Los Angeles County Museum

CONTRIBUTIONS IN SCIENCE

Number 25 August 15, 1958

MIOCENE SULIDS of SOUTHERN CALIFORNIA

By Hildegarde Howard

Los Angeles County Museum • Exposition Park • Los Angeles 7, Calif.

CONTRIBUTIONS IN SCIENCE is a series of miscellaneous technical papers in the fields of Biology, Geology and Anthropology, published at irregular intervals by the Los Angeles County Museum. Issues are numbered separately and numbers run consecutively regardless of subject matter. Number 1 was issued January 23, 1957. The series is available to scientists and scientific institutions on an exchange basis. Copies may also be purchased at a nominal price.

MIOCENE SULIDS OF SOUTHERN CALIFORNIA

By HILDEGARDE HOWARD

Sixteen species of fossil birds of the family Sulidae are now on record. Of these, five occur in three Middle Miocene localities of southern California, as follows:

Lompoc, Santa Barbara County (Miller, 1925)
Sula willetti Miller
Morus lompocana (Miller)
Miosula media Miller

Sharktooth Hill, Kern County (Wetmore, 1930)
Morus vagabundus Wetmore

Lomita, Los Angeles County (Miller, 1935)
Sula stocktoni Miller

Since Miller's latest Miocene record (1935), a second representative of the family has been found in the Lomita deposits, and sulid specimens have been discovered at two new localities in Los Angeles County, one in the San Fernando Valley, the other in El Sereno. These new occurrences are here recorded.

SAN FERNANDO VALLEY

Two specimens of fossil Sulidae have been recovered from a site on Ventura Blvd., near Whitsett Avenue, in Studio City. The first of these was given to this museum in May, 1954, by Howard Vein. This is a single bone, which the young student brought to the Museum still embedded in the shale matrix. Upon preparation, it was found to be a partial humerus (right) of a small sulid. Except for some fragmentation at the ends, the internal side of the element is preserved; the deltoid crest, external tuberosity, distal condyles (except the entepicondyle) and external contour of the shaft are missing; the proximal contour of the head is incomplete. The pneumatic fossa and internal contour of the bicipital crest are preserved, albeit with some apparent distortion. The length of the specimen, lacking the complete contour of the head and the internal distal condyle, is 145 mm. The length of the humerus in the type of *Sula willetti* is recorded (Miller, 1925, p. 114) as 156 mm. In view of the fact that precise measurements are impossible on either specimen (in all Lompoc fossils the bone had completely disintegrated leaving only the impression), the size of the single humerus suggested allocation with S. *willetti*. However, in the hope that further material might be obtained, allocation was withheld.

A second specimen from the San Fernando Valley locality was brought to the Museum in December, 1957, by Michael and Terry Pohl, of Studio City, California. The boys had collected the fossil two years before. This specimen, consisting of wing bones, sternum and furcula, occurs in two slabs of diatomaceous shale, and is represented by mineralized and greatly fragmented bone, as well as impressions.

The ulnar side of the right humerus is exposed on one slab, and by preparation the region of the pneumatic fossa has been revealed. The contour of this area shows marked resemblance to the specimen recovered in 1954 from the same locality, and I have no hesitation in contending that the two specimens represent separate individuals of the same species.

Description of the specimen on the slabs is complicated by the fact that the humerus and ulna of the left side are shorter than those of the right, and the shaft of the left humerus appears more curved. The right and left carpometacarpi, on the other hand, agree in length. As they are lying in place adjacent to the two ulnae, it is strongly suggested that the right and left wing bones represent the same individual. It is important, however, to determine which bones may be considered normal for the species. The humeri are in slightly different positions in the matrix; the right is tipped slightly toward the internal side, the left is lying with the ulnar surface straight down on one slab. This latter (left humerus) may be slightly warped. The ulnae do not appear to differ in their positions in the slab, but the left one is overlain by the left coracoid and scapula, and is broken where the bones cross; telescoping may have occurred at this point. There is nothing to suggest any abnormality in length or shape of the right humerus and ulna, and as the exposed proximal area of the humerus of this side so closely resembles the humerus collected in 1954, it is considered likely that the bones of the right side represent normalcy.

There are sufficient skeletal parts represented on these slabs to afford satisfactory comparison with the type of *Sula willetti*, and on the basis of a number of characters the two show specific distinction. Comparison with other Tertiary sulids also shows differences, to be pointed out below, that mark the Pohl skeleton as a species new to science.

