UNIVERSITY OF KANSAS
SCIENCE BULLETIN

UNIVERSITY OF KANSAS PUBLICATIONS

University of Kansas Science Bulletin - Vol. XXXI, Part I

May 1, 1946

Lawrence, Kansas

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PUBLICATION DATES

The actual date of publication (*i. e.*, mailing date) of many of the volumes of the University of Kansas Science Bulletin differs so markedly from the dates bourne on the covers of the publication or on the covers of the separata that it seems wise to offer a corrected list showing the mailing date. The editor has been unable to verify mailing dates earlier than 1932. Separata were issued at the same time as the whole volume.

Vol. XX—October 1, 1932.
Vol. XXI—November 27, 1934.
Vol. XXII—November 15, 1935.
Vol. XXIII—August 15, 1936.
Vol. XXIV—February 16, 1938.
Vol. XXV—July 10, 1939.
Vol. XXVI—November 27, 1940.
Vol. XXVII, Pt. I—Dec. 30, 1941.
Vol. XXVIII, Pt. I—May 15, 1942;
Pt. II—Nov. 12, 1942.
Vol. XXIX, Pt. I—July 15, 1943;
Pt. II—Oct. 15, 1943.
Vol. XXX, Pt. I—June 12, 1944.
Vol. XXX, Pt. II—June 15, 1945.

UNIVERSITY OF KANSAS

SCIENCE BULLETIN

DEVOTED TO

THE PUBLICATION OF THE RESULTS OF
RESEARCH BY MEMBERS OF THE
UNIVERSITY OF KANSAS

VOLUME XXXI, PART I
UNIVERSITY OF KANSAS PUBLICATIONS
LAWRENCE, MAY 1, 1946

PRINTED BY
FERD VOILAND, JR., STATE PRINTER
TOPEKA, KANSAS
1946
21-1586

CONTENTS OF VOLUME XXXI, PART I

THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN

VOL. XXXI, pt. I.] MAY 1, 1946 [NO. 1

List of Research Publications from the Science Departments from July 1, 1944, to June 30, 1945

Compiled by HOMER B. LATIMER

WE ARE listing the research publications of the science faculty in addition to the ten papers which are published in this number. We hope that this list will give a fairer idea of the research that is being done than the limited number of papers which can be published in this BULLETIN. A request for titles was sent to all science departments and we hope that all titles sent in are correctly published here. This list does not include any books, for this is an attempt to list only the research work which is being done here at the University of Kansas and which has been published in various national journals.

ASLING, C. W. (see Eiseley, L. C.).

BEAMER, R. H. 1945. A new species of *Dorydiella* from Kansas (Homoptera-Cicadellidae). J. Kan. Ent. Soc., 18, 48.

BEAMER, R. H. 1945. A new species of *Dikraneura* from Arizona (Homoptera-Cicadellidae). J. Kan. Ent. Soc., 18, 83-84.

BEAMER, R. H., and P. B. LAWSON. 1945. A revision of the genus *Stragania* (*Bythoscopus* of authors) in America north of Mexico (Homoptera-Cicadellidae). J. Kan. Ent. Soc., 18, 49-66.

BEAMER, R. H. (see Oman, P. W.).

BOWERS, R. A. 1945. Research in waxes. Trans. Kan. Acad. Sci., 47, 349.

BOWERS, R. A. 1945. Pharmaceuticals mentioned in the Bible. Tile and Till, 31, 18.

BOWERS, R. A. 1945. Copernicia cerifera. Pharm. Archives, 16, 8.

BOWERS, R. A. 1945. The chemotherapeutic approach to the development of new medicinals. Midwest. Druggist, 20, 21.

BREWSTER, R. Q., and ROBERT SLOCOMBE. 1945. Polarization effects in aromatic ethers. J. Am. Chem. Soc., 67, 562.

CALKINS, L. A. 1944. The second stage of labor—the descent phase. Am. J. Obst. and Gyn., 48, 798-803.

DAVIDSON, A. W. (see Sisler, H. H.).

DUDLEY, RUTH M. (see Moore, R. C.).

EISELEY, L. C., and C. W. ASLING. 1945. Extreme case of scaphocephaly. Trans. Kan. Acad. Sci., 47, 241-255.

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FRYE, J. C. 1945. Problems of Pleistocene stratigraphy in central and western Kansas. J. Geology, 53, 73-93.

FRYE, J. C. (see Elias, M. K.).

FRYE, J. C. (see Jewett, J. M.).

FRYE, J. C. (see Moore, R. C.).

FRYE, J. C. (see Swineford, Ada).

GINSBERG, A. MORRIS. 1945. Psychogenic factor in hypertension. J. Mo. Med. Assoc., 42, 24-25.

GINSBERG, A. MORRIS. 1945. Coronary artery disease. Kans. City Med. J., 21, 10-14.

GRAFFHAM, ALLEN. 1945. Notes on basalt artifacts. Trans. Kan. Acad. Sci., 47, 259-260.

GRAFFHAM, ALLEN. (see Hibbard, C. W.).

GREEN, M. 1945. Malformed skull of *Aplodonotus grunniens* refinesque. Trans. Kan. Acad. Sci., 47, 355-357.

GRIFFITH, M. E. 1945. The environment, life history and structure of the water boatman, *Ramphocorixa acuminata* (Uhler) (Hemiptera, Corixidae). Univ. Kan. Sci. Bull., 30, Pt. 2, 241-365.

HALL, E. R. 1944. A new genus of American Pliocene badger, with remarks on the relationships of badgers of the Northern Hemisphere. Carnegie Inst. Wash. Publ. 551, 9-23.

HALL, E. R. 1944. Classification of the ermines of eastern Siberia. Proc. Calif. Acad. Sci., 23, 555-560.

HALL, E. R. 1945. Chase Littlejohn, 1854-1943; observations by Littlejohn on hunting sea otters. J. Mamm., 26, 89-91.

HALL, E. R. 1945. Dental caries in wild bears. Trans. Kan. Acad. Sci., 48, 79-85.

HALL, E. R. 1945. Four new ermines from the Pacific Northwest. J. Mamm., 26, 75-85.

HAMILTON, BETTE W., and TOM HAMILTON. 1944. Pathology and bacteriology of streptococcus endocarditis in relationship to sulfonamide chemotherapy. Pt. II. Am. J. Clin. Path., 14, 502-507.

HAMILTON, TOM R., and BETTE W. HAMILTON. 1944. Pathology and bacteriology of streptococcus endocarditis in relationship to sulfonamide chemotherapy. Pt. I. Am. J. Clin. Path., 14, 495-501.

HARDY, D. E. 1944. New Asilidae and Mydaidae (Diptera) in the Snow Collection. Canad. Ent., 76, 226-230.

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HIBBARD, C. W., and L. F. PHILLIS. 1945. The occurrence of Eucastor and Epigaulus in the lower Pliocene of Trego county, Kansas. Univ. Kan. Sci. Bull., 30, Pt. 2, 549-555.

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HOFFMEISTER, D. F. 1945. Snow bunting in New Mexico. The Condor, 47, 41.

HUNGERFORD, H. B. 1944. Some Venezuelan aquatic Hemiptera. Zoölogica, 29, Pt. 3, 129.

JEWETT, J. M. 1945. Stratigraphy of the Marmaton group, Pennsylvanian, in Kansas. Kan. Geol. Survey Bull., 58, 1-148.

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LANE, H. H. 1944. Review of fossil vertebrates of Kansas. Part I, the fishes. Trans. Kan. Acad. Sci., 47, 129-176.

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LATIMER, H. B. 1944. The prenatal growth of the cat. XIV. The weight of the skeleton in the fetal and in the adult cat. Growth, 8, 149-158.

LATIMER, H. B. 1944. The prenatal growth of the cat. XV. The weight of the musculature in the fetal and in the adult cat. Growth, 8, 205-219.

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LEATHEROCK, CONSTANCE. 1944. The correlation of rocks of Simpson age in northcentral Kansas with the St. Peter sandstone and associated rocks in northwestern Missouri. Kan. Geol. Survey Bull., 60, 1-16.

LYON, L. L. (see Sisler, H. H.).

MILLER, A. K. (see Thompson, M. L.).

MOORE, R. C., and RUTH M. DUDLEY. 1944. Cheilotrypid bryozoans from Pennsylvanian and Permian rocks of the midcontinent region. Kan. Geol. Survey Bull., 52, Pt. 6, 229-408.

MOORE, R. C., et al. 1944. Correlation of the Pennsylvanian formations of North America. Geol. Soc. Am. Bull., 55, 657-706.

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OMAN, P. W., and R. H. BEAMER. 1944. Some new species of Cuerna (Homoptera-Cicadellidae). J. Kan. Ent. Soc., 17, 119-128.

ORR, T. G., and G. A. WALKER. 1945. Pancreaticoduodenectomy for primary carcinoma of the duodenum. Surg. Gynec. and Obstet., 80, 149-151.

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ROBERTS, SAM E. 1945. New sinus syndrome. Trans. Am. Acad. Ophth. Oto. Rhino. Lyg., 51, 358.

SCHOEWE, W. H. 1944. Coal resources of the Kansas City group, Thayer bed, in eastern Kansas. Kan. Geol. Survey Bull., 52, Pt. 3, 81-136.

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THOMPSON, M. L. (see Jewett, J. M.).

VANDER WERF, C. A., and H. H. SISLER. 1944. A correlation of some terms used in inorganic and organic chemistry. Trans. Kan. Acad. Sci., 47, 89-94.

VIRDEN, H. H. (see Latimer, H. B.).

WALKER, G. A. (see Orr, T. G.).

THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN
VOL. XXXI, pt. I.]   MAY 1, 1946   [No. 2

A Summary of Mexican Lizards of the Genus *Ameiva*

HOBART M. SMITH and LEONARD E. LAUFE

ABSTRACT: The eleven forms of *Ameiva* known in México are summarized with a key, diagnosis, statements of ranges, lists of localities, tabulations of variation, and discussion of intergradation and characteristics. A possible phylogeny of the races of *Ameiva undulata* is suggested.

CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

PREFACE

ANY observer of the trend of recent literature upon Ameivas would not fail to notice that interest in the Mexican forms of *Ameiva undulata* has been rising to a crescendo whose peak surely could soon be anticipated. The present summary certainly cannot claim the finality of such heights, but does add considerable new information and a number of interpretations to the growing mass of knowledge and theory regarding Mexican Ameivas.

We have attempted here to summarize briefly the previous contributions to the knowledge of Mexican *Ameiva undulata.* We have reëvaluated and recorded some of the variations of the subspecies on the basis of more specimens than any other authors have had available. Diagnoses of all the forms of *undulata* occurring in México, at least to the extent now known, are included. It has been our aim to establish more precisely than has been done before the ranges and areas of intergradation of the several forms involved. A possible course of phylogeny of all forms of *undulata* is discussed, and we present a key which may facilitate identification of Mexican specimens.

Since there is little variation in most features of scutellation of the species we have not described them in detail for all forms. For the benefit of those interested we have included a more or less complete description of one form, *A. u. dextra.* Other forms differ little from this description save in the characters receiving special note.

For the sake of completeness we have added the only other *Ameiva* of México, *A. festiva edwardsii.*

HISTORICAL SUMMARY

When *Ameiva undulata* was first described over 100 years ago, Wiegmann (1834) recognized the existence of a related form, which he called variety A. Bocourt (1874: 254-259) also recognized a variety A (by his statement the same as Wiegmann's variety A) and a variety B. Both varieties appear to belong to the race now known as *Ameiva undulata hartwegi.*

For some time no further attempt was made to distinguish the Mexican races of Mexican *Ameiva undulata.* Neither Boulenger (Catalog of Lizards) nor Günther (Biologia Centrali-Americana) recognized any variants in 1885. And in 1915 Barbour and Noble, in their monograph of *Ameiva,* still placed all Mexican specimens in *Ameiva undulata undulata.* They recognized two Central American races, one of which (*u. parva*) has since been recorded in México, while the other *u. quadrilineata*, is now known by the earlier name of *u. pulchra*. In 1934 Stuart tentatively (and incorrectly) allocated the name *A. u. parva* with specimens from the Petén área of Guatemala, although in 1935 he reverted to "*Ameiva undulata*" for them. Not until 1937 was there a further advance toward the understanding of Mexican races. In that year (1) Hartweg and Oliver cited the need for revision, and stated that specimens from the Yucatán and Petén areas are different from Tehuantepec specimens; and (2) Smith recognized an "*Ameiva undulata parva*" from Yucatán and an "*Ameiva undulata undulata*" from Campeche and Veracruz. Smith's allocation of both names was incorrect; in reality neither of his races possessed a name at that time.

In 1940 Smith corrected his previous erroneous allocation of the name *parva*, proposing *A. u. hartwegi* for the race; restricted the type locality of *undulata* to Tehuantepec, and named as *A. u. stuarti* the Campeche form which he had previously called *A. u. undulata*. Thus at that time three forms of *Ameiva undulata* were known in México. Dunn, later in the same year, hesitated to segregate races of *Ameiva undulata* either in México or in Central America, holding his decisions in abeyance for the appearance of Stuart's summary. In the following year, 1941, Schmidt and Stuart commented further upon the races of *Ameiva undulata*, accepting the races proposed previously, correctly allocating the name *u. parva* for the first time with the Pacific coast race ranging from the Isthmus of Tehuantepec to Guatemala, and pointing out the proper use of the name *u. pulchra* for the race Barbour and Noble had called *u. quadrilineata*.

Stuart's review of the entire *unduluta* group of *Ameiva* appeared in 1942. In it he recognized four Mexican subspecies of *undulata*. He regarded the Pacific coast material from west of Tehuantepec as probably distinct from typical *u. undulata*, but refrained from defining it. His discussion of diagnostic characters, variation and phylogeny of the group is the only attempt that has been made along such lines.

MATERIALS

The present study is based chiefly upon the Mexican specimens of *Ameiva undulata* in the Walter Rathbone Bacon collection secured by Smith from 1938 to 1940; in the E. H. Taylor-H. M. Smith collection; in the collection of the Museum of Zoölogy of the University of Michigan (part only); and in the U. S. National Museum collection (part only). These collections are indicated by the abbreviations HMS (uncatalogued specimens only; all Bacon specimens are on deposit at the U. S. National Museum and those entered in the permanent collection of that institution bear regular USNM numbers), EHT-HMS, UMMZ and USNM, respectively. The entire series includes some 875 specimens, and according to our interpretations represents 10 forms.

The material examined of *A. festiva edwardsii* includes some 50 specimens in the Bacon collection. No other Mexican specimens have been recorded in other U. S. collections.

CHARACTERS

As Stuart (1942: 146) has emphasized, in diagnosing the forms of the *undulata* group "a number of characters prove useful but few are infallible and, for the most part, they can be applied only to populations rather than to individuals."

PRIMARY CHARACTERS

There are a few characters which almost all students who have dealt critically with this group have realized are of primary significance. These are: (1) size and arrangement of the median gular scales, (2) arrangement of the preanals, and (3) separation of the third supraocular from the median head scales and, by two rows of granules, from the superciliary scales.

Gulars. The median gulars may be small and irregular, merging gradually with adjacent scales (Fig. 1C), abruptly enlarged and irregular (Fig. 1D), or abruptly enlarged and arranged in a single longitudinal row (Fig. 1B). Between these extremes variations do occur, although the usual condition in any one race as a whole places that race rather definitely in one of these groups. As one example of intermediate type, we may cite the occurrence of occasional specimens of *u. gaigeae* which have the central gulars aligned in a single row much as in Fig. 1B, although they are usually irregular as shown in Fig. 1C. In *u. podarga* two or three scales may be aligned at times, instead of all being irregular.

Preanals. The preanals are paired in most races (as in Fig. 2A), but in one (*u. undulata*) there is a single median row and on each side a smaller row (Fig. 2B). A specimen in which the former condition exists is said to have two rows of preanals, while those like *u. undulata* are said to have one row. In *u. sinistra* occasionally, and in *u. dextra* usually, the posterior preanal is paired as in Fig. 2C. In these latter two races the preanals are otherwise arranged in a single row.

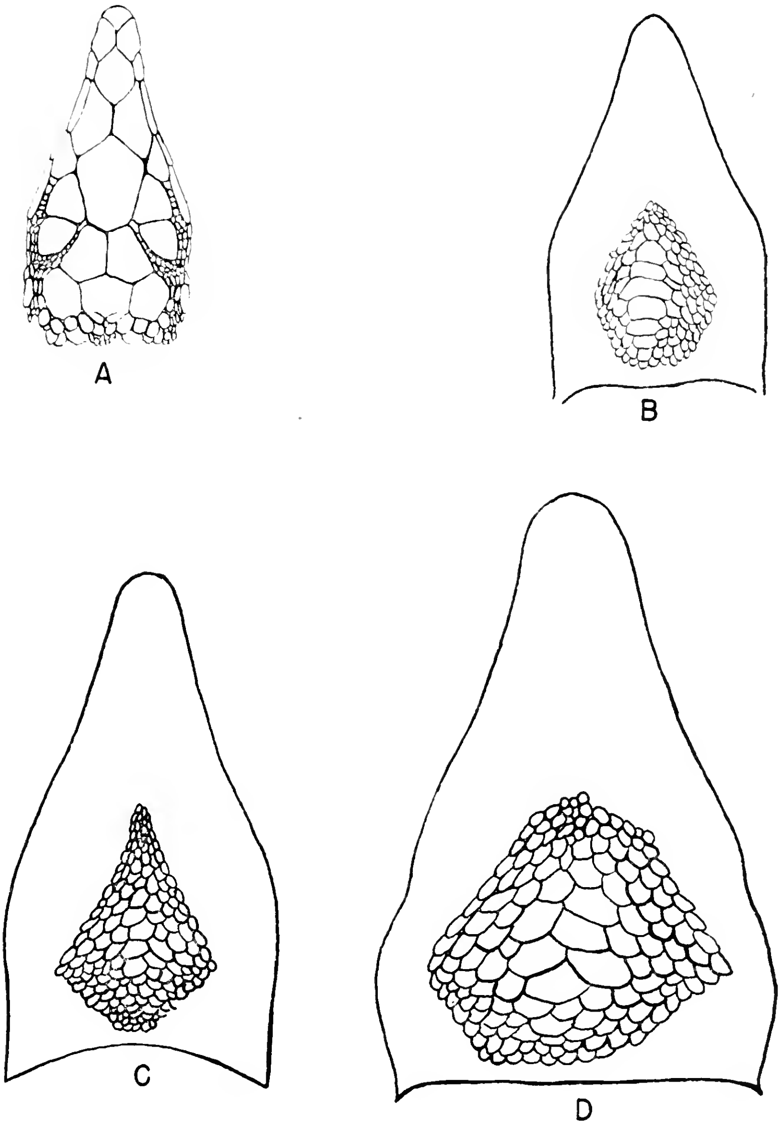


FIG. 1. A. Dorsal view of head scales of *A. u. parva*, HMS No. 14256, La Esperanza, Chiapas.
B. Gulars of *A. u. stuarti*, EHT-HMS No. 11952, San Ricardo, Chiapas.
C. Gulars of *A. u. gaigeae*, EHT-HMS No. 11927, Progreso, Yucatán.
D. Gulars of *A. u. podarga*, HMS No. 1597, Huichihuayán, San Luis Potosí.

Supraocular scales. In only one race, *u. parva,* the posterior supraocular is usually separated completely from the frontal and frontoparietal by a row of small scales. The same supraocular is likewise separated from the superciliaries by, usually, two rows of granules instead of a single row as in other races. In other forms the row of small scales between the supraocular and median head scales is short, allowing contact of the frontal or frontoparietal (or both) with the supraocular. These features in *u. parva* are illustrated in Fig. 1A.

SECONDARY CHARACTERS

Of secondary or racial significance are (1) pattern characters of varying types, including particularly the dorsal spotting and the nature of the dorsolateral and lateral dark and light spots, stripes and bars; (2) the number of lamellae under the fourth toe; (3) the number of femoral pores; (4) the exact character of the gulars (number of enlarged scales, regularity); (5) the size of the lateral gulars; and (6) the exact character of the preanals (whether one or more is split, and number of rows).

We have been unable to find other characters that are variable intersubspecifically and are not at the same time nearly equally variable intrasubspecifically. Some of these, in fact—the number of femoral pores and lamellae—Stuart (1942: 47) regards as of no diagnostic value whatever. As illustrated by the several tables included herewith, we believe them to be of considerable value in some cases. For example, in *A. u. stuarti* only one of the 72 lamellar counts is over 28, while all those (97) of the adjacent race *A. u. hartwegi* are 29 or over.

Our methods of treating data on the six secondary characters listed above are explained consecutively in the following.

Pattern. A number of forms typically possess numerous, irregular, dark spots on the back, arranged more or less in two rows. Others lack spots completely or else have very small ones. There is some variation intrasubspecifically, but in most forms it is not great. This character is particularly useful in distinguishing *u. dextra* from the two adjacent forms, *u. sinistra* and *u. undulata.*

Of greatest significance so far as pattern is concerned, however, is the nature of the dorsolateral and lateral pattern. Light and dark stripes, transverse bars and spots are the chief components. Some forms appear rather distinctly striped, others barred, and combinations of both types of pattern with neither particularly prominent is common. As Stuart (1942: 147) has pointed out, ontogenetic changes and sexual dimorphism in pattern occur in most forms. Juveniles of both sexes and all females tend to have a more linear pattern than adult and subadult males, which tend to stress the barred elements of the pattern. Adult males are more brightly marked than other specimens.

