior. The cardinal angles are indistinct. The lateral surface of each valve is evenly convex. No shoulders are present (text-fig. 36), but the lateral surface of each valve rises above the hinge line to form a shallow hinge channel. A trough is not present. The surface of each valve is smooth.

The hinge is straight to slightly arched, that of the left valve being generally more arched than that of the right valve. Cardinal teeth are present at either end of the right valve hinge, and a shallow groove exists between these teeth. Distinct hinge elements have not been seen on the valve. Tubules are present throughout the carapace. They do not open to the exterior but impart a punctate appearance to the interior surface of the shell. Muscle scars are not known.



Text-figure 36. Transverse cross section through the widest part of an adult carapace of *Tubulibairdia* cf. *T. longula* (Ulrich and Bassler) (OU 5406), x50. The left valve is on the left. The right valve has slipped into left valve so that the two valves do not meet properly at the hinge.

Length, 1.20 mm; height, 0.72 mm; width, 0.75 mm.

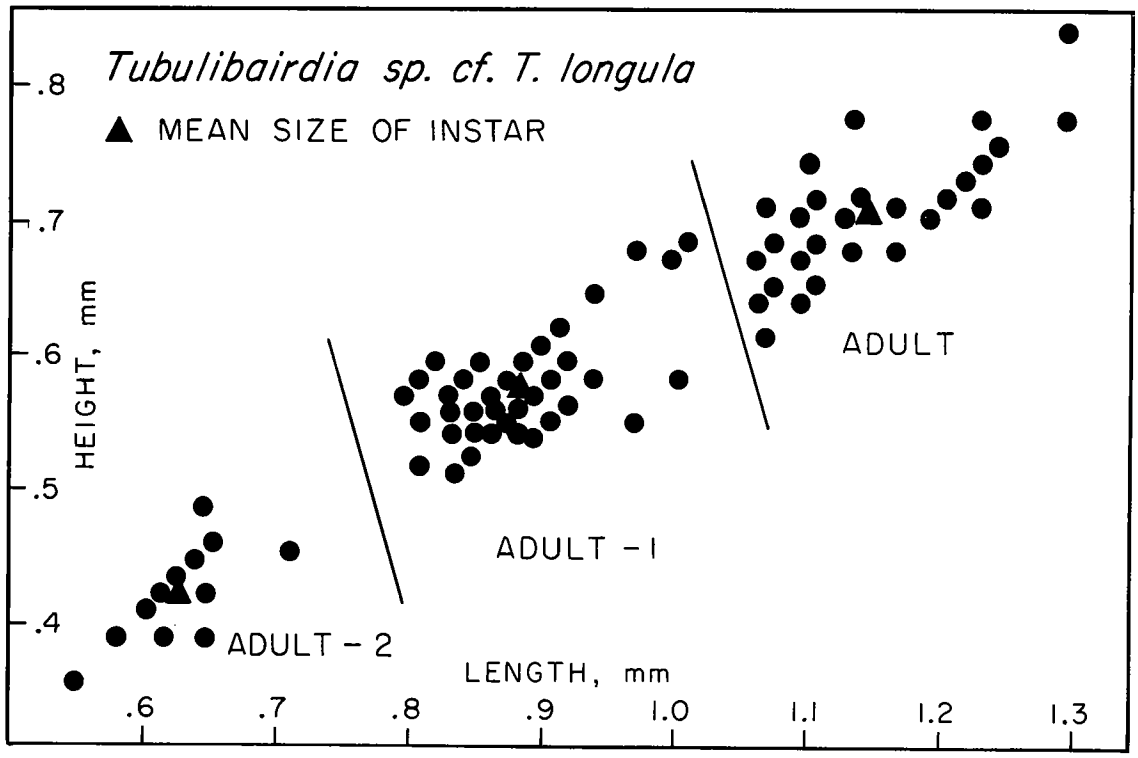
Ontogeny. — Three instars of this species have been studied in detail (text-fig. 37). Average length, height, and growth factors are given for left valves of the last three instars of the ontogenetic sequence in table 12.

No major morphological changes occur in the last three moult stages of this species. Equally as much variation (see below) is present in the immature instars as in the adults.

Variation. — The most noticeable variation in this species is the convexity of the dorsal border of the left valve. The dorsal border is gently convex on some specimens, but a dorsal medial hump is developed on some specimens, so that the dorsal border is distinctly convex. Also, the posterior margin of the left valve is more sharply rounded on some specimens than on others. The lateral

TABLE 12.—GROWTH FACTORS FOR TUBULIBAIRDIA CF. T. LONGULA

INSTAR	LENGTH (MM)	GROWTH FACTOR	HEIGHT (MM)	GROWTH FACTOR	NUMBER OF SPECIMENS
Adult	1.151		0.712		28
		1.298		1.229	
Adult —1	0.887		0.579		37
		1.406		1.369	
Adult —2	0.631		0.423		12



Text-figure 37. Size-dispersion diagram of left valves of *Tubulibairdia* cf. *T. longula* (Ulrich and Bassler) from sample P_{18}-1.

surface of some right valves rises higher above the hinge than in others. These variations result in considerable differences in the lateral outline of this species.

Remarks. — This species appears to be conspecific to *Tubulibairdia longula* (Ulrich and Bassler). Ulrich and Bassler's illustrations indicate that their species is identical to those specimens in the populations studied here which have the gently convex dorsal border. *T. longula* (Ulrich and Bassler) is from the Keyser Formation of Maryland.

Distribution — *T.* cf. *T. longula* is common throughout the Henryhouse strata. It is especially abundant in samples P_3-21, P_{18}-1, P_6-3, and P_6-4 but has been found in almost all Henryhouse samples which yield any ostracodes.

Materials studied. — Eighty-one carapaces and left valves representing three instars from sample P_{18}-1 have been measured and studied in detail (text-fig. 37). Right valves are equally abundant. Hundreds of specimens from other samples have been identified and studied. Preservation is excellent in most cases. Carapaces are sparse.

Figured specimens. — OU 5399-5400g, 5406, samples P_3-11, P_6-4, P_{18}-1.

Genus *Phanassymetria* Roth, 1929

Phanassymetria inequalis (Roth), 1929

Pl. XVI, figs. 4a-i

Aechmina inequalis Roth, 1929, p. 335, pl. 35, figs. 3a-c.

Description. — The carapace is subquadrate in lateral and end views and elliptical in dorsal and ventral views (exclusive of spines). The dorsum is straight to slightly convex, the ends are bluntly rounded, and the venter is slightly convex. The posterodorsal border of the right valve is straight and inclined backward to a position below midheight, where it meets the sharply rounded posteroventral border. The ventral border of the right valve is slightly sinuate. The valves are extremely asymmetrical, the left overlapping the right around the entire free margin. The cardinal angles are obtuse. The left valve and anterior portion of the right valve are convex in transverse cross section, but the posterior three-fifths of the right valve is distinctly concave. H_1 and H_2 are not developed, but H_3, H_4, and H_5 are distinct.

H_3 is represented by a heavy dorsal spine, which is directed posteriorly and slightly away from the hinge. It is at about midlength along the dorsum and fuses gradually with the surface of the cara-

pace. It rises above the level of the hinge and has its origin just behind the anterior cardinal corner. H_4 is in the same relative position on the right valve as H_3 is on the left valve. It also is a heavy blunt spine but arises farther behind the anterior cardinal corner than does H_3. It also fuses gradually with the general surface of the valve. H_5 is developed as a shoulder in the posterior three-fifths of the valve which separates the lateral surface from the venter. It fades gradually to the anterior and relatively abruptly to the posterior. The development of H_5 forces the concavity on the lateral surface of the right valve. No other ornamentation is present.

The hinge is straight and of the edge-and-groove type. The ends of the left valve hinge are slightly flattened, although no teeth are developed on the right valve. The right valve hinge is grooved to receive the edge of the left valve. Clean interiors of valves have not been observed, and thin sections have not been prepared. H_4 of one specimen is broken and proves to be hollow. It is likely that H_3 and H_5 are likewise reflected interiorly. Tubules can be seen from the exterior on some specimens when immersed in water.

Length, 1.13 mm; height, 0.80 mm; width, 0.73 mm.

Ontogeny. — The only basic difference between immature individuals and adults concerns the development of H_3 and H_4. These features are generally less spinose in the immature forms than in the adults. H_3 and H_4 of some of the immature instars observed (most of which belong to the adult −1 instar) cannot be considered spines at all because they are almost completely fused to the general surface of the valve. It is likely that H_3 and H_4 of the earlier instars also are true shoulders.

Variation. — In addition to the variation in spinosity of H_3 and H_4, some variation also occurs in the orientation of these spines. On some, these spines are directed more laterally than on others. Also H_4 is situated more posteriorly on some specimens than on others. In general, however, variation is so insignificant that identification of this species is no problem.

Remarks. — The valve relationships, shape, and tubules indicate that this species is undoubtedly a member of the genus *Phanassymetria.* It is closely related to *P. quadrupla* Roth, which is common in the Haragan. It differs from the latter in its more quadrate lateral outline and in the spinose aspect of H_3 and H_4.

Roth's locality is "Basal Haragan marl, White Mound." The author has not seen this species in the Haragan at White Mound. It is certain that Roth collected this species from the Henryhouse in the White Mound section.

Distribution. — *P. inequalis* is a common, although rarely abundant, species throughout the Henryhouse strata. It is especially well represented in sample P_3-7 and P_{18}-1.

Materials studied. — One-hundred and eighteen specimens representing three instars have been studied. Most of these are adult and adult −1 individuals. Preservation is fair to excellent. Carapaces are common.

Holotype. — USNM 80647 H; plate XVI, figure 4a.

Figured specimens. — UI X-1607a to X-1607e, samples P_3-7, P_6-4.

Phanassymetria parva Lundin, new species

Pl. XVI, figs. 1a-h; text-figs. 38, 39

Description. — The carapace is subreniform in lateral view, subelliptical in dorsal and ventral views, and subquadrate in end view. The dorsal border of the left valve is distinctly arched, that of the right valve is straight to very gently convex. The anterior border of each valve is broadly rounded and the ventral border is gently convex. The posterior border of the left valve is bluntly angular, whereas that of the right valve is sharply rounded. The right valve is elliptical in lateral view. The valves are extremely asymmetrical, the left valve being much larger than the right and overlapping it along the free margin and overreaching it along the hinge. The cardinal angles are indistinct. The surface of the carapace is ornamented by five longitudinal shoulders, three of which are on the left valve. H_1 separates the ventral and lateral surfaces of the posterior three-fifths of the left valve. It is not a well-developed shoulder. H_2 is situated in a dorsolateral position on the left valve and extends slightly more toward the anterior than does H_1. It is best developed at its posterior extremity, which in some specimens is slightly spinose. On most specimens a small swelling arises at the posterior extremity of H_2, from which the shoulder is inclined abruptly backward onto the surface of the valve. H_3 forms the dorsal border of the left valve. H_2 joins with it indistinctly just anterior to midlength to enclose a shallow U-shaped trough. H_2 and H_3 do not close around the posterior end of the trough. The hinge line is incised between H_3 and H_4, the latter of which occupies a dorsolateral position on the right valve. H_4 is weak and can be distinguished only in the posterior half of the valve. H_5 is ven-

trolateral on the right valve and is also weak, having the same extent as H_4. The lateral surface of the right valve is slightly concave in the posterior portion. The same is true of the left valve. The line of contact between the two valves is in essentially one plane around the entire ostracode.

The hinge is straight and of the edge-and-groove type. The groove is in the right valve hinge and best developed at the ends of the hinge. The shell is quite thick at the hinge of the left valve, and, in addition to an edge which fits into the groove of the hinge of the right valve, there is slight evidence of a groove about this edge. Distinct cardinal elements have not been seen. The shell is filled with tubules which do not completely perforate the shell wall (pl. XVI, fig. 1d). These tubules cannot be seen in exterior views of most specimens. Careful examination of thin sections normally is needed. The shell is extremely thick in comparison to the size of the ostracode. Interiorly the shoulders are reflected as depressions (text-fig. 38). The inner surface of the valves has a punctate appearance owing to the tubules which open on the interior surface.

Length, 0.69 mm; height, 0.48 mm.

Text-figure 38. Transverse cross section of an adult left valve of *Phanassymetria parva* Lundin, new species (UI X-1606c), x50.

Ontogeny. — Five instars have been recovered in the population studied (text-fig. 39). Growth factors for length and height are near the theoretical 1.26 (table 13). Because the right valves are difficult to distinguish from right valves of related forms, the discussion of ontogeny and variation will be limited to the left valves, which are distinctive.

Adult −1 instar: The shape remains the same in lateral view, but H_1 is weak and the concavity of the lateral surface is represented by only a slight depression ventral to H_2. The trough and H_2 are distinct.

Adult −2 instar: The lateral view is elliptical, and H_1 is almost absent. H_2 is present but weaker than in the adult −1 instar. The trough is correspondingly less distinct.

Adult −3 instar: H_1 is represented by only a slight swelling at its posterior extremity, and H_2 is represented by only a slightly larger swelling. In posterior view the lateral surface is flat. The trough can be seen clearly only in posterior view.

Adult −4 instar: H_1 is absent and the lateral surface is convex. H_2 is represented in most specimens as a small spine in the posterior portion. The trough is indistinct.

H_3 decreases in size in the early instars and is represented as only an extension of the lateral surface above the hinge in the adult −4 instar.

Variation. — The only variation noted within instars concerns the development of the posterior extremity of H_2 and the development of H_1. The posterior extremity of H_2 is spinose in some adults, slightly swollen in others, and not represented by any unusual development in others. H_1, in a few specimens, is quite sharp so that the concavity of the lateral surface is almost groovelike. In most specimens it is weak.

Remarks. — The general shape and occurrence of tubules require the placement of this species in the genus *Phanassymetria*. It is closely related to *P. triserrata* Roth but differs from it in its smaller size, the absence of tubercles on H_3 and H_4, and the presence of the trough and H_2 in at least four instars (they are present in only the last three instars of *P. triserrata*).

TABLE 13.—GROWTH FACTORS FOR PHANASSYMETRIA PARVA

INSTAR	LENGTH (MM)	GROWTH FACTOR	HEIGHT (MM)	GROWTH FACTOR	NUMBER OF SPECIMENS
Adult	0.689		0.484		23
		1.192		1.172	
Adult —1	0.578		0.413		35
		1.254		1.233	
Adult —2	0.461		0.335		39
		1.236		1.264	
Adult —3	0.373		0.265		6
		1.211		1.113	
Adult —4	0.308		0.238		5

The specific name is derived from the Latin adjective parvus, meaning little, and refers to the small size of this species.

Distribution. — *Phanassymetria parva,* new species, is known to occur throughout the Henryhouse Formation. It is especially abundant in sample P_3-11. This species is not known from the Haragan Formation.

Materials studied. — Sample P_3-11 yielded a population consisting of 108 measurable left valves, only a few of which have the right valve attached. The specimens are well preserved.

Holotype. — UI X-1606a, sample P_3-11; plate XVI, figures 1a,b.

Figured specimens. — UI X-1606a to X-1606g, sample P_3-11.

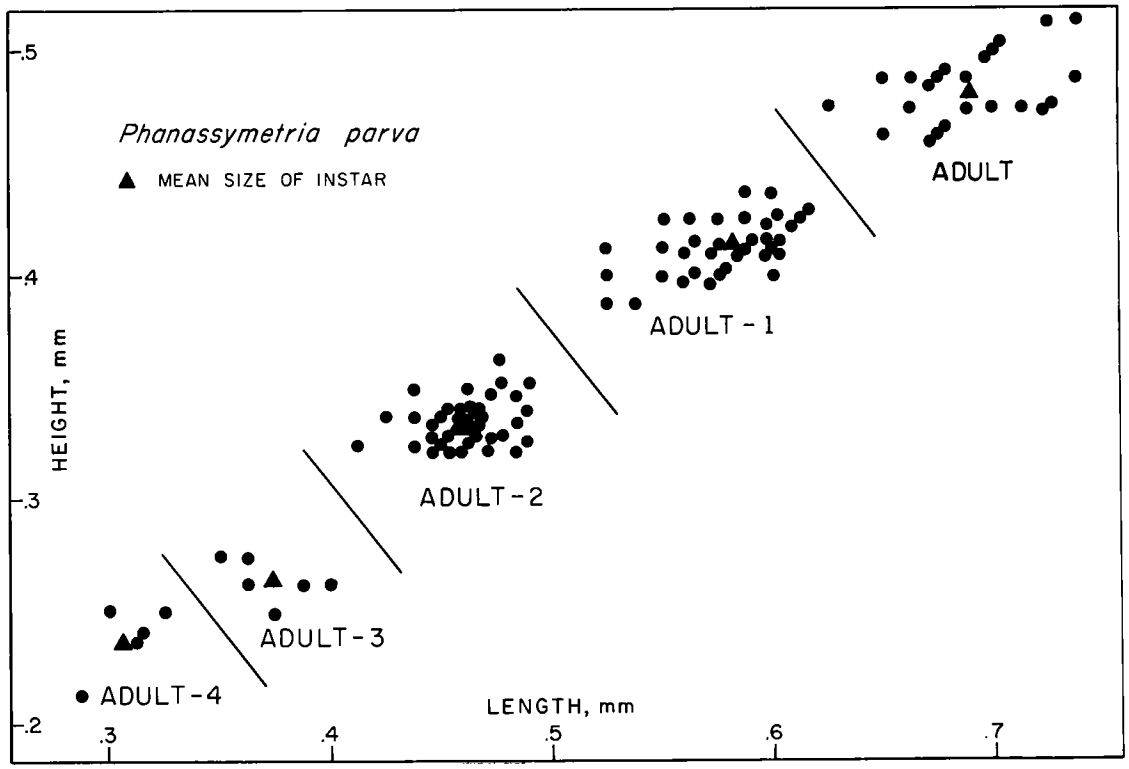
Superfamily THLIPSURACEA Ulrich, 1894

Family THLIPSURIDAE Ulrich, 1894

Genus *Octonaria* Jones, 1887

Remarks. — Considerable taxonomic difficulty has arisen with *Octonaria,* as with other thlipsurids, mainly through insufficient knowledge of the type species. These problems have been compounded with *Octonaria* because of Jones' (1887) vague description of the type species. Jones studied seventeen specimens in all, most of which came from different samples. Of these, he ascribed nine to one variety, one as the type species, and the remaining seven to five different varieties. The varieties resemble each other only in general shape. The ornamentation of the valves is similar mainly in one respect — the ridges and depressions are coarse in relation to the size of the ostracode. None of Jones' varieties has more than four pits or depressions. Since Jones' time, many species have been referred to *Octonaria,* and Swartz (1932) attempted to group existing species and new species into sections containing similar forms. His grouping is not wholly acceptable because some sections contain ostracodes which differ in ornamentation and other sections contain forms which differ in shape. New species have been added to the genus since Swartz's paper, some of which do not appear to be closely related to the type species.

Furthermore, the genus *Strepulites* Coryell and Malkin (1936) has compounded the problem. Certain species assigned to *Strepulites* are more similar to certain species of *Octonaria* than the latter are to the type species of *Octonaria.* Also,



Text-figure 39. Size-dispersion diagram of left valves of *Phanassymetria parva* Lundin, new species, from sample P_3-11.