Sula pohli, new species

(Figs. 1-2)

Type.—L.A. Co. Mus. no. 2674. Bones of right and left wing and wing girdle (proximal end of ulnar side of right humerus exposed by preparation), sternum and furcula exposed on slab of diatomaceous

shale. Collected, 1955, by Michael and Terry Pohl for whom the species is named.

Locality and Age.—L.A. Co. Mus. Vert. Paleon. loc. no. 1229, Ventura Blvd. between Whitsett Ave. and Coldwater Canyon Road, Studio City, California; Middle Miocene.

Diagnosis.—Ulna longer than humerus; humerus with distal contour relatively straight, bicipital crest deeply indented in outer contour, pneumatic fossa narrowly triangular, and ulnar surface near proximal end angular and sloping from median line towards bicipital and pectoral crests; coracoid relatively short from sternocoracoidal process to head; sternum with short, deep carina.

Cotype.—Pohl Mus. no. PV 68, reverse of type slab with same skeletal elements present; left coracoid exposed by preparation.

Referred material.—L.A. Co. Mus. no. 2532, single right humerus recovered by Howard R. Vein, 1954, from type locality.

Comparisons with Recent sulids.—Similar to *Sula* as contrasted with *Morus* as follows: ulna noticeably longer than humerus; coracoid relatively narrow and short from procoracoid to head; humerus angular between pectoral and bicipital crests on ulnar surface near proximal end. Distinguished from available specimens of Recent *Sula leucogaster, S. dactylatra, S. nebouxi,* and *S. sula* as follows: humerus with outer contour of bicipital crest more markedly indented below median crest, pneumatic fossa narrower and more angular, ligamental furrow (palmar side as seen in referred specimen no. 2532) broader and more deeply incised, condyles and epicondyles of more nearly equal distal development, giving distal contour a straight, square appearance; sternum with carina shorter and deeper, closest to *Sula sula websteri;* coracoid longer relative to length of sternum and humerus, and its posterior sternal facet (as seen in left coracoid on reverse slab) relatively deeper.

Comparisons with fossil sulids.—Of the sixteen fossil sulids heretofore known, four are represented by partial skeletal impressions in shale; the others are known only from disassociated, usually incomplete single elements. Comparisons are difficult to make; the single elements reveal characters in some detail, whereas the skeletal impressions show proportions, but very little detail. However, by use of Recent species as a means of cross reference, it has been possible to determine that the new species is indeed distinct from those previously described.

Basing the possible size range of *Sula pohli* on specimens of Recent *Sula leucogaster brewsteri* in the collections of the Los Angeles County Museum (see Tables I and III), seven of the other fossil species exceed

Fig. 1. *Sula pohli*, new species. Type specimen. Approx. x ½.

Fig. 2. *Sula pohli*, new species. Cotype (reverse of type). Approx. x ½.

in size the maximum that could be expected for *S. pohli.* These are, *Sula stocktoni* Miller, *Morus lompocana* (Miller) and *Miosula media* Miller from the California Miocene; *Miosula recentior* Howard from the California Pliocene; *Morus reyanus* Howard from the California Pleistocene; and *Sula arvernensis* Milne-Edwards and *Sula ronzoni* (Gervais) from the European Oligocene. On the other hand, *Sula pygmaea* Milne-Edwards from the European Miocene is smaller than *S. pohli.* The new species could be included in the size range of any of the remaining eight species. It is, however, distinguishable in each case on the basis of other characters, as outlined below.

Compared with the California Miocene *Sula willetti* Miller, (1925) known from practically complete skeletal impressions, the coracoid is actually, as well as relatively, longer, and the distance from procoracoid to head of coracoid is shorter as observed in comparison with a reverse cast of the type of *S. willetti* (see Table II); the ulna is longer relative to humerus (see Table I). The longer ulna is characteristic of all specimens of Recent *Sula* at hand, but, with the exception of *S. pohli*, the other (four) Miocene sulids, in which proportions of wing skeleton can be observed, have a short ulna as found in Recent *Morus.*

Compared with *Sula avita* Wetmore (1938) of the Miocene of Maryland, known from the distal end of humerus (type) and the carpometacarpus (referred), the process of metacarpal I of the carpometacarpus is straighter and is situated farther from the proximal trochlea. In these characters *S. pohli* is closer than *S. avita* to Recent specimens of *Sula.* It should be noted that Wetmore (op.cit., p. 25) erected a separate subgenus for *Sula* (*Microsula*) *avita* on the basis of still other characters.