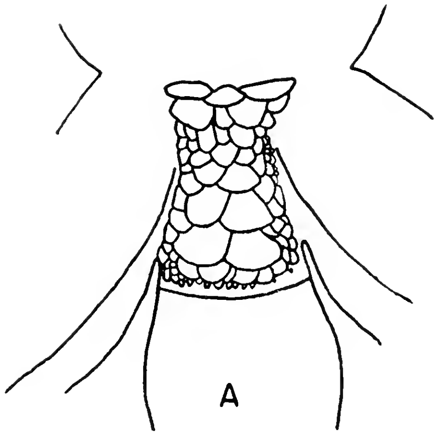
The most primitive patterns apparently are those in which stripes predominate, as in *u. stuarti*. Fig. 2D is a diagram of the stripes that may occur in *undulata*. Dorsolateral light stripes (D) are typical and are distinct in the young if not in the adult, or the position of the stripe is clearly evident where the adjacent dark upper lateral stripe (C) meets the broad, light middorsal area. In *u. stuarti* only, a distinct dorsolateral dark stripe (E) borders the dorsolateral light stripe medially; in all other forms the medial border of the latter is formed by the light middorsal area, which obviously meets the upper lateral dark stripe in case the dorsolateral light lines are poorly developed or absent. In *u. amphigramma* a light line develops in the middle of the upper lateral dark line; this we call the upper lateral light line (F). In several forms (particularly *u. podarga*, *u. dextra*, *u. sinistra*, and *u. thomasi*) the upper lateral light line is represented by large spots, which either remain isolated in the dark stripe (as in *u. podarga et al.*) or fuse with the dorsolateral light stripe (as in *u. thomasi*).

A lateral light stripe (B) is of general occurrence, but is usually broken into short lines or into spots. Frequently in adult males it is not evident, being either fused with transverse lines or completely absent.

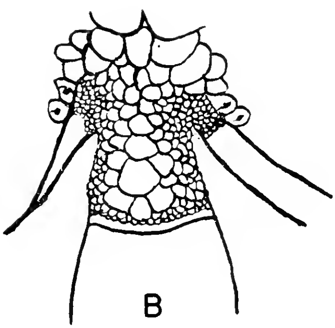
A broad lateral dark zone (A) borders the lateral light line ventrally. It is frequently marked with irregular light spots which tend to be elongate or oval and oriented transversely. Enlargement of these irregular light spots results in a fusion with the lateral light line (or parts thereof) and sometimes with the upper lateral light spots. Specimens in which such a fusion has occurred have irregular transverse light bars on the sides, producing a "tigroid" pattern. The width of the dark interspaces varies considerably, but is, within rather generous extremes, fairly constant for any one form. The narrower the dark bars, the more striking the tigroid effect becomes.

Lamellae. We have counted only the lamellae under the 4th toe, although differences in the lamellar counts of other digits are probably equally significant.

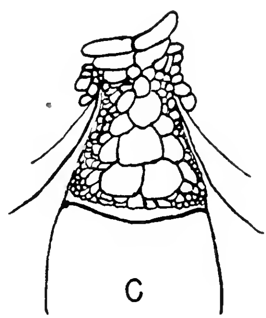
The lamellae on the three basal phalanges of the 4th toe are divided, and differ in number on the two sides. Those on the anterior surface (toward the third toe) are larger and apparently more con-



A



B



C

D

FIG. 2. A. Preanals of *A. u. podarga,* HMS No. 1597, Huichihuayán, San Luis Potosí.
B. Preanals of *A. u. undulata,* HMS No. 18543, Tehuantepec, Oaxaca.
C. Preanals of *A. u. dextra,* EHT-HMS No. 11682, Acapulco, Guerrero.
D. Diagrammatic scheme of dorsal and lateral pattern of *A. undulata.*
A. Lateral dark line.
B. Lateral light line.
C. Upper lateral dark line.
D. Dorsolateral light line.
E. Dorsolateral dark line.
F. Upper lateral light line.

stant than those in the posterior row. For that reason our counts were made along the preaxial border of the digit.

Fortunately it has been possible to mark an exact basal point from which the counts begin. A relatively large, single tubercle is present at the base of the 1st phalanx, immediately preceding the paired lamellae. Our counts begin with that tubercle as No. 1. Occasionally a single small tubercle precedes it, instead of paired scales; in such cases the count still begins with the larger, proximal tubercle.

The total range of variation in lamellar counts of Mexican *undulata* is from 22 to 36, the minimum occurring in *u. stuarti,* the maximum in *u. hartwegi* and *u. gaigeae.* The maximum range in any one form is 11 (*u. gaigeae,* 26-36), the minimum 7 in forms represented by a reasonable number of counts (*u. sinistra*),* the average 9, excluding doubtfully complete series (*u. stuart* 9, *u. amphigramma* 10, *u. parva* 8, *u. hartwegi* 8).

TABLE 1. Racial Variation in Lamellae and Pores

RACE.	Lamellae.			Pores.		
	Counts.	Range.	Average.	Counts.	Range.	Average.
stuarti	72	22-30	25.5	73	13-18	15.5
podarga	30	28-31	29.4	31	13-18	15.8
amphigramma	187	24-33	27.7	180	14-23	17.0
thomasi	17	25-30	28.4	18	14-20	17.2
parva	97	26-33	29.1	98	13-21	16.4
dextra	20	27-31	28.9	24	15-21	18.2
sinistra	111	26-32	29.6	121	15-22	18.1
undulata	94‡	25-30	27.7	162†	13-20	16.8
hartwegi	97	29-36	31.8	100	16-23	20.5
gaigeae	132	26-36	30.4	138	15-22	18.5

‡ All from Hartweg and Oliver, 1937: 7.

† Of these 94 counts are from Hartweg and Oliver, 1937: 7.

* Unreliable are *u. podarga* (31 counts, range 4), *u. thomasi* (17 counts, range 6), and *u. dextra* (20 counts, range 5).

The lowest average number of lamellae is 25.5 (*u. stuarti*), the highest 31.8 (*u. hartwegi*). For all races the mean average is 29.

Femoral pores. The number of pores has been found useful in the diagnosis of most of the races of *undulata,* separating almost all from at least one close relative. The most useful comparisons have been possible between *u. stuarti, u. hartwegi* and *u. gaigeae.* In other forms average differences may occur, but they do not always reach a minimum of seventy percent reliability desirable for a useful character. In some cases we have found it desirable to compare the total pore counts rather than those on one thigh only.

The total range of variation in Mexican *undulata* pore counts is 11, the actual counts varying between 13 and 23. The minimum number occurs in *u. stuarti, u. parva* and *u. undulata,* the maximum in *u. amphigramma* and *u. hartwegi.* The maximum range of variation in any one form is 10 (*u. amphigramma,* 14 to 23), the minimum 6 (*u. stuarti* and *u. podarga,* 13 to 18), the average 8 (*u. thomasi, u. dextra,* 7; *u. sinistra, u. undulata, u. hartwegi, u. gaigeae,* 8; *u. parva,* 9).

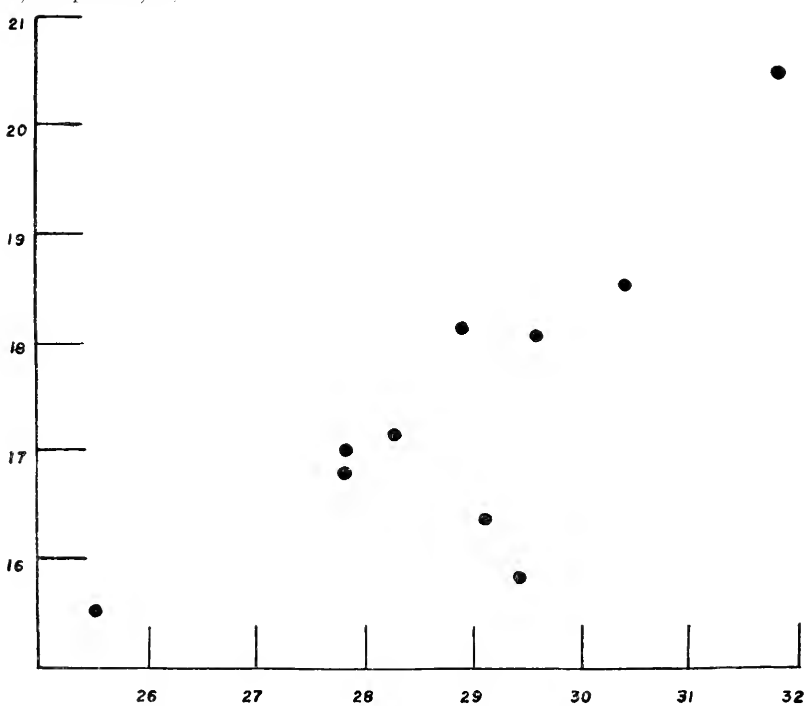


FIG. 3. Correlation in average femoral pore and lamellar counts of the races of *Ameiva undulata.* Based on Table 1. Abbreviations for subspecific names: st, *stuarti;* p, *podarga;* a, *amphigramma;* t, *thomasi;* pa, *parva;* d, *dextra;* s, *sinistra;* u, *undulata;* h, *hartwegi;* g, *gaigeae.*

The lowest average number of pores is 15.5 (*u. stuarti*), the highest 20.5 (*u. hartwegi*). For all races the mean average is 17.4.

There is a direct correlation in variation in number of pores and of lamellae at least racially; we have not attempted to determine whether there is a similar correlation individually. In general, the higher the average number of pores, the higher the average number of lamellae (Fig. 3). *A. u. parva* deviates most conspicuously from this correlation, although it is not far from the expected position. *A. u. podarga* is not represented by sufficient counts to be significant in its apparent divergence. All others are arranged closely about the line of correlation.

It is noteworthy that in average count, in maximum count and in minimum count, *u. stuarti* is the lowest and *u. hartwegi* the highest, in respect both to lamellae and pores. In other respects as well the races are the most widely differentiated of any in the species that occupy adjacent ranges.

Median gulars. We have already mentioned that the abruptness of enlargement of the median gulars is a character readily segregating *u. gaigeae* and *u. hartwegi* (not abruptly enlarged) from all other forms. The character of these scales is of still further use, however, in defining some forms. We recorded variation in two features: number of rows of central gulars, and number of regular and irregular scales.

The number of rows of gulars recorded included only those containing notably enlarged scales. In spite of the arbitrary nature of the count, marked differences definitely do occur. In *u. stuarti,* for example, a relatively large number of gulars (6 to 8) occurs; they are arranged very neatly in a median row which typically is bordered by much smaller gulars not perceptibly increasing in size medially. In most other forms there are fewer median gulars, but they are larger than in *u. stuarti* and somewhat more irregularly arranged. This difference has been used diagnostically in comparing *u. podarga, u. amphigramma* and *u. stuarti* with each other.

The regularity of arrangement of the gulars was measured by counting the number of more or less symmetrical scales (exceeding one) aligned in the midventral line. A minimum of two was recorded since even completely irregular scales might accidentally include one oriented medially.

In considering irregularity (as opposed to regularity) of the gulars some standard is necessary, since the anterior and posterior median gulars tend to be irregular and blend into the adjacent smaller gulars. We therefore selected a maximum of five gulars to be considered when counting the number of irregular scales. The five observed were the largest and most typical scales of the group. This number was selected of necessity because it was the smallest number of rows of enlarged gulars found in any of the forms compared; a larger number would have necessitated the inclusion, in some cases, of small gulars preceding or succeeding the enlarged series or group.

Lateral gulars. We have observed a marked enlargement of the lateral gulars only in *u. thomasi.* In other races the gulars are very nearly uniform throughout, except of course for the median area, but may be slightly enlarged laterally in the region of the jowls. The greater enlargement in *u. thomasi,* while clearly evident by direct comparison, is not prominent enough to be particularly useful in diagnosis.

Preanals. As stated previously, the preanals are arranged in two strikingly different ways: in a single or a pair of median rows. We have observed no variation of significance in the condition of paired median preanals, but the condition of an azygous row does show some variation of subspecific significance.

There are three races which belong in the group with azygous preanals: *u. undulata, u. dextra,* and *u. sinistra.* In *u. dextra,* however, the last large preanal is usually paired (see Fig. 2C), a condition which may well mean an incomplete transformation from the primitive paired condition. In most *u. sinistra* all are single, and in a very few *u. undulata* are any large scales paired. In other words the latter race approaches the perfect azygous arrangement, and therefore the peak of specialization along this line, more closely than any other. *A. u. sinistra* is intermediate, and *u. dextra* the least specialized.

In taking data on this character we found that there was some difficulty in determining what was to be considered the last preanal. Obviously the very small granules lining the cloaca are not to be counted, but these sometimes merge so gradually with the enlarged preanals that it is not certain just where the line of distinction should be drawn. For that reason it is well nigh impossible to compare homologous scales through large series of specimens of all the three forms involved. Moreover, in *u. undulata* the intermediate preanal-cloacal scales are frequently paired.

A moderately satisfactory solution to this dilemma was found by observing the number of rows of preanals. This was determined by following medially the row of scales in line with the femoral pores, and from their point of union counting posteriorly the number of rows of enlarged scales. The anterior point for the counts was thus relatively constant in all cases. Posteriorly, again, some doubt was entertained on the terminus of the enlarged scales. Some variation is to be expected and did occur, so that our counts of the number of preanal rows are not to be regarded absolute. It is true, however, that *u. undulata* tends to have more rows of preanals than either *u. dextra* or *u. sinistra*. Observing only the fifth preanal, if one would count five rows or more, we found that the variation introduced by the numerous terminal rows was eliminated in most cases. This procedure was particularly helpful in dealing with *u. undulata*, yielding a high percentage (89%) of single posterior preanals. We would have had a nearly equal dispersal by taking the very last enlarged scales. In *u. dextra* and *u. sinistra* the rows of preanals average fewer than in *u. undulata*, and frequently the last enlarged preanal would be in the fourth row.

Accordingly, we arbitrarily decided that the paired or single condition would be recorded for the preanals of what definitely appeared as the last row of enlarged scales if the number of rows was found to be five or less; if over five, the character of the scales of the fifth row only was recorded.

SUBSPECIFIC SECTIONS

There are four morphological sections in *undulata*, distinguished on the basis of the primary characters previously outlined. Excluding *u. pulchra*, each section occupies a distinct and continuous range, and forms a natural unit. The exceptional form, *u. pulchra*, is most closely related to *u. hartwegi* and *u. gaigeae*, but is morphologically closest to the group containing *u. stuarti*, *u. podarga*, *u. amphigramma* and *u. thomasi*. The natural, subspecific groups or their ancestral stocks have been indicated in Fig. 4 by the Roman numerals I through IV. The forms of these groups may be listed as follows:

I. *A. u. pulchra*, *u. hartwegi*, *u. gaigeae* (two rows of preanals; small gulars*).

II. *A. u. parva* (two rows of preanals; large gulars; third supraocular separated).

III. *A. u. stuarti*, *u. podarga*, *u. amphigramma*, *u. thomasi* (two rows of preanals; large gulars; third supraocular not separated).

IV. *A. u. dextra*, *u. sinistra*, *u. undulata* (one row of preanals).

* Except *u. pulchra*, with enlarged gulars and other characters as in group III.

Allocation of *u. pulchra* with the subspecific group I, while on morphological grounds it belongs with group III, is prompted by geographic considerations discussed in the following paragraphs.

The distinctness of these four groups in México is rather striking. *A. u. undulata* is the most highly specialized of its group and thus sharply distinguished from *u. parva* and *u. amphigramma*, members of two adjacent sections. *A. u. stuarti* is so widely different from *u. hartwegi* and *u. gaigeae*, the members of an adjacent section, that it might well be considered a member of a different species. We have refrained from considering *u. gaigeae* and *u. hartwegi* collectively as a distinct species chiefly because of the existence of a slight approach of specimens of *u. stuarti* toward *u. hartwegi*. Actual intergrades still are not known, and for that reason the possible specific distinctness of *hartwegi* should be kept in mind. In such an arrangement, however, the problem of relationship to *u. pulchra* becomes acute, for it fits morphologically with some of the other races, although it presumably intergrades with *u. hartwegi*.

Incontrovertible intergrades are known only between sections II and IV, via *u. parva* and *u. undulata*, respectively. None is known between III and either II or IV, or between III and I, although they may occur.

PHYLOGENY

The phylogeny of Mexican races of *Ameiva undulata* is not entirely clear. Forms which differ so slightly as these furnish few clues to their early peregrinations and relationships. Nevertheless certain rather probable steps in the subspeciation of the group seem fairly evident. These steps may be segregated into four groups: those of (1) Lower and Middle Miocene, of (2) Upper Miocene and Lower Pliocene, of (3) Upper Pliocene and Lower Pleistocene, and of (4) Pleistocene and Recent times.

LOWER AND MIDDLE MIOCENE

It is conceivable that in the Lower and Middle Miocene,† when the Isthmus of Tehuantepec was above water, the *undulata* stock was distributed rather widely from southern and probably central (coastal) México through all available territories in Central America (Fig. 4A). Whether this stock was originally dispersed from the north or south is not particularly clear, but because of the indisputable South American center of dispersal of the family we may suppose that the *undulata* stock migrated northward.

† Paleogeography based on Schuchert (1935).

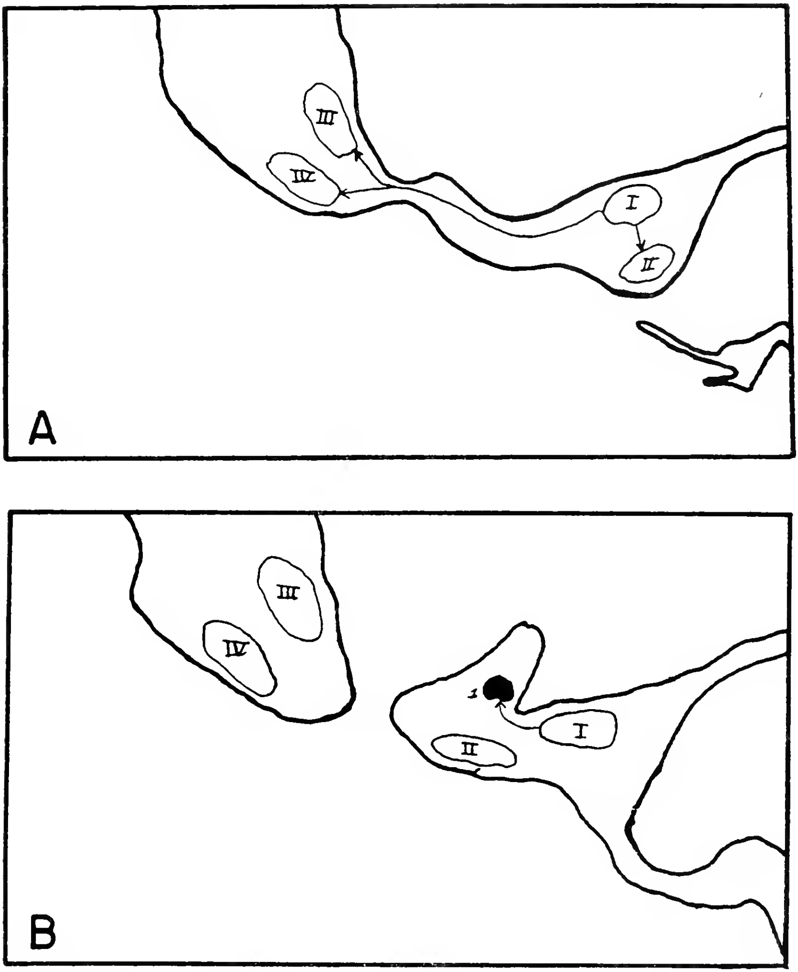


FIG. 4. Paleophylogenetic maps of *A. undulata*.
A. Lower and Middle Miocene.
B. Upper Miocene and Lower Pliocene.
I. *pulchra-hartwegi-gaigeae* parent stock.
II. *parva* parent stock.
III. *podarga-amphigramma-thomasi-stuarti* parent stock.
IV. *undulata-dextra-sinistra* parent stock.
1. *hartwegi-gaigeae* parent stock.

UPPER MIOCENE AND LOWER PLIOCENE

Since in this period these lizards were dispersed over a considerable area, some differentiation may have begun while the Tehuantepec portal (in reference to the oceans) was still closed. Whether it began then or after the opening of the portal in the Upper

Miocene and Lower Pliocene is relatively immaterial; it is clear enough that it proceeded apace with the isolation of México from Central America. Three physiographic features accomplished isolation of four groups of *undulata.* The ocean portal isolated northern and southern groups, and each of these was split by mountain ranges which reached very near if not quite to the ocean on both sides of the portal. The four groups are indicated by Roman numerals in Fig. 4B. They, in turn, became secondary centers of dispersal.