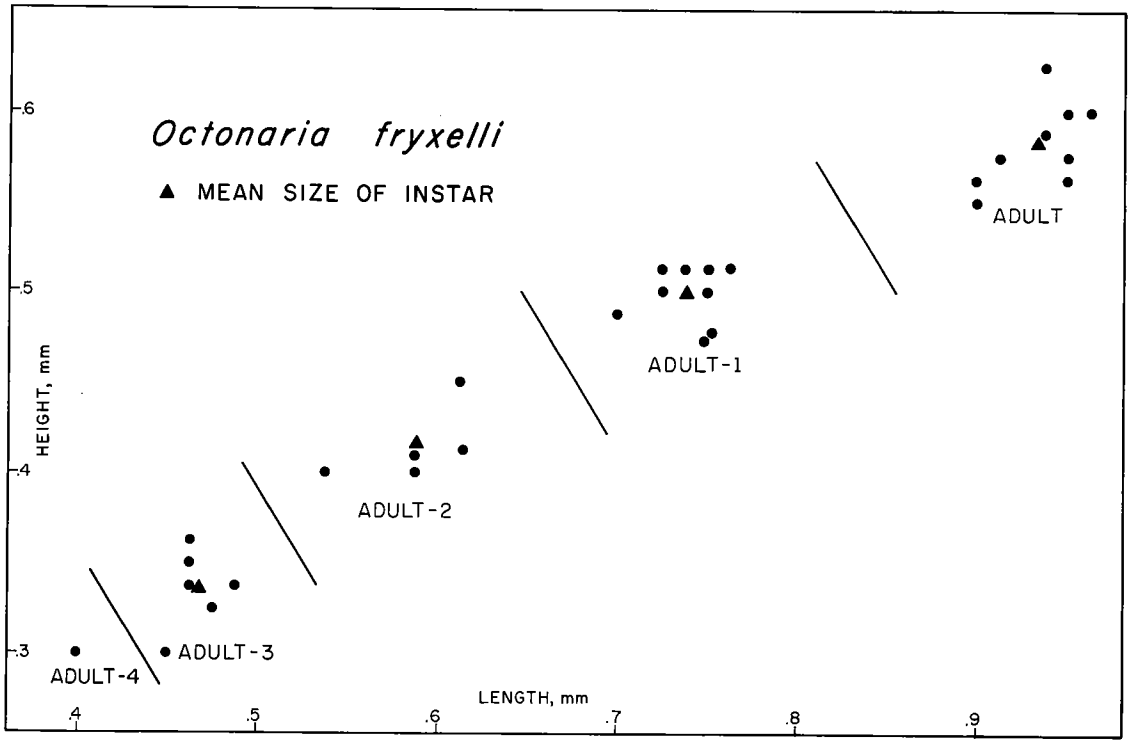
the ornamentation of the genotype of *Strepulites* is more similar to that of the type species of *Octonaria* than it is to other species of *Strepulites*. To further complicate the problem, apparently the orientation of some species of both genera is questionable.

Swartz (1932) suggested that *Octonaria punctata* Roth should probably be removed from that genus. Complete reevaluation of the generic characters of *Octonaria* and *Strepulites* is needed. In addition to this, reevaluation of the significance of shape, overlap, ornamentation, and direction of overlap in generic classification is necessary. The only apparent difference between the two genera according to Kesling (1961b) is that the ornamentation of *Strepulites* is coarser than that of *Octonaria*. However, the ornamentation of the type species of *Octonaria* is coarser than the ornamentation of genotype of *Strepulites* and to most, if not all, species assigned to *Strepulites*. It is not considered proper to erect new thlipsurid genera for the species described below until the true relationships of the present genera can be established. This certainly will require comparison of types and is beyond the scope of this study. It, therefore, should be emphasized that the classification of the following species under *Octonaria* is tentative.

Octonaria fryxelli Lundin, new species

Pl. XVI, figs. 2a-k; text-fig. 40

Description. — The carapace is elliptical in lateral view, subquadrate in end view, and cuneate in dorsal and ventral views. The dorsal border of the left valve is gently convex, that of the right valve straight and inclined anteriorly. The anterior border of the left valve is broadly rounded, that of the right valve sharply rounded. The posterior border of the left valve is bluntly angular. The posterodorsal border of the right valve is straight and inclined backward and meets the posteroventral border around a sharply rounded posteroventral corner. The ventral border of the left valve is gently convex, that of the right valve straight to slightly sinuate. The valves are asymmetrical, the left overlapping the right around the entire free margin. The cardinal angles are indistinct. The anterior portion of each valve is smooth and convex. Just in front of midlength on the left valve a pitted area arises and is surrounded dorsally and posteriorly by a ridge. It extends posteriorly to about three-fourths the length from the anterior border and is subelliptical in outline. This area can be divided into two parts. One is a dorsal troughlike depression ornamented with about ten relatively small pits. This depression is separated from the dorsum and pos-



Text-figure 40. Size-dispersion diagram of left valves of *Octonaria fryxelli* Lundin, new species, from sample P_6-4.

terior part of the valve by the distinct ridge which surrounds the whole pitted area. It is separated from the ventral part of the pitted area by a small but distinct ridge. The ventral portion of the pitted area is ornamented with four to six relatively large pits separated by thick bars. This portion of the pitted area grades gradually into the ventral and anterior portions of the valve. A pitted area exists in the posterior portion of the right valve. It is surrounded dorsally and posteriorly by a distinct dorsolateral shoulder, which arises just behind the anterior cardinal corner. This shoulder curves around the posterior portion of the pitted area, forming a ridge which separates the pitted area from the posterior border of the valve. Five or six relatively large pits are within this area. The pitted area fuses gradually with the anterior and ventral surfaces of the valve.

The hinge is straight and for the most part simple. Some evidence exists of a slight groove in the right valve hinge, with slight swellings at either end of the hinge. Thin sections have not been prepared for this species and clean interiors have not been observed.

Length, 0.93 mm; height, 0.58 mm.

Ontogeny. — Five instars have been found in this population (text-fig. 40). Growth factors for length and height are near the theoretical 1.26 (table 14). Although only 30 specimens have been measured, it is unlikely that the measurement of more specimens would significantly change the mean size of each instar. Measurement of 27 right valves produced the same size-dispersion pattern.

The only consistent ontogenetic change noted concerns the number of pits in the ventral portion of the pitted area of the left valve and in the pitted area of the right valve. There generally is an increase of one or two pits in each earlier instar. The pits and ridge surrounding the pitted area are distinct even in the adult −4 instar. The ridge separating the two portions of the pitted area of the left valve is not well developed in the adult −3 and adult −4 instars. Shape remains essentially constant throughout the ontogeny of this species, although the earlier instars are somewhat more elliptical in lateral view than are the later instars.

Variation. — Size variation can be seen in text-figure 40. Variation in shape is minor. The only other noticeable variation within instars is the number of pits; the number does not vary by more than two within any particular instar. This variation is not significant in classification of this species.

Remarks. — The same taxonomic problems exist with this species as with O. *punctata*. It has the shape and valve relationships of O. *laevilatata* Kesling and Kilgore, 1952, but the pitted area of the right valve is more restricted. Furthermore, O. *laevilatata* has no ornamentation on the left valve. However, if Kesling and Kilgore's generic designation is correct, then the new species described above certainly belongs to *Octonaria*. Some would be tempted to place this species in *Strepulites* because of its relatively coarse ornamentation. The new species differs slightly in shape from S. *quadricostata* (Van Pelt), but ornamentation of the two is basically the same. More study is needed before relationships of these genera can be certainly established. No forms have been found in the Henryhouse ostracode fauna with which this species can be confused.

This species is named in honor of Professor Fritiof M. Fryxell of Augustana College, Rock Island, Illinois, who was largely responsible for the author's early education in geology.

Distribution. — At present this species has been found in only one sample (P_6-4) from the Henryhouse. It has not been seen in the Haragan.

Materials studied. — Sample P_6-4 contained 27 right valves, 22 left valves, and 8 carapaces, all of which are well preserved.

Holotype. — UI X-1609a, sample P_6-4; plate XVI, figures 2a-d.

Figured specimens. — UI X-1609a to X-1609h, sample P_6-4.

TABLE 14.—GROWTH FACTORS FOR OCTONARIA FRYXELLI

INSTAR	LENGTH (MM)	GROWTH FACTOR	HEIGHT (MM)	GROWTH FACTOR	NUMBER OF SPECIMENS
Adult	0.934		0.583		9
		1.264		1.168	
Adult —1	0.739		0.499		9
		1.257		1.202	
Adult —2	0.588		0.415		5
		1.262		1.239	
Adult —3	0.466		0.335		6

Octonaria punctata Roth, 1929

Pl. XVI, figs. 3a-k; text-figs. 41, 42

Octonaria punctata Roth, 1929, p. 351, pl. 36, figs. 12a-f.

Description. — The carapace is subreniform in lateral view, cuneate in dorsal and ventral views, and subquadrate in end view. The dorsal border of the left valve is distinctly arched, that of the right valve straight. The ventral border of both valves is straight, and the anterior borders are rounded. The posterior border of the left valve is angular. The posterodorsal border of the right valve is straight and inclined posteriorly. The posteroventral border of the right valve is sharply rounded to meet the posterodorsal border. The right valve is subelliptical in lateral view. The valves are extremely asymmetrical, the left valve being much larger than the right and distinctly overlapping it on all margins. The cardinal angles are indistinct. The lateral surface of the left valve is convex in its anterior portion. Between lines one-third the length from the anterior border and one-fifth the length from the posterior border and including the lower two thirds of the lateral surface is an elevated elliptical platform in which a distinct, smooth circular spot occurs. Surrounding this spot and within a ridge that circumscribes the platform are numerous small pits. The number of pits varies but is generally between twenty and thirty. The edge of this platform slopes dorsally into a pitted troughlike depression, which ends abruptly about one-third the length from the anterior but fades gradually around the posterior and posteroventral part of the platform. The pits in this depression are restricted to the dorsal portion and are slightly larger than those in the platform. The dorsal side of this depression slopes upward to a shoulder which rises above the hinge of the ostracode. The right valve is ornamented by a small pit which is subcentral in location. This pit is not well developed on all specimens. In the posterocentral area of the right valve a small elevated platform, surrounded on its dorsal, posterior, and ventral sides by a ridge, arises from the general surface of the valve. This platform is pitted with a variable number of pits, generally between eight and twelve. The platform is more extensive in some specimens than in others. The dorsal ridge of this platform rises above the level of the dorsum of the valve in some specimens. The hinge is straight and simple. The only evidence of special hinge elements is a prominent tooth at the anterior end of the right valve hinge of some specimens. This tooth apparently pivoted on a slightly depressed area at the anterior end of the left valve hinge. A thin section through a left valve shows slight depressions interiorly corresponding to the ridge around the platform and the shoulder above the troughlike depression (text-fig. 41). The interior of a right valve has not been seen.

Text-figure 41. Transverse cross section of an adult left valve of *Octonaria punctata* Roth (UI X-1608g), x50.

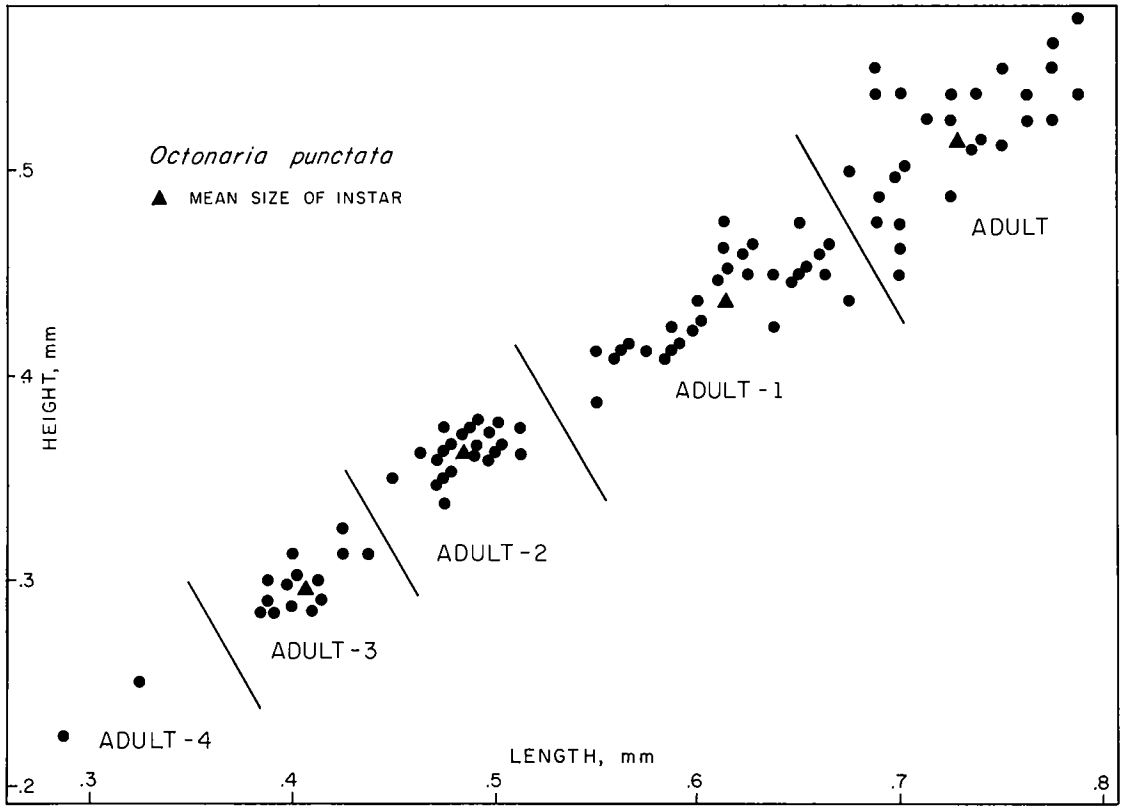
Length, 0.73 mm; height, 0.52 mm.

Ontogeny. — Five instars have been found in the population studied (text-fig. 42). Growth factors for length and height can be found in table 15. Those right valves of this species on which the platform and ornamentation are poorly developed are difficult to distinguish from the right valves of *Phanassymetria parva,* new species. For this reason, observations on ontogenetic changes have been made mainly upon the left valves.

The platform and pits and the small circular smooth spot within the platform are distinct even in the adult −3 instar. In the adult −4 instar the small circular spot is indistinct. No significant changes in shape occur during ontogeny. The only noticeable change which is consistent is a reduction in the number of pits in the platform. In the adult −1 and adult −2 instars there generally are fifteen to twenty-five pits in the platform. In the adult −3 instar these pits number ten to fifteen, whereas in the adult −4 instar there are eight to twelve. In the adult −4 instar the troughlike depression is not well developed.

The only basic change noticed in the right valves during ontogeny concerns the extent of the platform. In the immature instars the platform extends forward to include the subcentral pit of the adult. The smooth area between the subcentral pit and the platform in the adults is represented in the immature instars as a circular smooth spot such as occurs in the platform of the adult left valves. In general, the pitted platform of the right valve is relatively more extensive in the immature forms than in the adults.

Variation. — Variation of the left valves generally is not sufficient to cause difficulty in identification of this species. One noticeable varia-



Text-figure 42. Size-dispersion diagram of left valves of *Octonaria punctata* Roth from sample P_3-11.

tion, however, is that the small smooth circular spot in the platform of the left valve is fused in some specimens both dorsally and ventrally and in other specimens only ventrally with the ridge surrounding the platform. In some specimens this spot is completely separated from the ridge by small pits.

Size variation within each instar can be seen in text-figure 42. No significant variation in shape occurs within each instar. Variation in the number of pits has already been mentioned. Attendant with this variation is minor variation in the pattern of the pits.

Remarks. — The taxonomic problems of this genus have already been discussed (see remarks under *Octonaria*). This species remains provisionally in *Octonaria* despite Swartz's (1932) indication that it probably should be removed from that genus. At present no better generic designation can be given to this species. More study is needed.

Roth's localities are in Henryhouse rocks. The author has not seen this species in the Haragan, although it is common in the Henryhouse. Roth's report of *O. punctata* in the Haragan is incorrect.

Distribution. — This species has been found throughout the Henryhouse, although it general-

TABLE 15.—GROWTH FACTORS FOR OCTONARIA PUNCTATA

INSTAR	LENGTH (MM)	GROWTH FACTOR	HEIGHT (MM)	GROWTH FACTOR	NUMBER OF SPECIMENS
Adult	0.728		0.518		27
		1.188		1.183	
Adult —1	0.613		0.438		30
		1.264		1.207	
Adult —2	0.485		0.363		22
		1.198		1.214	
Adult —3	0.405		0.299		14

ly is not common. It has not been seen in the Haragan.

Materials studied. — The left valves of 95 specimens were measured from a population in sample P_3-11. Of these, 16 are carapaces. Numerous right valves are present, but they are less abundant than are left valves.

Lectotype. — USNM 80653 C; plate XVI, figure 3g.

Figured specimens. — UI X-1608a to X-1608g, sample P_3-11.

Genus *Thlipsurella* Swartz, 1932

Thlipsurella? curvistriata (Roth), 1929

Pl. XVII, figs. 1a-j; pl. XVIII, figs. 2a, b

Thlipsura curvistriata Roth, 1929, p. 354, pl. 36, figs. 15a, b.

Thlipsurella curvistriata (Roth) Swartz, 1932, p. 44; Warthin, 1945, card 55.

Description. — The carapace is subreniform in lateral view and subrectangular in dorsal, ventral, and end views. The dorsal border is distinctly arched to slightly angulate. The anterior border is sharply rounded, the posterior border bluntly rounded. The venter is straight to slightly sinuate. The valves are subequal, the left overlapping the right especially along the venter. The cardinal angles are indistinct. The valves are smooth except in the midposterior region, where an arcuate furrow is present. The posterior end of the furrow is just in front of the posterior border at midheight. From this position it curves anterodorsally with the concave side ventral. The length of the furrow varies considerably but in no case extends beyond midlength. The posterior portion of the furrow is surrounded by a distinct rim, which fades anteriorly into the general surface of the valve. This rim imparts a blunt appearance to the posterior end when viewed from above or below. The anterior portion of the valve is slightly swollen so that the anterior end also is blunt in dorsal and ventral views.

The hingement is poorly preserved on most specimens. One right valve has a groove in the hinge, and one well-preserved left hinge is a simple edge. The hinge is straight to slightly convex. Neither the furrow nor the rim surrounding it is reflected interiorly. Muscle scars have not been seen.

Length, 1.75 mm; height, 1.00 mm.

Ontogeny. — Sufficient material for detailed ontogenetic studies is not available. A few poorly preserved late immature specimens have been found, and they do not indicate any significant difference between the late immature instars and adults except size. It is of interest to note that the better preserved immature individuals indicate that the length-height ratio for immature specimens is greater than that for a number of adult specimens. More well-preserved material is needed to substantiate this observation.

