

## GREBES FROM THE LATE PLIOCENE OF NORTH AMERICA

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The Pliocene grebe fauna of North America is not well known. Brodkorb (1963a) lists two extinct species, *Pliodytes lanquisti* Brodkorb from the Lower Pliocene of Florida and *Podiceps subparvus* (L. Miller and Bowman) from the Middle Pliocene of California, and one extant species, *Podiceps caspicus* (= *nigricollis*) from the Middle Pliocene of Kansas. In addition, there are unnamed grebe remains from the Pliocene of Arizona (Wetmore, 1924), California (Miller and Bowman, 1958; Howard, 1963), Idaho (Wetmore, 1933; Brodkorb, 1958), and Kansas (Wetmore, 1944). Thus I am fortunate to have the opportunity to study and to report on the many grebe specimens that have been collected in Pliocene deposits in Kansas and Idaho by Claude W. Hibbard and his assistants. These specimens are in the collections of The University of Michigan Museum of Paleontology (UMMP).

The nomenclature of the grebes has changed considerably since the publication of Peters' Check-list (1931), and so I have used the names applied by Storer (1963).

### THE FOSSIL LOCALITIES

The fossil grebes are members of the Saw Rock Canyon local fauna and the Rexroad local fauna of Kansas and the Hagerman local fauna of Idaho. The Saw Rock Canyon local fauna was taken on the XIT Ranch in Seward County, Kansas. It is from the lower part (XI member) of the Rexroad formation and has been assigned to the early Upper Pliocene (Hibbard, 1949, 1964). The Rexroad local fauna is found in the upper part of the Rexroad formation in Meade and Seward counties, Kansas, and includes several localities. Grebes have already been reported from localities 2 and 3 (Wetmore, 1944), but the grebes now reported come from Fox Canyon locality UM-K1-47, described by Hibbard (1950), and from Wendell Fox Pasture locality UM-K3-53, described by Woodburne (1961), both in Meade County. Both are assigned to the late Upper Pliocene, but the Fox Canyon locality is considered older than the other Rexroad localities (Hibbard, personal communication.)

The Hagerman local fauna of Idaho is found in the Glens Ferry formation, which has been assigned to the Upper Pliocene and Lower Pleistocene by Malde and Powers (1962). The fossils occur at scattered localities (fig. 3) in Twin Falls and Owyhee counties, but most occur in the region of the Horse Quarry (see Gazin, 1936), from the level of the quarry to 280 feet below that level. The most reliable potassium-argon date of the Hagerman local fauna is  $3.48 \pm 0.27$  million years (Evernden *et al.*, 1964) from just below the level of the Horse Quarry, and the fauna is assigned to late Upper Pliocene (Hibbard *et al.*, 1965). Wetmore (1933) and Brodkorb (1958) have reported grebes from the Hagerman local fauna.

### DESCRIPTION OF THE ELEMENTS

Most of the specimens are broken or worn to some extent. The characters used in distinguishing genera are described here. Specific characters are described in the species' accounts. The terminology of Howard (1929) is used.

*Sternum.* *Podilymbus* differs from *Podiceps* (except *cristatus*) and *Aechmophorus* in having a distinct ledge across the manubrium, which is formed by the junction of the ventral lips of the right and left coracoidal sulci. On anterior view the coracoidal sulci form a flatter V in *Podiceps*

than in *Aechmophorus*. Also the ventral lip of the coracoidal sulcus is evenly rounded in *Podiceps*, whereas there is an indentation along the margin of the sulcus between the rounded anterior portion and the ventral labial prominence in *Aechmophorus* (Howard, 1929). *Podiceps cristatus* is larger than *Podilymbus podiceps* and *Podilymbus gigas*.

*Coracoid*. *Podilymbus* differs from *Podiceps* in having (1) a more slender and relatively longer shaft, (2) a relatively smaller glenoid facet, and (3) an excavated coraco-humeral surface.

*Scapula*. In *Podiceps* the surface of the glenoid facet and the dorsal surface of the neck form a distinct ridge; in *Podilymbus* the transition from surface to surface is more gradual.