It is important to observe that these four groups, each (except II) represented today by three or more subspecies, are extremely clearly differentiated from each other at the present time, almost to the extent of comprising different species in some cases. No differences between the subspecies of any one group (except perhaps in I) are as great or greater than those between the groups themselves. That a lengthy isolation may have been responsible for such differentiation seems reasonable.

Obviously migration continued after isolation of the four groups. One of the most significant migrations occurred in group I, which occupied territory adjacent to a new, extensive area of land thrust above the sea as the Tehuantepec portal was opened. This new area occupies the approximate position of the present-day Yucatán Peninsula. Probably the animals migrating into this new territory became well differentiated morphologically from their parent stock; that differentiation under such conditions does occur is well illustrated by the extremely extensive subspeciation and speciation of animals which have repopulated the modern Yucatán Peninsula. The stock which migrated into and differentiated on the new Paleo-Yucatán Peninsula we may suppose is that which later gave rise to modern *u. hartwegi* and *u. gaigeae.* This stock is indicated on Fig. 4B by the Arabic numeral 1. Very likely it was similar to modern *u. hartwegi.* The theory of differentiation of the pre-*hartwegi-gaigeae* stock on a Paleo-Yucatán Peninsula accounts satisfactorily for the very extensive differentiation within Group I—a differentiation far greater than has occurred within any other group.

On the northern side of the portal, migration proceeded probably with some differentiation into races. This topic will be discussed later.

Upper Pliocene and Lower Pleistocene

In this period the Tehuantepec portal was closed and migration across the Isthmus again became possible. Three important changes took place. It would appear (1) that the migration was effected

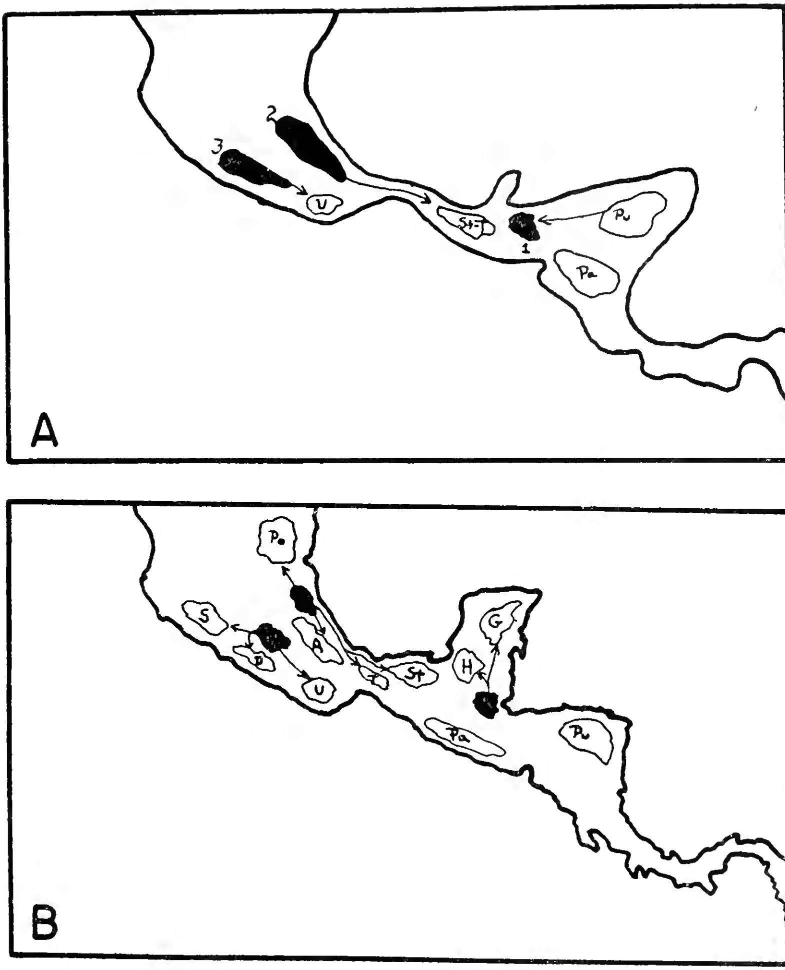


FIG. 5. Paleophylogenetic maps of *A. undulata*.
A. Upper Pliocene and Lower Pleistocene.
B. Upper Pleistocene and Recent.
1. *hartwegi-gaigeae* parent stock.
2. *podarga-amphigramma* parent stock.
3. *dextra-sinistra* parent stock.
A. *amphigramma*
D. *dextra*
G. *gaigeae*
H. *hartwegi*
Pa. *parva*
Po. *podarga*
Pu. *pulchra*
S. *sinistra*
St. *stuarti*
St-T. *stuarti-thomasi* parent stock.
T. *thomasi*
U. *undulata*

chiefly by what was later to become *u. stuarti*, for this race is the farthest from its secondary center of dispersal. The considerable differentiation of this race—the most extensive in its group—is probably correlated with this extensive migration and relatively early separation. *A. u. undulata* (2) on the Pacific coast migrated eastward slightly, and probably its limited, though distinct, differentiation is correlated with that relatively limited migration. *A. u. parva* apparently did not move into new territory, or if so there is no indication of it in differentiation of its stock, all of which remains today as a single form. Finally (3), the pre-*gaigeae-hartwegi* stock retreated from the Paleo-Yucatán Peninsula, which became largely submerged.

Upper Pleistocene and Recent

The major physiographic change marking this period was the emergence of the modern Yucatán Peninsula and much of the southern Atlantic border of México, in Tabasco, Campeche and Veracruz. Into this new area the pre-*hartwegi-gaigeae* stock migrated, giving rise to *u. gaigeae* in northern Yucatán and *u. hartwegi* at the base of the peninsula.

We have left in abeyance consideration of the differentiation of *u. sinistra* and *u. dextra*, and of *u. podarga*, *u. amphigramma*, and *u. thomasi*. Because of the lesser differentiation of these forms it is possible that they became distinguishable at a later time than the other races, although there is also the possibility that they merely differentiated more slowly.

In the case of *u. sinistra* and *u. dextra*, it is obvious that the arid valley of the Río Balsas effects the isolation of the two forms. We have no data on the geological history of this valley and cannot for that reason accurately correlate events in this area with those at the Isthmus. It is recorded, however, that the entire western coast of México, particularly between the Isthmus and Cape Corrientes, sank extensively after early Pleistocene times. It is possible that this depression extended the aridity of the lower basin of the Río Balsas farther into the interior, where today it penetrates even to within five or 10 miles of the extremely humid Atlantic slopes. This interpretation lends support to the idea of recent segregation of *u. dextra* and *u. sinistra*.

It appears that, like the preceding, *u. podarga* and *u. amphigramma* differentiated *in situ*. There is no prominent physiographic barrier between the areas occupied by the two races. The isolation is, in other words, ecological, and cannot well be considered anything but a relatively recent one—surely as recent as the isolation of *u. dextra* and *u. sinistra*.

The origin of *u. thomasi* is somewhat perplexing. The race appears to be most closely related to *u. amphigramma*, but is separated from the latter race by *u. stuarti* which occurs in the lower Grijalva valley in Chiapas. It cannot well have arrived there before the formation of the portal, for it surely would have differentiated more extensively than it has. It may have arrived there while *u. stuarti* was migrating southward, become more or less isolated, and proceeded to parallel *u. amphigramma*. It is assumed that the early stock crossing the Isthmus southward shortly after its reformation was little different from that which gave rise to *u. amphigramma* and *u. podarga*. Isolated from pre-*u. stuarti* stock, it is not surprising that it might evolve in much the same manner as *u. amphigramma* and *u. podarga* farther north. The differences between all three lie chiefly in pattern, and it is obvious that parallelism in pattern evolution is almost universal in *A. undulata*: practically all, save *u. stuarti* tend to break up the upper lateral dark lines either by forming light spots or a continuous light line. The parallelism of *u. amphigramma* and *u. dextra* in this respect is striking, although the races presumably have no direct relationship.

SPECIALIZATION

Since most forms of *A. undulata* differentiated *in situ*, dispersal of primitive characters is not a critical problem. Determination of the primitive condition of various characters is, however, of value

TABLE 2. Specialized and Primitive Characters in *Ameiva undulata*

CHARACTERS	Primitive	Specialized
Gulars	enlarged, irregular: *u. pulchra*, *u. podarga*	a. small: *u. hartwegi*, *u. gaigeae* b. enlarged and very regular: *u. stuarti*
Preanals	2 rows	1 row
Supraocular separation	$\frac{1}{2}$–1*	1–2*
Upper lateral dark stripe	unbroken, without light spots: *u. stuarti*	with light spots or stripe
Dorsolateral dark stripe	absent	present: *u. stuarti*
Femoral pores and lamellae	moderate number	a. reduced number: *u. stuarti* b. increased number: *u. hartwegi* and *u. gaigeae*
Dorsal spotting	reduced or none	well developed

* The first integer refers to the length of the row of granules between the last large supraocular and the median head scales; the second integer refers to the number of rows (complete or incomplete) between the last large supraocular and the superciliaries.

in considering the few forms that did arise by migration, and in considering the extent of change in other forms.

The primitive condition of the subspecific characters in *A. undulata* are recorded in Table 2. Our decisions on them are perhaps debatable, but we feel that the evidence available preponderantly favors this arrangement.

According to that evaluation of characters, *u. pulchra* is the most primitive of group I; *u. podarga* of group III; and *u. dextra* of group IV. It is to be expected that *u. pulchra* would be the most primitive of group I, since the rest of the stock moved into an environment probably a little different from that to which the race had become accustomed.

In group III, *A. u. podarga* may have large light spots in the upper lateral dark stripe, but is otherwise primitive and is peripheral.

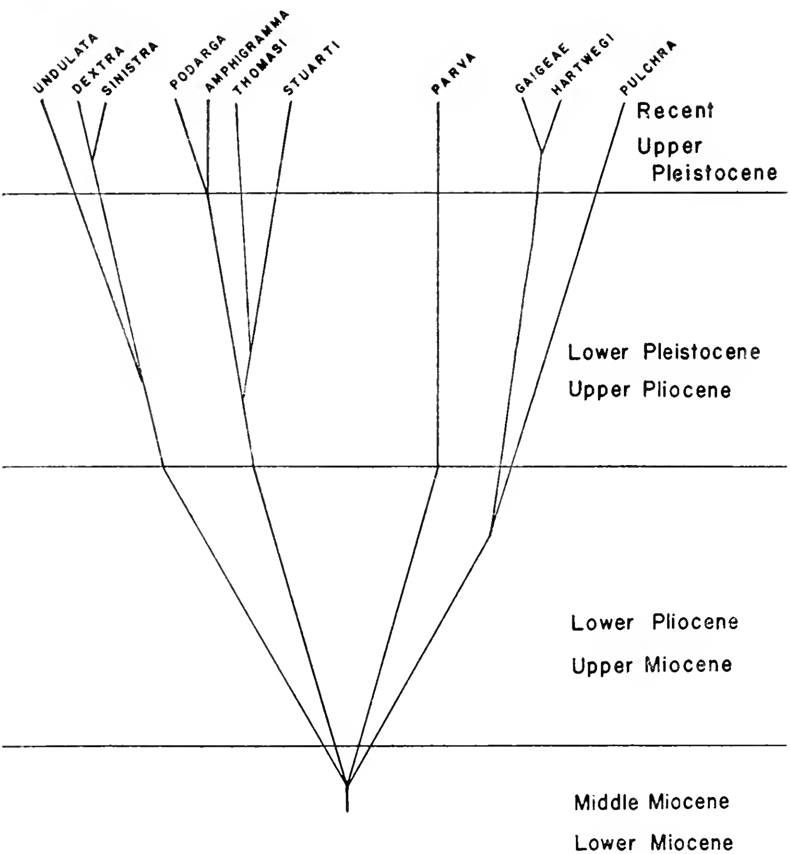


FIG. 6. Proposed phylogeny of the subspecies of *Ameiva undulata*.

With more regular gulars and a distant upper lateral light stripe, *u. amphigramma* is definitely more specialized than *u. podarga*. *A. u. thomasi* is nearly as specialized as *u. amphigramma*, and is a remarkably close parallel in spite of distinct isolation. *A. u. stuarti*, oddly enough, retains the most primitive pattern of the group or even of the species, in some respects, but combines with that a number of strongly specialized characters.

Of all members of group IV, *u. dextra* is clearly the most primitive, having only a partial specialization in preanals and no dorsal spotting, although the pattern in it is extreme in its development (very much like *u. amphigramma*). *A. u. sinistra* is more specialized in preanal arrangement, and *u. undulata* is the most highly specialized.

These relationships, and approximate time of differentiation, are indicated on Figure 6.

DIFFERENTIATION AGENCIES

Two major factors seem to have been involved in the subspeciation of *A. undulata*: isolation (1) *in situ*, due to geographical, physiological, or ecological changes; and isolation by (2) migration into new territory (see Table 3).

Before formation of the Miocene portal obviously a certain degree of differentiation correlated with migration into all available territory may have occurred, at least to such an extent that the 4 groups of *A. undulata* were slightly differentiated.

TABLE 3. Physical Factors Correlated with Subspecific Differentiation in *Ameiva undulata*

RACE OR STOCK	Physical factors
pre-*gaigeae-hartwegi*	migration (from stock of group I)
pulchra	ecological isolation from pre-*gaigeae-hartwegi*
gaigeae	migration (from pre-*gaigeae-hartwegi*)
hartwegi	ecological isolation from *gaigeae*
parva	isolation
stuarti	migration (from stock III)
thomasi	migration (from stock III)
amphigramma	ecological isolation (from stock III)
podarga	ecological isolation (from stock III)
undulata	migration (from stock IV)
sinistra	physiographic isolation (from pre-*dextra-sinistra*)
dextra	physiographic isolation (from pre-*dextra-sinistra*)

After mechanical isolation of the four groups by the portal, differentiation then became a phenomenon accomplished (1) *in situ* (without migration), through formation of barriers here and there and resultant, partial or complete isolation; and in certain instances (2) as the species migrated into new territory also undoubtedly partially isolated, by some factor, from adjacent territory.

Those forms which migrated into new territory differentiated perhaps more extensively than those remaining in the original areas. Unfortunately there are insufficient cases at hand to demonstrate whether the migrants evolved significantly more rapidly. In fact there is little evidence that the speed of differentiation is correlated with anything but time in these lizards; the longer the isolation, the greater the differentiation. There is in all probability little difference in end result between differentiation *via* isolation and differentiation *via* migration, especially since the real factor in the latter case may in reality be isolation. There is this difference, however: that differentiation *via* migration results in a geographic *trend* of specialization, while differentiation *in situ* does not.

CHARACTER DISPERSAL

Peripheral dispersal of primitive characters is commonly recognized in large groups, especially of mammals, but in small groups the phenomenon is not of regular occurrence. We can verify, however, that the peripheral forms of *Ameiva undulata* do appear to be the most primitive of the species; they are *u. podarga,* pre-*dextra-sinistra*, and *u. pulchra.* The reverse situation, however, occurs within the subspecies groups, which demonstrate peripheral specialization. In group I, pre-*gaigeae-hartwegi* is a peripheral specialization of earlier stock; in group III, *u. stuarti* is a peripheral specialization, again from a secondary center of dispersal; and in group IV, *u. undulata* is likewise a peripheral specialization. In each case migration into new territory, as opposed to differentiation *in situ,* has been involved.

Some explanation is in order for the apparently opposite trends of evolution of, on the one hand, the species as a whole, and on the other hand, of its subspecies groups. They appear to be fundamentally different, for migration of the species as a whole to its present peripheral range limits was accomplished with peripheral dispersal of primitive forms, while migration of lesser groups resulted in peripheral specialization.

In this particular case the apparent differences can be explained as follows. The earliest stock of the species, as it migrated from a center of dispersal, did specialize, and the four subspecies groups at the time of their isolation were in reality specialized as compared with the original stock, none of which persisted unchanged. Reaching the limits of its range, subsequent differentiation was accomplished *in situ* only, with obviously haphazard specialization at various points in the range. Further migration occurred only centrifugally into new territories elevated near the center of the range. Actually these territories can be considered peripheral, inasmuch as they are peripheral in the ranges of the groups themselves. The secondary migration, like the first, was accompanied by peripheral specialization. The peculiar effect of having peripheral primitiveness on the one hand and peripheral specialization on the other is, then, a false illusion. In reality peripheral specialization occurred in all cases.

MIGRATION EFFECTS

Migration has, in these lizards, been the most important factor in specialization of several races. In every case of migration, specialization has followed or occurred at the same time. It can, with some degree of confidence, be suggested that migration always is accompanied by specialization in some respect, at least in these lizards. Peripheral forms may always be expected to be more specialized than their ancestral forms, although they in turn may be more primitive than other derivatives of those ancestors. If these data may be applied to Matthew's theory of peripheral dispersal of primitive groups, it is obvious that Matthew is correct only as one line of derivatives (and migrants) is compared with another line of derivatives (later migrants) of the same ancestors; his theory appears to be incorrect as applied to a single line of derivatives, in which peripheral specialization is the rule. It thus seems that the often-heard, loose statement that this Matthewsian thesis is applicable only to larger categories [each representing a different line] but not the smaller ones [each representing only one line] is, in a general way, correct and reasonable.

NONPRIMITIVE AREAS

Three areas in México are shown by this study to be newly emerged; they are the Atlantic slopes on the eastern side of the Isthmus of Tehuantepec; Pacific slopes on the western side of the Isthmus; and the northern portion of the Yucatán peninsula. All these areas were populated by relatively recent migrants. Those which evolve at approximately the same rate as *Ameiva undulata* (most reptiles?) have not been able to use these areas as secondary centers of dispersal. Therefore, it is reasonable to postulate that, in those cases in which such animals are represented by one form in any of the three nonprimitive areas, and by one or more closely related species or subspecies in adjacent areas, the form in the nonprimitive area is never the most primitive. This postulate is not to be construed to imply that relatively primitive species cannot occur there; they can and do, but if they are represented in an adjacent area by another close relative, the latter is the more primitive of the two. Likewise this postulate is not to be construed to apply to any migrants which have already set up in those areas secondary centers of dispersal from which other forms have radiated. It is believed that these areas have served as secondary centers for very few, if any, reptiles and amphibians.

Ages of Races

Exact ages cannot be given for any race of *A. undulata*, but because of the rather precise correlation in some cases of differentiation with geological events, the geological time estimates can give a clue to the approximate ages of the races, as indicated in Figure 6. *A. u. gaigeae* appears to be the most recent, of Upper Pleistocene date. It is also one of the least well defined of all races. Perhaps equally recent are the differentiations from each other of *u. amphigramma* and *u. podarga*, and of *u. dextra* and *u. sinistra*, but the geological correlation with the Upper Pleistocene is not so well assured as in the case of *u. gaigeae*. *A. u. stuarti* and *u. thomasi* are marked as of no greater age than that of the Upper Pliocene.

Orthoevolution

It is pretty clearly demonstrated that the *undulata* stock can be interpreted to have evolved along one particular line with respect to pattern, all forms tending to develop light spots and later a longitudinal light line in the upper lateral dark line. Whether this extensive parallelism was effected by strong survival value of this particular type of pattern, or by a trend of mutation already established before segregation of the four groups, is not readily evident, and we hold no opinion on the basis of evidence afforded by these lizards.

PROBLEMS

Numerous problems in the systematic arrangement of Mexican *Ameiva undulata* await solution. A few are listed below.

1. Of prime interest is the status of the group containing *u. gaigeae* and *u. hartwegi.* If intergrades actually do not occur between *u. stuarti* and either of them, serious consideration should be given to the recognition of a distinct species, *Ameiva hartwegi.* In such case *gaigeae* would undoubtedly be one race of *hartwegi,* but the allocation of *u. pulchra* would remain in doubt until further studies revealed the existence or absence of intergrades between the latter and *hartwegi.* It is assumed that all the territory between these several forms is suitable for their habitation; if this actually is the case the forms must either intergrade or overlap geographically.

2. Of equal interest for future study is the possibility of intergradation between *u. undulata* and *u. amphigramma*— forms which represent two different groups not now proved to intergrade.

3. The status of *u. thomasi* is worthy of further study. It may intergrade either with *u. amphigramma* or, more probably, with *u. stuarti.*

4. Of considerable interest for future work is whether *u. parva* intergrades with *u. amphigramma.* It seems probable.

5. More material is needed to check the validity and variation in *u. dextra* and *u. sinistra.*

6. The range and geographic variation in *u. stuarti* needs further study. At present most of the recorded data are based upon specimens from a single locality.

7. The color in life has been recorded for only one race, *u. amphigramma.* Detailed notes are much to be desired on live material. Undoubtedly color differences not now evident occur between a number of races. The ventral color, particularly of adult males, may prove to be of diagnostic value.

ACKNOWLEDGMENTS

We wish to express our appreciation for the loan of vital material by Miss Doris Cochran, Mrs. Helen T. Gaige, and Dr. E. H. Taylor; for the assistance of Dr. A. B. Leonard and Mr. Richard Spieler in gathering material together and in the taking of data upon it; for the expert assistance of Mr. Ray Maas who took the photographs; and for financial assistance afforded through the courtesy of Dr. Curt Stern.