Variation. — The relatively small number of specimens available indicates that considerable variation exists among the adult individuals. The dorsum of some specimens is distinctly more arched than is that of others. Some of this variation certainly is due to the state of preservation because the posterodorsal portion of the valve tends to be deformed. Some specimens are more elongate than others. The development of the furrow and rim surrounding the furrow is quite variable. These features are well developed on some, hardly noticeable on others. Variation in length of the furrow has already been discussed in the description. The curvature of the furrow is pronounced in some specimens, indistinct in others. The posterior end of the furrow is widened in some specimens; in others it is merely a slit.

Whether any of this variation is due to dimorphism cannot be determined at this time. The author believes that likely the variation in length-height ratio is a dimorphic variation. The adult specimens available at present are generally the same length, but some have a considerably greater height than others. These would be the females if dimorphism occurs in this species. Large numbers of well-preserved specimens must be measured to determine if this species is dimorphic.

Remarks. — Swartz (1932) revised the family Thlipsuridae and consequently dealt with several of Roth's (1929) thlipsurid species. In his restriction of the genus *Thlipsura,* Swartz (1932, p. 38) stated: "Considering the large anterior [now considered posterior] sunken area as a diagnostic feature, the genus *Thlipsura* is here restricted to include only the following described species."

Roth's "*Thlipsura curvistriata*" does not have the large sunken area and therefore was moved to a new genus, *Thlipsurella,* by Swartz, (1932, p. 44). Swartz designated *Thlipsurella ellipsoclefta* Swartz (1932) as the type species of the genus. The author has not seen the type species, but published illustrations indicate that it has a well-developed S_2. The author has studied *Thlipsurella putea* Coryell and Cuskley (1934), which is quite similar to *T. ellipsoclefta.* It has a distinct S_2, which is reflected on the interior of the shell. No such sulcus is present in Roth's species.

Swartz's generic designation of *Thlipsurella curvistriata* was followed by Bassler and Kellett (1934) and by Warthin (1945).

Whether or not *Thlipsurella? curvistriata* (Roth) really belongs in *Thlipsurella* depends upon whether the "subvertical furrow" of *T. ellipsoclefta* is really a sulcus. If it is, Roth's species should not be in the genus *Thlipsurella*. If it is not, some question remains as to whether *T. ellipsoclefta* and *T.? curvistriata* are generically related.

T.? curvistriata is similar in many respects to the type species of *Thlipsuroides*. *Thlipsuroides* has two furrows rather than one, as in *Thlipsurella? curvistriata*. However, in *Thlipsuroides striatopunctatus* (Roth), a species similar to the type species, the two furrows are not reflected interiorly. The same is true of the furrow in *Thlipsurella? curvistriata* (Roth). Also, dimorphism occurs in *Thlipsuroides striatopunctatus* (Roth). The author suspects dimorphism in *Thlipsurella? curvistriata* (Roth). Therefore it is quite possible that *T.? curvistriata* (Roth) should be placed in *Thlipsuroides*. Until more detailed studies of the type species of *Thlipsurella* and *Thlipsuroides* can be made, the author prefers to leave Roth's species questionably in *Thlipsurella*.

Roth's locality probably is Cedar Hill (section P_3), which is mostly Henryhouse strata. The author has not seen this species in or associated with Haragan fossils. Roth's report of this species in the Haragan is incorrect.

Distribution. — This species is restricted in geographic distribution and is few in numbers. It has been found in only five samples, all from the Lawrence uplift, ranging through the upper 70 feet of the Henryhouse Formation. It has not been found in the Haragan Formation. No significance can be applied to this rather restricted occurrence because only 45 specimens have been found and all but six of these are from samples P_3-20 and P_3-21.

Materials studied. — Forty-five complete or nearly complete specimens have been studied. However, many of these are deformed and perfect specimens are scarce. About one-half of the specimens are carapaces but only a few of these are near perfect. In all but two immature carapaces the valves are deformed or have slipped over one another so that the true valve relationships cannot be observed.

Roth's type collection consists of three specimens: the holotype and two unfigured specimens. The holotype is a deformed carapace, which is illustrated by Roth (1929, pl. 36, fig. 15a). The specimen in figure 15b of the same plate apparently is not with the collection. One of the unfigured specimens is elongate. Roth's interpretation of the species apparently is similar to the interpretation given here.

Holotype. — USNM 80660 H; plate XVII, figure 1g.

Figured specimens. — OU 5401a-5403d, samples P_3-14, P_3-20, P_3-21.

Thlipsurella? sp.

Pl. XVIII, figs. 5a-c

Description. — The valves are subreniform in lateral view and subrectangular in dorsal, ventral, and end views. The dorsal border is strongly arched on most specimens, but on one specimen it is distinctly flattened. The ends are sharply rounded, and the venter is straight to sinuate. Only isolated valves are known and thus the valve relationships cannot be ascertained. The cardinal angles are indistinct. The valves are smooth except in the midposterior region, where a large subcircular depression is situated. The posterior portion of this depression is surrounded by a distinct rim, which gives the posterior end of the valve a blunt appearance in dorsal and ventral views. The depression is slightly elongated toward the anterior in some specimens.

Preservation prohibits clear observation of the hinge, but it appears to be simple. The nature of the interior of the valve cannot be determined. Muscle scars have not been seen.

Length, 1.46 mm; height, 0.78 mm.

Ontogeny. — Only two broken valves represent immature instars of this species. No comments on ontogeny of this species can be made at this time.

Variation. — Only five complete or nearly complete adult valves are known. One of these has a flattened dorsum and greater length-height ratio than have the others. Such variation may indicate dimorphism, but more material is needed to substantiate this. No other significant variation exists.

Remarks. — *T.?* sp. is closely related to *T.? curvistriata* (Roth) and to *Thlipsura fossata* Roth, which also belongs to *Thlipsurella* according to Swartz (1932). *T.?* sp. differs from *T.? curvistriata* (Roth) in having a subcircular depression rather than an arcuate furrow in its posterior part, and from *T. fossata* (Roth) in having no anterior depression.

The same taxonomic problems apply to *T.?* sp. as apply to *T.? curvistriata* (see remarks under *T.? curvistriata*). Until more material can be

studied, generic and specific designations of this species are questionable.

Distribution. — This species is known from only one sample (P_3-24).

Materials studied. — Only seven valves of this species are known. One adult and two immature specimens are broken. Four adult valves are complete or slightly chipped. Preservation is not good. No carapaces are known.

Figured specimens. — OU 5405a, 5405b, sample P_3-24.

Genus *Thlipsuroides* Morris and Hill, 1952

Thlipsuroides parallelus (Roth), 1929

Pl. XVIII, fig. 4a

Thlipsura parallela, Roth, 1929, p. 353, pl. 36, fig. 14a.

Remarks. — The author has not found this species in any of his samples. Roth's (1929) specimen has been studied, and it definitely belongs in the genus *Thlipsuroides*. This species certainly is a Henryhouse ostracode because no Haragan is in the vicinity of Roth's locality. As this species is known by only one specimen, the ontogeny, variation, and dimorphism are unknown.

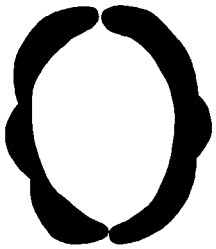
Holotype. — USNM 80657 H; plate XVIII, figure 4a.

Thlipsuroides striatopunctatus (Roth), 1929

Pl. XVIII, figs. 3a-g; text-figs. 43, 44

Thlipsura striatopunctata Roth, 1929, p. 352, pl. 36, figs. 13a,b.

Description of female. — The carapace is subreniform in lateral view and subrectangular in dorsal, ventral, and end views. The dorsum is gently arched, the ends sharply rounded, and the venter straight to slightly sinuate. The valves are gently convex to flattened laterally. The valves are subequal with only slight left-over-right overlap. The cardinal angles are indistinct. The valves are smooth except in the posterior portion, where two subparallel furrows are situated. These furrows extend from midlength almost to the posterior border of the valve, although the upper furrow is reduced in length in a few specimens. The furrows are subparallel to the ventral border, and the bottom of each is ornamented with small pits. The portion of the valve which ventrally borders the lower furrow ends posteriorly in a distinct posteriorly directed spine. This spine extends beyond the posterior border of the valve in some specimens. A slight ridge rises just in front of the posterior border of the valve. This ridge is inclined posteroventrally from the dorsum and fuses with the posteroventral spine.



Text-figure 43. Transverse cross section of an adult carapace of *Thlipsuroides striatopunctatus* (Roth) (UI X-1610g), x50.

No special hingement has been observed in interior views of valves. Transverse thin sections through the hinge indicate a slight edge-and-groove relationship, the groove being in the right valve. The interior is smooth as seen in transverse cross section. The furrows are not reflected interiorly (text-fig. 43).

Length, 1.07 mm; height, 0.58 mm.

Description of male. — The male is like the female except for shape, size, and development of the posteroventral spine. The dorsum of the males is more distinctly arched, and the ends are more broadly rounded. The height-length ratio is distinctly greater for the males than for the females.

The males have only a poorly developed posteroventral spine or none at all. Generally, the furrows of the males are slightly better developed than are those of the females.

Length, 0.96 mm; height, 0.62 mm.

Ontogeny. — Four instars have been found in this population (text-fig. 44). Growth factors for length and height do not deviate greatly from 1.26 (table 16). The unusually large length growth factor for the last moult of the females is due to dimorphic variation (discussed below).

The immature instars are basically the same as the adult males. The posterior ridge, furrows, and posteroventral spine are less well developed in the immature forms, although all of these features can be seen in some specimens of the adult −2 instar. Only two specimens of the adult −3 instar have been found. A small spine more ventrally directed than on the later instars can be seen on both specimens. The furrows are weak and the posterior ridge is absent.

Variation. — The only variation within any particular instar other than the dimorphic variation of the adults concerns the development of the posterior ridge, posteroventral spines, and furrows. The ridge is quite prominent on some adults and almost indistinguishable on others. The furrows are present on all specimens but are more distinct on some than on others. The postero-

TABLE 16.—GROWTH FACTORS FOR THLIPSUROIDES STRIATOPUNCTATUS

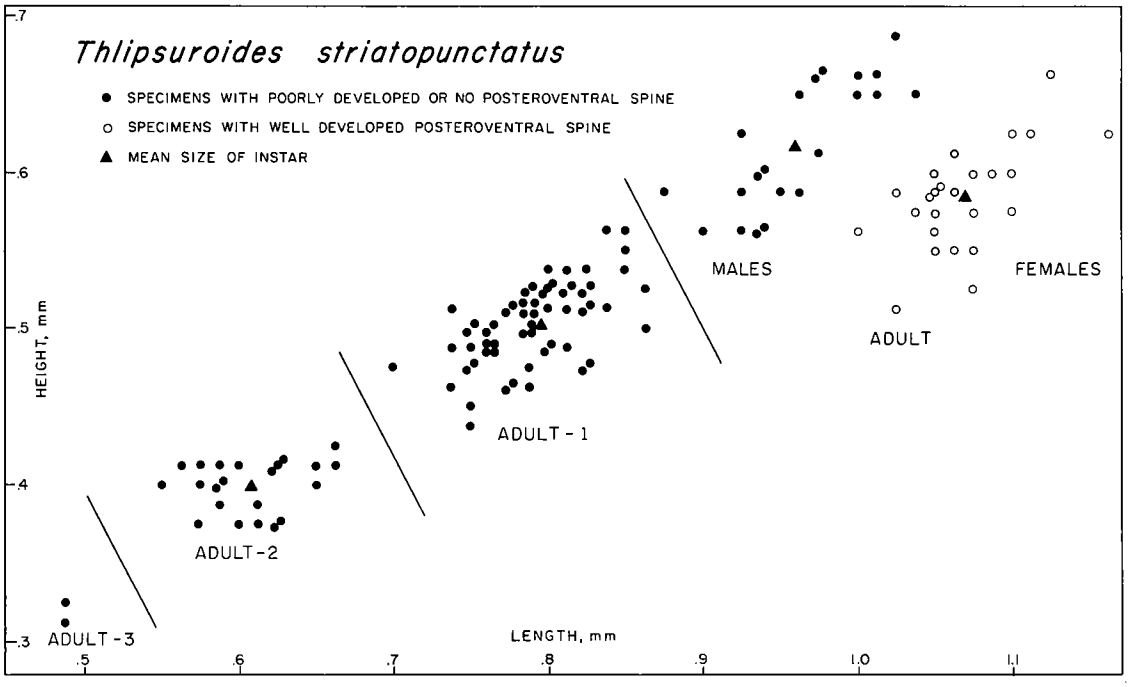
INSTAR	LENGTH (MM)	GROWTH FACTOR	HEIGHT (MM)	GROWTH FACTOR	NUMBER OF SPECIMENS
Adult (females)	1.069		0.584		25
		1.351		1.159	
Adult (males)	0.961		0.618		21
		1.215		1.226	
Adult —1	0.791		0.504		58
		1.301		1.260	
Adult —2	0.608		0.400		22

ventral spines are present and well developed on all adult females but are poorly developed to absent in adult males and immature specimens.

The considerably greater length and lower height-length ratio of one group of adults is here considered a dimorphic variation caused by the greater development of the sex organs in the female. This is reflected exteriorly by distinct lengthening of the female carapace. This type of domiciliar dimorphism is not uncommon in modern ostracodes, and unusual lengthening of the female carapace is easily understood when the position of the sex organs is considered. This has been adequately illustrated by Howe, Kesling, and Scott (1961). The same type of dimorphism is illustrated by *Dizygopleura* and related genera, only it is generally reflected as a swelling of the posterior portion of the carapace. The principle is the same — more space is required by the female sex organs than by the male sex organs. Whether this space is acquired by lengthening, widening, or increasing the height of the domicilium is not important. This depends on the details of shape, orientation, and position of the organs.

Remarks. — According to present classification, this species definitely belongs to *Thlipsuroides*. It is closely related to the type species *Thlipsuroides thlipsuroides* Morris and Hill, 1952, which differs from it in having no posteroventral spine, more overlap, and a distinct sinuation of the right valve.

This is the first thlipsurid ostracode for which dimorphism has been reported. Future taxonomic studies on the Thlipsuridae should take into account the phenomenon of dimorphism, which is possibly a better solution to a more critical classi-



Text-figure 44. Size-dispersion diagram of *Thlipsuroides striatopunctatus* (Roth) from sample P_3-11.

fication of thlipsurid ostracodes than now exists.

Roth's locality is in Henryhouse strata. This species is not known from the Haragan.

Distribution. — *Thlipsuroides striatopunctatus* has been found throughout the Henryhouse strata. It has not been seen in the Haragan.

Materials studied. — Sample P_3-11 yielded 128 specimens of *T. striatopunctatus*. Carapaces are scarce. Preservation is good.

Holotype. — USNM 80656 H; plate XVIII, figure 3d.

Figured specimens. — UI X-1610a to X-1610g, sample P_3-11.

Genus *Thlipsuropsis* Swartz and Whitmore, 1956

Thlipsuropsis inaequalis (Ulrich and Bassler), 1913

Pl. XVIII, figs. 1a-j; text-fig. 45

Octonaria inaequalis Ulrich and Bassler, 1913, p. 538, pl. 98, figs. 12-18.

Description. — The carapace is subovate in lateral view and subrectangular in dorsal, ventral, and end views. The dorsal border is strongly convex. The anterior and posterior borders are sharply rounded. The ventral border is straight to slightly convex. The greatest length is just below midheight and the greatest height is about midlength. The lateral surface of the valves is flattened so that the width of the carapace is uniform throughout most of the length. The valves are strongly unequal, the left overlapping the right around the entire free border and overreaching it along the dorsum. The typical left valve is ornamented with three distinct grooves. The dorsal groove originates in the anteroventral portion of the valve. From this area it curves posterodorsally and parallels the dorsum to the posterior part of the valve, where it fades onto the general surface of the valve. Ventral to this groove is a ridge which encircles the subcentral portion of the valve. The subcentral portion of the valve is ornamented with two more or less horizontal grooves separated by a straight horizontal ridge. The dorsal of these two grooves is elongate and slightly convex. It may be represented by two short elongate depressions. The ventral groove in the subcentral area is straight and slightly longer than the one above it. Outside the ridge which encloses the subcentral area of the valve along the ventral and posteroventral borders is a faint elongate depression. It does not meet the dorsal groove at either end. The right valve is ornamented by three grooves. One is straight, inclined, parallel to, and just below the posterodorsal border. Ventral to this groove and separated from it by a ridge is a deep elongate groove which is slightly convex. It extends from the posteroventral area of the valve to just in front of midlength along the ventral border. The third groove runs parallel to the anterodorsal and anterior borders of the valve. It is separated from the other two grooves by a well-developed ridge.

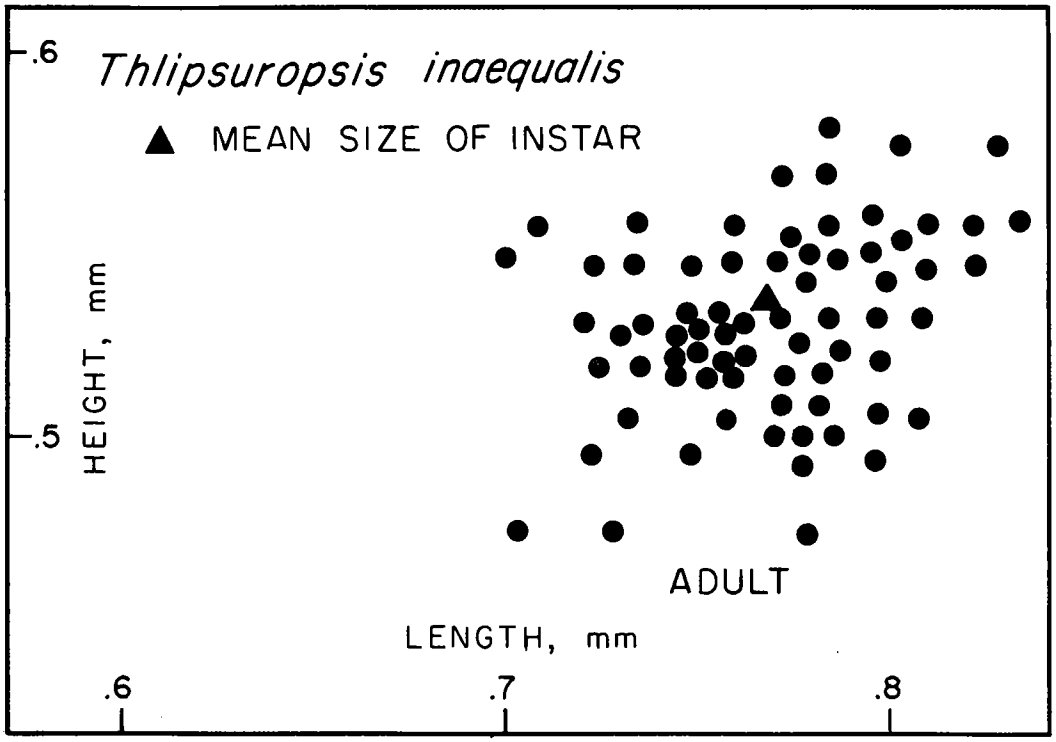
The hinge is simple and poorly defined. It is slightly convex. The interior is smooth. The ridges and grooves which are so prominent on the exterior of the valves are not reflected internally. Interior views of the valves indicate that the contact marginal area is thickened. This condition may represent a primitive inner lamella. Muscle scars have not been seen.