*Humerus*. *Aechmophorus* and *Podilymbus* differ from *Podiceps* in having a straighter shaft. On lateral view in *Podiceps* the anconal surface is curved throughout, especially the distal third, whereas the middle of the shaft of *Aechmophorus* and *Podilymbus* is straight, and the greatest curvature is in the distal fifth of the bone.

*Ulna*. *Podiceps* can be distinguished from *Aechmophorus* by the characters listed by Howard (1929). *Podilymbus* differs from *Podiceps* in having (1) a more slender shaft, which tapers toward the distal end, and (2) on proximal view the palmer rim of the internal cotyla blends with the olecranon, whereas in *Podiceps* the rim and cotyla are separated by a distinct notch.

*Carpometacarpus*. *Podilymbus* differs from *Podiceps* in having (1) the internal surface of metacarpal I deeply excavated and (2) the ligamental groove anterior to the pisiform process deeper. Also in *Podilymbus* the proximal end of metacarpal I is rotated toward the internal side, whereas it is parallel to the shaft of metacarpal II in *Podiceps* (Brodkorb, 1963b).

*Femur*. *Podilymbus* differs from *Podiceps* in being relatively more slender, in having the anterior external condyle narrower but more prominent, and in having the rotular groove more distinct. *Rollandia micropterum* resembles *Podilymbus* in being slender for its length. But the fibular condyle of *Rollandia* flares laterad, the surface being broader than high, causing the fibular groove to be at a 45° angle to the axis of the shaft, whereas the surface of the fibular condyle in *Podilymbus* is higher than broad, and the fibular groove forms about a 30° angle with the axis of the shaft.

*Tibiotarsus*. *Podilymbus* differs from *Podiceps* in that the distal surface of the external condyle and the surface of the intercondylar fossa are in the same plane and the external ligamental prominence is not so distinct as in *Podiceps*.

*Tarsometatarsus*. *Podilymbus* differs from *Podiceps* in having (1) the shaft rotated along the long axis, the distal end externally and the proximal end internally (not rotated in *Podiceps*), (2) the groove between trochleae 2 and 3 distinct throughout its length (interrupted in *Podiceps*), (3) the shaft flattened or square in cross-section (compressed in *Podiceps*), and (4) the anterior metatarsal groove less distinct. A canal for the tendon of insertion of *M. flexor perforatus digiti II* is present in the hypotarsus of *Podilymbus*, but it is absent in those of *Aechmophorus* and *Podiceps* (Storer, 1963). *Podiceps* differs from *Aechmophorus* in having a distinct drop from the intercotylar depression to the hypotarsus (gradual grade in *Aechmophorus*), noted by Howard (1929), and in having a deep muscle scar on the internal side of the hypotarsus.

#### UPPER PLIOCENE GREBE FAUNA

##### ***Pliolymbus*, new genus**

*Type*. *Pliolymbus baryosteus*, new species.

*Diagnosis*. The sternum agrees with sterna of other genera of Podicipedidae in having deep, nonoverlapping coracoidal sulci with dorsal and ventral lips being similar in size and shape. Resembles *Podilymbus* and *Podiceps cristatus* and differs from *Podiceps* (except *cristatus*), *Tachybaptus*, *Rollandia*, and *Aechmophorus* in having the ventral lips joined across the manubrium by a ledge. On anterior view the ledge is horizontal between the sulci, whereas in *Podilymbus* and *Podiceps cristatus* there is a distinct dip ventrad. The fossil is distinguished by a short antero-medial projection of the ledge, a character unknown in other grebes.

**Pliolymbus baryosteus**, new species

(Figure 1)

*Type.* Anterior portion of a sternum (UMMP 51839), collected by Claude W. Hibbard and party in the summer of 1950.

*Horizon and locality.* Upper Pliocene, Rexroad formation. Fox Canyon locality UM-K1-47, sec. 35, T34S, R30W, Meade County, Kansas.