KEY TO MEXICAN AMEIVA

1. Outer row of ventrals considerably smaller than the others.........*festiva edwardsii*
   Outer row of ventrals as large as the others................................ 2
2. Preanal scales in two rows.. 3
   Preanal scales in one row or with no more than one posterior scale divided....... 9
3. Two rows of granules between third supraocular and superciliaries; third supraoculars generally completely separated from frontoparietals by granules.........*u. parva*
   A single row of granules between third supraoculars and superciliaries; third supraoculars in contact with frontoparietals anteriorly.............................. 4
4. Median gulars abruptly enlarged.. 6
   Median gulars little enlarged, gradually merging with lateral gulars............. 5
5. Upper lateral vertical light lines from axilla to groin 12 or more ....*u. gaigeae*
   Upper lateral vertical light lines from axilla to groin 11 or less ....*u. hartwegi*
6. Median gulars irregular or no more than 2 regular (87%); lamellae under 4th toe 28 or more; no upper lateral light stripe, although large spots take its place in adult males .... *u. podarga*
   At least 3 median gulars regular (100% in all except *u. amphigramma*, with 87%); lamellae variable; upper lateral light stripe present or absent.................... 7
7. Dorsolateral dark stripes present except in some large adults, in which the upper lateral light spots if present are much narrower than the spaces between them: lamellae on the 4th toe usually (88%) 27 or less...............................*u. stuarti*
   No dorsolateral dark stripes; upper lateral light spots as wide as or wider than spaces between, or represented by a continuous upper lateral light stripe; lamellae variable 8
8. Upper lateral light spots or lines not contacting dorsolateral light area or line in adult males, separated by a narrow dark area; lateral gulars not or scarcely enlarged .... *u. amphigramma*
   Upper lateral light spots merged with dorsolateral light line in adult males; lateral gulars markedly enlarged .... *u. thomasi*
9. Last preanal scale generally (86%) divided; lateral markings showing little tendency to be arranged vertically; middorsal markings greatly reduced......*u. dextra*
   Last preanal scale generally entire; lateral markings tending to be arranged vertically; middorsal markings well developed 10
10. Upper lateral light spots in adult males large, wider than intervening dark spaces; generally (95%) 5 or less rows of preanals............................*u. sinistra*
    Upper lateral light spots in adult males small, narrower than intervening dark spaces in all males; frequently (65%) 6 or more rows of preanals.............*u. undulata*

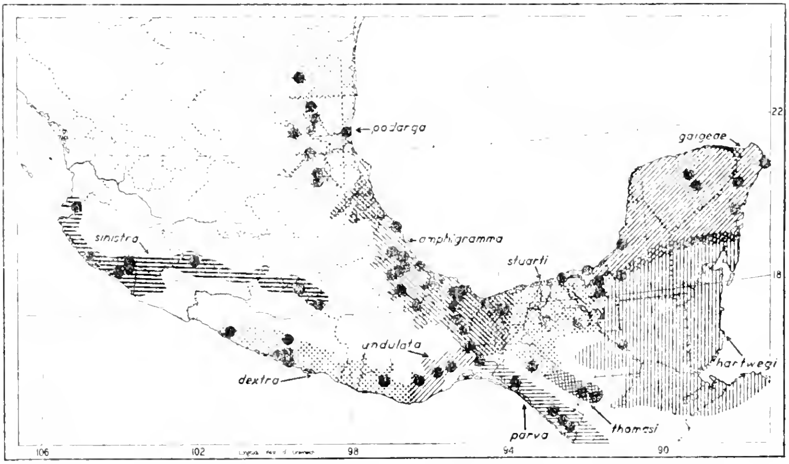


FIG. 7. Distribution of subspecies of *Ameiva undulata* in México.

ACCOUNTS OF SUBSPECIES

The arrangement of these accounts follows, as closely as linear sequence will permit, the apparent phylogenetic relationships of the various forms. As explained elsewhere, we regard the group containing *u. pulchra* as the most primitive of *A. undulata,* even though other members of the group are rather highly specialized. Since *u. pulchra* is not Mexican it is omitted, and the list accordingly begins with *u. hartwegi* and *u. gaigeae* respectively, the latter of which obviously is a derivative of *u. hartwegi* or an ancestor very much like it. *A. u. podarga* is perhaps the least modified of trans-Isthmian forms. In geographic and partly phylogenetic sequence three other forms follow: *u. amphigramma, u. thomasi,* and *u. stuarti.* Whether *u. parva* or the trans-Isthmian Pacific forms should follow is an orbitrary decision; *u. undulata* and *u. parva* are about equally specialized. In deference to the rather remarkable preanal change in the more northerly group, and to the advantage of placing *u. parva* near the other races with paired preanals, we follow with the southern race. It is fairly clear that of the remaining three forms *u. dextra* is the most generalized and *u. undulata* the most specialized.

Ameiva undulata hartwegi Smith

(Pl. 2, Fig. B)

Ameiva undulata hartwegi, Smith, 1940: 55 (type locality Chiapas, México, across the Río Usumacinta from Piedras Negras, Petén, Guatemala; type U. S. Nat. Mus. No. 108600).

When originally diagnosed this form was conceived to be more or less homogeneous, ranging throughout the Yucatán Peninsula and its base, including the Petén area of Guatemala. This interpretation was likewise held by Stuart (1942: 145). Both authors observed chiefly the uniformity of the character of the gular scales throughout this area, Stuart extending its range as far as Honduras. Since the character is so peculiar in the species *Ameiva undulata* it is not surprising lesser geographical variations received little attention. It is well known, however, that a very large percentage of wide-ranging species, whose ranges include the entire Yucatán Peninsula, have differentiated in such a way that a northern Yucatán race is distinguishable. Examination of specimens from northern and southern extremes revealed that differences occur in this form, as well as in many others.

Diagnosis. A. u. hartwegi as at present defined may be diagnosed as follows: gulars small and irregular, preanals in two rows; lamellae on 4th toe 29 or more (100%), generally 31 or more (81.5%) femoral pores on both sides 39 or more (89.8%), upper lateral vertical light lines between axilla and groin 11 or less (98.2%). The last two characters differentiate this race from *u. gaigeae*, comparisons with which are given in Table 7.

Range. Atlantic slopes of México and Guatemala from the vicinity of the southeastern end of Laguna de Términos south and eastward across the base of the Yucatán Peninsula to northwestern Honduras.

TABLE 4. Variation in *A. u. hartwegi*

Character		Counts	Range	Average
Femoral pores, one side	♂♂	62	17–23	20.9
	♀♀	38	16–22	19.9
Femoral pores, total	♂♂	30	37–45	41.9
	♀♀	19	34–44	39.7
Lamellae on 4th toe		97	29–36	31.8
Upper lateral vertical light lines from axilla to groin		55	8–12	9.6

Locality records. We have examined 78 specimens from the type locality, and from Piedras Negras, Petén, Guatemala. We have taken data on only fifty of this series. We are aware of no other locality records for México.

Discussion. This is the largest of Mexican races of *Ameiva undulata*, reaching a maximum size of 138 mm. snout to vent in males, and 115 mm. in females. Variation in femoral pores, lamellae on fourth toe and upper lateral light lines are given in Table 4.

TABLE 5. Comparisons of *A. u. hartwegi* with *A. u. stuarti*

Character	*hartwegi*	*stuarti*
Femoral pores	18 or more 98%	17 or less 97.3%
Lamellae on 4th toe	29 or more 100%	28 or less 98.6%
Gulars	small, irregular	large, regular

Comparisons. The only forms in México with which *u. hartwegi* intergrades are *u. gaigeae* and possibly *u. stuarti*. Comparisons with the latter are given in Table 5, with the former in Table 7. The intergrades are discussed with the other species.

Ameiva undulata gaigeae subsp. nov.*

(Fig. 1C; Pl. 2C)

Holotype. An adult male, EHT-HMS No. 11927, from Progreso, Yucatán, collected by Hobart M. Smith, 1935.

Paratypes. Sixty-three, including 6 topotypes (EHT-HMS Nos. 11925-6, 11928-31), fifty-nine (EHT-HMS No. 11985, UMMZ Nos. 68215, 72934-72957, 80847-80860, 80861 (3), 80862 (5), 83289 (3), 80890 (5)) from Chichén Itzá, Yucatán; three (UMMZ No. 78586 [3]) from a locality five miles inland from Vigía, Quintana Roo; and two (UMMZ No. 78587[2]) from Ascención Bay, Yucatán.

Locality records. All specimens available have been included in the type series, except UMMZ Nos. 68216-68224, from Chichén Itzá, all juveniles; UMMZ No. 83535, from Ciudad del Carmen, Campeche; EHT-HMS No. 11942-11945, 13114, from Encarnación, Campeche (intergrades with *u. hartwegi*); and UMMZ No. 83945, from Cobá, Quintana Roo. The U. S. National Museum has specimens (not seen) from La Vega, Mujeres Island, and Tunkas, Yucatán. Gaige (1936:297) reports it from Champotón, Campeche.

Diagnosis. Related to *u. hartwegi*, having small, irregular gulars and preanals in two rows. Differs from that form in having 12 or more (89.5%) lateral vertical light spots between axilla and groin, and in having fewer femoral pores (in males, 19 or less on one side [61%], 40 or less on both sides [77.5%]; in females, 18 or less on one side [76%], 37 or less on both sides [82%]).

Description of type. Head scales typical of *Ameiva undulata*. Frontoparietals very narrowly in contact with second supraocular; 3 supraoculars, followed by a group of 3 enlarged granules; 2 frenoculars; an incomplete secondary row of small scales in addition to the primary between posterior chin shields and infralabials; central gulars irregular, small, one-half or one-third size of largest mesoptychial, about 2 or 3 times as large as adjacent lateral scales; mesoptychials relatively small, no larger than scales in anterior row of abdominals; 32 rows of ventrals; 6 rows of preanals, paired; femoral pores 17-18; lamellae on fourth toe 30-31.

Dorsal ground color dull, bluish slate; middorsum with small, irregular, dark spots posteriorly, none on neck or scapular region; dorsolateral dark stripes and dorsolateral light stripes completely

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* Named for Mrs. Helen T. Gaige of the Museum of Zoölogy, University of Michigan, in recognition of her contributions to the knowledge of the Yucatán herpetofauna and to the guidance of many students whose good fortune it has been to be hers. It is a pleasure to associate her name in one genus with that of her closest professional colleagues, Drs. Norman Hartweg, Alexander Ruthven and L. C. Stuart.

absent; upper lateral dark area split into numerous transverse spots, separated from each other by 18 vertical light blue lines from axilla to groin, nearly or quite equal in width to the dark spots; lateral light line indicated by a series of small light spots, one at the ventral end of each of the vertical light lines previously mentioned; sides dimly barred, the lines for the most part tending to coincide with those in the upper lateral zone; hind legs with an ill-defined, open, dark reticulation and with small, scattered, light spots, especially on the shank.

Variation. The males resemble the type very closely, varying chiefly, so far as pattern is concerned, in the amount of spotting on

TABLE 6. Variation in *A. u. gaigeae*

CHARACTER		Counts	Range	Average
Femoral pores, one side	♂♂	80	15–22	19.1
	♀♀	58	15–21	17.6
Femoral pores, both sides	♂♂	40	31–43	38.1
	♀♀	28	31–42	35.3
Lamellae on 4th toe		132	26–36	30.4
Upper lateral vertical light lines from axilla to groin		57	9–18	13.1

the back. The number of vertical light lines in the upper lateral area also varies somewhat as indicated in Table 6. In all the upper lateral spots are clearly defined.

Females, at least in the young and half-grown specimens, possess fairly distinct dorsolateral light lines; the upper lateral dark area is split by dim light lines forming a pattern similar to that of the males, but much less distinct; the lateral light line is more clearly evident than in the males, although it still consists of spots and short lines; the sides below the level of the lateral lines are very feebly marked. On the whole, females are readily distinguishable from males by the emphasis in them of the longitudinal elements of the pattern.

The gulars vary somewhat in size and arrangement, but in very few specimens are any central gulars abruptly enlarged. In occasional specimens there is a tendency toward alignment of the central gulars in a single, median row, but the scales are no larger than in other specimens.

The largest male measures 125 mm. snout to vent; the largest female 107 mm.

Variation in femoral pores, lamellae on the 4th toe, and the number of upper lateral light lines is given in Table 6.

Comparisons. The present race is distinguished from the west coast forms except *u. parva,* by a double row of preanals, and from all others, save *u. hartwegi,* by the small, irregular gulars. It differs from *u. hartwegi* as shown in Table 7.

Intergrades between *u. hartwegi* and *u. gaigeae* are available from Encarnación, Campeche (EHT-HMS 11942-5, 13114). These five specimens are all large females measuring between 95 mm. and 108 mm., snout to vent. The gulars are completely irregular and relatively small; lamellae on the fourth toe vary from 29 to 32 (29, one; 30, four; 31, four; 32, one); femoral pores 15 to 19 (15, one; 16, one; 17, one; 18, three; 19, four); upper lateral light spots between axilla and groin 10 to 14 (10, two; 12, one; 13, one; 14, one).

TABLE 7. Comparisons of *A. u. gaigeae* and *A. u. hartwegi*

CHARACTER		*gaigeae*	*hartwegi*
Femoral pores, one side	♀♀	18 or less 75.9%	19 or more 92.1%
	♂♂	19 or less 61.2%	20 or more 90.3%
Femoral pores, both sides	♀♀	37 or less 82.1%	38 or more 89.5%
	♂♂	40 or less 77.5%	41 or more 73.3%
Upper lateral vertical light lines from axilla to groin		12 or more 89.5%	11 or less 98.2%

These specimens cannot be referred to *u. stuarti,* nor do they more than slightly resemble it; in practically every respect they differ from that form. Therefore, we need consider only *u. hartwegi* and *u. gaigeae.* In pattern, one of the chief differential characters, they are intermediate, but perhaps nearer *u. gaigeae;* and in number of femoral pores they are fairly close to *u. gaigeae.* The large size is more typical of *u. hartwegi,* although the difference is slight; one specimen exceeds by 1 mm. the maximum known for typical *u. gaigeae.* For the present we prefer to allocate the population represented with *u. gaigeae.*

Range. Northern half of the Yucatán Peninsula, and southward to the island of Carmen along the extreme eastern coast. Intergrades with *u. hartwegi* occur at least east of Laguna del Carmen, and probably northward through the central part of the peninsula where the high forest meets the coastal scrub. Intergradation with *u. stuarti* probably occurs in areas near the eastern end of Laguna del Carmen.

Ameiva undulata podarga * subsp. nov.

(Figs. 1D, 2A)

Holotype. An adult male, EHT-HMS No. 14471, from 7 miles west of Victoria, Tamaulipas, collected by Hobart M. Smith and David H. Dunkle, 1934.

Paratypes. Fifteen, including 5 (EHT-HMS Nos. 14472-4, USNM Nos. 106141-2) from Hacienda La Clementina, near Forlón, Tamaulipas; 3 (EHT-HMS Nos. 11959-61) from Antiguo Morelos, Tamaulipas; 2 (UMMZ No. 88232 [2]) from Río Guayala, near Magiscatzin; 3 (EHT-HMS Nos. 11677-9) from near Ciudad Maiz, San Luis Potosí; one (EHT-HMS No. 11962) from near Valles, San Luis Potosí; and one (HMS No. 1597) from Huichihuayán, San Luis Potosí.

Diagnosis. Related to *u. amphigramma* and *u. stuarti* having paired preanals, abruptly enlarged gulars, and the last supraocular broadly in contact with median head scales and separated from the superciliaries by a single row of granules. Differs from *u. amphigramma* chiefly in the absence of the upper lateral light stripe and in reduction of spotting, but also in having completely irregular gulars or no more than two regular median scales (84.6%). Differs from *u. stuarti* in having irregular gulars, lamellae on the fourth toe twenty-eight or more (100%), presence of large upper lateral light spots in males, and in the absence of a dark median border on the dorsolateral light stripe.

Description of type. Head scales similar to the type of *u. dextra* except as follows: chin shields separated from posterior infralabials by a single row of small scales; central gulars enlarged, irregular, except for two broad scales in the median line; enlarged mesoptychials in two rows; 32 ventrals from gular fold to preanal region; five rows of preanals, paired; femoral pores 17-18; lamellae on fourth toe 29-29.

Snout to vent, 102 mm.; tail broken; hind leg, 77 mm.; foreleg, 36 mm.; snout to gular fold, 35.5 mm.; snout to anterior margin of ear, 24 mm.

Middorsum slate gray; very few small scattered dark spots on posterior part of back; dorsolateral light line dimly evident on neck, not elsewhere; below the level of the dorsolateral light line a series of large subquadrangular, light spots, separated from each other by narrow, dark brown bars, half as wide as the light spots; sides

* From Greek, swift-footed.

lighter brown, traversed by numerous, narrow vertical, broken or continuous, light streaks which extend from the belly almost or quite to the level of the upper lateral light spots; gular region bluish, belly darker.

TABLE 8. Variation in *A. u. podarga*

CHARACTER		Counts	Range	Average
Femoral pores, one side	♂♂	14	15–18	16.8
	♀♀	17	13–17	15.3
Lamellae on 4th toe		30	28–31	29.4
Rows of gulars		16	5–7	5.7

Variation. Six males are available, all adults except two juveniles, one measuring 48 mm. snout to vent, the other 36 mm. All specimens (save the smallest in which the upper lateral light spots are present but very dim) clearly show markings similar to those of the type, with no tendency whatever of the lateral light spots to fuse, forming a stripe. The spots are, in all, separated by dark bars at least half as wide as the light spots, usually wider. As in the type the middorsum is practically immaculate. The sides are dimly marked in all except the largest male (HMS 1597) which has a distinct, broken lateral light line as well as vertical, lateral light lines; in it also the dorsolateral light lines are distinct, while in the others they are very dim.

Females are very much like the males; the middorsal markings are somewhat better developed; the dorsolateral light stripes are somewhat clearer; the upper lateral light spots are absent in the young, but appear dimly in specimens measuring about 80 mm. or more, and in some specimens closely approach the condition in the males. The lateral light stripe is well developed in the young and is usually retained in the adults, but may disappear (1 specimen). Even to a greater extent than in the males the lateral light markings are reduced in number, size and distinctness.

The largest male measures 116 mm. snout to vent; the largest female 96 mm.

Variation in femoral pores and lamellae are given in Table 8. The central gulars are irregular in arrangement; in six specimens they are completely irregular, no two scales being alike and situated in the median line; in 5 specimens a maximum of two scales are medially situated, and in two specimens all the enlarged central gulars but one (in a total of five) are regularly arranged.

Comparisons. The race of *Ameiva undulata* nearest to *u. podarga* both geographically and, presumably, taxonomically is *u. amphigramma.* There are few differences between the two races except in gulars and pattern. The pattern differences are, however, very striking and include, as the most important, the development of the upper lateral light stripe. In *u. amphigramma* this stripe is, in males, either continuous (the usual condition) or broken into blotches, separated from each other by very narrow dark lines, considerably less than half the width of the blotches. This condition obtains in males of all sizes but increases in distinctness with age. Oddly enough in the females either a continuous or discontinuous upper lateral light stripe similar to that of the males only much dimmer, is developed in adult specimens; unlike the males, however, juvenile females do not show the stripe or spots.

TABLE 9. Comparisons of *A. u. podarga* with *A. u. amphigramma*

CHARACTER		*podarga*	*amphigramma*
Femoral pores, one side..	♂♂	average 16.8	average 17.6
	♀♀	15 or less 64.7%	16 or more 75.0%
Gulars (based on the largest 5 median scales)		irregular or no more than 2 regular 86.7%	regular or no more than 3 irregular 87.3%
Pattern	mottling	reduced	well developed
	upper lateral light stripe	absent or represented by spots less than twice width of intervening spaces	present or represented by spots over twice width of intervening spaces

In *u. podarga* the upper lateral light stripe is never continuous but is represented by large light blotches separated from each other by dark spaces at least half as wide as the light areas. As in *u. amphigramma* this pattern occurs in all males and in adult females with the same limitations.

In *u. amphigramma* the body and legs are rather strongly spotted; the markings are most distinct on the middorsum and, with the exception of adult males, on the legs. In *u. podarga* on the other hand, the back and legs are practically unicolor, and as described for both sexes, the sides have very little spotting.

There is some difference in the average number of femoral pores of these two races as indicated in Table 9, but the character is not of taxonomic value, except perhaps in females. Further data are required on this point. There is also an apparent difference in the number of rows of sublabials between the posterior infralabials and the chin shields, although again the difference appears to be of little taxonomic value. In *u. podarga* eight specimens have only one row, five have an incomplete secondary row, while one has a short, complete secondary row.

The arrangement of the median gulars is a character of considerable importance in separating *u. podarga* and *u. amphigramma*. In the former 86.7 percent of the specimens have completely irregular or no more than two regular median scales (restricting to five the number of gulars considered); in *u. amphigramma* only 12.7 percent are of that character.