Length, 0.77 mm; height, 0.53 mm.

Ontogeny. — Only adult specimens of this species have been found. The average length and height for 71 adult left valves are given above. The absence of immature specimens in this population (sample P_4-1) is unusual. It possibly represents a distinct change in the thickness of the shell between the adult −1 and adult instars. Adult left valves are abundant and carapaces and adult right valves are common. The absence or near absence of immature specimens must be explained. Sorting by currents is not a feasible explanation because the adult right valves are about the same size as the adult −1 left valves should be. Also, other species are represented by specimens which are about the same size as immature specimens of *T. inaequalis* should be. If the immature specimens of *T. inaequalis* are extremely thin shelled, they may not have been preserved. It does not seem likely that the immature forms of this species are unrecognizable. The ornamentation of the adults is distinct, and certainly a few of the immature instars would be rather distinctly ornamented. More work must be done to be certain of the above explanation.

Variation. — Text-figure 45 shows that the size and shape of the adult specimens are quite constant, although some specimens are more circular in lateral view than are others. Some variation occurs in the ornamentation of this species, but it is not enough to cause difficulty in identification.

Remarks. — This certainly is the species which Roth identified as *Octonaria inaequalis* Ulrich and Bassler, 1913. The author has not seen the type specimens of *T. inaequalis* (Ulrich and Bassler). Specimens of this species identified by Dr. Jean Berdan of the U. S. Geological Survey from the



Text-figure 45. Size-dispersion diagram of left valves of *Thlipsuropsis inaequalis* (Ulrich and Bassler) from sample P_4-1.

Keyser Formation in the Cumberland quadrangle are conspecific with the Henryhouse specimens. The type specimens also are from the Keyser Formation in the Cumberland quadrangle.

T. longisulcata Swartz and Whitmore, 1956, from the Decker Limestone of New Jersey and New York probably is a synonym of *T. inaequalis*. Swartz and Whitmore, however, illustrated only right valves. As the specific characters of this genus are best shown on the left valve, more study is needed to determine definitely if *T. longisulcata* and *T. inaequalis* are conspecific.

The specimen identified by Roth as *O. inaequalis* is in his type collection of *O. punctata* (USNM 80653). It is conspecific with the author's specimens of *T. inaequalis*.

Distribution. — This species has been found in large numbers in only one sample (P_4-1). One specimen has been found in each of two other samples (P_7-6, P_3-21). Roth reported this species from the Haragan, but it is definitely from the Henryhouse. No Haragan is in the area of his collecting locality. The author has not found this species in the Haragan Formation.

Materials studied. — Seventy-one measurable left valves and numerous right valves and carapaces have been studied from sample P_4-1. Preservation is excellent, although most specimens require cleaning.

Syntypes. — Two right valves are illustrated by Swartz and Whitmore (1956; plate 110, figures 14, 15). A holotype is not designated.

Figured specimens. — OU 5404a-5404f, sample P_4-1.

ADDENDUM

After this report went to press it came to the author's attention that Sohn (1961b, p. 140) questionably placed *Amphissella primaeva* (Roth) in the genus *Reticestus* which has no marginal or adventral structures. The problem most likely is in interpretation of marginal or adventral structures. Well-preserved specimens of *A. primaeva* have an adventral structure in the form of a ridge which is an expansion of the ridges of the outermost row of reticulations. On the other hand, *A. primaeva* is similar to species of *Reticestus* in shape and in possession of a subcentral pit. The author agrees with Sohn that *A. primaeva* might well belong in *Reticestus*. Comparison of specimens should be made.

REFERENCES

Amsden, T. W., 1949, Stratigraphy and paleontology of the Brownsport formation (Silurian) of western Tennessee: Peabody Museum Nat. History, Yale Univ., Bull. 5, 138 p., 34 pls., 30 text-figs.

—— 1951, Brachiopods of the Henryhouse formation (Silurian) of Oklahoma: Jour. Paleontology, vol. 25, p. 69-96, 6 pls., 1 text-fig.

—— 1956, Catalog of fossils from the Hunton Group, Oklahoma: Okla. Geol. Survey, Circ. 38, 63 p.

—— 1957, Stratigraphy and paleontology of the Hunton group in the Arbuckle Mountain region; Part I — Introduction to stratigraphy: Okla. Geol. Survey, Circ. 44, 57 p., 3 pls., 6 text-figs.

—— 1958, Stratigraphy and paleontology of the Hunton group in the Arbuckle Mountain region; Part II — Haragan articulate brachiopods: Okla. Geol. Survey, Bull. 78, 144 p., 14 pls., 38 text-figs.

—— 1960, Stratigraphy and paleontology of the Hunton group in the Arbuckle Mountain region; Part VI — Hunton stratigraphy: Okla. Geol. Survey, Bull. 84, 311 p., 17 pls., 3 panels, 56 text-figs.

—— 1962, Silurian and Early Devonian carbonate rocks of Oklahoma: Amer. Assoc. Petroleum Geologists, Bull., vol. 46, p. 1502-1519, 10 text-figs.

Bassler, R. S., and **Kellett, Betty,** 1934, Bibliographic index of Paleozoic Ostracoda: Geol. Soc. America, Spec. Paper 1, 500 p., 24 figs.

Berdan, Jean, and **Sohn, I. G.,** 1961, Family Pachydomellidae, **in** Arthropoda 3, pt. Q **of** Moore, R. C., ed., Treatise on invertebrate paleontology: Geol. Soc. America and Univ. Kans. Press, p. 373-374, fig. 295.

Boucot, A. J., 1958, Age of the Bainbridge limestone: Jour. Paleontology, vol. 32, p. 1029-1030.

Coryell, H. N., and **Cuskley, V. A.,** 1934, Some new ostracodes from the "White Mound" section of the Haragan shale, Murray County, Oklahoma: Amer. Museum Nat. History, Amer. Museum Novitates, no. 748, 12 p., 2 pls.

Coryell, H. N., and **Malkin, D. S.,** 1936, Some Hamilton ostracodes from Arkona, Ontario: Amer. Museum Nat. History, Amer. Museum Novitates, no. 891, 20 p., 2 pls.

Coryell, H. N., and **Williamson, Marjorie,** 1936, A study of the Ostracoda fauna of the Waldron shale, Flat Rock Creek, St. Paul, Indiana: Amer. Museum Nat. History, Amer. Museum Novitates, no. 870, 6 p.

Decker, C. E., 1935, Graptolites from the Silurian of Oklahoma: Jour. Paleontology, vol. 9, p. 434-446, text-figs.

Guber, A. L., 1962, Some Richmond (Ordovician) ostracodes from Indiana and Ohio: Ill., Univ., unpublished Ph. D. dissertation, 115 p., 3 pls., 10 text-figs.

Ham, W. E., 1955, Field conference on the geology of the Arbuckle Mountain region [Oklahoma]: Okla. Geol. Survey, Guide Book 3, 61 p., text-figs., maps.

Henningsmoen, Gunnar, 1953, Classification of Paleozoic straight-hinged ostracods: Norsk Geologisk Tidsskrift, vol. 31, p. 185-288, 2 pls., 12 text-figs.

—— 1954, Silurian ostracods from the Oslo region, Norway: Norsk Geologisk Tidsskrift, vol. 34, p. 15-71, 8 pls., 5 figs.

Hessland, Ivar, 1961, Family Aparchitidae, **in** Arthropoda 3, pt. Q **of** Moore, R. C., ed., Treatise on invertebrate paleontology: Geol. Soc. America and Univ. Kans. Press, p. 170-173, figs. 107-109.

Howe, H. V., Kesling, R. V., and **Scott, H. W.,** 1961, Morphology of living Ostracoda, **in** Arthropoda 3, pt. Q **of** Moore, R. C., ed., Treatise on invertebrate paleontology: Geol. Soc. America and Univ. Kans. Press, p. 3-17, text-figs. 1-12.

Jaanusson, Valdar, 1957, Middle Ordovician ostracodes of central and southern Sweden: Uppsala, Univ., Palaeontol. Institution, Pub. 17, p. 173-442, 15 pls., 46 text-figs.

Jones, T. R., 1887, Notes on the Paleozoic bivalved Entomostraca, No. XXIV, On some Silurian genera and species (continued): Annals and Magazine Nat. History, ser. 5, vol. 19, p. 400-416, pls. 12, 13.

Kegel, Wilhelm, 1932, Zur Kenntnis palaozoischer Ostrakoden, II Bairdiidae aus dem Mitteldevon des rheinischen Schiefergebirges: Pruess. Geol. Landesanstalt, Jahrb. 1931, vol. 52, p. 245-250, pl. 13.

Kesling, R. V., 1952, Doubling in size of ostracod carapaces in each molt stage: Jour. Paleontology, vol. 26, p. 772-780, 1 fig.

—— 1954, Ornamentation as a character for specific differentiation of ostracods: Mich., Univ., Museum Paleontology, Contr., vol. 12, no. 2, p. 13-21, 2 pls.

—— 1957, Origin of beyrichiid ostracods: Mich., Univ., Museum Paleontology, Contr., vol. 14, p. 57-80, 7 pls., 5 figs.

—— 1961a, Family Hollinidae, **in** Arthropoda 3, pt. Q **of** Moore, R. C., ed., Treatise on invertebrate paleontology: Geol. Soc. America and Univ. Kans. Press, p. 133-140, figs. 65-71.

—— 1961b, Family Thlipsuridae, **in** Arthropoda 3, pt. Q **of** Moore, R. C., ed., Treatise on invertebrate paleontology: Geol. Soc. America and Univ. Kans. Press, p. 377-380.

Kesling, R. V., and **Kilgore, J. E.,** 1952, Ostracods of the families Leperditellidae, Drepanellidae, Glyptopleuridae, Kloedenellidae, Bairdiidae, Barychilinidae, and Thlipsuridae from the Genshaw formation of Michigan: Mich., Univ., Museum Paleontology, Contr., vol. 10, no. 1, p. 1-19, 4 pls.

Kesling, R. V., and others, 1960, Middle Ordovician Black River ostracods from Michigan, Introduction and Part I — The nature of **Macronotella:** Mich., Univ., Museum Paleontology, Contr., vol. 15, no. 13, p. 293-314, 3 pls.

Levinson, S. A., Moore, R. C., and **Berdan, Jean,** 1961, Family Beyrichiidae, **in** Arthropoda 3, pt. Q **of** Moore, R. C., ed., Treatise on invertebrate paleontology: Geol. Soc. America and Univ. Kans. Press, p. 112-122, fig. 47-56.

Lundin, R. F., and **Scott, H. W.,** 1963, Morphology and ontogeny of **Phanassymetria** Roth: Jour. Paleontology, vol. 37, p. 1272-1283, pls. 179-180, text-figs. 1-4.

Martinsson, Anders, 1962, Ostracodes of the family Beyrichiidae from the Silurian of Gotland: Uppsala, Univ., Paleont. Institution, Pub. 41, 369 p., 203 figs.

Maxwell, R. A., 1936, The stratigraphy and areal distribution of the "Hunton formation," Oklahoma: Northwestern Univ., unpublished Ph. D. dissertation, 120 p.

Moore, R. C., 1961, Glossary of morphological terms applied to Ostracoda, **in** Arthropoda 3, pt. Q **of** Moore, R. C., ed., Treatise on invertebrate paleontology: Geol. Soc. America and Univ. Kans. Press, p. 47-56.

Morris, R. W., and **Hill, B. L.,** 1952, New Ostracoda from the Middle Silurian Newsom Shale of Tennessee: Bull. Amer. Paleontology, vol. 34, p. 131-148, pls. 9, 10.

Reeds, C. A., 1911, The Hunton formation of Oklahoma: Amer. Jour. Science, vol. 182, p. 256-268.

—— 1926, The Arbuckle Mountains of Oklahoma: Amer. Museum Nat. History, Jour., vol. 26, p. 463-474, 11 figs.; Okla. Geol. Survey, Circ. 14, 15 p., 11 figs.

Roth, R. I., 1929, Some ostracodes from the Haragan marl, Devonian, of Oklahoma: Jour. Paleontology, vol. 3, p. 327-372, 4 pls.

Sars, G. O., 1866 Oversigt af Norges marine Ostracoder: Norsk-Vidensk. Akad. Forhandlinger (1865) 1866, p. 1-130.

Scott, H. W., 1961, Classification of Ostracoda, **in** Arthropoda 3, pt. Q **of** Moore, R. C., ed., Treatise on invertebrate paleontology: Geol. Soc. America and Univ. Kans. Press, p. 74-92, 3 figs., 1 table.

Scott, H. W., and **Wainwright, J.,** 1961a, Dimorphism of Ostracoda, **in** Arthropoda 3, pt. Q **of** Moore, R. C., ed., Treatise on invertebrate paleontology: Geol. Soc. America and Univ. Kans. Press, p. 37-43, 3 figs.

—— 1961b, Family Bolliidae, **in** Arthropoda 3, pt. Q **of** Moore, R. C., ed., Treatise on invertebrate paleontology: Geol. Soc. America and Univ. Kans. Press, p. 127-131, fig. 62.

Shannon, J. P., Jr., 1962, Hunton Group (Silurian-Devonian) and related strata in Oklahoma: Amer. Assoc. Petroleum Geologists, Bull., vol. 46, p. 1-29, 17 figs.

Sohn, I. G., 1960, Paleozoic species of **Bairdia** and related genera: U. S. Geol. Survey, Prof. Paper 330-A, 105 p., 6 pls., 15 text-figs.

—— 1961a, Family Amphissitidae, **in** Arthropoda 3, pt. Q **of** Moore, R. C., ed., Treatise on invertebrate paleontology: Geol. Soc. America and Univ. Kans. Press, p. 165, figs. 96-98.

—— 1961b, **Aechminella, Amphissites, Kirkbyella,** and related genera: U. S. Geol. Survey, Prof. Paper 330-B, p. 106-160, pls. 7-12, text-figs. 16-31.

Stoll, N. R., and others, 1960, International code of zoological nomenclature adopted by the XV International Congress of Zoology: London, International Trust for Zoological Nomenclature, 176 p., 3 tables.

Stover, L. E., 1956, Ostracoda from the Windom shale (Hamilton) of western New York: Jour. Paleontology, vol. 30, p. 1092-1142, 3 pls. 8 text-figs.

Swain, F. M., 1953, Ostracoda from the Camden chert, western Tennessee: Jour. Paleontology, vol. 27, p. 257-284, pls. 37-39, 21 text-figs.

Swartz, F. M., 1932, Revision of the ostracode family Thlipsuridae, with descriptions of new species from the Lower Devonian of Pennsylvania: Jour. Paleontology, vol. 6, p. 36-58, pls. 10, 11.

—— 1936, Revision of the Primitiidae and Beyrichiidae with new Ostracoda from the Lower Devonian of Pennsylvania: Jour. Paleontology, vol. 10, p. 541-586, pls. 78-89.

Swartz, F. M., and **Whitmore, F. C., Jr.,** 1956, Ostracoda of the Silurian Decker and Manlius limestones in New Jersey and eastern New York: Jour. Paleontology, vol. 30, p. 1029-1091, pls. 103-110.

Taff, J. A., 1902, Description of Atoka quadrangle [Indian Terr.]: U. S. Geol. Survey, Geol. Atlas, Folio 79, 8 p., maps.

—— 1904, Geology of the Arbuckle and Wichita Mountains in Indian Territory and Oklahoma: U. S. Geol. Survey, Prof. Paper 31, 111 p., 8 pls., text-figs.

Ulrich, E. O., 1890, New and little known American Paleozoic Ostracoda: Cincinnati Soc. Nat. History, Jour., vol. 13, p. 104-137, pls. 7-10.

—— 1891, New and little known American Paleozoic Ostracoda: Cincinnati Soc. Nat. History, Jour., vol. 13, p. 173-211, pls. 11-18.

—— 1894, The Lower Silurian Ostracoda of Minnesota, **in** The geology of Minnesota: Minn., Geol. Nat. History Survey, Rept., vol. 3, pt. 2, p. 629-693, pls. 43-46, text-figs. 46-52.

—— 1900, New American Paleozoic Ostracoda; No. 1 — **Ctenobolbina** and **Kirkbya:** Cincinnati Soc. Nat. History, Jour., vol. 19, p. 183, pl. 8.

Ulrich, E. O., and **Bassler, R. S.,** 1909, New American Paleozoic Ostracoda; preliminary revision of the Beyrichiidae, with descriptions of new genera: U. S. Natl. Museum, Proc., vol. 35, p. 277-325, pls. 37-44, text-figs. 1-64.

—— 1913, Ostracoda in systematic paleontology, Lower Devonian: Md. Geol. Survey, Lower Devonian [volume], p. 513-542, pls. 95-98.

—— 1923a, Paleozoic Ostracoda: Their morphology, classification, and occurrence: Md. Geol. Survey, Silurian [volume], p. 271-391.

—— 1923b, Systematic paleontology; Arthropoda; Ostracoda: Md. Geol. Survey, Silurian [volume], p. 500-704.

Warthin, A. S., Jr., 1937-1945, Type invertebrate fossils of North America (Devonian), Ostracoda: Wagner Free Institute Science, 105 cards.

Wilson, C. W., 1935, The ostracode fauna of the Birdsong shale, Helderberg, of western Tennessee: Jour. Paleontology, vol. 9, p. 629-646, pls. 77-78.

