Chapter 6
Clam Shrimps

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INTRODUCTION

This chapter contains a description of the clam shrimps (conchostracans) found in the Ciniza Lake Beds and a discussion of the paleoecological implications of the fossils. It also includes an estimate of the duration of the lake based on the evidence derived from the conchostracans. The conchostracans considered here are referred to a new species of *Cyzicus* (*Lioestheria*) and appear to be closest to *C.* (*L.*) *ovata* from the Upper Triassic (Carnian) of Utah, Virginia, and elsewhere.

Conchostracans are abundant and widely distributed in the lake beds and occur as compressions throughout its vertical and lateral extent. They are especially common in the gray shale that makes up the bulk of the lake beds and are much less common in the transitional beds at its base and top. Small fossiliferous slabs have been studied from nearly every known exposure of the lake beds as shown in chapter 1, figure 9. They were all collected by S. R. Ash for this project. Initially several grab samples were collected by him from four localities (FW2, FW3, FW6, FW7). Later he collected a series of slabs every 15 cm through the vertical extent of the lake beds at localities FW1 and FW5 (see chap. 1, fig. 17). A few of the slabs were oriented when they were collected with respect to their top, but most were not.

Dozens of right or left valves, flattened on bedding planes give an etched appearance to the fossiliferous slabs. The valves are sparse on some slabs, but they often occur in coquinoid assemblages (figs. 1a–1c). They are predominantly crushed and carbonized and occasionally have gypsum crystals embedded in them. One valve (locality FW1, unit 2h) retained a reddish brown hue denoting haemolymph in the valve at the time of demise, a condition signifying poor aeration (low oxygen) in the pool. (Tasch 1967, p. 258).

SPECIATION

Although Lake Ciniza persisted a considerable time, as will be discussed later, conchostracan occupancy was intermittent over a period of somewhat less than two centuries. This fact can explain the dominance of the single species described in this paper, *Cyzicus* (*Lioestheria*) *wingatella* n. sp. During the time of conchostracan occupancy wind-transport did not bring the eggs of other estheriid species, embedded in dried muds, into the lake or its marginal pools. Thus, the biogram of a single species circulated in what may be considered a well-isolated gene pool.

LIOESTHERIID AFFINITIES AND DISPERSAL

Triassic (Carnian) lioestheriids were far ranging in North America (including Canada, the United States, and Mexico). The new species differs from a common Triassic form, *Cyzicus* (*Lioestheria*) *ovata* known from Virginia, Utah, and elsewhere in umbonal position on the adult valve (farther from the anterior margin in the new species), and overall configuration (ovate valves that do not tend to be subcircular in the new species). The one instance of an elongate-subcircular valve (loc. FW1, unit 2b) is attributed to possible dimorphism. Even in this case, *C.* (*L.*) *ovata* valves are not elongate.

Geographically, Carnian lioestheriids closest to the new species, came from the state of Sonora, Mexico (Tasch and Shaffer 1964). Valves of the Mexican forms, however, are obliquely subovate, and the umbo is subterminal in position. Thus, the Chinle lioestheriids have closer affinities to *C.* (*L.*) *ovata* than to the Mexican forms. Presumably cyziciid egg dispersal came from the north and/or east rather than from south of the Lake Ciniza area.

SYSTEMATIC DESCRIPTION

Cyzicus (*Lioestheria*) *wingatella* n. sp.
(figs. 1, 2)

Diagnosis.—Broad to narrowly ovate conchostracan valves (adult) that are more elliptico-ovate in naupliids. Umbo, subdued, situated one-third valve length distance from anterior margin. Growth bands variable.

Marked hachure-type ornamentation of intervals between growth lines, with individual markings granulose.

Measurements.—

	Specimen Number	Length (mm)	Height (mm)	h/1*
Holotype	CF2	5.40	3.90	.72
Paratype	CF3	5.40	3.75	.69

Growth Bands.—Holotype: 19 bands in two sets; first ten bands with 3 bands/0.48 mm; subsequent nine bands, with 3/0.34 mm. Paratype: 16 bands, with first nine having 3/0.75 mm, and subsequent seven bands, 3/0.45 mm.

Repository.—Wichita State University Geology Dept., Tasch Conchostracan Collections.

Locality.—FW6 (also, FW1, FW2, FW3, FW5, FW7).