*Diagnosis.* This species is distinguished from all other species of grebes in having an antero-medial projection on the ledge between the coracoidal sulci (see generic diagnosis). The portion of the sternum that remains is 7.8 mm long and 13.1 mm wide.

*Referred material.* Four additional specimens from the Rexroad local fauna are referred to this species on the basis of size: the distal 17.5 mm of a humerus (UMMP 51840); the proximal 10.4 mm of a coracoid (UMMP 51841); the shaft (29.3 mm) of a tarsometatarsus (UMMP 51844); and an association of 14 bones (UMMP 27173), including two almost complete coracoids, almost complete ulna and carpometacarpus, a complete and a partial cervical vertebra, and portions of two radii, scapula, femur, synsacrum, two ribs, and an unidentifiable bone.

The coracoid is indistinguishable from *Podiceps*, being nearest in size to *Podiceps dominicus*, but it is much more robust, having a broader base and being built more like those of *Podiceps grisegena* and *nigricollis*. *Pliolymbus* can be distinguished from *Pliodytes* (Brodkorb, 1953) by the absence of two scars on the anterior surface of the head of the coracoid. Overall length, 21.6 mm. Breadth across sternal facet, 8.8 mm.

The distal end of the humerus (UMMP 51840) is similar in size to that of *Rollandia rolland chilensis*, except that the shaft is much stouter, and the brachial depression is more deeply excavated. Greatest breadth across condyles, 5.6 mm. Greatest diameter of shaft 15 mm from distal end, 3.5 mm; least, 2.8 mm.

The ulna is longer than those of *R. rolland chilensis* and *P. dominicus*, but considerably shorter than that of *P. nigricollis*, although it is as robust as in a female *P. nigricollis*. Overall length, 53.7 mm. Narrowest antero-posterior measurement along shaft, 2.7 mm; maximum, 3.2 mm.

The carpometacarpus is short compared with those of other grebes. It is about the same length as that of *R. rolland chilensis*, but it is more stout, the diameter of metacarpal II being about that in female *P. nigricollis*. Length from distal end to distal end of metacarpal I, 20.9 mm. Dorsal-ventral diameter of metacarpal II, 1.9 mm.

The breadth of the shaft of the femur just proximal to the rotular groove (4.0 mm) is great relative to the greatest breadth across the condyles (6.7 mm), in comparison with other grebes.

The shaft of the tarsometatarsus (UMMP 51844) is compressed, but not so much as in the shafts of *Podiceps* of similar size. Distance from the distal end of the proximal ligamental scars to the distal foramen, 25.1 mm; least breadth of shaft, 2.5 mm. Comparable measurements from six specimens of *P. nigricollis*: (males) 28.6, 2.4; 29.0, 2.3; 29.2, 2.2; (females) 28.4, 2.3; 28.7, 1.9; 29.8, 1.9.

*Pliolymbus baryosteus*, then, was a small grebe with a more robust skeleton than those of modern grebes.

*Hagerman local fauna.* There are seven fragments that are not complete enough to permit positive identification. However, they are not distinguishable from *Pliolymbus baryosteus*, and they are referred to that species until better material is available from Idaho. They are the distal ends of two coracoids (UMMP 49577 and 49593), proximal 12.0 mm of a coracoid (UMMP 45236), proximal 8.8 mm of a scapula (UMMP 52454), distal ends of two humeri (UMMP 48936 and 52584), and the proximal 11.6 mm of a carpometacarpus (UMMP 49835).

**Podiceps discors**, new species

(Figure 2)

*Type.* A complete left tarsometatarsus (UMMP 29079), slightly worn, except



Figure 1. Upper right. Dorsal and anterior views of the type sternum (UMMP 51839) of *Pleiomyces baryosteus*, new species,  $\times 3.1$ . Left and lower right. Type ulna and humerus (UMMP 45316) of *Aechmophorus elasson*, new species,  $\times 1.7$ .