HENRYHOUSE OSTRACODES

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Aechmina sp. B	IV
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Aechminaria henryhousensis	V
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Bairdiocypris profusa	XI
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Bairdiocypris? sp. B	X
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Plate I

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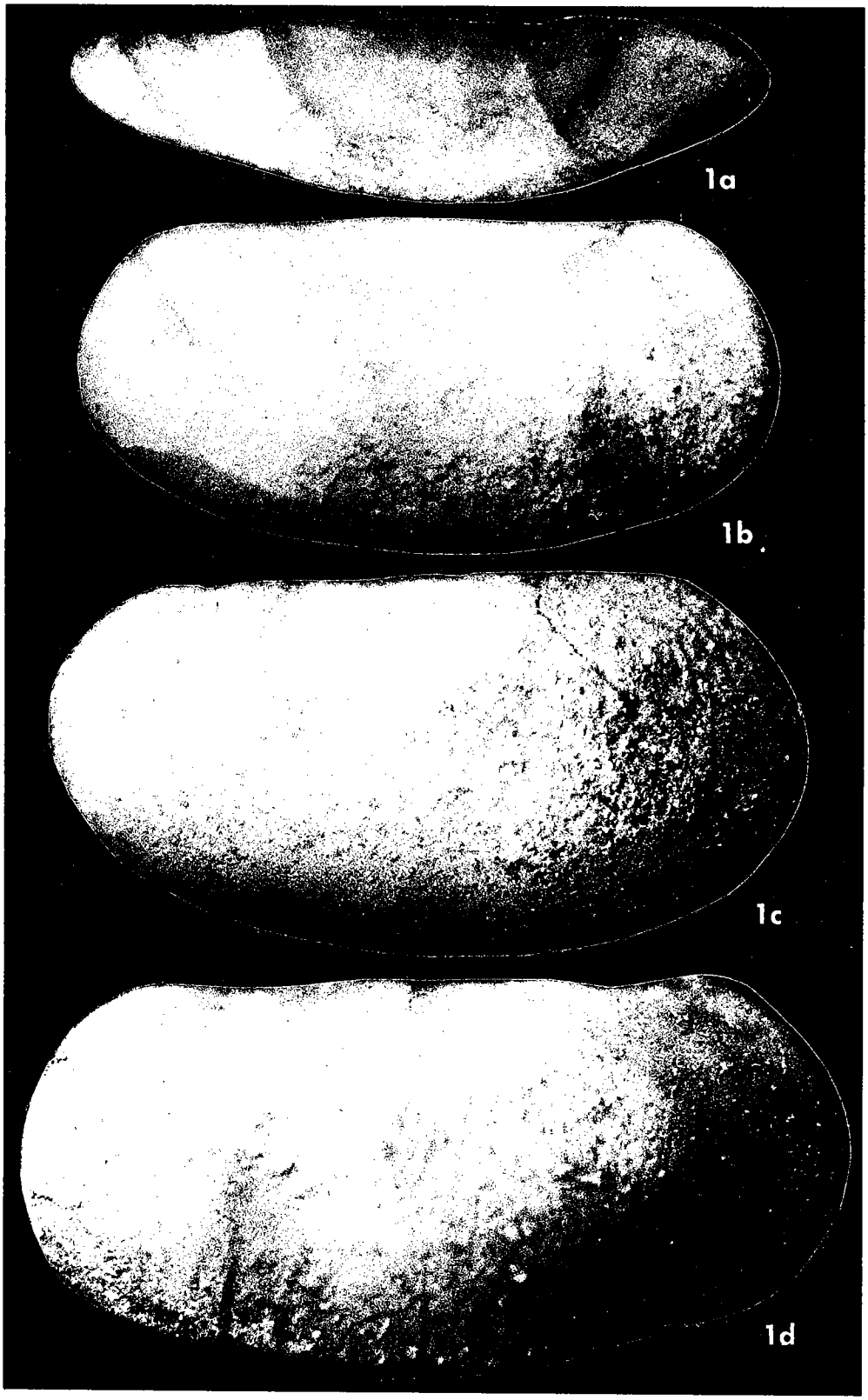
Figures 1a-d. *Leperditia symmetrica* Lundin, new species 20

a, b. Dorsal and lateral views of adult left valve; holotype (OU 5069).

c. Lateral view of adult left valve (OU 5070a).

d. Lateral view of adult left valve (OU 5070b).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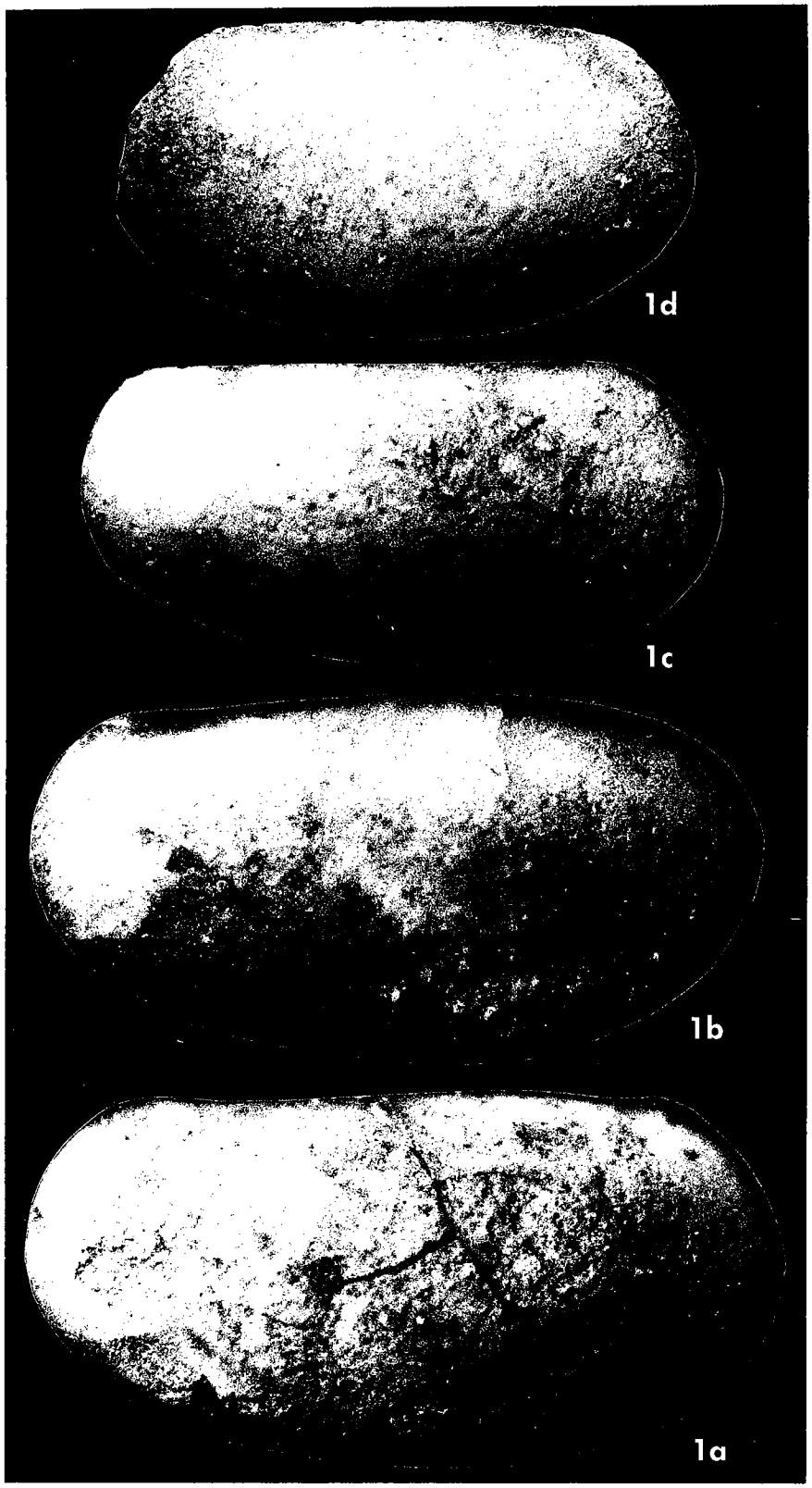
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Plate II

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Figures 1a-d. *Leperditia symmetrica* Lundin, new species 20

a. Lateral view of adult left valve (OU 5072a).

b. Lateral view of adult left valve (OU 5071).

c. Lateral view of immature left valve (OU 5070c).

d. Lateral view of immature left valve (OU 5070d); the anterodorsal portion of this specimen is abraded.

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b, c. Lateral and oblique ventral views of female right valve (OU 5073a).
d. Lateral view of female right valve (OU 5073b).
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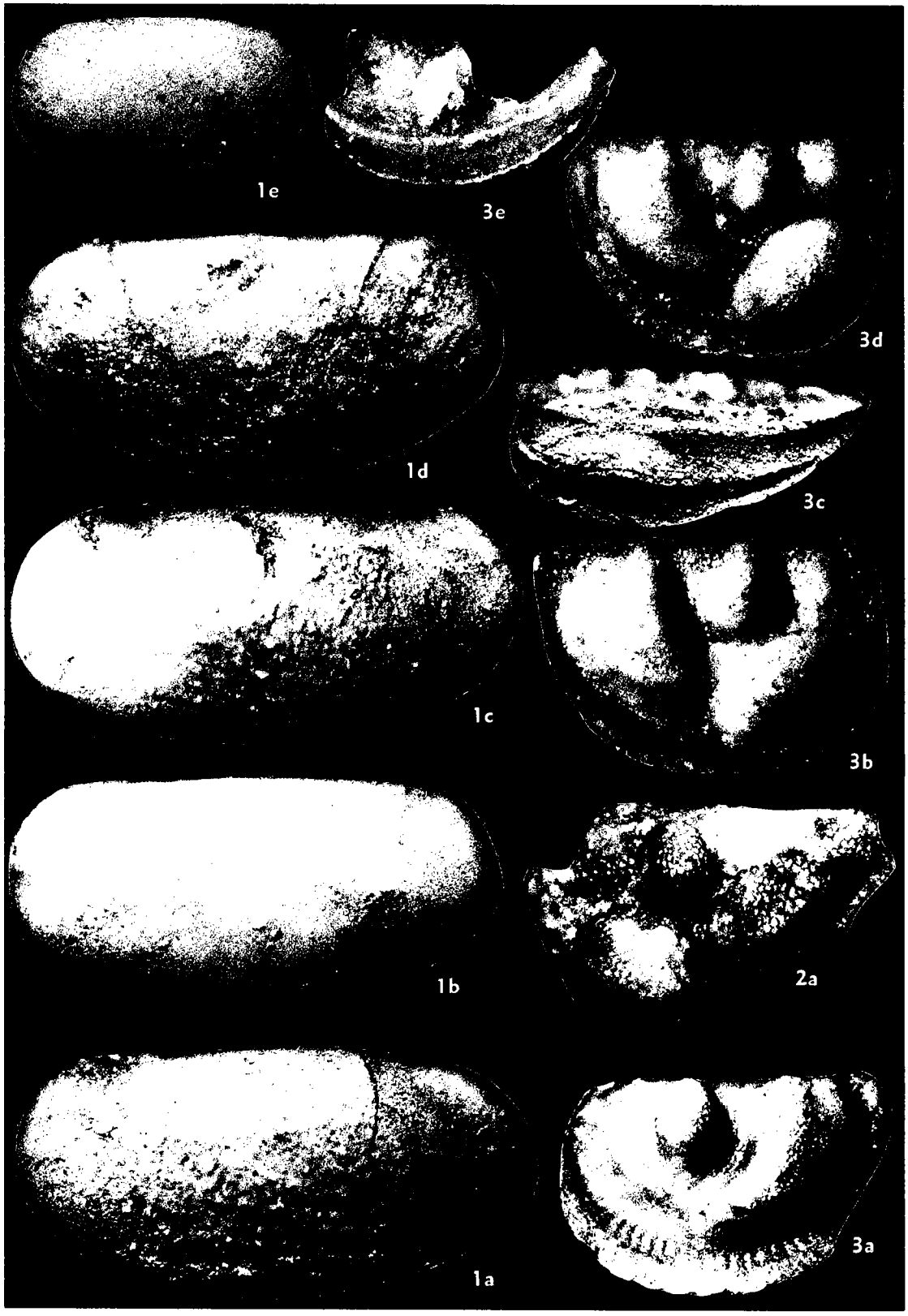
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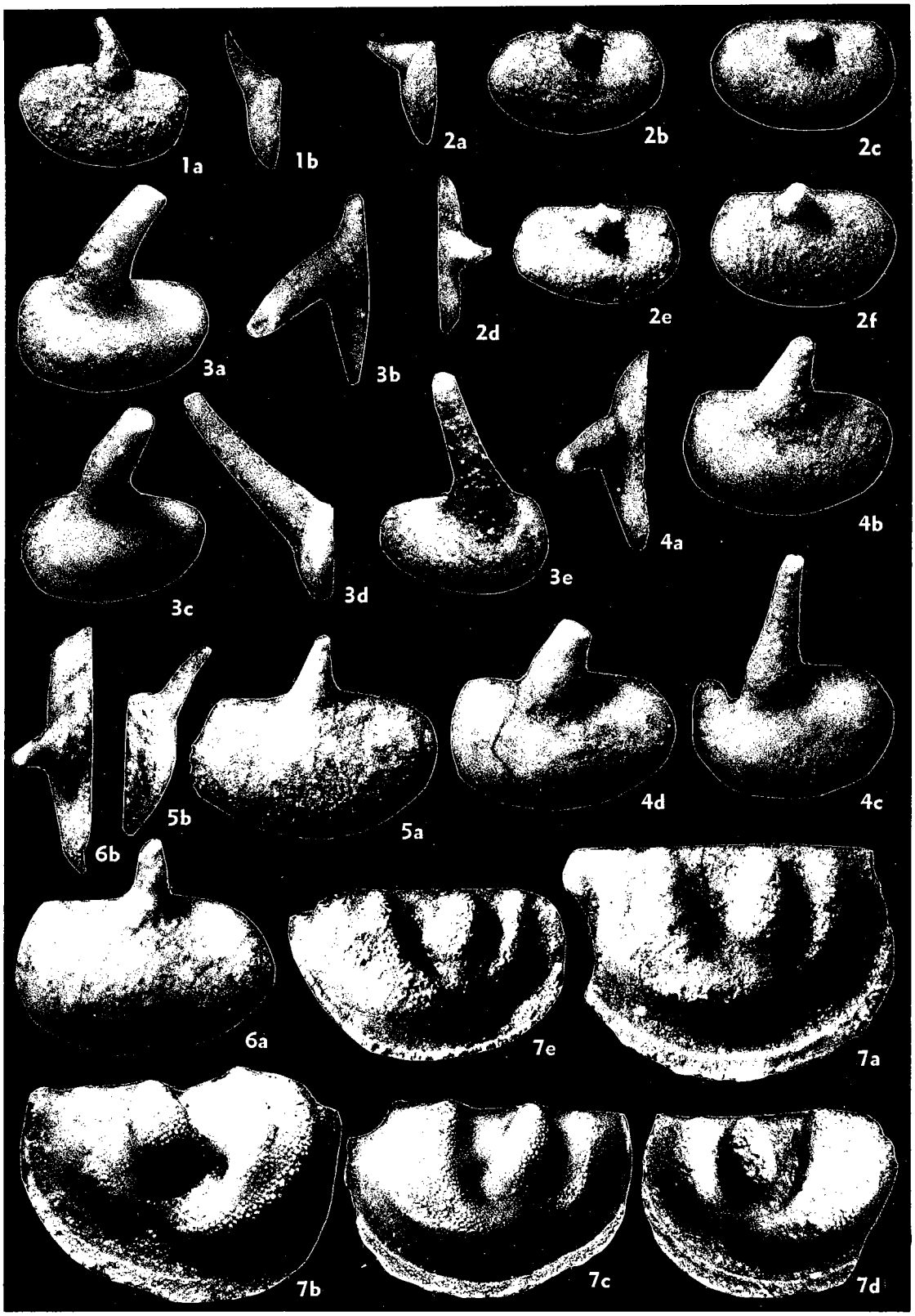
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- d. Lateral view of adult left valve (UI X-1600b).
- e. Lateral view of adult —1 left valve (UI X-1600c).
- f. Lateral view of adult —2 left valve (UI X-1600d).
- g. Lateral view of adult —2 left valve (UI X-1600e).
- h. Lateral view of adult —3 left valve (UI X-1600f).
- i. Lateral view of adult —1 right valve (UI X-1600g).
- j. Lateral view of adult —1 right valve (UI X-1600h).

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- a-c. Left lateral, dorsal, and ventral views of adult carapace; holotype (UI X-1601a).
- d. Lateral view of adult right valve (UI X-1601b).
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- b, c. Lateral and dorsal views of adult female right valve; holotype (OU 5083).
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- e. Lateral view of adult male right valve (OU 5084c).
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- h. Lateral view of immature right valve (OU 5084e).
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- a, b. Lateral and anterior views of adult right valve; holotype (OU 5085).
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- d, e. Dorsal and lateral views of adult right valve (OU 5086b).

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- a. Lateral view of adult female right valve; holotype (OU 5092).