TABLE 10. Comparisons of *A. u. podarga* with *A. u. stuarti*

CHARACTER		*podarga*	*stuarti*
Lamellae on 4th toe		28 or more 100%	27 or less 87.5%
Gulars (Based on the largest 5 median scales)	arrangement	irregular or no more than 2 regular 86.7%	regular or no more than 3 irregular 100%
Pattern	upper lateral light spots	present, broad	absent or narrow
	dorsolateral dark stripe	always absent	present except in some adults
	dorsolateral light stripe	faint or absent	well developed

Comparisons of *u. podarga* with *u. stuarti* are given in Table 10. The differences as cited in the table are self-explanatory.

Range. Aside from the localities represented by the paratypes, we have records of specimens from the following: *San Luis Potosí:* Tamazunchale (EHT-HMS); *Tamaulipas:* Alta Mira (USNM); Victoria (USNM). The range appears to extend along the Atlantic coast from the latitude of Victoria, Tamaulipas, southward into northern Veracruz. The exact area of intergradation with *u. amphigramma* is unknown at present.

Ameiva undulata amphigramma Smith and Laufe

(Pl. 1, Figs. C, D)

Ameiva undulata amphigramma Smith and Laufe, 1945: (type locality San Andrés Tuxtla, Veracruz; type EHT-HMS No. 11983)

Diagnosis. A member of the *undulata* group of *Ameiva*, closely related to *u. stuarti* and *u. podarga;* preanals in two rows; median gulars rather abruptly enlarged, arranged generally in a median row of 5 to 8 scales. Differs from *u. podarga* in having (1) usually (87%) no more than 2 of the 5 largest gulars divided or irregular, (2) usually (75%) 16 or more femoral pores in females; (3) considerable mottling on the back, and (4) an upper lateral light stripe which is never or rarely broken into light spots less than twice as wide as the dark intervening spaces. Differs from *u. stuarti* to some extent in number of lamellae under the fourth toe (55% with 28 or more), and in having fewer gulars of which more are irregular, but chiefly in pattern: (1) Adult males possess a conspicuous, broad, longitudinal, light, upper lateral stripe which may be broken into large spots not less than twice the width of intervening spaces; this character is discernible although indistinct in adult females, and is generally at least feebly evident in young males; (2) there is no continuous dorsolateral dark stripe, typically, although females may have it broken into spots or reduced in length or width; and (3) the dorsolateral light stripes completely disappear in adult males. Differs from *u. stuarti* and *u. gaigeae*, the only other races with two rows of preanals, chiefly in the possession of the upper lateral light stripe, abruptly enlarged gulars, and a smaller maximum size.

Range. Northern Veracruz (exact area uncertain, perhaps in the vicinity of Laguna Tamiahua, where it intergrades with *u. podarga*, southward at relatively low elevation (below about 4,000 ft.) through most of Veracruz to the Isthmus of Tehuantepec, there intergrading with *u. stuarti;* westward into valleys extending into extreme eastern Oaxaca and probably northeastern Puebla.

Localities. We have now examined a total of 104 specimens of this race. Localities represented by specimens examined include: *Veracruz:* Atoyac, Boca del Río, Cuatotolapam, Lake Catemaco, Jalapa, Orizaba, Potrero Viejo, Puente Nacional, Rodriguez Clara, San Andrés Tuxtla, Tierra Colorada; *Oaxaca:* Cosolapa, Matías Romero. Literature records include Achotal, Hda. del Hobo, Jicaltepec, Mirador, Obispo, Otopa, Perez and Presidio in *Veracruz,* and Agua Fría, *Oaxaca.* The U. S. National Museum has specimens (not seen) from Tuxtepec, *Oaxaca,* San Rafael, *Veracruz,* and La Venta, *Tabasco.*

Discussion. Two additional topotypes (EHT-HMS Nos. 15136-7), from San Andrés Tuxtla, Veracruz, have come to hand since the form was described. One is a juvenile male measuring 54 mm. snout to vent; it shows a dark dorsolateral stripe typical of *u. stuarti* and never present in more northern *u. amphigramma;* the lamellae on the fourth toe, however, number 30-32, as is characteristic of *u. amphigramma.*

The other specimen, an adult male, has large upper lateral spots separated from each other by vertical dark bars generally less than half the width of the light areas; its lamellae on the fourth toe number 29-29. In both these characters it resembles *u. amphigramma*.

TABLE 11. Variation in *A. u. amphigramma*

Character		Counts	Range	Average
Femoral pores, one side	♂♂	88	14–23	17.6
	♀♀	92	14–20	16.4
Lamellae on 4th toe		187	24–33	27.7
Rows of gulars		95	5–8	5.9

While the type and two paratypes, all adult males, from this same locality have the typical pattern of *u. amphigramma*, they do have fewer lamellae (27-28, 27-?, 27-28) than most *u. amphigramma*, but like most (88%) *u. stuarti*.

These five specimens as a group definitely appear to represent an intergrading population between these two races. The most outstanding feature of *u. amphigramma*, the pattern, is apparently typical of the population.

It is unfortunate that the type locality lies within an area of intergradation, but obviously the intergrades approach the northern race, which we defined and intended to name, much more closely than the southern (*u. stuarti*).

Thirty-three specimens from very near the type locality, at Cuatotalapam (UMMZ 41422-41442, 41444-41454) and Lake Catemaco (UMMZ 41443), Veracruz, agree well with the types in pattern. There are 16 males, of which all but one are of large or moderate size. The smallest (43 mm. snout to vent) shows only faint evidence of a dorsolateral dark band (in the neck region), and has a faint upper lateral light stripe. In the other males, nine have continuous upper lateral light stripes, and five have the stripes broken by a few very narrow dark lines. In one the upper lateral light spots are small and separated from each other by dark spaces as broad as the light spots, or broader. Of the seventeen females, nine show evidence of an upper lateral light stripe; all these are 67 mm. or more in snout-vent length. The other females, which lack any evidence of an upper lateral light stripe, are smaller, 70 mm. or less in snout-vent length. Two show a fairly distinct dorsolateral dark stripe, but no other specimens, male or female, possess them, even though one female measures only 38 mm. snout to vent. Many females do, however, possess numerous dark spots which may represent the dorsolateral dark stripe, since they border the dorsolateral light stripe medially. This lot of specimens approaches *u. stuarti* in some characters, as in the occasional presence of a dorsolateral dark stripe and in a reduced number of fourth toe lamellae. There is no question whatever, on the other hand, that they represent a population essentially like *u. amphigramma*, and but little diluted by *u. stuarti*. An excellent description of the color in life of this series is given by Ruthven (1912: 320-322), who calls attention to the distinct upper lateral light stripe in males.

The two juvenile paratypes from Matias Romero, Oaxaca, have the low lamellar count (24-24, 27-27) of *u. stuarti*, although in other respects they are typical of *u. amphigramma*. This may indicate an intergradient character for this population.

Four specimens (EHT-HMS 11955-8) from Rodriguez Clara, Veracruz, some 70 kilometers south of the type locality, probably can also be considered as intergrades. The single adult is a female with relatively large upper lateral light spots, which are to be sure narrower than the dark spaces between them, but on the other hand broader than in typical *u. stuarti*. The other three specimens are juveniles with the typical paradorsolateral dark stripes of *u. stuarti*. The lamellae on the fourth toe are intermediate between the expected counts: Two have 29-29, 29-?, as in the northern race, while the others have 26-26, 27-27 as in the southern. In view of the pattern of the female, the intermediate nature of the lamellar counts, and the expected pattern of adult males as based on specimens known from the nearby type locality, we allocate the specimens, tentatively, to *u. amphigramma* although the population represented is undoubtedly an intergrading one.

Forty-four other specimens from central Veracruz at Matacabresto (UMMZ No. 88647), the vicinity of Potrero Viejo (UMMZ Nos. 85407 (5), 85408 (13), 85409 (4), 88648-9, 89325, EHT-HMS No. 19582), and Tierra Colorada (EHT-HMS Nos. 11968-76, 11978-81), have been examined since the original description was written. They are essentially similar to those previously recorded and described from this area.

The largest specimens examined measure 101 mm. in females, 105 mm. in males.

The extreme southeastern record for the race is one now to be considered dubious. It consists of a single specimen (USNM

TABLE 12. Comparisons of *A. u. amphigramma* with *A. u. stuarti*

CHARACTER		*amphigramma*	*stuarti*
Lamellae on 4th toe	....	28 or more 54.6%	27 or less 87.5%
Pattern	dorsolateral dark stripe	absent	well developed
	upper lateral light stripe	present or represented by spots over twice width of intervening spaces	absent or spots very narrow
Gulars	No. of rows	6 or less 76.5%	7 or more 56.9%

117350) recorded by Smith (1944) from La Venta, fifteen miles southeast of Tonalá, Tabasco. This specimen, not reëxamined, is said to have 21-21 femoral pores and 30-32 lamellae. Such counts do occur in *u. amphigramma*, but not in *u. stuarti* to our knowledge, in which 18 femoral pores and 30 lamellae are the recorded maximum. We accordingly refer it tentatively to the former race.

Comparisons. Variation and comparisons with *u. stuarti* are given in Tables 11 and 12.

*Ameiva undulata thomasi** subsp. nov.

(Pl. 1, Fig. A)

Holotype. Adult male, EHT-HMS No. 15327, from La Libertad, Chiapas, near Río Cuilco where it crosses the Guatemalan border; collected by Henry D. Thomas.

Paratypes. Eight, including seven topotypes (EHT-HMS Nos. 15323-15326, 15328-15330) and one labeled "Chiapas" and probably from the same locality (EHT-HMS 15374); all collected by Henry D. Thomas.

Diagnosis. A member of the *undulata* group possessing paired preanals, abruptly enlarged gulars, lacking a secondary row of superciliary granules, and with supraoculars broadly contacting the frontoparietals. The adult male pattern differs from that of all other forms of *A. undulata,* in having the upper lateral light spots merged with the dorsolateral light line to form a continuous light band, the dorsal border of which is regular, the ventral irregular and giving rise to the vertical light bars. Possibly differs from *u. stuarti,* the most closely related form, in having more numerous lamellae under the fourth toe (75.5% with more 28 or more). Differs from all other races in that the extreme lateral gulars are enlarged.

* Named for its collector, Henry D. Thomas, who also was a field companion of the senior author in México during the summer of 1936.

Description of type. Scutellation typical except as below: Three supraoculars, the posterior two separated from the superciliaries by a single row of granules; central gulars normal with a regular median row of abruptly enlarged scales; lateral gulars enlarged; largest mesoptychial narrower but longer than largest median gular, approximately the same area; 32 ventrals from gular fold to preanal region; six rows of preanals each consisting of paired scales; femoral pores 20-20; lamellae under fourth toe 29-29.

Snout to vent, 82 mm.; tail regenerated; hind leg, 57 mm.; foreleg, 29 mm.; snout to gular fold, 29 mm.; snout to anterior margin of ear, 21 mm.

Middorsum bluish-gray, flecked with very small, lateral dark spots which tend to form two rows, beginning on rump and disappearing at the level of the shoulders; dorsolateral dark stripe faintly evident, bordered laterally by a broad continuous light line formed by the merging of the dorsolateral light line with the upper lateral light spots between the axilla and groin; anterior to the level of the shoulder the dorsolateral light line continues, normal in width, to the posterodorsal border of the eye; the ventral border of the broad light line is irregular, giving rise to short, light vertical bars which are half as broad as the intervening dark spaces or less; ventrally the vertical light lines meet the lateral light line which is occasionally broken. Ventrum discolored.

Variation. Males show some variation in the dorsolateral light band. In one specimen the pattern is completely typical; in the other two, the upper lateral light spots have merged with the dorsolateral light line, which is very narrowly broken at irregular intervals. In all three the dorsal mottling closely resembles that of the type, and the upper vertical light lines are one-half as broad as the intervening dark spaces or less.

In the five available females, in all but one the lateral light spots are greatly reduced and only faintly evident. In these four specimens, there appears to be no tendency whatever of these spots to merge with the dorsolateral light line which is completely distinct. In the other specimens the upper lateral light spots are well developed anteriorly and medially, laterally fusing with each other but narrowly separated from the dorsolateral line; posteriorly they are reduced as in the other females. In all specimens the dorsolateral dark line is faintly evident and the lateral line is broken into a series of small, rounded or ovoid light spots. In all but one specimen, in which it is well-developed posteriorly, the dorsal mottling resembles that of the males.

TABLE 13. Variation in *A. u. thomasi*

NUMBER	Sex	Femoral pores	Lamellae under 4th toe
15323	♀	16–18	26–?
15324	♀	16–17	27–29
15325	♂	16–17	28–29
15326	♀	14–16	30–30
15327	♂	20–20	29–29
15328	♀	16–18	25–26
15329	♀	16–16	29–29
15330	♂	17–19	29–30
15374	♂	18–19	28–29
Average	♂, ♀	17.2	28.4

The largest male measures 92 mm. snout to vent, the largest female 78 mm.

Variation in femoral pores and lamellar counts are given in Table 13. The central gulars are abruptly enlarged and arranged in a single median row in all the specimens. In only one male one of the median gulars is split. All the specimens possess the enlarged lateral gulars.

Comparisons. The present race is distinguishable from *u. dextra*, *u. sinistra*, and *u. undulata* in its possession of a complete double row of preanal scales; from *u. parva* in lacking an accessory row of granules between the supraoculars and superciliaries; from *u. hartwegi* and *u. gaigeae* in possessing abruptly enlarged median gulars; and from *u. podarga* in possessing regular median gulars. From *u. amphigramma* and *u. stuarti*, its closest relatives, and all other Mexican forms of *Ameiva undulata*, *u. thomasi* differs in having the upper lateral light spots merged with the dorsolateral light lines to form a continuous broad light line. Possibly the present race also differs from *u. stuarti* in having more lamellae under the 4th toe (28 or more 76.5%). Another character of considerable importance separating *u. stuarti* and *u. thomasi* is the nature of the dorsolateral dark stripes. In the former they are well developed, only very faintly evident in the latter. Although in most scutellation characters *u. thomasi* resembles *u. amphigramma*, the difference in the make-up of the broad light line coupled with the geographic isolation of the two forms from each other warrants segregation. Comparisons with *u. stuarti* are given in Table 14.

Range. The race probably occurs in all the dry, hot valleys of the upper tributaries of the Río Grijalva in the interior of Chiapas and of western central Guatemala.

TABLE 14. Comparisons of *A. u. thomasi* with *A. u. stuarti*

CHARACTER		*thomasi*	*stuarti*
Lamellae under 4th toe,	....	28 or more 76.5%	27 or less 87.5%
Pattern..............	dorsolateral dark stripes	reduced	well developed
	upper lateral light spots in males	present, fused with dorsolateral light line	absent

Localities. We have seen specimens only from the type locality, but Stuart (1943: 21) records a specimen, referred to *A. u. stuarti,* from Nentón, Guatemala, which undoubtedly belongs to this race. We know of no other localities.

Ameiva undulata stuarti Smith

(Fig. 1B; Pl. 1, Fig. B)

Ameiva undulata stuarti Smith, 1940: 55-56 (type locality Palenque, Chiapas; type U. S. Nat. Mus. No. 108601).

Diagnosis. The salient features of this race include the small size, the paired preanals, the single row of abruptly enlarged, numerous (6-8) median gulars, the reduced number of lamellae on the fourth toe (22-30, average 25.5, 27 or less 87.5%) and of femoral pores (13-18, average 15.5, 17 or less 97.3%), and the presence of well-defined dorsolateral dark stripes (except in some adults). There are no upper lateral light stripes or spots.

Range. Atlantic slopes of México from the middle of the Isthmus of Tehuantepec eastward in the lowlands to the southern borders of Laguna de Términos and to Tenosique, Tabasco; southward up the valley of the Río Grijalva at least as far as Tuxtla Gutiérrez, Chiapas.

Localities. We have examined 107 specimens from Palenque and San Ricardo, Chiapas; Tenosique, Tabasco; Balchacaj and Tres Brazos, Campeche. We have taken data on most of this series. Records for other localities include Frontera and Teapa, Tabasco (USNM).

Discussion. Variation in femoral pores, lamellae on the fourth toe, and in the central gulars is given in Table 15.

TABLE 15. Variation in *A. u. stuarti*

Character		Counts	Range	Average
Femoral pores, one side		73	13–18	15.5
Lamellae on 4th toe		72	22–30	25.5
Gulars	No. of rows	58	6–8	6.7
	No. of scales regular	58	3–8	6.1

This race possibly intergrades with *u. hartwegi* and *u. gaigeae* toward the west (see Table 5). Intergrades with *u. amphigramma* are discussed with that form (Table 12).

In spite of the close proximity of localities from which *u. hartwegi* and *u. stuarti* are known, we have seen no incontrovertible intergrades between the two. If intergradation does occur, it must be restricted to a very narrow belt. There appears to be a sharp difference in ecological preference, *u. stuarti* preferring the mixed scrub-savanna coastal areas, while *u. hartwegi* prefers the dense, high, inland forests. The specimens from Campeche do approach *u. hartwegi,* since the dorsolateral dark stripes are somewhat variable; otherwise the specimens are typical. Eastward, southeastward, and probably southward also, it meets *u. hartwegi* in the dense inland forests and foothills. Toward the west it meets *u. amphigramma* near the isthmus of Tehuantepec which presumably is occupied by intergrades. The specimens from San Ricardo indicate the extension of the race up to the valley of the Río Grijalva into the lower portion of the Chiapas plateau. No trend whatever toward *u. parva*, which occurs not far from San Ricardo across the Sierra at Tonalá, is evident in these specimens, which include an adult male and female, and a juvenile male. There is no visible approach toward the characters of *u. thomasi*, although intergrades may well occur.

Ameiva undulata parva Barbour and Noble

(Fig. 1A; Pl. 2, Fig. A)

Ameiva undulata parva Barbour and Noble, 1915: 476-477 (type locality Guatemala, here restricted to Mazatenango; type MCZ No. 5831).

Diagnosis. This race, possibly the most ornate of Mexican forms, is characterized by having paired preanals, a median row of about 6 or 7 abruptly enlarged gulars, generally a complete or incomplete accessory row of granules between supraoculars and superciliaries, generally the third supraocular separated from median head scales by its full length; femoral pores rather few, averaging 15.5 in females, 17.2 in males; lamellae on 4th toe average 29.1; dorsolateral light lines relatively well defined in all specimens, even adult males; upper lateral dark zone broken in adults (both sexes) by vertical light lines which tend to reach the dorsolateral light line and expand somewhat *below* its level at the position of the upper lateral light line (as most other *undulata*); young lined, lacking a dorsolateral dark line. The dorsal spotting is rather variable, but tends to be prominent. The tail is brightly marked below with blue, in adults.

Range. Pacific slopes from the Isthmus of Tehuantepec in Oaxaca, near Niltepec, southeastward to Costa Rica.

Localities. We have examined 377 specimens from the following localities: *Oaxaca:* near Niltepec (EHT-HMS Nos. 27505-27506). *Chiapas:* Tapachula (EHT-HMS Nos. 11917-11924, 15130-15135); Tonalá (HMS Nos. 18728-18787, 18990-19010); La Esperanza (near Acacoyaqua) (HMS Nos. 13485-13516, 13591-13615, 13699-13730, 13877, 13937-13994, 14056-14085, 14098-14099, 14141-14155, 14228-14272, 14407-14413, 14425, 15626, 17424-17425); Cruz de Piedra, Las Nubes, Salto de Agua, Finca Juárez, and Colonia Soconusco, all in the vicinity of La Esperanza (HMS Nos. 14506, 14592-14596, 15276, 15940-15941, 16655-16659, 17398). Data have been taken only on the Niltepec intergrades and twenty-five specimens of each sex from Tapachula (all specimens) and the vicinity of La Esperanza. Tabulated data excludes the intergrades. The only other locality known to us is Huehuetán, *Chiapas,* represented by two specimens in the U. S. National Museum.

Discussion. The secondary row of small scales between the supraoculars and superciliaries, a character which has been accepted as the chief peculiarity of *u. parva,* is subject to some variation. In only six specimens (of 49) are there two complete rows (*i. e.,* to the posterolateral border of the first supraocular); in others the secondary row varies in length from complete absence nearly to the extreme condition of full length. For convenience in tabulation we arbitrarily allocated every specimen to one of five conditions: absence of secondary row (0), secondary row extending to a point at one-half the length of the third supraocular (½), the full length of the third supraocular (1), to a point at one-half the length of the second supraocular (1½), and the full length of the second supraocular (2). Variation in length of the row of small scales between the supraoculars and median head scales, another character which has been considered of considerable significance in *u. parva,* was similarly tabulated. Results of these tabulations as well as femoral pore and lamellar counts are given in Table 16. They verify the value of the supraocular characters in defining *u. parva*.

TABLE 16. Variation in *A. u. parva*

CHARACTER		Counts	Range	Average
Femoral pores, one side	♂♂	49	15–21	17.2*
	♀♀	49	13–19	15.5
Lamellae on 4th toe		97	26–33	29.1
Granules between supraoculars and superciliaries†		49	0–2†	1
Granules between supraoculars and median head scales†		50	½–2†	1

* Slevin (1942: 460) records the counts of 572 thighs: his range is 11 to 21, two greater than that recorded here. The average, sexes combined, was 16.2, extremely close to our average, 16.35.

† See text for explanation.