PALEOECOLOGICAL IMPLICATIONS

The lioestheriids described here yield a variety of paleoecological data: variation in population density; variation in sedimentation rate in marginal pools of Lake Ciniza through time; an estimate of the lake's maximum duration, as well as the total time of intermittent conchostracan occupancy. Information on mineralogy, evaporative events, and biotic associates is also considered.

*Valves of this species on successive slabs from FW1, unit a (oldest) through unit j (youngest), were measured; n = 79; h/1 varied within and between samples, the dominant trend being between 0.6 and 0.8. Occasional values greater than 0.8 may be due to distortion arising from compaction and flattening. See table 1 for population densities of the new species.

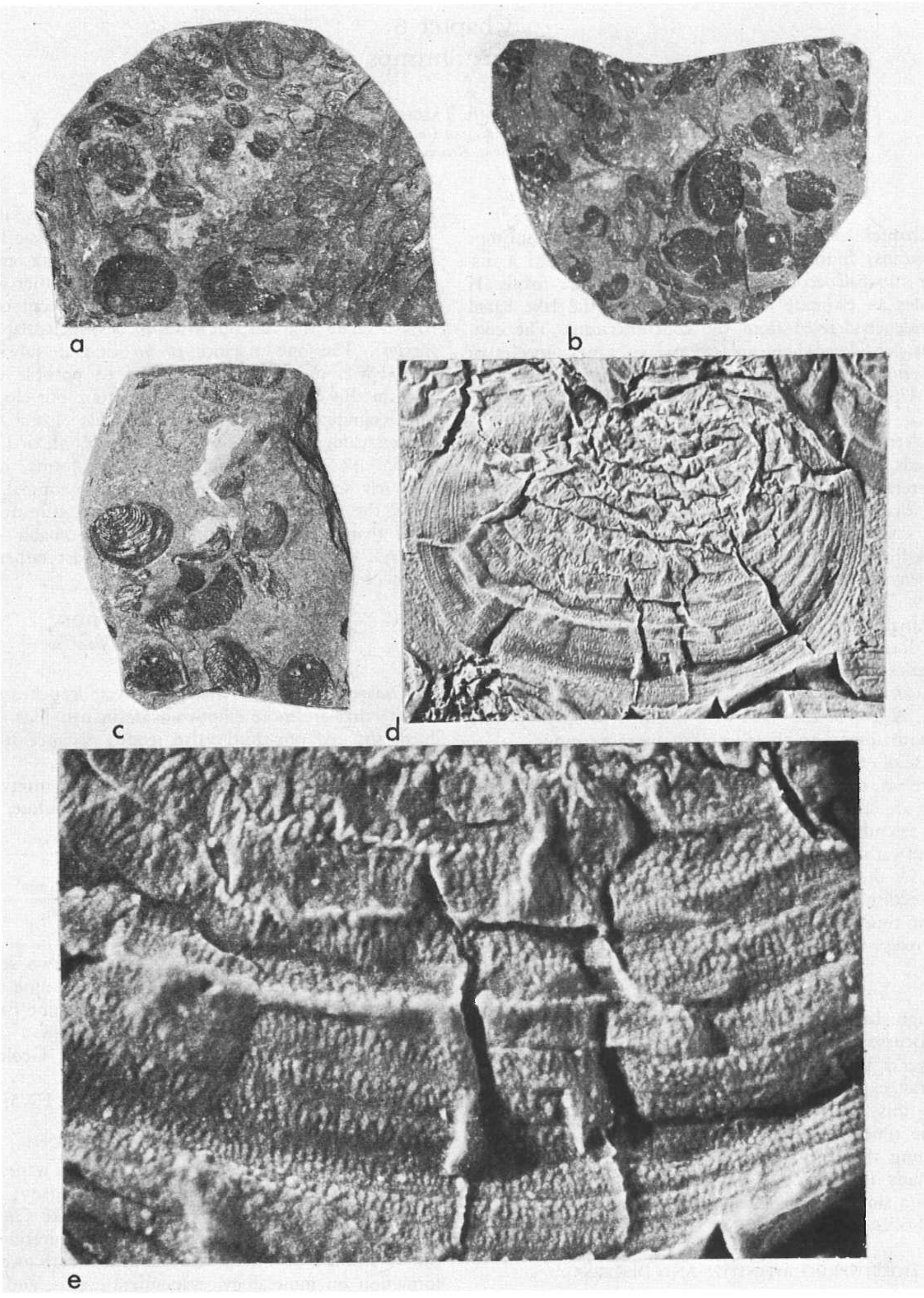

FIGURE 1.–*Cyzicus* (*Lioestheria*) *wingatella* n. sp. a-c.–Bedding planes covered with crushed valves of the new species. Note the unusually small valves in the upper part of figure 1a. CF4-CF6, locality FW6. X2. d, e.–Holotype, right valve showing overall ovate configuration. d, CF1, locality FW6. X12, 7. e, Detail of 1d showing granulose hachure-type ornamentation in the intervales. CF1, locality FW6. X17.