Figures 7a-e. *Hollinella originalis* Lundin, new species 35
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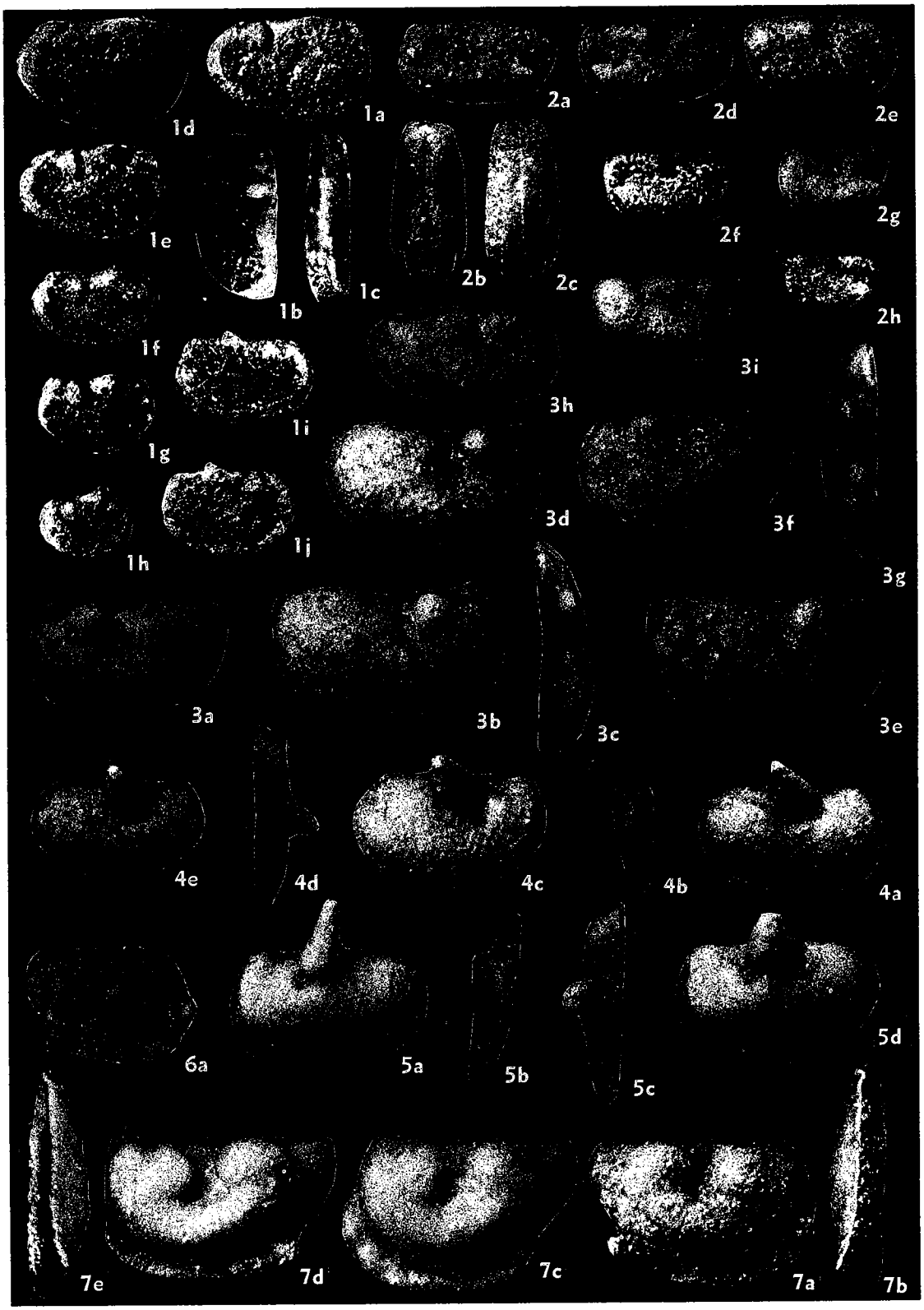
- c. Lateral view of adult male left valve (OU 5094).
- d, e. Lateral and ventral views of adult male left valve (OU 5093b).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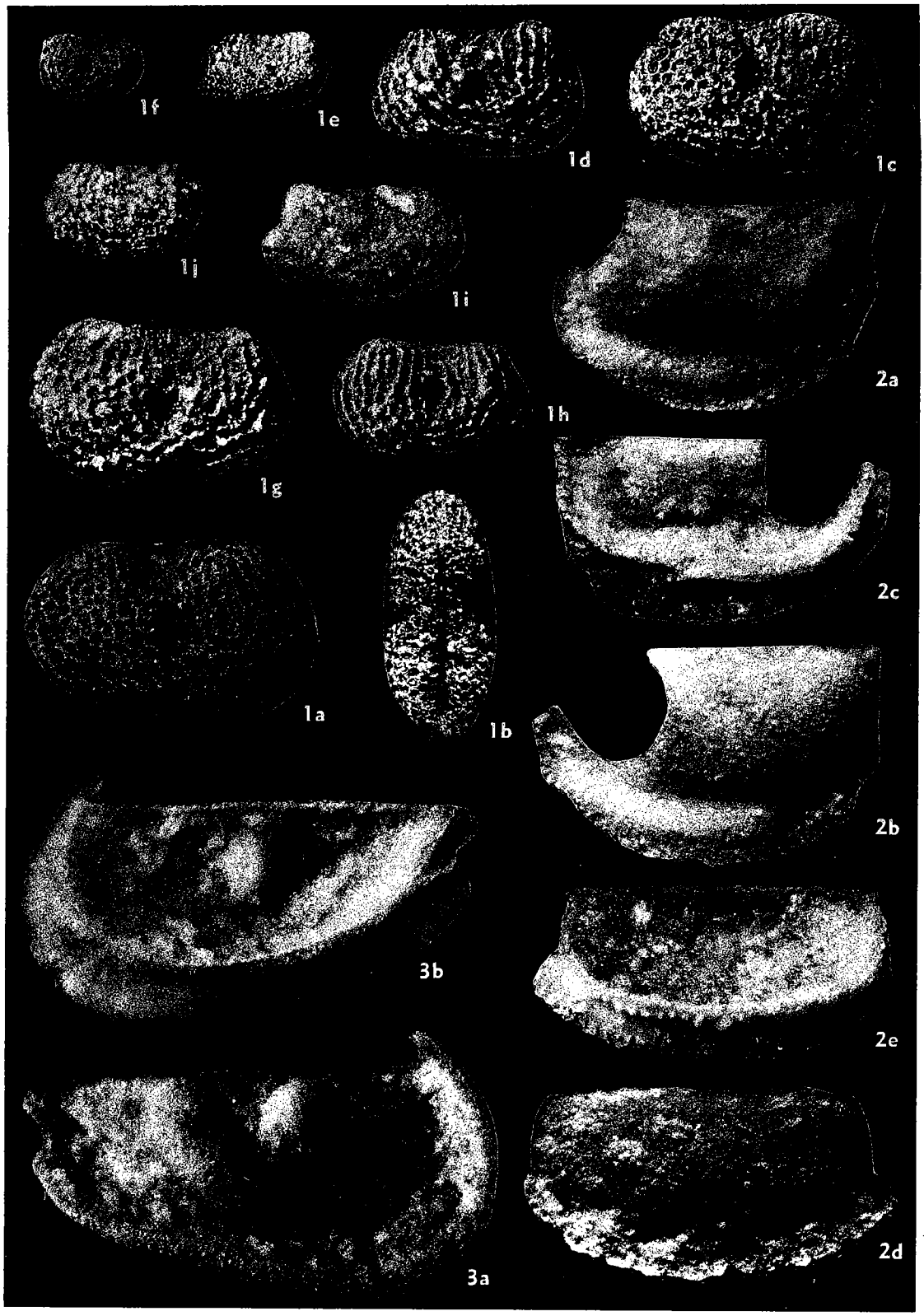
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b, c. Dorsal and left lateral views of adult carapace (UI X-1602b).
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e. Lateral view of adult —3 left valve (UI X-1602d).
f. Lateral view of adult —4 left valve (UI X-1602e).
g. Lateral view of adult right valve UI X-1602f).
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Figures 2a-e. *Eurychilina esulcata* Lundin, new species 37

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Figures 3a, b. *Rakverella*? sp. 38

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a, b. Lateral and interior views of adult female left valve; holotype (OU 5100).

c. Lateral view of adult female right valve (OU 5251a).

d. Lateral view of adult female right valve (OU 5251b).

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g. Lateral view of adult male right valve (OU 5251d).

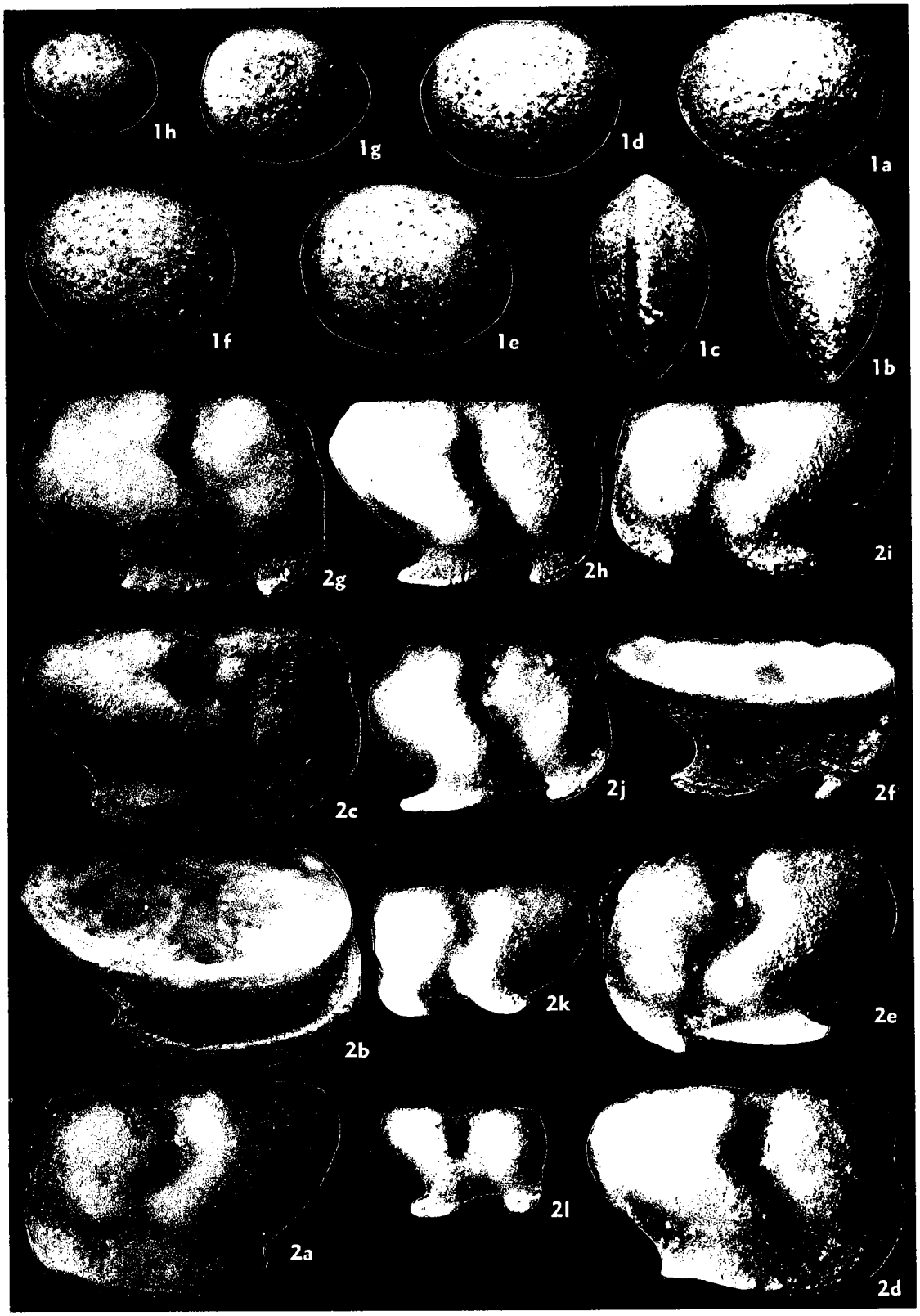
h. Lateral view of immature right valve (OU 5251e).

i. Lateral view of immature left valve (OU 5251f).

j. Lateral view of immature right valve (OU 5251g).

k. Lateral view of immature left valve (OU 5251h).

l. Lateral view of immature right valve (OU 5251i); this specimen has a hole in S_2.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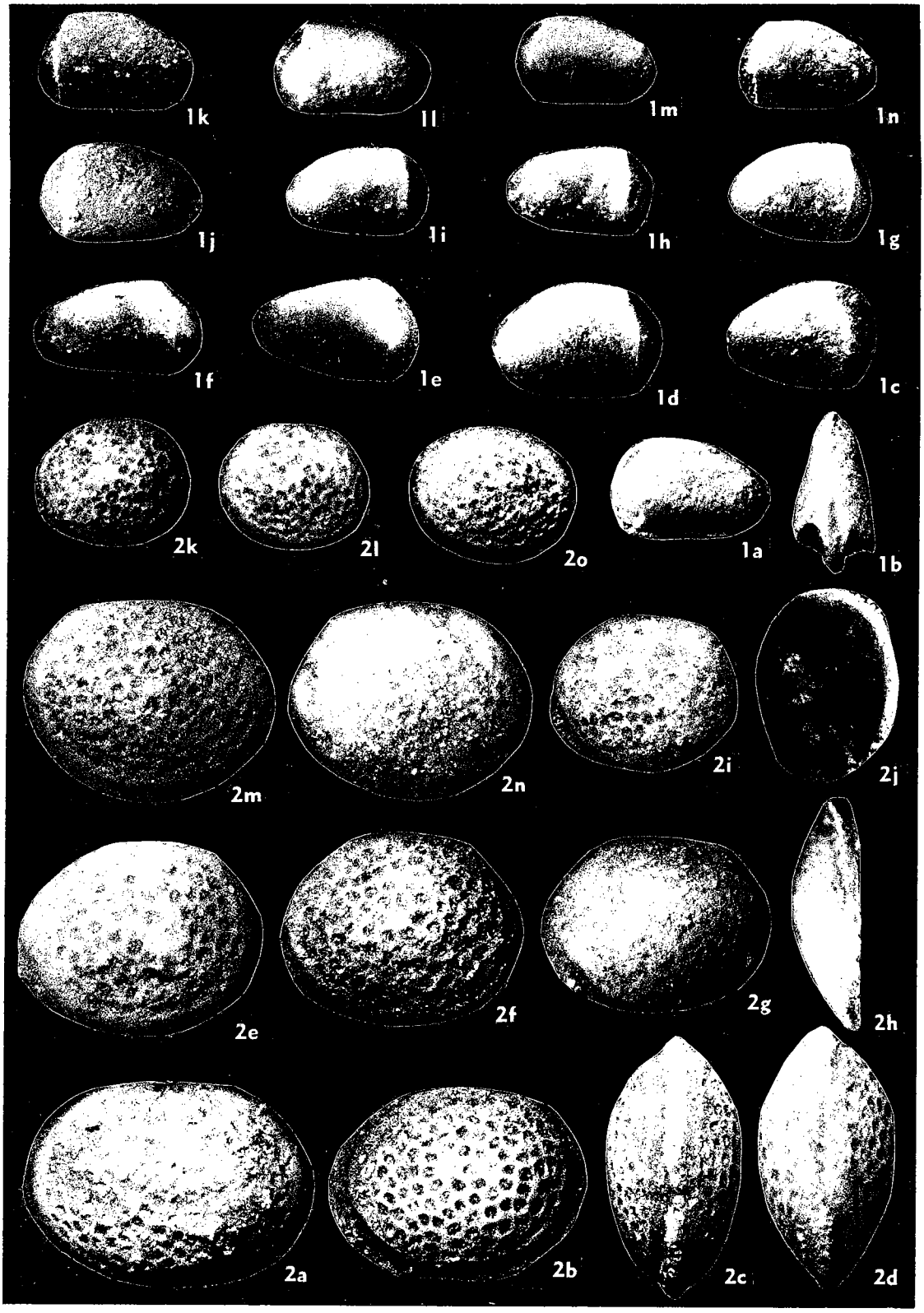
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a, b. Right lateral and dorsal views of adult carapace; lectotype (USNM 80661 C).
c. Lateral view of adult left valve (UI X-1603a).
d. Lateral view of adult left valve (UI X-1603b).
e. Lateral view of adult left valve (UI X-1603c).
f. Lateral view of adult left valve (UI X-1603d).
g. Lateral view of adult —1 left valve (UI X-1603e).
h. Lateral view of adult —1 left valve (UI X-1603f).
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a. Lateral view of adult left valve; lectotype (USNM 80654 C).
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e. Lateral view of adult right valve (OU 5253a).
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g, h. Lateral and ventral views of adult right valve (OU 5253b).
i, j. Lateral and oblique ventral (posteroventral area at upper right side of photograph) views of immature right valve (OU 5253c).
k. Lateral view of immature right valve (OU 5253d).
l. Lateral view of immature right valve (OU 5252c).
m. Lateral view of adult left valve (OU 5252d).
n. Lateral view of adult left valve (OU 5252e).
o. Lateral view of immature left valve (OU 5252f).

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c. Lateral view of right valve with broken spine (OU 5255).

Figures 2a-t. *Ehlersia ambigua* Lundin, new species 42

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h. Lateral view of adult right valve (OU 5257d).
i, j. Lateral and oblique ventral (posteroventral portion of valve at upper right side of photograph) views of adult right valve (OU 5257e).
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s. Lateral view of immature left valve (OU 5257j).
t. Lateral view of immature right valve (OU 5257k).

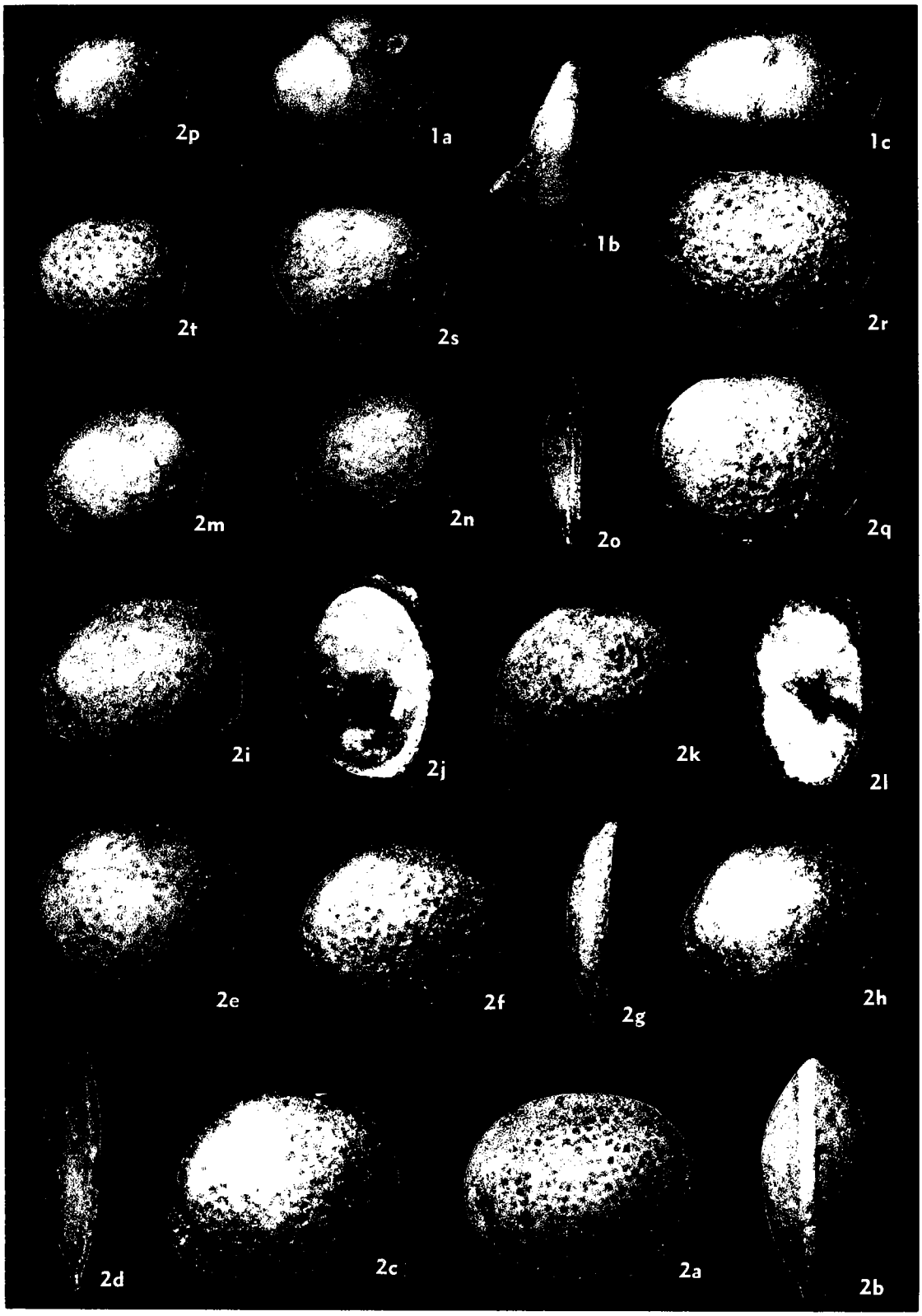
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Plate X

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Figures 1a-h. *Bairdiocypris*? sp. A 58

- a-c. Dorsal, right lateral, and left lateral views of adult carapace (OU 5260a).
- d, e. Right lateral and dorsal views of adult carapace (OU 5260b).
- f, g. Right lateral and anterior views of adult carapace (OU 5260c).
- h. Lateral view of adult left valve (OU 5260d).

Figures 2a-e. *Bairdiocypris*? sp. B 59

- a-c. Right lateral, dorsal, and ventral views of adult carapace (OU 5261a).
- d. Lateral view of adult left valve (OU 5261b).
- e. Lateral view of adult right valve (OU 5261c).

Figures 3a-q. *Dizygopleura landesi* Roth 45

- a. Right lateral view of adult carapace; lectotype (USNM 80645 C).
- b-e Left lateral, right lateral, dorsal, and ventral views of adult female carapace (UI X-1604a).
- f-h. Left lateral, right lateral, and ventral views of adult male carapace (UI X-1604b).
- i. Lateral view of adult —1 left valve (UI X-1604c).
- j. Lateral view of adult —2 left valve (UI X-1604d).
- k. Lateral view of adult —3 left valve (UI X-1604e).
- l. Lateral view of adult —3 left valve (UI X-1604f).
- m. Lateral view of adult —4 left valve (UI X-1604g).
- n. Lateral view of adult —1 right valve (UI X-1604h).
- o. Lateral view of adult —2 right valve (UI X-1604i).
- p. Lateral view of adult —2 right valve (UI X-1604j).
- q. Lateral view of adult —3 right valve (UI X-1604k).