Compared with *Sula guano* Brodkorb (1955) and *Morus peninsularis* Brodkorb (1955) from the Florida Miocene, described from coracoids, the coracoid is narrower both across the head and at the level of the scapular facet, and relatively shorter from the procoracoid to the head. *S. pohli* resembles Recent *Sula* in these proportions, whereas the Florida species agree more closely with *Morus* (see Table II).

Compared with *Sula phosphata* Brodkorb (1955), also from the Florida Miocene, and described from an incomplete coracoid, the internal sternal facet of the coracoid is longer although all other measurements of the element are less.

Compared with *Morus loxostylus* (Cope) of the Miocene of Maryland and New Jersey, known from two coracoids (the type and a referred specimen) and the distal end of a humerus (referred), the posterior sternal articulation of the coracoid is evenly rounded, rather

TABLE I

Measurements (in millimeters) of Wing Elements of Sulids

	Sula pohli		S. willetti	Sula I. brewsteri	
	Right	Left	Type	L.A.M. no. 1349	L.A.M. no. 1352
Humerus					
Length	150.5	145.0	156.0	147.2	166.0
Breadth prox. end	22.1	22.1	———	20.0	24.0
Breadth dist. end	17.3	17.9	———	15.5	18.2
Ulna					
Length (greatest)	170.0	148.5	147.0	159.0	177.0
Carpometacarpus					
Length	69.3	69.3	70.0	70.5	77.3
Phalanges of Manus					
Length D2, P1	32.5	———	37.0	32.4	37.3
Length D2, P2	31.5*ap.*	———	23.0	32.3	37.1

TABLE II

Measurements (in millimeters) and Proportions (in per cent) of Sulid Coracoids

	S. pohli	S. willetti	S. guano[1]	M. peninsularis[1]	Average ratios, living sulids[2] Morus	Sula
a. Length along axial border	55.0	45.0	50.0	54.0-55.6		
b. Breadth of head	11.4		13.4	14.2		
c. Breadth at scapular facet	13.7		14.7	17.0-17.7		
d. Height from head to procoracoid	19.1*ap.*	17.0*ap.*	21.0	25.0-25.1		
Ratio of b to a	20.7		26.8	25.5-26.3	26.7	22.9
Ratio of c to a	24.8		29.4	30.5-32.7	30.8	26.1
Ratio of d to a	34.7	37.7*ap.*	42.0	45.0-46.4	42.9	38.6

[1]Ratios calculated from measurements given by Brodkorb (1955, p. 13, Table 4).
[2]From Howard, 1936, p. 213.

TABLE III

Measurements (in millimeters) and Proportions (in per cent) of Sulid Sterna

	Sula pohli	Sula websteri L.A.M. no. 1339	Sula I. brewsteri L.A.M. no. 1349	L.A.M. no. 1352
a. Greatest length, carina to xiphius	94.3	110.0	95.0	114.0
b. Sternocoracoidal process to xiphius	57.0	63.3	51.0	62.3
c. Sternocoracoidal process to anterior edge of manubrium	26.0	32.0	27.0	32.0
d. Depth of carina through manubrium	28.7	33.5	26.0	31.1
Ratio of c to b	45.6*	50.7	52.9	51.3
Ratio of d to a	30.4	30.4	27.3	27.2
Ratio of d to c	110.4	104.9	96.3	97.1

*The minimum ratio among Recent specimens available is found in **Sula nebouxi** (43.8 per cent).

than wide at the median end and contracting abruptly to one-half the width as described for *Morus loxostylus* (Cope, 1871, p. 236). Both coracoid and humerus of *M. loxostylus* are said to be characteristic of the genus *Morus* (Wetmore, 1926, p. 466), whereas other skeletal characters of *S. pohli* relate the new species to *Sula*.

Also on the basis of generic allocation, *S. pohli* is distinguished from *Morus vagabundus* Wetmore of the California Miocene. The latter species is described from a distal end of a humerus, and the characters noted are not visible in the specimen of *S. pohli*. Wetmore (1930, pp. 90-91), however, states that *M. vagabundus* resembles *M. loxostylus* and is clearly of the genus *Morus*. It is significant to note that in this original description of *M. vagabundus*, size is noted as the sole distinction from *M. loxostylus* (breadth of distal end, *M. vagabundus*, 18.3 mm.; *M. loxostylus*, 21.1 mm.). In view of the size range now noted for the living *S. leucogaster brewsteri* (Table I), it is possible that the relationship between *M. vagabundus* and *M. loxostylus* should be reviewed.