Figure 2. Left. Medial and anterior views of the type left tarsometatarsus (UMMP 52470) of *Podilymbus majusculus*, new species,  $\times 2$ . Right. Medial and anterior views of the type left tarsometatarsus (UMMP 29079) of *Podiceps discors*, new species,  $\times 2$ .

hypotarsus worn, collected by Claude W. Hibbard and party in the summer of 1951.

*Horizon and locality.* Upper Pliocene, Rexroad formation. Fox Canyon locality UM-K1-47, sec. 35, T34S, R30W, Meade County, Kansas.

*Diagnosis.* Near size of *Podiceps nigricollis* and female *Podiceps auritus* (table 1), but differs from them and other *Podiceps* in that the support of the internal condyle is not so flared internally, and the head is small relative to the length of the bone (table 1). The same part of the tarsometatarsus on medial view is not so long nor directed so far anteriorly as in other *Podiceps*.

*Hagerman local fauna.* Several specimens of *Podiceps* from the Hagerman local fauna differ in size, some being the size of comparable elements of *auritus*, others the size of *nigricollis*.

A complete femur (UMMP 52423) is as long as that of male *auritus*, but differs in being slender, especially in the width of both the proximal and distal ends; overall length, 35.1 mm; least breadth of shaft, 3.6 mm; depth of shaft, 4.1 mm; breadth across proximal end, 9.3 mm; and breadth across distal end, 9.0 mm.

An almost complete carpometacarpus (UMMP 49653) is about the size and shape of a large *nigricollis*; overall length, 32.2 mm; least thickness of metacarpal II, 1.8 mm.

The remaining specimens are three coracoids (UMMP 49590, 52277, and 52585), two scapulae

TABLE 1

MEASUREMENTS (IN MM) OF TARSOMETATARSI OF *Podiceps auritus*, *P. nigricollis*, AND *P. discors*

	n	Overall length			Proximal breadth			Shaft breadth			Distal breadth		
		Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.
<i>auritus</i> ♂ ♂	11	45.8	47.7	49.5	8.0	8.6	9.0	2.0	2.4	2.8	5.5	6.2	7.0
<i>auritus</i> ♀ ♀	12	42.3	45.2	47.6	7.8	8.3	8.9	2.0	2.3	2.6	5.5	5.8	6.3
<i>nigricollis</i> ♂ ♂	3	40.3	41.6 <sup>a</sup>	42.2	7.8	7.9 <sup>a</sup>	8.2	2.2	2.3 <sup>a</sup>	2.4	5.8	6.0 <sup>a</sup>	6.0
<i>nigricollis</i> ♀ ♀	3	40.3	40.7 <sup>a</sup>	41.9	7.3	7.5 <sup>a</sup>	7.6	1.9	1.9 <sup>a</sup>	2.3	5.4	5.5 <sup>a</sup>	5.8
<i>discors</i>			42.3			6.9			2.3			5.5	

<sup>a</sup> This is actual measurement of third specimen.

(UMMP 45289 and 49589), and the distal ends of two tibiotarsi (UMMP 52432 and 52448), which appear to fall within the range of either *auritus* or large *nigricollis*.

These specimens may represent one or possibly even two new species. However, I cannot reject the possibility that *discors* is a species whose size range is similar to that of *auritus*. Therefore, until further material is available, I tentatively refer the Hagerman specimens to *discors*.

*Remarks.* The reported occurrence of *Podiceps nigricollis* from the Middle Pliocene of Kansas (Wetmore, 1937a), based on a tarsometatarsus with the head and internal trochlea missing, becomes questionable with the discovery of *P. discors* because the distal portion of the tarsometatarsus of *discors* is virtually indistinguishable from *P. nigricollis*. Determination of the Middle Pliocene species requires more material.

The unnamed grebe specimens from the Upper Pliocene of Arizona (Wetmore, 1924) and the San Diego formation of California (Miller and Bowman, 1958) are apparently near *discors* in size and, thus, may represent this species.

### ***Aechmophorus elasson*, new species**

(Figure 1)

*Type.* Distal 58.1 mm of left humerus and associated left ulna (UMMP 45316), slightly worn, collected by Claude W. Hibbard in the summer of 1962.