The race is of about the same size as most forms of *undulata*, the largest male measuring 109 mm. snout to vent, the largest female 95 mm. It is markedly smaller than *u. undulata* or *u. hartwegi*, and larger than *u. stuarti*.

Two specimens from "between Niltepec and La Gloria," Oaxaca (EHT-HMS 27505-6), while similar to *u. parva* in most respects, resemble *u. undulata* in others and are accordingly, we think, to be considered intergrades. One (No. 27506) is a juvenile female measuring 52 mm. snout to vent. There are four rows of preanals, the last of which consists of paired scales; there are 15-15 femoral pores; the median mesoptychial is enlarged; and the dorsolateral light spots are large and somewhat wider than the dark inner spaces. There is an incomplete second row of granules between the posterior supraoculars and the superciliaries. Likewise the last supraocular is almost completely separated from the median head scales and two or three small scales are intercalated between the other supraoculars and the median head scales. Except for the character of the preanals this specimen resembles *u. parva*.

The other specimen is an adult male measuring 91 mm. snout to vent. There are five rows of preanals, all the median scales of which are paired; there are 18-18 femoral pores; the median mesoptychials are small; the dorsolateral light spots are large and conspicuous, subequal in width to the spaces between; and the dorsal spotting is greatly reduced, nearly absent. There is a very incomplete secondary row of granules consisting of only 3-4 scales, between the supraoculars and the superciliaries; and the last supraocular is broadly in contact with the frontoparietal. The character of the preanals, the upper lateral spotting, and the additional granules between supraoculars and superciliaries clearly are typical of *u. parva;* while the absence of dorsal spotting, the small median mesoptychials, and very broad contact of the last supraocular with the median head scales are typical of adult males of *u. undulata.*

Both specimens clearly approach *u. parva* more closely than *u. undulata* although certain characters parallel those of the latter race. In considering them as representatives of an intergrading population we emphasize that they are nearly typical *u. parva.* This locality is the nearest to the range of typical *u. undulata* from which specimens of *u. parva* have been taken.

The exact locality is open to some doubt, yet is of considerable importance since Niltepec is on the Pacific slopes at an elevation of about 200 ft.; while La Gloria is on the Atlantic at about 1,500 ft. They are separated from each other in a straight line by the Sierra Madre, which there reaches an elevation of somewhat more than 4,500 ft. We assume in referring these specimens to *u. parva* that they were taken on the Pacific slopes, for *u. stuarti* is to be expected on the Atlantic slopes. We do not believe that these specimens involve *u. stuarti* or *u. amphigrammma* (which at this point are completely isolated by the Sierra Madre from the Pacific coast), since none of the unique characters and few of the general characters are possessed. The brown bands bordering the dorsolateral light stripes medially, which are universally present in *u. stuarti,* are here absent, One specimen has a nearly complete row of median preanals, a condition never occurring in *u stuarti* or any other Atlantic coast form; and the large upper lateral light spots are never found in *u. stuarti.*

Comparisons. This race is unique in the possession of a secondary row of small scales between the supraoculars and superciliaries and in the considerable extent of the row of small scales forward between the third supraocular and median head scales.

*Ameiva undulata dextra** subsp. nov.

(Fig. 2C)

Holotype. Adult male, EHT-HMS No. 11966, near Rincón, Guerrero, collected by Edward H. Taylor and Hobart M. Smith, 1932.

Paratypes. Thirteen, including three topotypes (EHT-HMS Nos. 11964-5. 11967); one from Organos, Guerrero (EHT-HMS No.

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* In reference to the occurrence of this form on the right (southern) watershed of the Río Balsas.

11963); one from El Treinta, Guerrero (EHT-HMS No. 11683); three from Acapulco, Guerrero (EHT-HMS Nos. 11680-2); and five from 8 kilometers east of Coyuca, Guerrero (HMS 5234-8). All those in the EHT-HMS collection were secured by the same collectors and at the same time as the type; those in the U. S. National Museum (HMS) were collected February 7, 1939, by Hobart M. and Rozella Smith.

Diagnosis. Related to *u. undulata* and *u. sinistra,* having essentially a single median row of preanals, and a median row of enlarged gulars. Differs from *u. undulata* in pore counts and in preanal rows: in males femoral pores generally 19 or more on one side (73%), 38 or more on both sides (86%); in females femoral pores usually 17 or more on one side (62.5%), 34 or more on both sides (50%); 5 rows of preanals or less (100%). Differs from *u. undulata* and *u. sinistra* in having the last preanal divided generally (85.8%) and in pattern; lateral markings showing little tendency to be arranged vertically; upper lateral light spots in males tending to form a continuous broad band; and back little mottled.

Description of type. Head scales typical; frontonasal separated from both rostral and frontal, broadly in contact laterally with postseminasal; four supraoculars, anterior in contact with frontal and narrowly with loreal, posterior very small; one row of small scales between three posterior supraoculars and superciliaries; third supraocular very broadly in contact with frontoparietal, latter very narrowly in contact with second supraocular; only three small scales extending forward from posterior corner of supraorbital disc adjacent to the parietal and interparietal, completely separating the last supraocular from these scales; interparietal single, half as large as parietals; two rows of large flat scales posterior to parietals; three suboculars; one frenocular; one preocular; five supralabials to below middle of eye, two following; five infralabials; one undivided postmental; five chinshields on either side, separated from posterior three infralabials by two rows of smaller scales; central gulars enlarged, very irregular;† enlarged mesoptychials larger than median gulars, extending laterally nearly to level of arm insertion.

Dorsals subgranular, subconical, slightly mucronate; ventrals in eight longitudinal rows, thirty from gular fold to preanal region; five rows of preanals, each of the anterior four with an enlarged median scale, posterior row consisting of enlarged paired scales;

† This is an anomaly; in others the gulars are enlarged and in a regular median row.

largest preanal slightly smaller than largest mesoptychial; femoral pores 20-21; lamellae under fourth toe 28-29.

Two rows of radials, anterior smaller; two rows of humerals, posterior smaller; one row of postbrachials; three rows of tibials, posterior much the smallest, anterior somewhat the largest.

Snout to vent, 84 mm.; tail, 205 mm.; hind leg, 62 mm.; foreleg, 32 mm.; snout to gular fold, 30 mm.; snout to anterior margin of ear, 22 mm.

Ground color dull yellowish-brown; dorsolateral light stripe very faintly evident, broken over most of its length into small spots; a narrow, irregularly serrate-edged, dark brown band bordering this laterally; lateral to this a broader, light blue, upper lateral stripe beginning on shoulder and disappearing at base of tail, with irregular edges, bordered laterally by a dark brown area similar to that which borders it medially; lateral ground color merging with the lateral dark border of the upper lateral light stripe; numerous small, light bluish spots on sides, tending more or less to be arranged in vertical series; middorsum uniform; no distinct markings on head; limbs with irregular, very feeble light spots above. Venter discolored.

TABLE 17. Variation in *A. u. dextra*

CHARACTER		Counts	Range	Average
Femoral pores, one side	♂	15	15-21	19.1
	♀	9	15-19	16.6
Femoral pores, total	♂	7	31-42*	38.6
	♀	4	30-35	32.5
Lamellae on 4th toe	♂	14	27-31	29.1
	♀	6	28-31	28.3
Row of preanals		13	4-5	4.4

* One aberrant specimen of the 7 available has a total count of 31 (15-16); all others have 38 or more.

Variation. Four adult males including the type are available: in two of these the upper lateral light stripes are continuous, while in the other two they are broken into large, more or less rectangular, or irregular spots separated from each other by short vertical dark brown streaks of varying width. The other four males, varying in snout-vent length from 48 to 60 mm., are similar to the adults except that the lateral pattern is not so clearly evident; the youngest is so discolored that no pattern can be discerned. One shows a developing continuous upper lateral light stripe similar to that of the type; in the other two that stripe is broken and there is a tendency in one to form fairly distinct vertical bars on the sides. Thus in three of the seven males in which this character is evident the upper lateral light stripe is continuous. The dorsolateral light stripes are very poorly defined, even in the smaller specimen.

Females possess a pattern essentially the same as that of the males, with the following differences. The dorsolateral light stripes are well defined throughout life, although more distinct in the shoulder region; their median borders are ill-defined, the lateral border sharply delimited. There is a distinct upper lateral dark zone between the dorsolateral and lateral light lines. In two specimens vertical bars are dimly evident in this zone, while in the others no markings are evident. The lateral light line is broken into a series of small, rounded or elongate light spots. The sides below this may either be uniform brownish or provided with small light blue spots arranged irregularly or tending to form vertical series.

The largest male measures 113 mm. snout to vent, the largest female 80 mm.

The median scales in the posterior row of preanals are paired in twelve specimens (excluding the type), single in two. In two specimens the median gulars are irregular, in one all except two are subdivided, while in all others there is a single regular median row. Variation in femoral pore, preanal and lamellar counts is indicated in Table 17.

TABLE 18. Comparisons of *A. u. dextra* and *A. u. undulata*

CHARACTERS		*dextra*	*undulata*
Femoral pores. . ♂♂	one side only	19 or more 73%	18 or less 81%
	total	38 or more 86%	37 or less 90%
♀♀	one side only	17 or more 62.5%	16 or less 76.7%
	total	34 or more 50%	33 or less 84.5%
Preanals.	number of rows	5 or less 100%	6 or more 65%
	5th (or last if less than 5)	divided 85.8%	entire 89.2%
Pattern.	lateral vertical bands	poorly developed, particularly in females	well developed, young and adult males and females
	middorsal markings	greatly reduced or absent	well developed
	continuous upper lateral light band in males	present in 43% (3 out of 7 specimens), represented by large, narrowly separated light blotches in the remainder (57%)	never present or represented by light spots as large as intervening dark spaces 100%

Comparisons. The present race is easily distinguishable from all the Atlantic coast forms of *Ameiva undulata,* as well as *u. parva,* by the essentially single row of preanals (in spite of the subdivision of the posterior scale), which character links it with *u. undulata* and and *u. sinistra.* Comparisons with the former are given in Table 18, and with the latter in Table 20.

Discussion. Four unique characters, within the group with a median row of preanals, define *u. dextra:* the divided posterior preanal, the absence of middorsal markings, the reduction of the lateral bars, and the presence of a continuous upper lateral light stripe. In all these respects *u. undulata* and *u. sinistra* are alike. The last possibly is not of sufficiently frequent occurrence to be a reliable indicator in itself, since less than fifty percent of known *u. dextra* males possess the stripe; yet in conjunction with the other characters it is of considerable importance since it is unknown in either of the adjacent races, and in fact is known elsewhere in *Ameiva undulata* only in *u. amphigramma.* In the latter race the stripe is of regular occurrence. Whether the partial parallelism of these two races in this character is coincidental or indicative of close relationship is not certain; we believe the former. In *u. undulata* the broad upper lateral band is usually not evident at all, even as isolated spots, while in *u. sinistra* large light spots are present in its position. Longitudinal extension of the spots would result in creation of a line typical of *u. dextra.* In the latter all adult males which lack the continuous line do at least have the large spots in its position.

It is unfortunate that so few *u. dextra* have been available. We believe that a larger series will reveal a more appreciable difference from *u. undulata,* particularly of females in femoral pore counts, than is apparent now (*cf.* Table 18). The number of rows of preanals is markedly different in the two races, but the extent of overlap is considerable; further data on *u. dextra* are required.

The nature of the dorsal and lateral markings is evaluated with some difficulty since there is no sharp distinction, and, moreover, an actual overlap of extremes in the two races. Vertical bars are, nevertheless, a conspicuous feature of *u. undulata,* even in the young, which usually (i. e., in most races of *undulata*) have no transverse markings. The usual condition obtains in *u. dextra,* few specimens showing marked transverse bars. The distinction between the two races in this character is most clearly evident in females; there is little postnatal ontogenetic change in specimens of this sex in *u. dextra.*

The dorsal spotting is not extensive in any specimen of *u. dextra,* although it is prominent in most *u. undulata,* with the exception of adult males.

Range. Southern slopes of the Sierra Madre del Sur of Guerrero and perhaps extreme western Oaxaca, below about 4,000 ft. above sea level. In addition to the types records are available of specimens from Juquila, *Oaxaca,* Chilpancingo (USNM), Cocoyul (Gadow), and Los Cajones (Gadow), *Guerrero.*

*Ameiva undulata sinistra** subsp. nov.

Holotype. Adult male, EHT-HMS No. 11908, from Manzanillo, Colima, collected by Hobart M. Smith, 1935.

Paratypes. Sixty, including 8 from Quesería, Colima (EHT-HMS Nos. 11906-7, 11946-8, 14499, 15121; UMMZ No. 80109); 20 from Hacienda Paso del Río, Colima (EHT-HMS Nos. 11909-16, 11949-51, 14500, 15122-9; UMMZ Nos. 80110, 80111 [3], 80112 [5], 80115 [3], 80120); Salvador (UMMZ No. 80116); Pascuales (UMMZ Nos. 80113 [3], 80114); and Periquillo (UMMZ Nos. 80117 [11], 80118 [2], 80119).

Diagnosis. Related to *u. dextra* and *u. undulata,* having a single row of median preanals (posterior sometimes divided, 37.7%), and a single median row of enlarged gulars. Differs from *u. dextra* in usually having all the median preanals entire (or at least the fifth is entire if there are more than five preanals), and in pattern: lateral vertical bars present in males, taking the form of a tigroid pattern (dark bars relatively widely separated); well developed middorsal markings; and no continuous upper lateral light band in males (although there is a tendency to form large light spots). Differs from *u. undulata* in pore counts, preanals and in pattern: in males femoral pores generally 19 or more on one side (54.4%), thirty-seven or more on both sides (63%); in females femoral pores usually seventeen or more on one side (81.2%), thirty-four or more on both sides (72.8%); five rows of preanals or less (95%); and in the presence of large upper lateral light spots in adult males.

Description of type. Similar to the type of *u. dextra* except as follows: Three supraoculars; interparietal asymmetrically split longitudinally; central gular scales normal with a median row of enlarged scales; largest mesoptychial subequal in size to median gulars; thirty-two ventrals from gular fold to preanal region; four

* In reference to the occurrence of this form on the left (northern) watershed of the Río Balsas.

rows of preanals, each of the anterior two rows consisting of a pair of scales, third row with one very large scale, larger than any mesoptychial or gular, fourth row with three scales, the central one twice as large as the others and approximately three-fifths the size of the preceding scale; femoral pores 18-19; lamellae under fourth toe 30-30.

Snout to vent, 90 mm.; tail 228 mm.; hind leg, 71 mm.; foreleg, 34 mm.; snout to gular fold, 33 mm.; snout to anterior margin of ear, 23.5 mm.

Middorsum bluish gray-brown, varied by small dark brown spots, largest posteriorly, beginning on rump and becoming gradually smaller anteriorly and disappearing at the level of the shoulders; these spots tend to form two rows; dorsolateral light stripe very dimly evident, bordered laterally by a continuous narrow dark brown band which varies in intensity in pigmentation; lateral to this is a longitudinal series of large, subquadrangular, bluish-white spots, each connected ventrally with one or more wavy, vertical, light blue lines which extend to the sides of the belly; the upper lateral light spots are separated from each other by dark bars one-half or one-third as wide as the light spots; these dark bars expand in width on the sides of the body.

Variation. Males show little variation in pattern. The smallest available (72 mm. snout to vent) possesses the typical adult pattern. The most conspicuous variation is in the size of the upper lateral light spots; in four specimens they are not or scarcely wider than the intervening dark spots, while in all the other twenty-four specimens the light spots are enlarged much as in the type.

TABLE 19. Variation in *A. u. sinistra*

CHARACTERS		Counts	Range	Average
Femoral pores, one side	♂♂	57	17–22	18.8
	♀♀	64	15–22*	17.5
Femoral pores, total	♂♂	27	34–43	37.7
	♀♀	33	31–42	35.1
Lamellae on 4th toe	♂♂	57	27–32	29.7
	♀♀	54	26–32	29.1
Rows of preanals		61	3–6	4.6

* Only one aberrant specimen has 22 pores on one side. All other specimens have 20 or less.

In females the dorsal mottling is somewhat better developed than in males; the dorsolateral light lines are somewhat more distinct; the upper lateral light spots are not or poorly developed; and the lateral light line, which is not or scarcely evident in males, is strongly indicated by a series of elongate spots; below this irregular, narrow, wavy, vertical light streaks may or may not be present.

The largest male measures 109 mm. snout to vent, the largest female 95 mm.

Variation in femoral pores, preanal and lamellar counts is given in Table 19. The central gulars are irregular in three specimens, but in all others they are arranged in a single, regular median row in which no more than one scale is divided, if any.

Comparisons. Like *u. undulata* and *u. dextra* the present race is distinguishable from all other forms of *Ameiva undulata* by the presence of a single median row of preanals. Comparisons with *u. undulata* and *u. dextra* are presented in the accompanying tables (Tables 20 and 21). The pattern characters which distinguish *u. sinistra* from *u. dextra* and *u. undulata* are perhaps the most important; in comparison with the former, the tigroid pattern of males is very distinctive, and equally striking in comparison with *u. undulata* are the large upper lateral light spots. Obviously the three races are very close, but since there are some very significant differences (which by themselves would not meet the minimum requirement of seventy percent recognition) in scutellation, in addition to those in pattern, we feel that the sum total of peculiarities characterize a population recognizably as well as genetically distinct. *A. u. sinistra* is physiographically isolated from other forms of *undulata*, being separated by the arid Balsas Basin from *u. dextra* and *u. undulata*, and by the plateau from other forms of the Atlantic coast. The isolation makes reasonable the divergence of *u. sinistra* and *u. dextra*, which probably would not remain even as feebly distinct as they are at present if no barrier existed between them.

Table 20. Comparisons of *A. u. sinistra* with *A. u. dextra*

Characters		*sinistra*	*dextra*
Preanals...	5th (or last if less than 5)	entire 62.3%	divided 85.8%
Pattern...	lateral vertical bands	well developed in adult males	poorly developed, particularly in ♀♀
	middorsal markings	well developed	greatly reduced or absent
	continuous upper lateral light band in ♂♂	never present	present in 43% (3 out of 7 specimens)

Range. Pacific coastal drainage from the arid Balsas Basin at

TABLE 21. Comparisons of *A. u. sinistra* with *A. u. undulata*

CHARACTER		*sinistra*	*undulata*
Femoral pores... ♂♂	one side only total	19 or more 54.4% 37 or more 63.0%	18 or less 81% 36 or less 75%
♀♀	one side only total	17 or more 81.2% 34 or more 72.8%	16 or less 76.2% 33 or less 84.5%
Preanals............	number of rows	5 or less 95.0%	6 or more 65%
Pattern.............	upper lateral light spots in adult males	large, wider than intervening spaces 83.3%	small, narrower than intervening spaces in all males 100%

the border of Guerrero and Michoacán northwestward at least to Jalisco, and perhaps farther; the northern drainage of the Río Balsas, at lower elevations and in humid localities, from Michoacán to Puebla. It is completely isolated from *u. dextra,* its closest relative both geographically and taxonomically, by the extremely arid valley of Río Balsas. Aside from the 61 in the type series, specimens have been recorded from Tenacatita and Tenacatita Bay, *Jalisco;* Colima, *Colima;* Uruapan, *Michoacán;* and Chiautla, *Puebla.* The U. S. National Museum has specimens (not examined) from Ixtapa, *Jalisco,* and Puente de Ixtla, *Morelos.* All of the specimens from the southern part of the range of *u. sinistra* are of special interest; their allocation with this race is tentative.

Ameiva undulata undulata (Wiegmann)

(Fig. 2B)

Cnemidophorus undulatus Wiegmann, 1834: 27 (type locality, México by inference; restricted to Tehuantepec by Smith 1940: 56).

Diagnosis. A member of the *undulata* group of *Ameiva,* with usually one row of preanals (89%), a median row of abruptly enlarged gulars, one row of granules between supraoculars and superciliaries, third supraocular generally at least partly in contact with median head scales. Most closely similar to *u. dextra* and *u. sinistra,* differing from them in the following: reduced number of femoral pores, greater number of rows of preanals, lack of division of the last preanal (from *u. dextra* only), presence of tigroid lateral marks, presence of well-developed middorsal markings (from *u. dextra* only), and reduction of the size of the upper lateral light spots.

Range. The Pacific slopes of the Isthmus of Tehuantepec in Oaxaca, as far west as Puerto Angel and eastward about to Niltepec.

Localities. A series of thirty-seven specimens has been examined from the following localities, all in Oaxaca: El Limón (USNM No. 18383); Palmar (USNM Nos. 18543-6, 185438); Tres Cruces (USNM Nos. 12052-7, 12392-5, 12499-12508, 16278-87, 18541-2). In addition, two intergrades with *u. dextra* are available as follows: one (EHT-HMS No. 27516) is from San Felipe Lachillo, Oaxaca; and the other (EHT-HMS No. 27523) is from Finca Mirador, between San Felipe Lachillo and San Juan Guivini, Oaxaca. Records for localities other than those cited above are as follows: Cafetal Concordia (USNM), Juchitán (USNM), Puerto Angel (USNM), Totontepec (USNM), Tehuantepec (USNM), and Ranchería La Manga (UMMZ), all in *Oaxaca.* Of particular importance are those from Cafetal Concordia and Puerto Angel, which probably are intergrades with *u. dextra,* as indicated by the existence of intergrades nearby at San Felipe Lachillo; they may well approach *u. dextra* more closely than *u. undulata,* however, and be referable to the former race.