Compared with the type of *Sula humeralis* Miller and Bowman (1958) from the California Pliocene (a distal half of a humerus), the entepicondyle is more prominent laterally and more extended proximally, but the condyles are less developed, so that the distal contour is straighter.

LOMITA

Shortly after Miller's description of *Sula stocktoni* (1935) from the Lomita diatomite, the superintendent of the dacelite company at that site presented him with another, smaller specimen of sulid in two slabs of diatomaceous shale. Miller tentatively identified the skeleton as *Sula willetti* but did not record the specimen. At his suggestion it is included in this report.

The specimen is number 2543 in the collections of the University of California at Los Angeles. A partial skeleton is represented on the two slabs, by obverse and reverse impressions, as follows: sternum; right and left tibiotarsi and tarsometatarsi with some pedal phalanges; and right humerus, ulna, partial radius, and carpometacarpus. The left humerus and scapula are incompletely impressed. There is no bone remaining in the impressions.

Until the discovery of *Sula pohli* in the San Fernando Valley, there would have been little doubt that the Lomita specimen could be referred to *Sula willetti*. Its general size and proportions appear to agree with the specimens from Lompoc on which the description of *S. willetti* was based. Only one measurement is strikingly different as compared

with the type of S. *willetti*, namely the length of the hind toe. This toe is shown to be only 34 per cent of the length of the tarsometatarsus in the type (Miller, 1925, p. 114), whereas in the Lomita specimen it is over 50 per cent of the tarsal length. In the referred specimen of S. *willetti* figured by Miller (op. cit., pl. 8) the hind toe appears to be longer than in the type, and the proportion to the tarsometatarsus is close to that of the Lomita specimen.

The discovery of *Sula pohli* introduces an element of doubt regarding the assignment of the Lomita skeleton to *Sula willetti*. Unfortunately the leg and foot elements are not present in the type of *Sula pohli*, and the important characters of coracoid and proportions of ulnar to humeral length that distinguish this species from *Sula willetti* cannot be accurately ascertained in the Lomita specimen. The coracoid is lacking; the ulna is broken, with the proximal quarter offset and possibly extended; the humerus is crushed and distorted. A latex cast made from the impression of the humerus shows the bone to be lying with the ulnar face of the proximal end impressed, but so twisted midway down the shaft that the external surface is impressed at the distal end. The proximal end is abnormally bent over, and there is a suggestion, also, that the shaft of the bone may be shortened where it is crushed and twisted. Therefore, although the measurements of the impressions of humerus and ulna show the ulna to be longer than the humerus, as in S. *pohli*, it is doubtful that these measurements are accurate. Two other characters of the Lomita skeleton can be compared with S. *pohli* and seem to distinguish it from that species, namely a greater length of the sternum and a more smoothly rounded contour of the ulnar face of the shaft of the humerus below the proximal head. The size of the sternum in proportion to the rest of the skeleton appears to be close to that noted in the referred specimen of S. *willetti* from Lompoc (Miller, op. cit., plate 8), but it is impossible to determine accurately the detail on the latter specimen. Details of the contour of the proximal end of the humerus are not available for S. *willetti*.

Although it is important to record the occurrence of this small sulid at the Lomita locality, it seems wise, in view of the several uncertainties involved in its identification, to refer it only tentatively at this time – to *Sula willetti*.

EL SERENO

A very large, almost complete humerus was given to the Museum in April, 1954, by Eugene Robkin and Harry Ralph Wilbur of El Sereno. The boys found the bone embedded in a chunk of matrix that had

fallen from a Miocene shale embankment on Round Drive near Chester Street, El Sereno.

The specimen (fig. 3) is strongly compressed laterally through the upper portion, and there is a marked longitudinal ridge external to the pneumatic fossa on the ulnar surface. The very heavy head extends proximally beyond the internal tuberosity. In part these characters may be distortions due to crushing, but the condition cannot be entirely abnormal. Compared with *Sula* and *Morus*, the large, extended head and the marked compression below the external tuberosity are so notably different that allocation to the sulids was at first questioned. However, the shape of the pneumatic fossa and the internal tuberosity, as well as the contour of the bicipital crest are sulid in character though markedly heavier than in *Morus bassanus*, the largest of the living sulids. The length of the specimen, lacking the distal end, is 222 mm. Another 25-30 mm. should be allowed for the distal contour, giving an estimated total length of 247-252 mm.