*Horizon and locality.* Upper Pliocene, Glens Ferry formation. U.S.G.S. Cenozoic locality 19217. NE  $\frac{1}{4}$ , NE  $\frac{1}{4}$ , sec. 20, T7S, R13E, 150 feet W, 800 feet S of NE corner; elevation, 3115 feet; Twin Falls County, Idaho.

*Diagnosis.* The humerus resembles living *Aechmophorus occidentalis* but is slightly, probably not significantly, smaller (table 2), whereas the ulna is considerably smaller than that of *A. occidentalis* (table 2). These two elements were found together in place, and they are no doubt from one bird.

*Referred material.* Other specimens from the Hagerman referred to this species are a complete, slightly worn ulna (UMMP 48914), which is shorter than the type (table 2), short distal ends of two ulnae (UMMP 49572 and 49588), short proximal end of another ulna (UMMP 52538), two almost complete coracoids (UMMP 49578 and 52388), distal portions of two coracoids (UMMP 49582 and 52587), and the proximal 33.9 mm of a tarsometatarsus (UMMP 52403).

Two coracoids (49578 and 49582) were directly compared with two cotype coracoids (American Museum of Natural History no. 3570) of *Podiceps parvus* (Shufeldt, 1913), known from the Pleistocene of Oregon and California (Brodkorb, 1963a). The larger specimen (49582) is about the same size as the larger *P. parvus*, and the smaller specimen (49578) is about the same size as the smaller *P. parvus*. However, the specimens of *P. parvus* have a deeper articulation with the sternum, and the internal angle of the sternal facet does not extend so far medially as it does in specimen 49578 (broken off in 49582). Also the glenoid facet of *P. parvus* is larger than in the

TABLE 2  
MEASUREMENTS (IN MM) OF *Aechmophorus occidentalis* AND *A. elasson*

	n	Humerus									Ulna		
		Breadth distal end			Breadth shaft			Depth shaft			Overall length		
		Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.
<i>occidentalis</i> ♂ ♂	4	11.6	11.9	12.2	6.0	6.4	6.8	4.8	4.9	5.0	109.9	111.1	112.1
<i>occidentalis</i> ♀ ♀	5	10.5	10.8	11.0	5.5	5.8	6.0	4.5	4.7	4.9	101.0	103.4	106.4
<i>elasson</i> 45316			10.5			5.8			4.3			93.9	
<i>elasson</i> 48914			—			—			—			91.3+	

Idaho specimens, and the furcular facet is more broad and the coraco-humeral surface is less broad in *P. parvus* than in specimen 49582 (these surfaces are missing in specimen 49578). The other two coracoids (52388 and 52587) are similar to the larger specimen.

The large grebe from the San Diego formation of California (Howard, 1949; Miller and Bowman, 1958), formerly assigned to *P. parvus* and now considered to be a different, as yet unnamed, species (Howard, 1963), has a humerus much smaller than that of *A. elasson* (compare measurements in table 2 with those given by Howard (1949): breadth of distal end, 8.8 mm; breadth of shaft, 4.2 mm; depth of shaft, 3.7 mm).

### ***Podilymbus majusculus*, new species**

(Figure 2)

*Type.* An almost complete tarsometatarsus (UMMP 52470), collected by Claude W. Hibbard and party in the summer of 1965.

*Horizon and locality.* Upper Pliocene, Glens Ferry formation. SW  $\frac{1}{4}$ , SW  $\frac{1}{4}$ , sec. 33, T7S, R13E; elevation, 3050 feet; Twin Falls County, Idaho.

*Diagnosis.* The tarsometatarsus resembles those of *Podilymbus podiceps*, but differs in size, being larger (table 3). It differs from *Podilymbus gigas* in being more slender in width, especially in the width of the proximal end of the shaft, as well as in being longer (table 3).