Coloration. The salient features of the pattern in males are as follows: young with numerous middorsal dark spots decreasing in size and number anteriorly; in adults these spots disappear completely or nearly so; dorsolateral light stripes not evident except feebly in juveniles; upper lateral dark stripe broken by narrow vertical light streaks narrower than, or not more than subequal to the dark spaces between; even in the youngest specimens the dark band is as described for the adults; sides with irregular light markings or with narrow vertical light lines which frequently are fused with the light streaks in the upper lateral zone, forming a rather bold, barred pattern of alternating broad dark bands and narrow light streaks. Throats suffused with orange.

There appears to be less sexual dimorphism in this race than in any other in México in dorsal pattern. The middorsal spotting is more prominent in the females and does not disappear in the adults.

TABLE 22. Variation in *A. u. undulata*

CHARACTERS		Counts	Range	Average
Femoral pores, one side	♂♂	42	14–20	17.4
	♀♀	26	13–18	15.5
Femoral pores, total	♂♂	20	29–29	35.
	♀♀	13	27–35	31.
Rows of preanals		37	4–7	5.8

The sides, however, are marked much as in the males, although perhaps more dimly. In females the throat is not marked with orange.

Scutellation. There is a strong tendency for the gulars to be arranged in a single median row. The median preanals are arranged in a single row, with the exception of the posterior scale which is frequently divided (52%). Hartweg and Oliver (1937:7) record that there is a single row of median, enlarged, preanal scales . . . in . . 91.5 percent of their specimens (47). The discrepancy between their percentage and ours can be attributed to the difficulty of determining which is the last row of preanals. Preceding the anus is one row of small scales varying greatly in size, sometimes nearly equalling the other preanals. They vary more in disposition than the others, as indicated by our counts. To eliminate the variation caused by consideration of the small posterior row we have arbitrarily selected the 5th row from the abdominals as the critical one, disregarding the form of the following rows. Thus the fifth (or the last if less than five) median preanal is entire in 33 out of our 37 specimens (89.2%).

Our largest male slightly exceeds Hartweg and Oliver's (1937:7) figure, measuring 116 mm. snout to vent. Their maximum measurement for females (95 mm.) remains the record.

Variation in the number of femoral pores and preanal rows is presented in Table 22.

Intergradation. The specimens from near San Felipe Lachillo combine certain characters of *u. undulata* and *u. dextra*. They resemble *u. dextra* in number of femoral pores (20-21 male, 16-18 female). The female (No. EHT-HMS 27523) has only four rows of preanals, and in the male the posterior two preanals are paired. However, they resemble *u. undulata* since in the female the preanals are undivided, and in the male there are six rows. The pattern also resembles that of *u. undulata;* the sides in both are strongly barred with wide, dark bands, and the middorsal area is strongly spotted. We regard these specimens as approaching *u. undulata* more closely than *u. dextra*.

Ameiva festiva edwardsii Bocourt

Ameiva edwardsii Bocourt, 1873: 1-2 (type locality Izabal and Santa-María de Panzos near Río Polochic, Guatemala; cotypes in Mus. Hist. Nat. Paris).

Diagnosis. Most closely related to *f. festiva* but differing from that race in having the most posterior sublabial scale divided into three scales which form a rough triangle. Differs from *A. undulata* in having the outer row of ventrals considerable smaller than the others; in possessing fewer enlarged median gulars; in having one extremely enlarged median preanal; and in possessing two rows of distal tibials.

Range. Atlantic foothills from southern México (Tabasco) through Honduras, in heavy forests.

Locality records. We have examined 49 specimens from the following localities: Piedras Negras, Petén, Guatemala; Palenque, Chiapas, and from Chiapas just across the border from Piedras Negras. The only other locality record for this race in México is Ixtacomitán, Chiapas (Dugès, 1894).

Discussion. The original diagnostic characters proposed by Bocourt (1873) were proven by Stuart (1943) to be fallible. However, Stuart was able to diagnose the race on the character of the posterior sublabial.

Of the 42 USNM specimens we have examined, in only one is the posterior sublabial entire (one side). In five specimens it is divided into four scales, and in another five it is divided into two. Variation in femoral pores and lamellae under the fourth toe is given in Table 23.

TABLE 23. Variation in *A. festiva edwardsii*

CHARACTER		Counts	Range	Average
Lamellae under 4th toe		69	23–33	29.4
Femoral pores	♀♀	40	19–23	20.25
	♂♂	34	19–22	20.6

The species differs so remarkably from *undulata* that the relationship cannot be close. There are several rows of small scales between the posterior part of the frontoparietals and the supraoculars; the gulars are extremely large; there is but one row of enlarged mesoptychials; the distal preantebrachials are in one row; there is but one row of prebrachials; there are but two rows of large tibials; the femorals are large and fewer; the preanals extremely large and not grading into the much smaller adjacent scales; the ventrals in the lateral row are small; the postantebrachials are smaller; and there are various other peculiarities, less easily described.

There is surprisingly little dimorphism in dorsal and lateral pattern. In both sexes the juveniles are dark brown with a conspicuous, broad, light blue middorsal stripe extending from the rostral to the rump, where it fades. The edges of the stripe from the shoulder region posteriorly are wavy. A fine dorsolateral light stripe extends from the head in line with the superciliaries to the tail; it is discontinuous usually, broken into numerous short lines. A discontinuous lateral light line extends from the upper postocular region above the tympanum to the upper edge of the groin. In the shoulder and axillary regions a number of vertical light blue bars extend from the level of the forelimb to the lateral light stripe.

This pattern remains constant throughout life except for the middorsal light band, which gradually becomes fainter until it disappears in specimens measuring about 95 mm. snout to vent. The dark color originally occupying all the area between the dorsolateral light lines and the middorsal stripe decreases in extent and forms a row of dark spots on either side, each spot marking the approximate position of an indentation into the middorsal stripe. The spots remain as long as the middorsal stripe is evident, but finally disappear. The ground color between the dorsolateral light stripes is then light brown. The color remains dark between the dorsolateral and lateral light lines, but the sides below the latter become lighter, like the middorsum.

Males are bluish below and no doubt in life are strikingly different from females in the entire ventral color, but the preserved material examined is so discolored that no accurate description of differences in ventral color can be given.

Males appear to have wider heads and more slender bodies than females.

SUMMARY

1. Ten forms of *Ameiva undulata*, six of which are new, and one form of *Ameiva festiva* occur in Mexico:
   a. *Ameiva undulata hartwegi* Smith
   b. *Ameiva undulata gaigeae subsp. nov.*
   c. *Ameiva undulata podarga subsp. nov.*
   d. *Ameiva undulata amphigramma* Smith and Laufe
   e. *Ameiva undulata stuarti* Smith
   f. *Ameiva undulata thomasi subsp. nov.*
   g. *Ameiva undulata parva* Barbour and Noble
   h. *Ameiva undulata dextra subsp. nov.*
   i. *Ameiva undulata sinistra subsp. nov.*
   j. *Ameiva undulata undulata* (Wiegmann)
   k. *Ameiva festiva edwardsii* Bocourt

2. Characters of primary importance in differentiating subspecies in *Ameiva undulata* are: (1) size and arrangement of the median gular scales, (2) arrangement of the preanals, and (3) separation of the third supraocular from the median head scales and, by two rows of granules, from the superciliary scales.

3. Characters of secondary importance are: (1) pattern, (2) number of lamellae under the 4th toes, (3) number of femoral pores, (4) the arrangement of the gulars, (5) the size of the lateral gulars, and (6) the arrangement of the preanals.

4. A tentative phylogeny of the four subspecific sections of *Ameiva undulata* is suggested.

5. The Matthew concept of peripheral dispersal of primitive forms is upheld insofar as it may be applied to a comparison of the end products of several lines of derivatives from common ancestors, but it is not applicable to evolution in single lines of derivatives, in which peripheral specialization is the rule.

6. Differentiation of all races of *Ameiva undulata* appears to have been accompanied by isolation, either *in situ* or by migration. The rate of differentiation appears to be the same in either case and is correlated chiefly with time.

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PLATE I

A. *A. u. thomasi*, EHT-HMS No. 13330. La Libertad, Chiapas.
B. *A. u. stuarti*, HMS No. 8798, Tenosique, Tabasco.
C. *A. u. amphigramma*, male, EHT-HMS No. 11983, Tierra Colorada, Veracruz.
D. *A. u. amphigramma*, female, EHT-HMS No. 11971, Tierra Colorada, Veracruz.

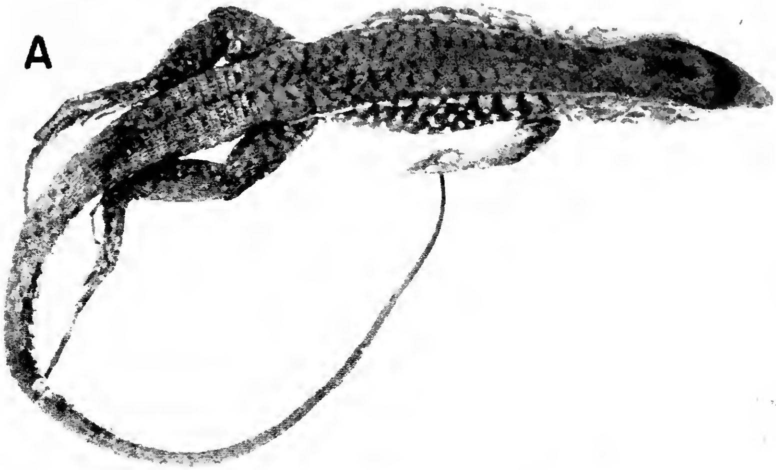
PLATE I

PLATE II

A. *A. u. parva,* EHT-HMS No. 11921, Tapachula, Chiapas.
B. *A. u. hartwegi,* HMS No. 7801, Piedras Negras, Guatemala.
C. *A. u. gaigeae,* EHT-HMS No. 11927, Progreso, Yucatán.

PLATE II

A



B

C

THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN

Vol. XXXI, pt. I.] May 1, 1946 [No. 3

Preliminary Notes and Speculations on the *Triseriatus* Group of Rattlesnakes in México

HOBART M. SMITH

Abstract: A new subspecies of rattlesnake, *Crotalus gloydi lautus*, is described from the states of Veracruz and Puebla, México; the type is in the U. S. National Museum, collected near El Limón Totalco, Veracruz. Brief diagnoses are given for the five subgroups of the *triseriatus* group of *Crotalus*, based upon scutellation and partly upon cranial characters. One theory of the phylogeny of the members of that group is discussed, and a possible means of reconciling the apparently opposing ideas of peripheral specialization and central specialization is suggested.

Recent collections from México of the small rattlesnakes comprising the *triseriatus* group have revealed the existence of a previously undefined species subgroup and have made possible a clarification of the relationships of the known forms of the entire group. All the forms of the subgroup of which I am aware have been described, save for one, whose description follows.

The material which furnishes the basis for these notes has been secured partly through the efforts of the members of the Department of Fish and Game at the Agricultural and Mechanical College of Texas; and partly by Dr. E. H. Taylor and myself. I am much indebted to Dr. W. B. Davis and Mr. Max M. Whisenhunt of Texas A. and M. College, and to Doctor Taylor, for permission to study their specimens. To Doctor Taylor I owe a double debt of gratitude for his generous counsel and innumerable other courtesies.

I

Crotalus gloydi lautus subsp. nov.

Holotype. U. S. Nat. Mus. No. 110598, collected by Dyfrig McH. Forbes at the lava beds about one kilometer east of El Limón Totalco, Veracruz, on March 1, 1940. *Paratypes.* E. H. Taylor-H. M. Smith No. 5475, same locality, collected by E. H. Taylor and

H. M. Smith, August, 1932. Texas Coöperative Wildlife Collection No. 822, Lago Salado, about five kilometers west of El Limón Totalco, in the state of Puebla, 8,300 ft., July 25, 1942, collected by S. H. Wheeler.

Diagnosis. A member of the *triseriatus* group with no subloreals; postseminasal* in contact with first and second supralabials; loreal generally (?) in contact with supralabials. Pattern of 41 to 44 small, oval spots in a middorsal series; belly nearly immaculate. Differs from *transversus* in having oval blotches instead of narrow crossbands and generally (?) in having the loreal in contact with the supralabials and the lower preocular divided. Differs from *gloydi* in having a larger postseminasal in contact with two instead of just one supralabial, and generally (?) in having the lower preocular in contact with the loreal.

Description of holotype. Adult male. Rostral moderate, portion visible from above about half as long as broad; two large internasals, narrower laterally than medially, length about two-thirds width; a pair of large, oval canthals, somewhat longer than broad, separated from each other medially by a single, elongate scale nearly as large as an internasal; supraocular flat, twice as large as a canthal, slightly longer than distance from end of snout; four scales in a transverse row between supraoculars behind canthals, two (somewhat larger) in the next row, and three in a third row; scales on head posterior to supraoculars nearly uniform in size.

Naris pierced at about the middle at the lower border of nasal; latter completely divided, upper portion of anterior section projecting far posterior to the level of the lower portion; postseminasal less than half size of preseminasal, broadly in contact with first supralabial, narrowly with second, and narrowly with internasal; loreal large, rounded, in contact with second supralabial, canthal, postseminasal, upper and lower preocular, and the anterior pit scale; upper preocular single, lower divided into anterior and posterior halves; scale bordering lower edge of pit wedged between preocular and lacrimal, narrowly separated from orbit; a single row of two scales between orbit and supralabials; two postoculars (on one side the lower postocular and posterior subocular are fused); length of orbit, 3 mm., half its distance from tip of snout. (Fig. 1.)

Supralabials 9-9, posterior border of orbit above the middle of the fifth; infralabials 9-9, the first of each side in contact medially; one pair of small chinshields.

* The terms subloreal, preseminasal and postseminasal are defined on p. 82; see, also, figs. 1-4.

Dorsal scales moderately strongly keeled, except those in the outer two rows; scale rows 21-21-15; ventrals 161; caudals 25, the posterior 3 paired. Total length, 480 mm.; tail length, 40 mm.; basal rattle, 5.5x3 mm.

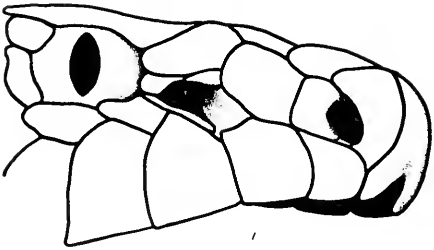
Dorsal surface pale brown, with 40 dark brown, black-edged median blotches on body, 7 on tail. The blotches are separated from each other by about 1½ scale lengths; they are nearly twice as broad as long, and cover about 2½ scale lengths longitudinally and about 6 or 7 transversely. A dorsolateral row of very indistinct, rounded spots alternates with the middorsal series, occupying the sixth and seventh scale rows. A lateral row of somewhat more distinct spots, alternating with those of the dorsolateral row (coinciding with those of the median row) occupies the 3d, 4th, and 5th rows. A sublateral row of dim spots, alternating with the preceding, occupies the 1st and 2d rows.

The only distinct headmarking is a dark postocular stripe disappearing a short distance back of the angle of the mouth and involving the upper portion of the supralabials; the edges of the band are well defined and straight, bordered with white below and with gray above. The top of the head is generally gray brown between the postocular stripes, varied only by a pair of dim darker spots in the anterior parietal region just back of the supraoculars. The snout, including the anterior supralabials, is dark gray, but the color fades below the eye so that the posterior supralabials are white except for the upper edges. The entire ventral surface of the head is very dark, and darkest on the chin.

Belly nearly white, with scattered dark stippling concentrated laterally. Subcaudal surface moderately darkly stippled.

Variation. In No. 5475, several of the small dorsal head scales are fused between and in front of the level of the orbits (Fig. 2). The lower preocular is divided as in the type, and the loreal bears much the same relation to other scales, except that it is in contact with the upper posterior border of the preseminasal, separating the postseminasal from contact with dorsal scales. The suboculars are in a single row as in the type, and the labials are the same. It is a young male, measuring 218 mm. snout to vent, the tail, 18 mm.; ventrals, 161; caudals, 24. Blotches as in type, 44 on body, 6 on tail.

No. 822 seems somewhat aberrant in certain respects. Two juxtaposed scales intervene medially between the canthals. The lower preocular is single, tapering anteriorly, and on one side is narrowly in contact with the loreal *inside* the pit (Fig 3); on the other side the scales are narrowly separated (Fig. 4).



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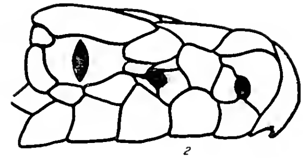

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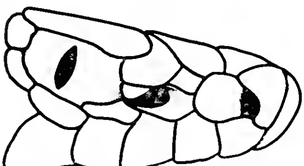

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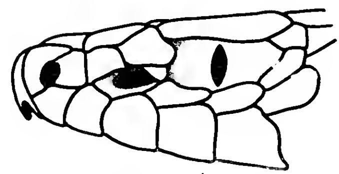

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FIG. 1. Lateral view of orbitonasal region of head of *C. g. lautus*. From USNM 110598, type.
FIG. 2. As in Fig. 1, from EHT-HMS 5475, paratype.
FIG. 3. As in Fig. 1, from TCWC 822, paratype, right side.
FIG. 4. As in Fig. 3, left side.

The loreal is greatly reduced on one side, where the postseminasal is greatly enlarged; on that side the pit scale contacts the nasal below the loreal, and the postseminasal contacts the canthal and internasal and is nearly as large as the preseminasal. On the other side the loreal is only slightly reduced, narrowly contacting the labials, but the postseminasal remains in contact with both canthal and internasal. The suboculars and labials are as in the type except 8 infralabials occur on one side. The specimen is a young female measuring 255 mm. snout to vent, the tail, 20 mm.; ventrals, 153; caudals, 20.

II

SUBGROUP COMPARISONS

Gloyd's recent monograph on *Crotalus* (Special Publ. Chicago Acad. Sci., No. 4, 1940, pp. i-viii, 1-270, pls. 1-31, maps 1-22, figs. 1-10) recognizes 7 forms in the 2 species of the *triseriatus* group, 5 belonging to *triseriatus*, and 2 to *lepidus*. The forms now known are as follows:

OMILTEMANUS SUBGROUP:

Crotalus omiltemanus Günther.
Crotalus gloydi gloydi Taylor.
Crotalus gloydi lautus subsp. nov.
Crotalus transversus Taylor.

PRICEI SUBGROUP:
- *Crotalus pricei miquihuanus* Gloyd.
- *Crotalus pricei pricei* Van Denburgh.

TRISERIATUS SUBGROUP:
- *Crotalus triseriatus anahuacus* Gloyd.
- *Crotalus triseriatus triseriatus* (Wagler).

LEPIDUS SUBGROUP:
- *Crotalus lepidus klauberi* Gloyd.
- *Crotalus lepidus lepidus* Kennicott.

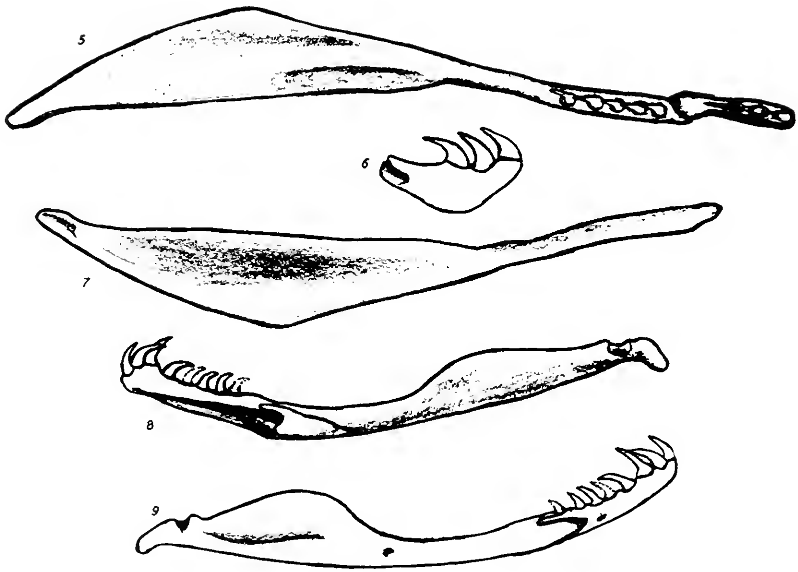
SEMICORNUTUS SUBGROUP:
- *Crotalus semicornutus* Taylor.

OMILTEMANUS SUBGROUP

The new subgroup mentioned previously is that here referred to as the *omiltemanus* subgroup. Its segregation as a group of forms distinct from the rest of the *triseriatus* group is of considerable importance. Heretofore its members (except for *transversus*) have been treated as subspecies of *triseriatus*. Certainly that disposition is incorrect, but the arrangement of the forms within the subgroup —as races of a single species or involving several species—is not yet clear.