Plate XI

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Figures 1a-h. *Bairdiocypris profusa* Lundin, new species 56

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b. Lateral view of adult left valve (UI X-1605b).
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d. Lateral view of adult —2 left valve (UI X-1605d).
e. Lateral view of adult —3 left valve (UI X-1605e).
f. Lateral view of adult right valve (UI X-1605f).
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Figures 2a-n. *Condracypris quasisimplex* Lundin, new species 59

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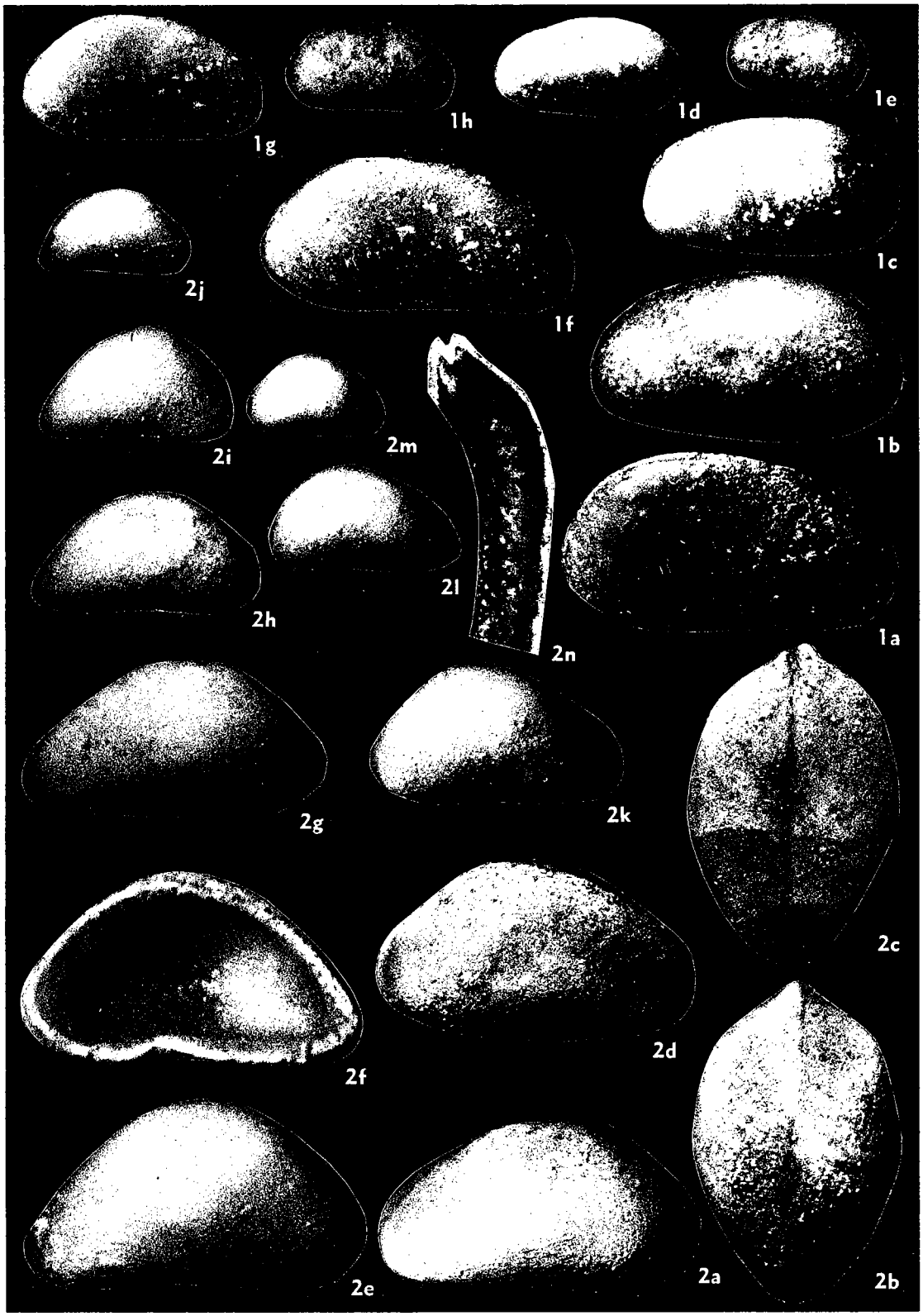
g. Lateral view of adult right valve (OU 5264a).
h. Lateral view of adult —1 right valve (OU 5264b).
i. Lateral view of adult —2 right valve (OU 5264c).
j. Lateral view of adult —3 right valve (OU 5264d).
k. Lateral view of adult —1 left valve (OU 5264e).
l. Lateral view of adult —2 left valve (OU 5264f).
m. Lateral view of adult —3 left valve (OU 5264g).
n. Longitudinal thin section of anterior two-thirds of adult right valve showing inner lamella, x65 (OU 5264h).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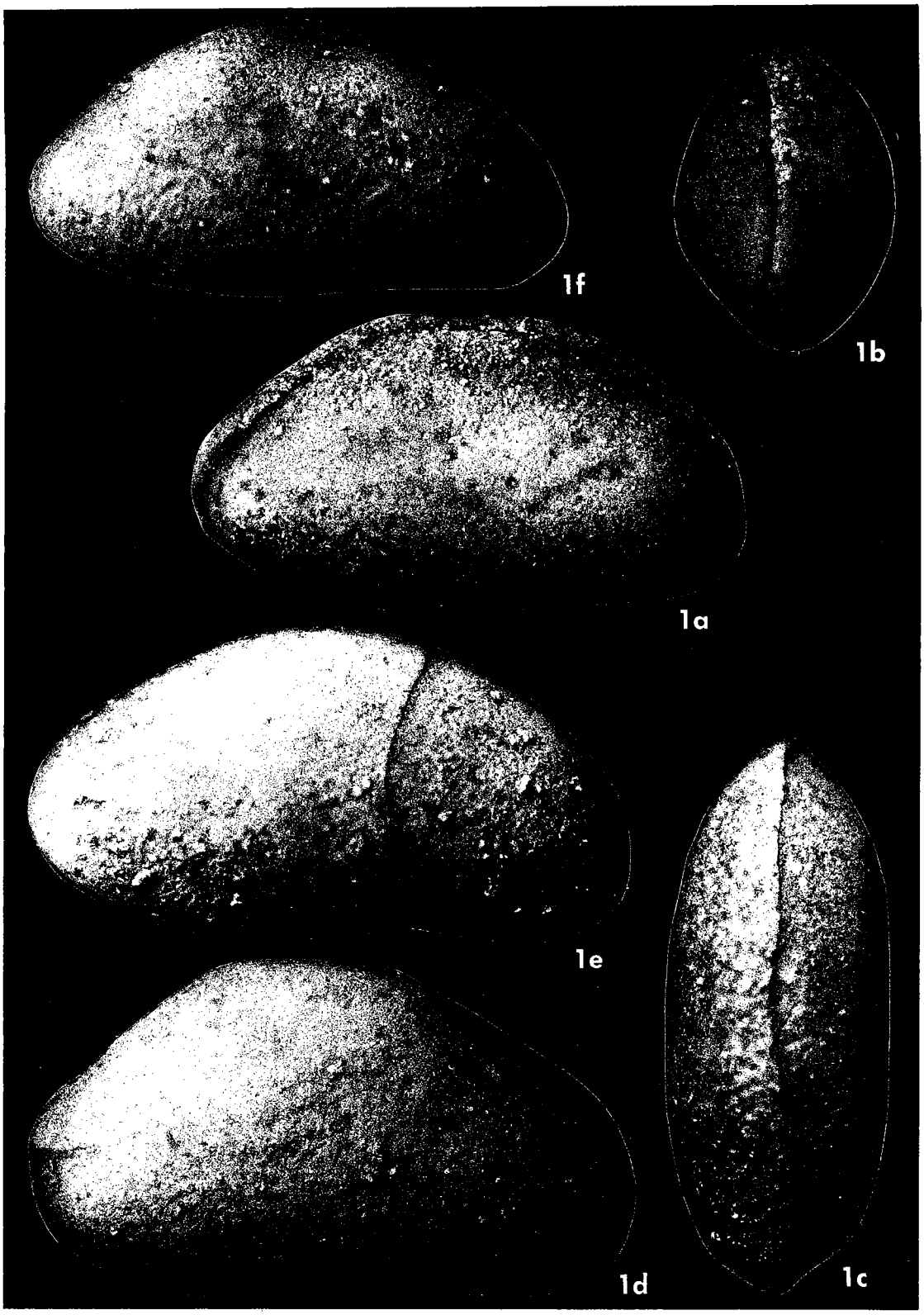
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Plate XII

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Figures 1a-f. *Bairdiocypris magna* (Roth) 55

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e. Lateral view of adult right valve; lectotype (USNM 80643 C).

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Figures 1a, b. *Bairdiocypris magna* (Roth) 55

a. Lateral view of right valve (OU 5267).

b. Lateral view of immature right valve (OU 5268).

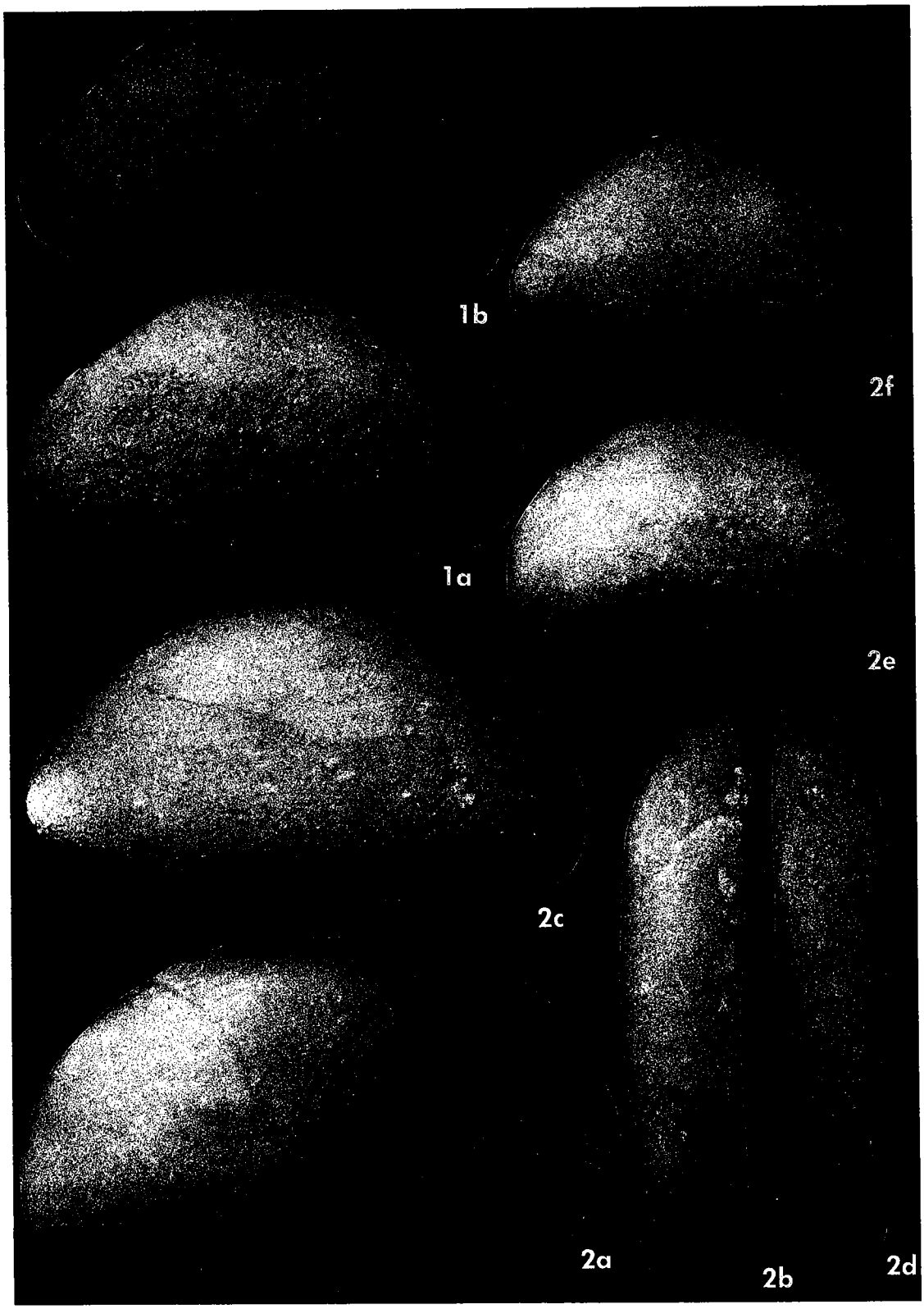
Figures 2a-f. *Amsdenia binoda* Lundin, new species 61

a, b. Lateral and dorsal views of adult left valve; holotype (OU 5269).

c, d. Lateral and dorsal views of adult right valve (OU 5270a).

e. Lateral view of adult —1 left valve (OU 5270b).

f. Lateral view of adult —1 right valve (OU 5270c).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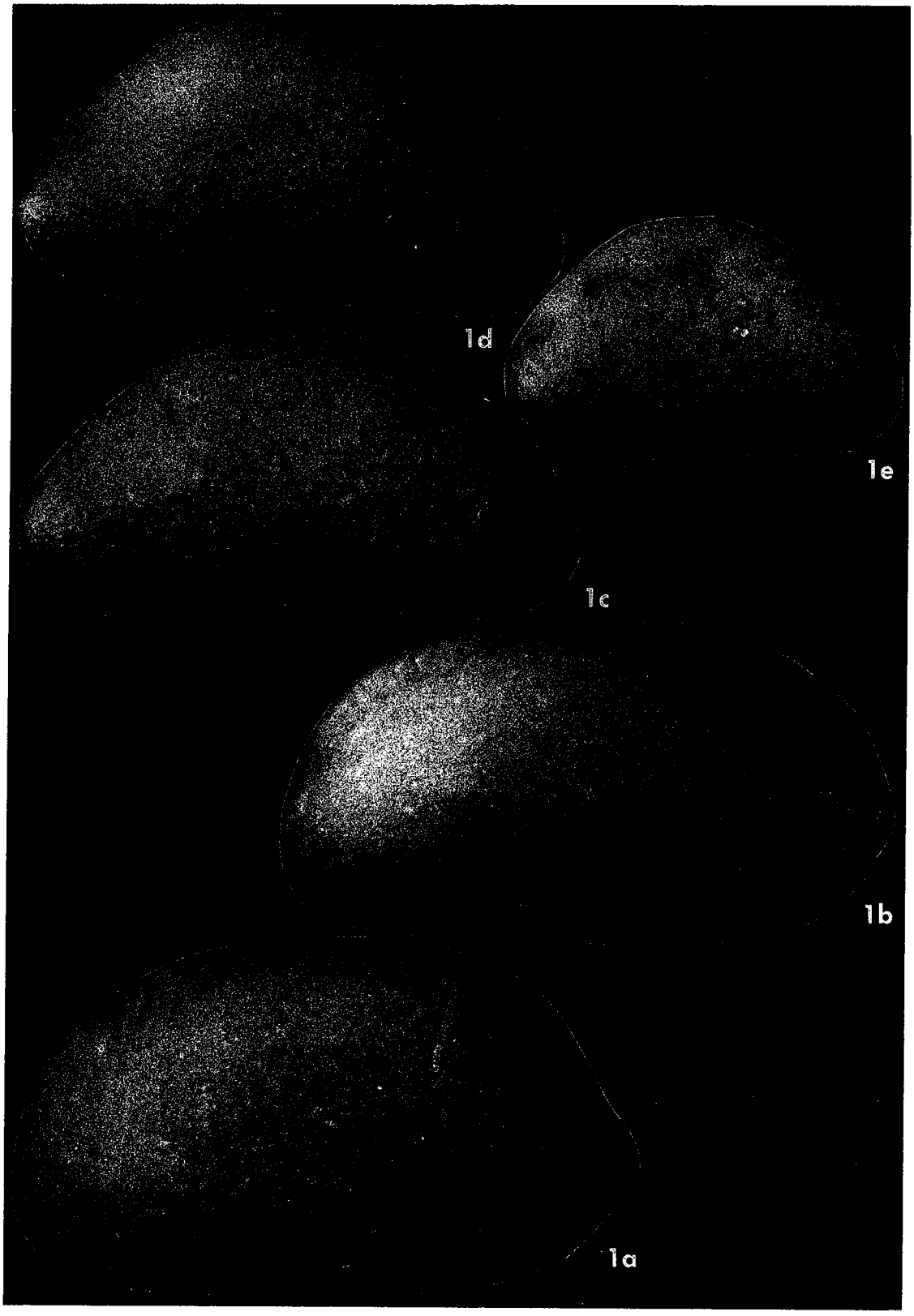
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Figures 1a-e. *Amsdenia binoda* Lundin, new species

a. Lateral view of adult left valve (OU 5270d).
b. Lateral view of adult left valve (OU 5270e).
c. Lateral view of adult right valve (OU 5270f).
d. Lateral view of adult right valve (OU 5270g).
e. Lateral view of adult —1 right valve (OU 5271).