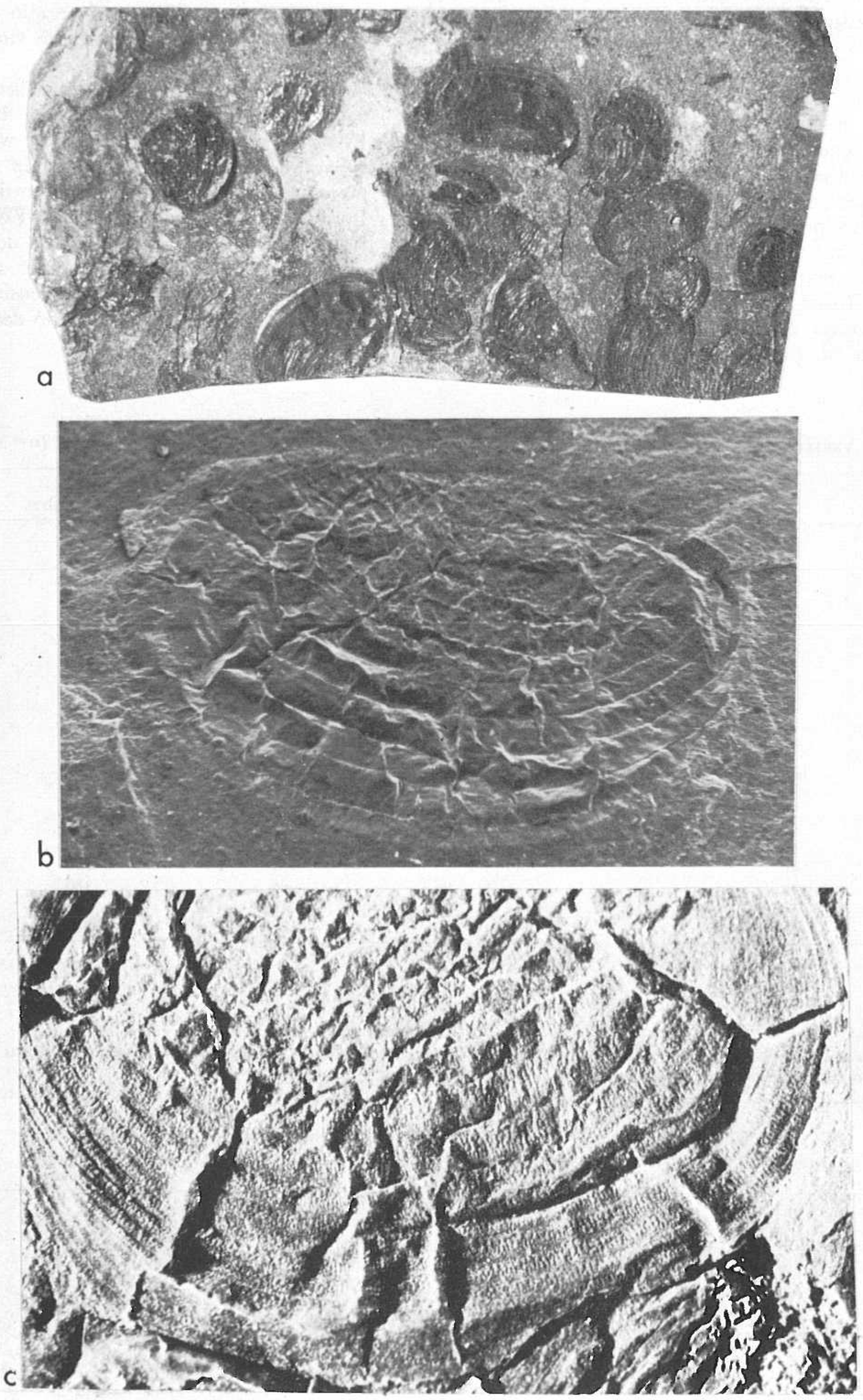

FIGURE 2.–*Cyzicus* (*Lioestheria*) *wingatella* n. sp. a.–Bedding plane covered with crushed valves. CFB, locality FW6. X2. b.–SEM Micrograph of a paratype, right valve. CF7, locality FW6. X15. c.–Paratype, left valve. CF3, locality FW6. X33.