*Referred material.* Hagerman specimens definitely referred to *P. majusculus* are a femur (UMMP 52455) that lacks only the proximal end and that is larger than any *P. podiceps* (table 3) and the anterior portion of a sternum (UMMP 45277) that is slightly larger than the largest sternum in a sample of 20 male *P. podiceps* in the UMMZ collection. Tentatively referred to *P. majusculus* are a complete ulna (UMMP 52536), an almost complete femur (UMMP 52300), the distal portion of another femur (UMMP 49496), the proximal portion of a third femur (UMMP 52383), and a nearly complete, but badly worn tarsometatarsus (UMMP 53703), all of which are within the size range of male *P. podiceps* (table 3). Also referred to *P. majusculus* is an almost complete scapula (UMMP 52672), which also is within the size range of male *P. podiceps*. While it is possible that these smaller specimens represent *P. podiceps*, I think it is more likely that they represent female *P. majusculus*, while the large specimens represent males, especially because specimens of the size of female *P. podiceps* have not been found. The ratio of the length of the "male" *majusculus* tarsometatarsus (52470) to the "female" (53703) is 1.14, and the ratio of the mean lengths of tarsometatarsi of male and female *P. podiceps* is 1.11.

Also referable to *P. majusculus* is a quadrate (UMMP 33912) that Brodkorb (1958) reported as representing a species in an undescribed genus, although he recognized it to be nearest *Podilymbus*. Among 40 specimens of *P. podiceps* that I examined there were three that had the medial side deeply excavated, and one specimen (UMMZ 151327) almost matches the fossil. To my eye, the base of the orbital process does not appear proportionately wider than in *P. podiceps*. The quadrate is larger than those of *P. podiceps* and probably represents a male *majusculus*.

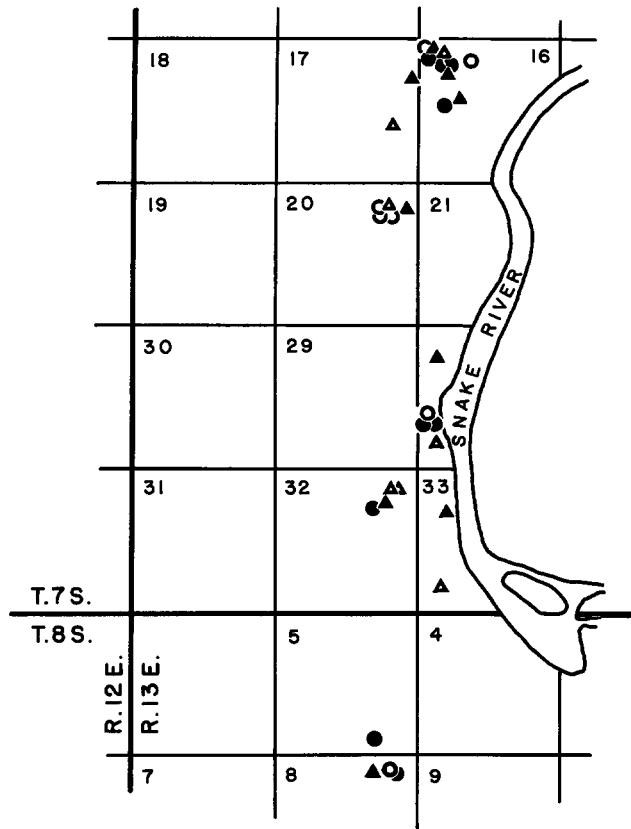


Figure 3. Distribution of fossil grebes in Twin Falls County, Idaho. *Podilymbus baryosteus* is represented by an open circle, *Podiceps discors* by a solid circle, *Aechmophorus elasson* by a solid triangle, and *Podilymbus majusculus* by an open triangle. Three other Idaho specimens come from Owyhee County. *Podilymbus majusculus* (UMMP 52672) was found in SE  $\frac{1}{4}$ , sec. 1, T6S, R8E, while *P. majusculus* (UMMP 52536) and an *Aechmophorus elasson* (UMMP 52538) were found in N  $\frac{1}{2}$ , sec. 7, T7S, R7E.