Compared with other Miocene sulids, the El Sereno bone unquestionably exceeds in size all but *Morus lompocana* (Miller) from Lompoc and *Sula stocktoni* Miller from Lomita. From the former it is, however, distinguished by the shape of the proximal end. The proximal contours of the humerus of *M. lompocana* are well preserved in a reverse cast of the type and show the element to be quite typical of *Morus*, with a broad, smooth ulnar surface external to the pneumatic fossa and a broad, low head. A cast of the type of *Sula stocktoni* is also at hand for comparison. Although the proximal contours of the humerus are not so well preserved as in the specimen of *M. lompocana*, a marked longitudinal ridge is evident external to the pneumatic fossa, as in the El Sereno humerus, and the head appears to extend considerably beyond the internal tuberosity, and to differ from living sulids in this respect in the same manner noted in the single humerus. Because of these structural similarities, as well as close agreement in size, the new humerus is assigned to *S. stocktoni*.

In view of the distinctive characters of the humerus, as above noted, combined with other characteristics of the skeleton remarked by Miller (1935, pp. 75-78), a new genus is hereby designated for this species, with characters defined as follows:

Paleosula, new genus

Type.—Paleosula stocktoni (Miller)

Diagnosis.—Humerus very large, both actually, and relatively with respect to length of ulna; proximal end massive, with head extended proximally beyond internal tuberosity; shaft laterally compressed below

Fig. 3. *Paleosula stocktoni* (Miller). Referred humerus from El Sereno, L.A. Co. Mus. no. 2533. Approx. x 0.8.

Note: In the photograph, the shape of the distal end of the broken shaft resembles the outline of condyles which, however, are not present.

head on external side, with strong longitudinal ridge on ulnar surface external to pneumatic fossa. Manubrium of sternum with less forward thrust than in either *Sula* or*Morus*. Distance from procoracoid to head of coracoid relatively greater than in *Sula* or *Morus*.

The characters of the proximal portion of the humerus (prominence of the head and compression of the shaft below it, externally), while distinctly different from those of *Sula* or *Morus*, are approached in *Miosula* (as observed in reverse cast of type of *Miosula media*). The latter genus might be said to be intermediate in these respects between *Sula* and *Morus* on one hand and *Paleosula* on the other. *Miosula* also appears to be intermediate between *Morus* and *Paleosula* in the matter of relative length of ulna to humerus. Due to the fact that the best preserved humerus in the type of *P. stocktoni* is broken and overlain by other bones, the exact length cannot accurately be determined. The maximum measurement of the element, lying in place, is given (Miller, 1935, p. 78, Table I) as 264 mm. In calculating the ratio of length of ulna to humerus, a lesser humeral length (presumably of the impression actually present) is used, showing that even at the minimum estimate, the humerus is far longer in proportion to the ulna, than in any living sulid. The reasoning presented (op. cit., pp. 76-77) for believing that the maximum figure is essentially accurate, is, however, sound. Therefore, the ratio of ulna to humerus should be closer to 66 per cent rather than 75 per cent as given in Miller's Table I. The ratio in *Miosula* is given as 77 per cent, in *Morus* 87-89 per cent.

The proportionate forward thrust of the manubrium of the sternum relative to the length of the lateral border is found to be only 36.4 per cent in the type of *Paleosula stocktoni* on the basis of the measurements given by Miller (op. cit., p. 78, Table I), although in the text (op. cit., p. 76) this ratio is given as 41 per cent. Even this latter figure, however, is less than that of any specimen of *Sula* or *Morus* examined (see "Ratio of c to b," Table III above).

Miller describes the coracoid of *P. stocktoni* as proportionately longer from procoracoid to head than that of *Morus bassanus*. As noted in Table II above, the coracoid of *Morus*, in turn, is longer in this region than is that of *Sula*.

SUMMARY AND CONCLUSIONS

As a result of new discoveries of specimens of fossil sulids in Miocene deposits of Los Angeles County, a new species, *Sula pohli*, is described, and a new genus, *Paleosula*, is established to contain the species formerly known as *Sula stocktoni* Miller. A new locality record is noted for

the latter form. A tentative identification of *Sula willetti* from the Lomita deposits marks the first record of this species outside its type locality of Lompoc, and the second sulid species to be recorded from the Lomita locality.

Sula pohli is the first of the California Miocene species in which the character of short humerus - long ulna, typical of present-day *Sula* as contrasted with *Morus*, has been clearly observed. *Sula willetti* has been maintained in the genus *Sula* in spite of its longer humerus because of other characters of the skeleton (see Wetmore, 1930, p. 91).

Paleosula is the second extinct genus of sulids to be established in the fossil record.