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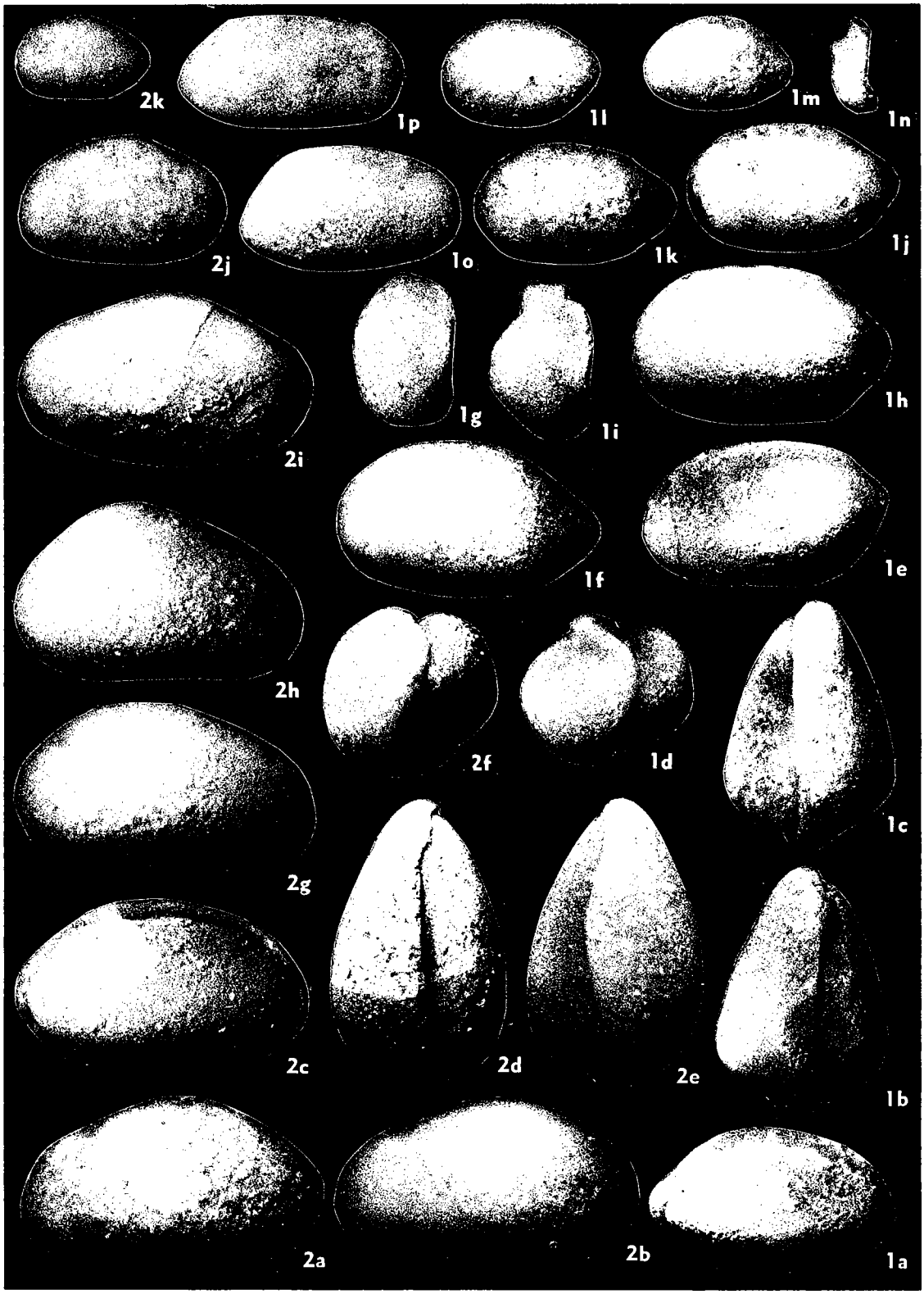
Figures 1a-p. *Pachydomella dividia* Lundin, new species 63

- a-e. Right lateral, dorsal, ventral, posterior, and left lateral views of adult carapace; holotype (OU 5397).
- f, g. Lateral and posterior views of adult left valve (OU 5398a).
- h, i. Lateral and posterior views of adult left valve (OU 5398b).
- j. Lateral view of adult —1 left valve (OU 5398c).
- k. Lateral view of adult —1 left valve (OU 5398d).
- l. Lateral view of adult —2 left valve (OU 5398e).
- m, n. Lateral and posterior views of adult —2 left valve (OU 5398f).
- o. Lateral view of adult right valve (OU 5398g).
- p. Lateral view of adult right valve (OU 5398h).

Figures 2a-k. *Tubulibairdia* cf. *T. longula* (Ulrich and Bassler) 65

- a. Lateral view of adult left valve (OU 5400a).
- b. Lateral view of adult left valve (OU 5400b).
- c-f. Right lateral, dorsal, ventral, and posterior views of adult carapace (OU 5399).
- g. Lateral view of adult right valve (OU 5400c).
- h. Lateral view of adult right valve (OU 5400d).
- i. Lateral view of adult left valve (OU 5400e).
- j. Lateral view of adult —1 left valve (OU 5400f).
- k. Lateral view of adult —2 left valve (OU 5400g).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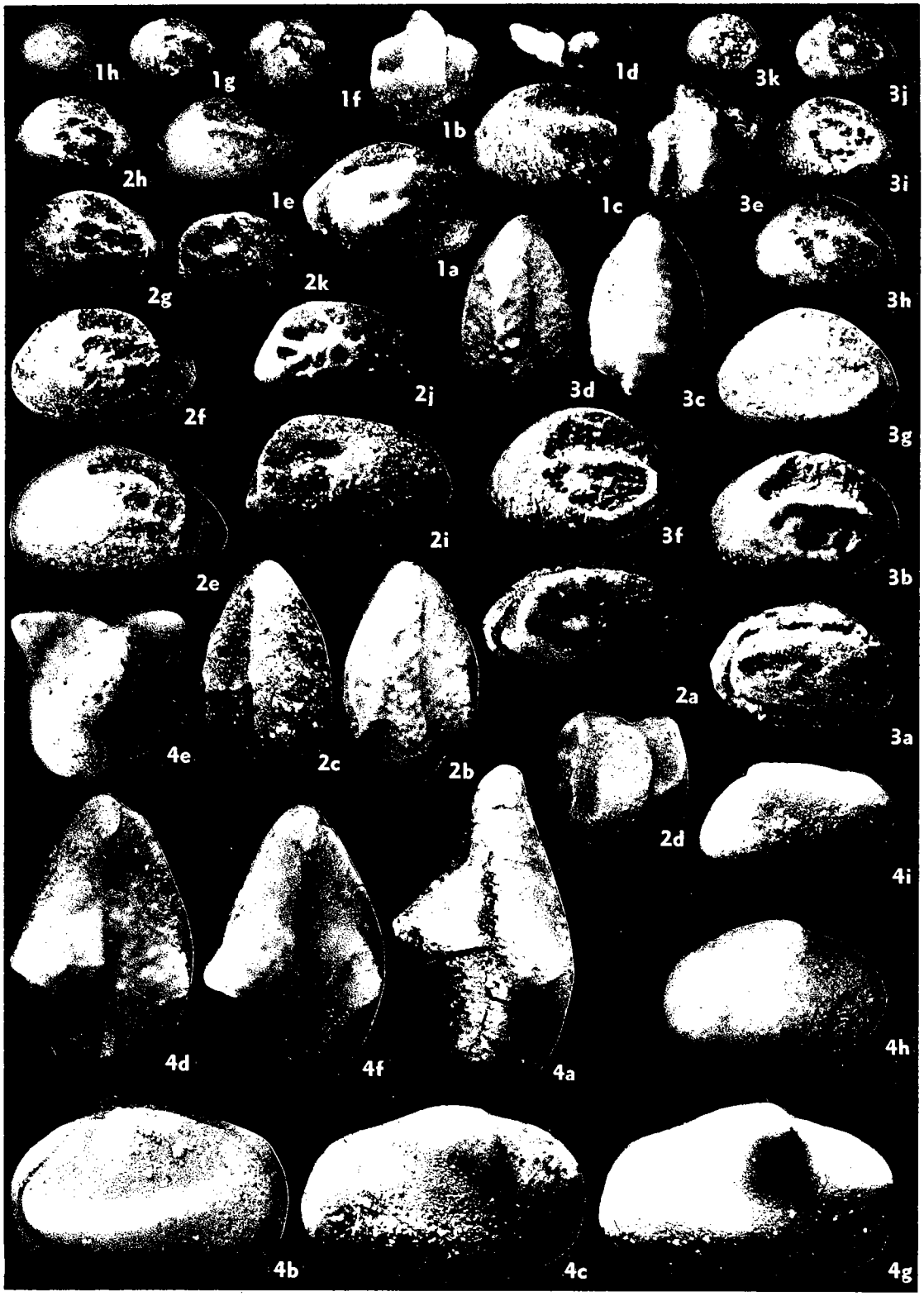
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Figures 1a-h. *Phanassymetria parva* Lundin, new species 67

a, b. Right lateral and posterior views of adult carapace; holotype (UI X-1606a).
c. Lateral view of adult left valve (UI X-1606b).
d. Transverse thin section through venter of adult left valve showing tubule, x72 (UI X-1606c).
e. Lateral view of adult —1 left valve (UI X-1606d).
f. Lateral view of adult —2 left valve (UI X-1606e).
g. Lateral view of adult —3 left valve (UI X-1606f).
h. Lateral view of adult —4 left valve (UI X-1606g).

Figures 2a-k. *Octonaria fryxelli* Lundin, new species 70

a-d. Right lateral, dorsal, ventral, and posterior views of adult carapace; holotype (UI X-1609a).
e. Lateral view of adult left valve (UI X-1609b).
f. Lateral view of adult —1 left valve (UI X-1609c).
g. Lateral view of adult —2 left valve (UI X-1609d).
h. Lateral view of adult —3 left valve (UI X-1609e).
i. Lateral view of adult right valve (UI X-1609f).
j. Lateral view of adult —1 right valve (UI X-1609g).
k. Lateral view of adult —2 right valve (UI X-1609h).

Figures 3a-k. *Octonaria punctata* Roth 72

a-e. Right lateral, left lateral, ventral, dorsal, and posterior views of adult carapace (UI X-1608a).
f. Lateral view of adult left valve (UI X-1608b).
g. Left lateral view of adult carapace; lectotype (USNM 80653 C).
h. Lateral view of adult —1 left valve (UI X-1608c).
i. Lateral view of adult —2 left valve (UI X-1608d).
j. Lateral view of adult —3 left valve (UI X-1608e).
k. Lateral view of adult —4 left valve (UI X-1608f).

Figures 4a-i. *Phanassymetria inequalis* (Roth) 66

a. Dorsal view of deformed carapace; holotype (USNM 80647 H).
b-e Right lateral, left lateral, dorsal, and posterior views of adult carapace (UI X-1607a).
f. Dorsal view of adult carapace (UI X-1607b).
g. Lateral view of adult left valve (UI X-1607c).
h. Lateral view of adult —1 left valve (UI X-1607d).
i. Lateral view of adult —1 right valve (UI X-1607e).

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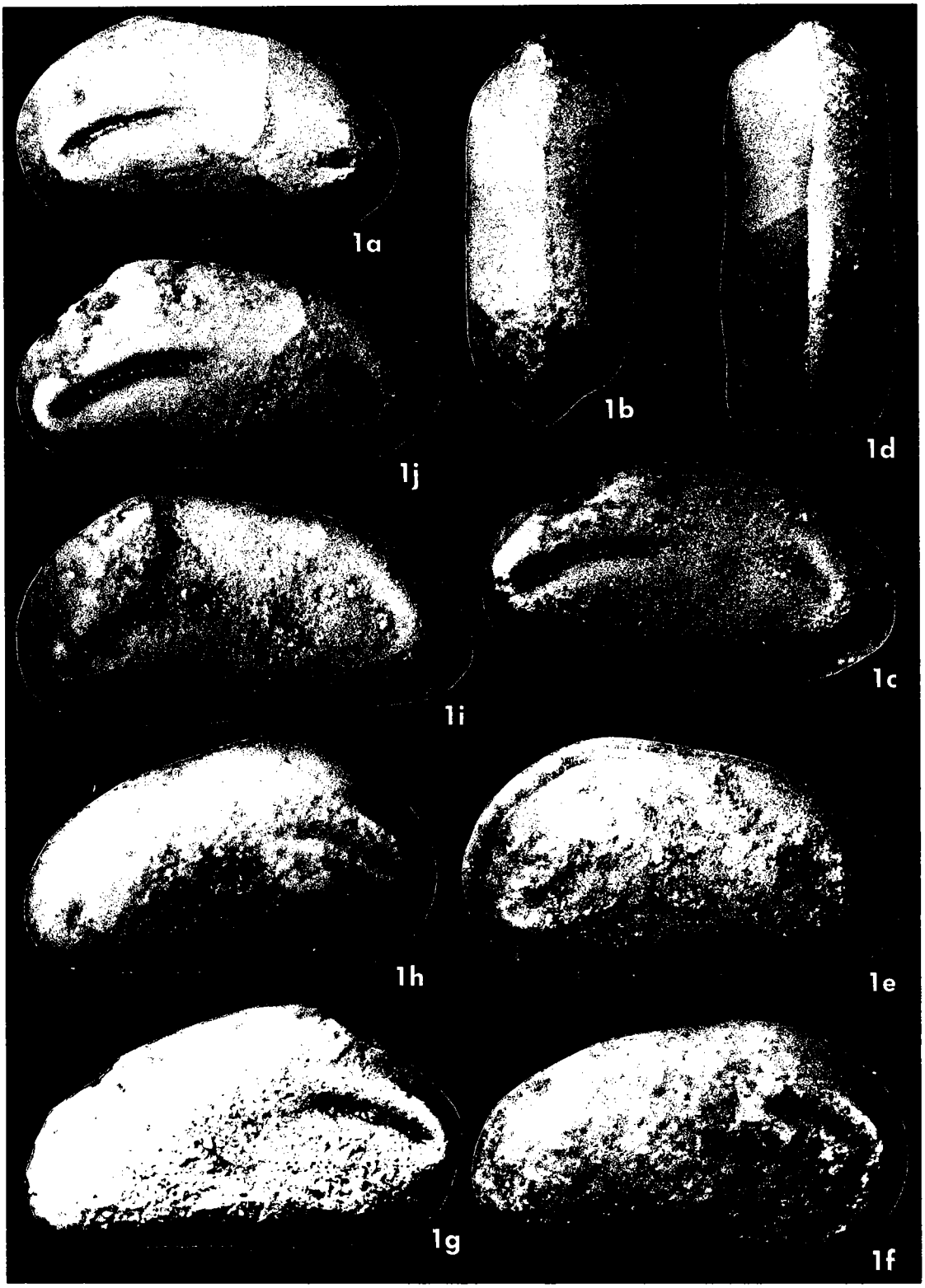
Figures 1a-j. *Thlipsurella? curvistriata* (Roth) 74

a, b. Right lateral and dorsal views of adult carapace (OU 5401a).
c, d. Right lateral and ventral views of adult carapace with posterodorsal area broken (OU 5401b).
e, f. Right lateral and left lateral views of adult carapace (OU 5402).
g. Left lateral view of adult carapace; holotype (USNM 80660 H).
h. Lateral view of adult left valve (OU 5403a).
i. Lateral view of adult right valve (OU 5403b).
j. Lateral view of adult right valve (OU 5403c).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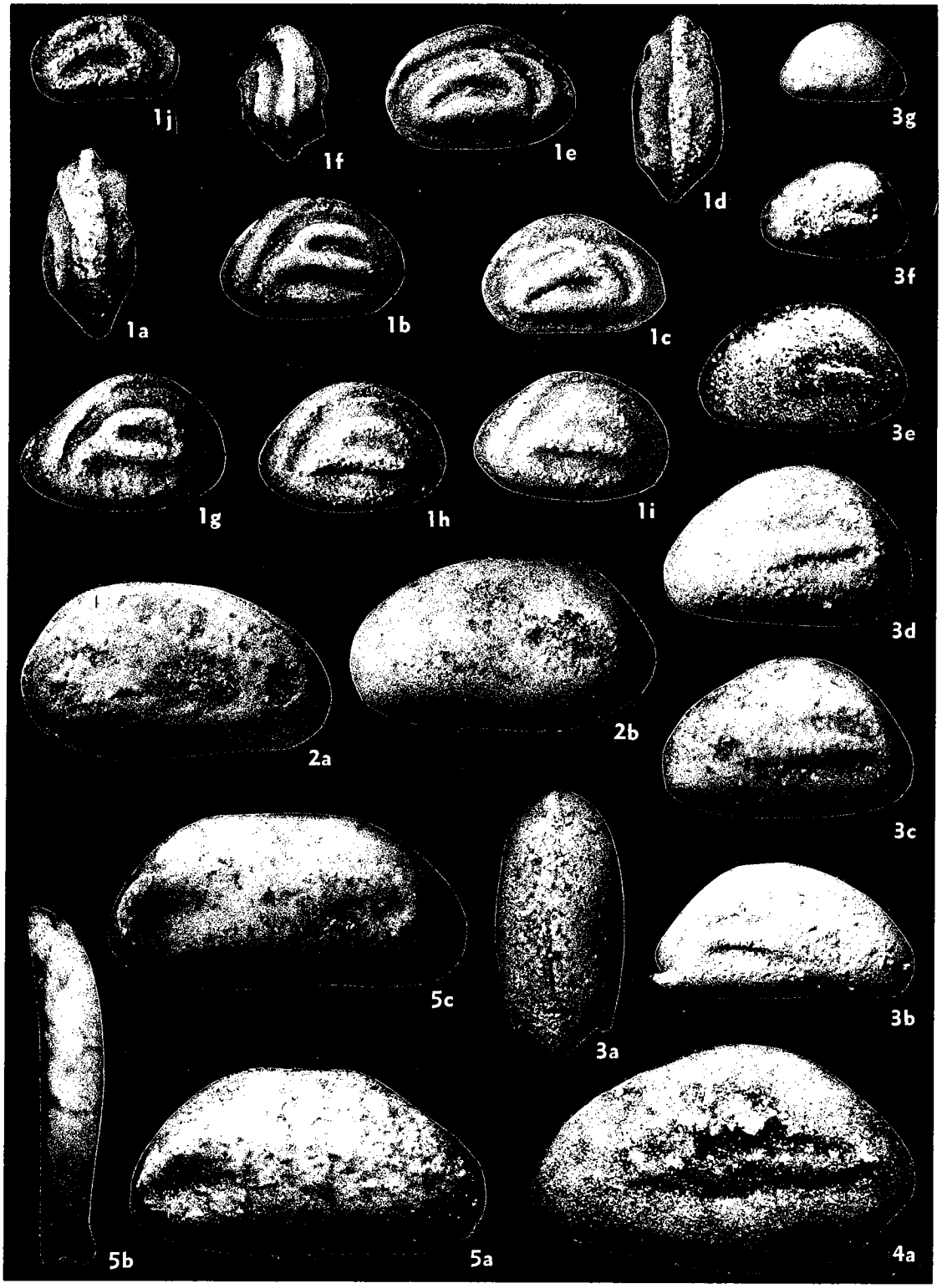
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Plate XVIII

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Figures 1a-j. *Thlipsuropsis inaequalis* (Ulrich and Bassler) 78

a-d. Dorsal, left lateral, right lateral, and ventral views of adult carapace (OU 5404a).
e, f. Right lateral and anterior views of adult carapace (OU 5404b).
g. Lateral view of adult left valve (OU 5404c).
h. Lateral view of adult left valve (OU 5404d).
i. Lateral view of adult left valve (OU 5404e).
j. Lateral view of adult right valve (OU 5404f).

Figures 2a, b. *Thlipsurella*? *curvistriata* (Roth) 74

a, b. Right lateral and left lateral views of immature carapace (OU 5403d).

Figures 3a-g. *Thlipsuroides striatopunctatus* (Roth) 76

a. Dorsal view of adult female carapace with spines abraded (UI X-1610a).
b. Lateral view of adult female right valve (UI X-1610b).
c. Lateral view of adult male left valve (UI X-1610c).
d. Left lateral view of adult male carapace; holotype (USNM 80656 H).
e. Lateral view of adult —1 left valve (UI X-1610d).
f. Lateral view of adult —2 left valve (UI X-1610e).
g. Lateral view of adult —3 right valve (UI X-1610f).

Figure 4a. *Thlipsuroides parallelus* (Roth) 76

a. Left lateral view of carapace; holotype (USNM 80657 H).

Figures 5a-c. *Thlipsurella*? sp. 75

a, b. Lateral and dorsal views of right valve (OU 5405a).
c. Lateral view of right valve (OU 5405b).

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(*Italic number* indicates main reference)