*Rexroad local fauna.* The distal end of a tibiotarsus (UMMP 31716) from the Wendell Fox Pasture locality is similar in size and shape to male *P. podiceps*, and it is tentatively referred to *majusculus*.

*Saw Rock Canyon local fauna.* The distal end of a right tibiotarsus (UMMP 51846) is within the range of variation of male specimens of *P. podiceps*, except that the arc formed by the rim of the internal condyle and the shaft has a slightly greater diameter than in *podiceps*. It is tentatively referred to *majusculus*.

*Remarks.* The tarsometatarsi of *Podilymbus magnus*, described by Shufeldt (1913) from the Pleistocene of Oregon, do not exceed in length the longest tarsometatarsus of *P. podiceps* (the one measurement given by Shufeldt is 44 mm), and Wetmore (1937b) has synonymized *magnus* with *podiceps*.

#### UNIDENTIFIED MATERIAL

A small group of specimens may represent another species of *Podiceps*. The following specimens are slightly larger than *Podiceps dominicus* and smaller than



TABLE 3  
MEASUREMENTS (IN MM) OF *Podilymbus podiceps*, *P. gigas*, AND *P. majusculus*

Tarsometatarsus													
	n	Overall length			Greatest breadth head			Least breadth shaft			Greatest breadth trochleae		
		Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.
<i>podiceps</i> ♂ ♂	23	39.8	41.9	44.3	7.8	8.3	8.8	3.0	3.4	3.7	6.5	6.9	7.5
<i>podiceps</i> ♀ ♀	16	35.5	37.6	39.1	7.2	7.5	8.1	2.6	3.0	3.2	5.7	6.2	6.7
<i>gigas</i> ♂	1		45.1			10.1			4.0			8.3	
<i>gigas</i> ♀ ♀	3	43.4	43.6 <sup>a</sup>	44.6	8.8	8.8 <sup>a</sup>	9.1	3.5	3.6 <sup>a</sup>	3.7	7.5	7.6 <sup>a</sup>	7.6
<i>majusculus</i> 52470			48.1			9.0			3.5			7.7	
<i>majusculus</i> 53703			41.9			8.2			3.3			—	

Femur													
	n	Overall length			Greatest proximal breadth			Least breadth shaft			Greatest distal breadth		
		Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.
<i>podiceps</i> ♂ ♂	23	39.1	40.8	42.7	9.1	9.5	10.2	3.2	3.6	4.0	9.1	9.5	10.5
<i>podiceps</i> ♀ ♀	16	35.3	36.8	39.2	8.0	8.4	9.5	3.0	3.2	3.4	7.8	8.5	9.9
<i>gigas</i> ♂	1		46.3			10.5			4.5			11.3	
<i>gigas</i> ♀ ♀	3	42.9	43.9 <sup>a</sup>	44.1	9.4	9.8 <sup>a</sup>	10.4	4.0	4.0 <sup>a</sup>	4.1	10.1	10.2 <sup>a</sup>	10.5
<i>majusculus</i> 52455			—			—			4.2			11.0	
<i>majusculus</i> 49496			—			—			3.3			8.7	
<i>majusculus</i> 52300			40.6			—			3.6			9.6	
<i>majusculus</i> 52383			—			9.0			3.6			—	

Ulna												
	n	Overall length										
		Min.	Mean	Max.								
<i>podiceps</i> ♂ ♂	21		69.2	72.0	76.1							
<i>podiceps</i> ♀ ♀	11		61.1	64.1	66.7							
<i>gigas</i> ♂	1			76.5								
<i>gigas</i> ♀ ♀	2		72.0		73.7							
<i>majusculus</i> 52536				71.5								

<sup>a</sup> This is actual measurement of third specimen.