LITERATURE CITED

Brodkorb, Pierce

1955. The avifauna of the Bone Valley Formation. Florida Geol. Surv. Rep. Investigations No. 14, 57 pp., 11 pls.

Cope, E. D.

1871. Synopsis of the extinct Batrachia, Reptilia and Aves of North America. Trans. Amer. Philos. Soc., n.s., 14:1-252, pls. 1-14a, 53 figs. in text.

Howard, Hildegarde

1936. A new fossil bird locality near Playa del Rey, California, with description of a new species of sulid. Condor 38:211-214, 1 text fig.

Miller, Loye

1925. Avian remains from the Miocene of Lompoc, California. Carnegie Inst. Washington Publ. 349, pp. 107-117, 9 pls., 1 fig. in text.

1935. New bird horizons in California. Publ. Univ. California at Los Angeles Biol. Sci., 1 (5): 73-80, 2 text figs.

Miller, Loye and Robert I. Bowman

1958. Further bird remains from the San Diego Pliocene. Los Angeles Co. Mus. Contrib. Sci. No. 20, 16 pp., 5 text figs.

Wetmore, Alexander

1926. Observations on fossil birds described from the Miocene of Maryland. Auk 43(4):462-468.

1930. Fossil bird remains from the Temblor Formation near Bakersfield, California. Proc. California Acad. Sci., ser. 4, 19(8):86-93, 7 figs. in text.

1938. A Miocene booby and other records from the Calvert Formation of Maryland. Proc. U.S. Nat. Mus., 85(3030):21-25, 3 text figs.

LOS ANGELES COUNTY MUSEUM CONTRIBUTIONS
IN SCIENCE

No. 1. The Machris Brazilian Expedition. General Account, by Jean Delacour.

No. 2. The Machris Brazilian Expedition. Botany: General, by E. Yale Dawson.

No. 3. The Machris Brazilian Expedition. Botany: A New Dodder from Goiás, *Cuscuta burrellii*, by T. G. Yuncker.

No. 4. The Machris Brazilian Expedition. Botany: The Lichens, by Carroll W. Dodge.

No. 5. The Machris Brazilian Expedition. Botany: Cyanophyta, by Francis Drouet.

No. 6. The Machris Brazilian Expedition. Botany: A New Mint from Goiás, *Hyptis machrisae*, by Carl Epling.

No. 7. The Machris Brazilian Expedition. Botany: Phanerogamae, various smaller families, edited by E. Yale Dawson.

No. 8. Notes on Eastern Pacific Insular Marine Algae, by E. Yale Dawson.

No. 9. A New Species of Passerine Bird from the Miocene of California, by Hildegarde Howard.

No. 10. The Machris Brazilian Expedition. Botany: A New Columnar Cactus from Goiás, by E. Yale Dawson.

No. 11. The Machris Brazilian Expedition. Botany: Chlorophyta; Euglenophyta, by G. W. Prescott.

No. 12. The Machris Brazilian Expedition. Entomology: General; Systematics of the Notonectidae (Hemiptera), by Fred S. Truxal.

No. 13. The Machris Brazilian Expedition. Botany: Phanerogamae, Leguminosae, by Richard S. Cowan.

No. 14. The Machris Brazilian Expedition. Entomology: Gelastrocoridae (Hemiptera), by E. L. Todd.

No. 15. Marine Algae of the Pacific Costa Rican Gulfs, by E. Yale Dawson.

No. 16. A Classification of the Oscines (Aves), by Jean Delacour and Charles Vaurie.

No. 17. The Machris Brazilian Expedition. Botany: Phanerogamae, Bromeliaceae and other smaller families, by Lyman B. Smith.

No. 18. The Machris Brazilian Expedition. Botany: Musci, by Howard Crum.

No. 19. A new Race of the Pocket Gopher *Geomys bursarius* from Missouri, by Charles A. McLaughlin.

No. 20. Further Bird Remains from the San Diego Pliocene, by Loye Miller and Robert I. Bowman.

No. 21. The Machris Brazilian Expedition. Botany: Phanerogamae, Euphorbiaceae, Lentibulariaceae, Rubiaceae, by Julian A. Steyermark.

No. 22. The Machris Brazilian Expedition. Botany: Gramineae, by Jason R. Swallen.

No. 23. The Machris Brazilian Expedition. Botany. Phanerogamae, Alstroemeriaceae and other families, by Lyman B. Smith and collaborators.

No. 24 The Machris Brazilian Expedition. Botany: Fungi, by G. W. Martin and collaborators.