Population Density

In table 1, the Total Area (mm^2) column represents the sum of the area of each counted sample within a given unit (such as FW1, unit j). Similarly the column headed Total Valves is a summation of valve counts in each of the samples of a unit. Population density (σ) for the whole sample is derived by dividing total area into total valves. The grand total of all valves sampled is n=3,223.

It is possible to determine variation in population density through time in the two vertical sample sequences (FW1, FW5). In the sequence at FW1, for example, starting at unit 2a, the oldest deposited sediment in the fossiliferous shale, $\sigma=0.13$, and area exceeds valve concentration by a factor of almost X8. This proportion decreases markedly in the next overlying unit, 2b, to approximately X1/5. By the time represented by the next higher unit, 2c, the relationship of the two variables (total area and total valves) reversed. Now valve concentration exceeded total area by a factor of X2. This condition of valve concentration exceeding total area persisted through unit 2f-time, and then reversed again through unit 2j-time.

Comparable events occurred at FW5, unit 3–unit 4d-time as samples from these units show greater valve concentration than total area, and subsequently there was a reversal. Valve concentration exceeded total area in the samples from localities FW3 and FW7, but in the sample from FW2 the reverse held.

These changes in population density across the area of Lake Ciniza (chap. 1, fig. 9) and through time (FW1 and FW5) denote that at times there were effective population explosions. This fact is reflected in dense coquinoid assemblages of conchostracans. At other times conchostracan density was relatively sparse (compare FW1, units 2a and 2f, and FW5, units 4c and 4f). Population decline or sparsity may be related to shrinking lake margins and marginal lake pool evaporation. Contrariwise, great density denotes persistence of the conchostracan habitat with no decline in available oxygen and nutrient.

TABLE 1

VARIATION IN POPULATION DENSITY (σ) OF Conchostracan *Cyzicus* (*Lioestheria*) *wingatella* n. sp. (n=3223 valves)

Locality	Unit	Counted Number of Samples	Total Area (mm^2)	Total Valves	σ=Valves/mm^2
FW1	2j	6	236	155	0.65
	2i	5	236	230	1.00
	2h	6	492	184	0.37
	2g	5	252	248	1.00
	2f	8	154	319	2.07
	2e	9	237	381	1.61
	2d	6	101	106	1.05
	2c	6	86	169	1.96
	2b	4	93	77	0.82
	2a	5	122	16	0.13
FW2	3	5	154	68	0.44
FW3	4	4	38	68	1.78
FW5	4f	6	78	17	0.22
	4e	4	59	49	0.83
	4d	6	53	111	2.09
	4c	8	263	408	1.55
	4b	8	232	276	1.14
	4a	4	65	180	2.77
	3	2	44	51	1.15
FW7	2	9	125	327	2.61

TABLE 2

VERTICAL SCAN OF SEDIMENTATION RATE, CONCHOSTRACAN OCCUPANCY AND NUMBER OF GENERATIONS DURING LAKE CINIZA TIME (Data from section collected at locality FW1, unit 2a [oldest] through unit 2j [youngest])

Unit	(1) Thickness of Fossiliferous Slab (mm)	(2) Maximum Number of Growth Bands	(3) Number of Conchostracan Generations	(4) Rate of Sedimentation (mm/yr)	(5) Duration of Lake (Years) (1)/(4)
Top of section					
j	9.1	26+	8	1.1	8.2
i	16.0	29+	16	0.81	19.7
h	14.2	35+	11	1.4	10.1
g	13.7	28+	8	1.0	13.7
f	17.1	38	15	1.2	14.2
e	9.5	26+	9	0.86	11.0
d	9.3	29	7	1.1	8.4
c	12.3	32	10	0.9	13.6
b	17.6	17	10	2.9	6.0
a	6.9	31	3	0.9	7.6
Base of section					
Totals			97		112.5*

*The intervening space between each sample, as, for example, between a and b, was 6.5 to 10 cm. Assuming conchostracan occupancy during such times as well adds 56.2 to 75.0 years to 112.5, or 168.7 to 187.5 years for total conchostracan occupancy.