*Pliolymbus baryosteus*: complete, worn femur (UMMP 52261), distal 15.3 mm of a tibiotarsus (UMMP 49592), and proximal 20.8 mm of a tarsometatarsus (UMMP 52276) from the Hagerman local fauna; the distal 10.4 mm of a tibiotarsus (UMMP 51848) from Wendell Fox Pasture of the Rexroad local fauna; and the proximal 14.8 mm of a tarsometatarsus (University of Kansas Museum of Vertebrate Paleontology no. 4484) from locality 3 of the Rexroad local fauna, reported by Wetmore (1944). The femur is like that of *Podiceps discors* (UMMP 52423) in that the breadth across both proximal and distal ends is small relative to the length of the shaft. The shafts of the tarsometatarsi are compressed, quite unlike the tarsometatarsi of *P. dominicus*. While these specimens may represent small *Pliolymbus*, I think they do not because they are characterized by a slenderness not seen in specimens of *Pliolymbus*, which include portions of a femur and a tarsometatarsus.

There remain a large number of fragments that have not been identified at this time. Those from Kansas are small, about the size of *nigricollis* or small *auritus*, whereas those from Idaho range from small to large. From the Rexroad local fauna of Kansas: proximal ends of two humeri (UMMP 29100 and 51845), distal ends of three humeri (UMMP 51847 (2) and 51843), distal end of an ulna (UMMP 51849), and the proximal end of a carpometacarpus (UMMP 51842). From the Hagerman local fauna: anterior portion of a sternum (UMMP 48942), distal end of a coracoid (UMMP 49928), proximal end of a humerus (UMMP 52396), distal ends of six humeri (UMMP 45286, 49547, 49622, 49651, 52517, 52997), part of a radius (UMMP 48904), proximal ends of two ulnae (UMMP 45279 and 52996), distal end of an ulna (UMMP 52285), proximal end of a femur (UMMP 52254), distal end of a femur (UMMP 52465), large portion of a worn tibiotarsus (UMMP 52545), distal tip of a tibiotarsus (UMMP 52995), distal ends of five tarsometatarsi (UMMP 48872, 49584, 49632, 50301, 52420), and two cervical vertebrae (UMMP 49579 and 52527).

#### DISCUSSION

Evidence is presented in this report for the existence of at least four species of grebes in western North America in the late Pliocene: *Pliolymbus baryosteus*, *Podiceps discors*, *Aechmophorus elasson*, and *Podilymbus majusculus*. Because the San Diego formation of California is younger than Middle Pliocene and may include the Pliocene-Pleistocene boundary (Allison, 1964), *Podiceps subparvus* (Miller and Bowman, 1958) and a larger, unnamed *Podiceps* (Howard, 1963) may be contemporaneous with the species from Idaho and Kansas. In addition, there probably existed a smaller, unnamed *Podiceps* in Idaho and Kansas (Wetmore, 1944; and additional material reported in this paper). However, fossils from Hagerman thought to be a species of an undescribed genus, reported by both Wetmore (1933) and Brodkorb (1958), probably represent species now known from the Hagerman local fauna. Brodkorb's is referable to *Podilymbus majusculus* (see species account), and Wetmore's seems to me to be an aberrant *Podilymbus*.

Because no modern species of grebe is known certainly to exist before the Pleistocene and because the late Pliocene grebe fauna is now known to be different from and as diverse as the modern grebe fauna, modern grebes probably first appeared sometime during the Pleistocene. Whether modern forms are only modifications of lines existing in the Pliocene or the result of divergences (especially in *Podiceps*) in the Pleistocene remains to be determined. If *Aechmophorus elasson* is ancestral to *A. occidentalis*, then it is interesting that a change occurred in the Pleistocene in the direction of evolution of body size in the line from the relatively small *elasson* to the large *A. occidentalis lucasi* (Howard, 1946) and, later, to the intermediate *A. o. occidentalis*. On the other hand, if *Podilymbus majusculus* is ancestral to *P. podiceps*, the trend has been toward decreasing size, because the Pleistocene *Podilymbus (magnus)* of Shufeldt, 1913) was, if different, larger than modern *Podilymbus* (Brodkorb, 1963a). The course of evolution in *Podiceps* is more difficult to trace because more species are involved and because the fossil species have not been adequately described. Only one late Pliocene line of grebes (*Pliolymbus*) appears to have become extinct.

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