Sedimentation Rate and Related Items

Determination of the rate of sedimentation requires two types of measurements: (1) the thickness of a given fossiliferous slab and (2) determination of the smallest sedimentary interval between any two successive estheriid-bearing layers in this slab (table 2). Thus if one starts with the oldest unit, 2a, at locality FW1, the sedimentary rate per annum was 0.9 mm, but more than X3 that amount in the next unit, 2b. Thereafter the value fluctuated between 0.9± and 1.2± mm.

In brief, other than for unit b, sedimentation in the estheriid-bearing margins of Lake Ciniza varied about 0.3± mm per annum. It follows that the erosional process and subsequent sediment transport to the lake must have been very regular during the time represented.

Summing column 4, table 2, and dividing by the total number of units–ten–the average sedimentation rate is 1.22 mm per annum, or 1.0 mm when rounded off.

Conchostracan Generations and Duration of Occupancy

Total number of successive conchostracan generations in a given slab (table 2, example FW1, unit 2j) is also a variable through time (compare FW1, units 2a and 2j). These data are directly determined by use of a binocular microscope, micrometer scale, and vernier calipers.

Number of generations varied from 3 (FW1, unit 2a) to 16 (FW1, unit 2i). Through the time represented by all the units of FW1 (table 2, column 5–112.5 years), there were 97 conchostracan generations. (Equivalent production for unsampled intervals would increase this figure to 145-162 successive generations). Productivity on this scale, both in successive number of generations and population density (table 1), attests to most favorable life conditions for conchostracan populations. Such conditions effectively recurred throughout the duration of Lake Ciniza.

For any given unit (FW1, 2a-2j) conchostracans with the maximum number of growth bands on any given bedding plane, were noted (table 2, column 2). These data indicate the probable duration of a seasonal lake pool for the time represented on any given plane of a slab. Thus for unit 2f, the maximum number of growth bands for any of the 15 conchostracan generations was 38. Since molting occurs about every 3 days (as determined experimentally with several modern conchostracans) and is represented by a new growth band added to the valve, one can multiply 38×3=114 days or almost one week less than four months.

The upper limit for a Lake Ciniza marginal pool before a drying (evaporative) event, is about 15 weeks (FW1, unit h), on the basis of growth band count multiplied by 3. Similarly, about 7+ weeks was the lower limit at this same locality. Obviously drying events were followed seasonally by renewed wetting events, accounting for multiple generations.

Duration of Lake Ciniza

Given the maximum thickness of about 1.5 m (FW1) for the estheriid-bearing shales of Lake Ciniza, and a sedimentation rate of 1.0± mm, dividing thickness by this rate yields a year value for duration of the lake–some 1500 years. During this time conchostracans intermittently occupied the lake marginal pools for a total of 168.7 to 187.5 years (see footnote, table 2).

Clay Mineralogy, Evaporative Events, and pH

A sample of the estheriid-bearing shale (FW6) was analyzed by X-ray diffraction by a colleague, Dah Cheng Wu. The shale fraction consisted of kaolinite, illite, and some quartz; the salt fraction, gypsum and some quartz (see also Dean, chapter 2).

The combined occurrence of gypsum in the shale–veinlets, thin encrustations and "small aggregations" (Ash, chap. 1), disseminated blobs observed by the writer, and embedded crystals in some estheriids–denotes a shrinkage of lake margins and evaporative events in relict lake pools. The above interpretation gains additional support from the presence of illite. Keller (1957, p. 66) observed that illite formed in nonmarine situations may be attributed to alkaline and evaporative conditions. Since kaolinite also formed (and is favored by excess precipitation over evaporation), it is clear that evaporation events were intermittent. The fact of seasonal recurrence of estheriids in the marginal pools supports a similar conclusion.

Both presence of illite and dense estheriid populations recurring through the time represented point to a pH of 7.0+–that is, slightly alkaline.

Two sets (cycles) of growth bands on valves (wide-to-narrow spacing between successive bands followed by wide spacing) were seen on some fossils. These relate to wetting-drying events in the lake pools. Close spacing corresponds to lake pool shrinkage and accompanying decrease in available oxygen, and wide spacing following it, a wetting event and increase of available oxygen. Presence of kaolinite throughout the time represented also evidences intermittent precipitation.

Biotic Associates

The biota actually observed with the estheriids include plant material, which is widespread (both horizontally and vertically) in all samples of the Ciniza Lake Beds (chap. 1, fig. 9), and more restricted ctenoid fish scales (FW3, unit 4; FW5, unit 4c).

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