Primary characteristics. The forms are distinguished from *triseriatus*, whose geographic range they overlap, by a number of striking features. Of greatest importance are the relationships to each other of the scales on the sides of the head; until recently the importance of certain of these scales has not been fully appreciated. In all members* of this section the subloreals are completely lacking (Figs. 1-4, 18); they are present (1 to 3) in all other species of the genus (Figs. 15-17). The scales referred to as subloreals are small ones interposed between the loreal and labials, and between the nasal and the pit scales. Since the term loreal has been restricted by Klauber (Trans. San Diego Soc. Nat. Hist., vol. 8, 1936, p. 222) to apply in rattlesnakes to "the scales [one or more] on the side of the head between the postnasal and the preocular . . .." and is generally used in this sense by other specialists, the scales described above cannot be considered as lower loreals; upper and lower loreals do occur in rattlesnakes, but both are between the "postnasal" and the preocular. Thus in the absence of any other term in general use I suggest "subloreal" as one sufficiently appropriate.

* In the type of *transversus*, according to the drawing (Taylor, Univ. Kan. Sci. Bull., vol. 30, 1944, fig. 10, p. 48), there appears to be a subloreal on one side. The scale is, however, a pit scale.



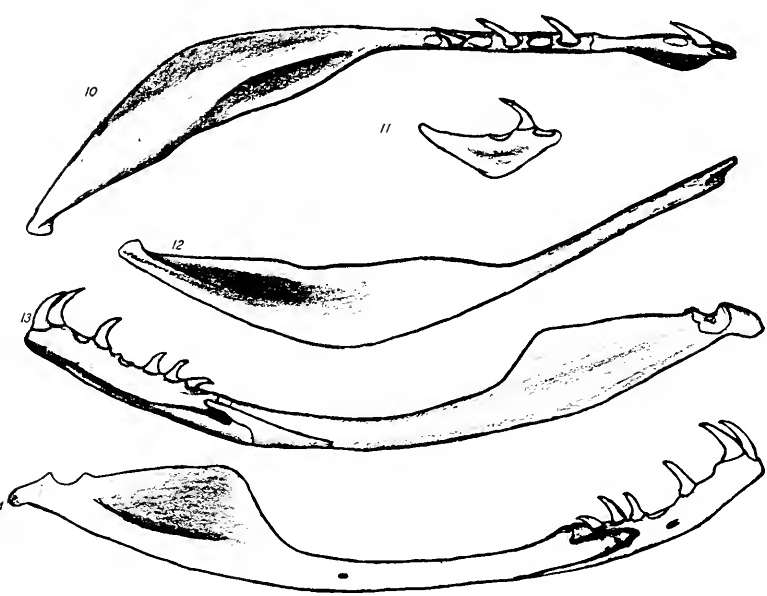


FIG. 5. Ventral view of right palatine and pterygoid of *C. g. lautus*. From USNM 110598, type.
FIG. 6. As in Fig. 5, lateral view of right palatine.
FIG. 7. As in Fig. 5, dorsal view of right pterygoid.
FIG. 8. As in Fig. 5, medial view of right lower mandible.
FIG. 9. As in Fig. 5, lateral view of right lower mandible.

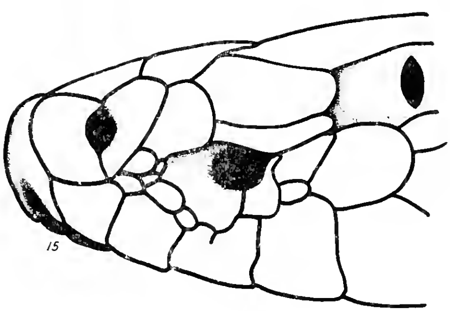
FIG. 10. Ventral view of right palatine and pterygoid of *C. t. triseriatus*. From EHT-HMS 21502, from Tacícuaro, Michoacán (*var. pallidus*).
FIG. 11. As in Fig. 10, lateral view of right palatine.
FIG. 12. As in Fig. 10, dorsal view of right pterygoid.
FIG. 13. As in Fig 10, medial view of right lower mandible.
FIG. 14. As in Fig. 10, lateral view of right lower mandible.

There is an indication that at least one skeletal character may be correlated with the *omiltemanus* section, but since I have been able to check it only in *lautus*, no generalizations are advisable. One pterygoid bone examined of *lautus* bears 5 teeth (Fig. 5); on the other hand each of the 2 pterygoids of *pricei* and 6 of *t. triseriatus* bears 6 or 7 teeth (Fig. 10). Since the head is notably shorter in species of the *omiltemanus* subgroup than in other species (except perhaps *pricei*) the lesser tooth number is not surprising. Other differences, some very striking, occur in shapes and contours of the palatines, pterygoids and dentaries of the 3 forms examined, but their significance is not clear. The palatine, for instance, is very short in *lautus*, more elongate in *triseriatus*. In *lautus* the posterior end of the pterygoid lacks the peculiar, ridgelike process on the dorsal surface that is present in *triseriatus;* also the concavity on the dorsal surface is more central in position. In *lautus* the palatine articulates on the medial side of the anterior tip of the pterygoid, while in *triseriatus* the suture between the two appears (in ventral view) to be transverse. One of the characters believed to be most significant is the direction taken by the anterior border of the splenial ventral to the anterior meckelian foramen; in *triseriatus* it passes a considerable distance posteriorly, while in *lautus* it passes almost straight ventrally from the posterior border of the foramen. The flared dorsal border occupying the posterior third of the length of the dentary is more accentuated in *triseriatus* than in *lautus*. The depth of the angular notch in the dentary (as seen in lateral view), and the positions of the two lateral foramina, also differ. Other differences, which may be of considerable significance, can be discerned by making comparisons of the accompanying figures (Figs. 5-14).

Secondary characteristics. But little less significant than and almost if not quite as useful as the characteristics mentioned above are a number of others which find few exceptions. The supralabials are with rare exception 9; that number occurs elsewhere only in *pricei*, of the *triseriatus* group. The supralabial below the posterior border of the orbit is the 5th (Figs. 1-4, 18), while in all others of the group (Figs. 15-16), except *pricei* (Fig. 17), it is the 6th or 7th.

Of great interest in the entire group is the conformation of the nasal. This scale is always split (perhaps rare exceptions) in rattlesnakes, and perhaps for this reason has generally been treated as two separate scales—postnasal and prenasal. These terms, however, are in general use in other groups of reptiles for scales following or preceding, respectively, the nasal, which may or may not be split. The concept of the nasal is a scale in which the nasal opening is pierced; a vertical suture may split the scale into anterior and posterior halves, but these are still parts of the nasal, and are not prenasals or postnasals in the sense of being scales preceding or following the nasal itself. It is the usual procedure to refer to the parts of the divided nasal as the anterior or posterior section, but since this is clumsy and involves quite a few words the terms *preseminasal* and *postseminasal* are suggested.

In the *omiltemanus* subgroup, the postseminasal is always in contact with the first or first and second supralabials (Figs. 1-4, 18); this condition is found elsewhere in the group only in *pricei* (Fig. 17) and in rare *t. triseriatus* (Fig 15), and in none of even these is there contact with the second supralabial. It follows, and is true, that in the four forms of the *omiltemanus* subgroup (Figs. 1-4, 18);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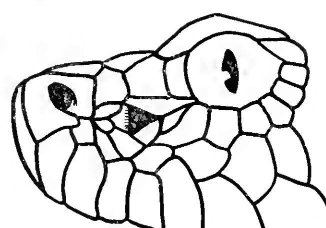
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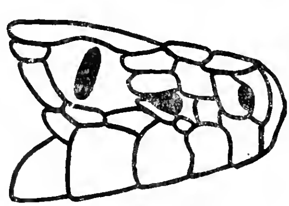
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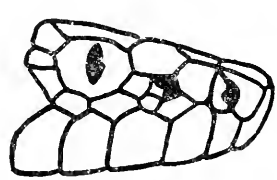
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FIG. 15. Lateral view of orbitonasal region of head of *C. t. triseriatus*. From USNM 46465, Ameca, Jalisco.
FIG. 16. As in Fig. 15, *C. l. klauberi*. After Stejneger.
FIG. 17. As in Fig. 17, *C. p. miquihuanus*. After Gloyd.
FIG. 18. As in Fig. 18, *C. omiltemanus*. After Gloyd.

the lower border of the preseminasal is not produced posteriorly, while in *triseriatus* and *lepidus* (all forms of each) it is markedly produced posteriorly (Figs. 15, 16).

The dorsal border of the postseminasal may be in contact with the canthal and internasal, internasal only, or neither scale in the various forms of the *omiltemanus* subgroup (Figs. 1-4, 18); no one condition is necessarily constant for any one form. In *pricei* (Fig. 17), however, the dorsal border of the postseminasal is always (so far as known) in contact only with the internasal, while in *triseriatus* and *lepidus* (all forms of each) generally both canthal and internasal are contacted. Therefore the loreal may be in contact with both canthal and internasal, or with the canthal only, depending upon the nature of the nasal.

The loreal may in the *omiltemanus* subgroup be in contact with the labials, or it may be separated (Figs. 1-4, 18); in the latter case the separation is always by means of contact of the nasal and pit scales, never by subloreals.

Klauber (*loc. cit.*) states that a loreal is always present in rattlesnakes. Taylor (Univ. Kan. Sci. Bull., vol. 30, 1944, pp. 47-48, fig. 1) however, says the loreal is absent in *transversus*, and accounts for the extra scale by assuming it to be an anterior section of a divided upper preocular. Other specimens that have become available since Taylor made his study, however, show intermediate conditions that indicate rather conclusively that the scale in *transversus* is actually a loreal, not a part of a preocular.

The lower preocular is generally separated from the loreal, or split into two scales, in members of this section (not evident in figures). Only in *transversus* is the scale entire and in contact with the loreal. In all other sections of the group the scale contacts the loreal, and is very rarely divided (I have seen it divided in but one, a *t. triseriatus*).

A further characteristic is the reduced dorsal scale rows of the *omiltemanus* subgroup. All specimens have 21-17 (15) rows. In *pricei* the rows are usually 21 at the middle of the body, but in all others of the group 23 rows is the usual number.

Finally the body size is smaller, in general, in the *omiltemanus* subgroup; the head is likewise proportionately smaller, and the rattle smaller. In view of the characteristics cited there can be no question, I think, of the distinctness of the *omiltemanus* subgroup apart from the others of the *triseriatus* group. But as stated before the relationship to each other of the various forms in that section is not yet completely clear.

Status of forms. The form *omiltemanus* is one of the best differentiated of its subgroup, because of the high ventral count. No overlapping between its ventral counts (172 to 183) and those of other members of the subgroup (145 to 161) is apparent, and moreover only *klauberi,* of all other forms of the entire group, overlaps the counts of *omiltemanus* to any extent whatever (152-175). That character should then be given considerable weight, and because of it I regard *omiltemanus* as a species instead of a subspecies. The number of dorsal blotches (51 to 60) is also unique among members of the *omiltemanus* subgroup (others with 34 to 45); *anahuacus* and *pricei* (both forms), however, overlap this range completely. Moreover the character of the lower preocular is not absolutely unique (separated from loreal), as one specimen of *lautus* has been examined with a similar condition on one side, and the type of *gloydi* also has the scales separated.

Nevertheless the total characteristics of *omiltemanus* favor its consideration as a full species. Since there is some degree of continuity of ecological conditions (Fig. 20) between the areas occupied by *omiltemanus* and *gloydi,* however, the possibility of intergradation is not to be overlooked.

The remaining forms of the section comprise a compact unit of very uniform character. They are from distinct geographical areas: *gloydi* from Oaxaca, *transversus* from the Morelos-Mexico border, and *lautus* from the central Veracruz-Puebla border (see map, Fig. 20). The latter is known from 3 specimens, *transversus* from two, *gloydi* from one. The character of the loreal and postseminasal are generally to be considered of considerable importance in distinguishing the forms of the group, and in the present three some widely divergent types occur. In *gloydi* the postseminasal is greatly reduced and in contact with only the loreal, first labial and preseminasal, while in *transversus* it is the loreal that is greatly reduced, resulting in contacts of the postseminasal with the canthal, internasal, loreal, pit scale, first and second labials, and preseminasal. Two specimens of *lautus* from the border area of Veracruz and Puebla near Perote are rather like *gloydi* in this character, except that the postseminasal is a little larger and contacts the second labial and, in one specimen, the internasal. But a third specimen from the same area is exactly like *transversus* on one side of the head (Fig. 3), and approaches that condition on the other (Fig. 4). It cannot now be assumed that the latter specimen is of a different species than the other two specimens from the same area, and thus one is forced to regard the nature of the loreal and postseminasal with suspicion in this subgroup until enough specimens are available to show the normal range of variation. The scales may be of great importance and of considerable constancy in other members of the group, yet in this subgroup some variation must be anticipated.

The form *gloydi* is distinguished from *lautus* and *transversus*, then, on the basis of the great reduction of the nasal (questionable), the separation of lower preocular and loreal (not infallible, also known on one side of some specimens of *lautus*), and upon the pattern (very similar to that of *lautus*). The type (which I have examined) has about 42 blotches on the body, and these are more or less quadrangular or oval in outline, covering 2 to 3 scale lengths and occupying 5 to 7 scale rows; they are separated from each by about one scale length. There is nothing in these characters to encourage regarding *gloydi* as a species distinct from *lautus*.

C. transversus has a mottled belly, and very narrow crossbands or spots 34 to 45 in number, which are split or almost divided on the middorsal line. Known specimens also have the postseminasal in contact with the pit scales, and the preocular in contact with the loreal; but one *lautus* specimen shows the same condition, in each category, on one side of the head. To this species I believe should be referred Martín del Campo's specimen (Anal. Inst. Biol., vol. 11, 1940, pp. 472-473, fig.) from Cempoala, Morelos. The form is more distinct from the other two than the latter are from each other, but only in pattern; and that pattern, particularly as exemplified by Martín del Campo's specimen, is not so remotely different from that of *lautus* that intergradation is not easily conceivable. Yet for the present, the greater degree of difference of *transversus* from *lautus* and *gloydi* leads me to regard the former a distinct species.

C. g. lautus has oval blotches, longer than in *transversus*, not interrupted at the middorsal line, and the belly is marked only with fine, scattered dark stippling. The postseminasal is reduced but in contact with 2 labials, and may or may not be in contact with the pit scales and with the internasal alone or both the internasal and the canthal. The relationship with *gloydi* appears to be very close and that with *transversus* is scarcely less so.

PRICEI SUBGROUP

The two forms of this species are associated together on the basis of morphological and patterns similarity, and geographic probability. Each has a single subloreal (Fig. 17), contrary to the *omil-*

temanus subgroup which has none (Figs. 1-4, 18), and the other subgroups which normally have several. The supralabials are usually nine, and the fifth lies below the posterior border of the orbit, as in the *omiltemanus* subgroup, and thus the species is a rather short-headed one. Of great significance is the fact that the preseminasal is not produced at its ventral border, but is in contact with only about the anterior half of the upper surface of the first supralabial (Fig. 17); in *triseriatus, lepidus* and *semicornutus* the border is so prominently produced posteriorly that it nearly or quite reaches the second supralabial, generally (Fig. 16) separating the postseminasal from the labials (not always, Fig. 15). Likewise in *pricei* the postseminasal is in contact above only with the internasal, while in *triseriatus* and *lepidus* the scale generally touches both canthal and internasal. The scale rows are generally twenty-one medially in *pricei,* twenty-three in *triseriatus* and *lepidus.* These are the chief characteristics by which the two forms differ from others; and there can be no question that together they comprise a distinct species. The species finds its closest relatives at least so far as external characters are concerned, not in *triseriatus* but in the *omiltemanus* subgroup. *C. transversus* approaches it most closely in pattern. The characters of the pterygoid, palatine and lower jaw bones, however, approach or duplicate those of *triseriatus.*

TRISERIATUS SUBGROUP

The preceding discussion has brought out differences between *triseriatus, pricei,* and the *omiltemanus* subgroups. The chief features mentioned that define *triseriatus* as a species are the numerous (10 or more) supralabials; 6th, 7th and 8th labial below posterior border of orbit (Figs. 15, 16); several (rarely one) subloreals (Figs. 15, 16); postseminasal generally in contact with canthal and internasal (Fig. 15); preseminasal produced posteriorly (Fig. 16); 23 or 25 scale rows at middle of body. In addition the dorsal blotches on the body are not less than 25. The species is completely and well differentiated from others of its group.

The two forms of the species are rather clearly subspecies, as their characters overlap and they occupy adjacent ranges. The chief differences between *t. triseriatus* and *t. anahuacus* are in number and size of dorsal blotches, and in number of ventrals. The latter has more numerous oval blotches (usually 40 or more, *triseriatus* with usually less than 40 quadrate blotches) and fewer ventrals. Specimens now referred to *t. triseriatus,* however, may represent still other forms not now clearly distinguishable.

The closest relatives of *triseriatus* are not in the previously considered forms, but in *lepidus*. There is a great similarity between the two species, and I believe it indicates relatively close relationship. The frequent occurrence of a divided upper preocular in *triseriatus* links it with *lepidus*, as does the curious form of the nasal, the several subloreals, the numerous supralabials, and the numerous scale rows. Klauber (Copeia, 1940, No. 3, pp. 206-207) refers to differences in hemipenial structure, but in external features, the two species are so alike that one specimen from Santa Teresa, Nayarit (U. S. Nat. Mus. No. 46333) is the subject of some disagreement as to which species it represents. Gloyd (*op. cit.*, p. 87) places it in *t. triseriatus*, while I would call it a *l. klauberi*. It has only 22 cross-bands on the body (including the occipital band), and although these are narrow (occupying only 5 to 8 scale rows) except near the tail, they are spaced and shaped as in *lepidus*, and are serrate-edged as in that species. Since the known minimum in *triseriatus* is 25 body blotches, while the range in *lepidus* is 14 to 23, the specimen falls best in *lepidus*, whose pattern it matches in other respects. It resembles *triseriatus*, however, in the gray-brown ground color, the very dark belly and chin, and the absence of a division in the upper preocular. Since apparently all other *lepidus* invariably have the upper preocular divided, this exception is extraordinary. Unfortunately the specimen is a female, so no comparisons of hemipenes are possible. In view of the variability of the head scales, I prefer to follow the indication of the pattern in allocating the specimen to *lepidus*. It does not, however, agree completely with the form of *lepidus* (*klauberi*) known from the same general area, for it has a dark postocular stripe and a darkly mottled belly (no stripe, belly nearly or quite immaculate in *klauberi*). Altogether the specimen appears quite intermediate in character between *triseriatus* and *klauberi*; it may represent a distinct race or species, or, of course, a hybrid. Further specimens will be necessary to arrive at a definite conclusion. In any event the postulate of a close relationship between *lepidus* and *triseriatus* is given strong support by the specimen.

SEMICORNUTUS SUBGROUP

This recently described form is almost as much of a puzzle as the preceding specimen from Nayarit. The single known example is unique in the development of the supraocular, but in most other respects is very similar to *lepidus*. The blotches resemble those of the other species of the *triseriatus* group rather strongly, as they are about equally as long as broad. The species evidently demonstrates a pattern that may be close to the ancestral type of *lepidus*, for it is clear that the latter form must have been derived from something with blotches not unlike those of *triseriatus*.

III

ZOÖGEOGRAPHY AND EVOLUTIONARY DISCUSSION

The arrangement of pattern types in the *triseriatus* group suggests that *semicornutus* is the most primitive of all forms of the group in pattern. It is not, it would seem, primitive in scutellation, but is rather the most highly modified of the group. The situation requires explanation.

Migration waves. As has long been urged by many zoögeographers, and as reëmphasized by Schmidt (Amer. Midl. Nat., vol. 30, 1943, pp. 241-253), in the course of evolution of animals upon the American continents a succession of waves of more and more advanced forms radiated outward from a center of distribution in the north. Thus an aggregation of primitive forms at, for instance, the southern edge of the Mexican plateau, is not to be interpreted as indication that the edge of the plateau is a center of distribution; rather it indicates the extreme periphery of distribution of the several groups represented. The *triseriatus* group appears to fit this distributional law. The most primitive forms (*omiltemanus* subgroup) are at the extreme periphery of the range of the group (Fig. 19); they together can be visualized as the present-day counterparts of the primary portion of the first wave (IA of Fig. 21) of migration from some northern center of dispersal. As a secondary portion (IB of Fig. 21) of the first wave, the *pricei* subgroup followed the *omiltemanus* subgroup, but because of close relationship, as a member of the same wave movement, never over-ran the primary portion. Some time elapsed before a second wave, carrying along as its primary portion (IIA of Fig. 21) the *triseriatus* subgroup, migrated southward, eliminating most evidence of the first wave except in the Oaxaca and Guerrero regions, which may by that time have become inaccessible. The secondary portion of the second wave (IIB of Fig. 21) carried *lepidus* in its wake, and perhaps a tertiary portion (IIC of Fig. 21) carried *semicornutus*. Thus the picture of waves of migration might be represented as in figure 22. The number of waves, their relative importance and their temporal distinctness are purely a matter of conjecture and may well be in

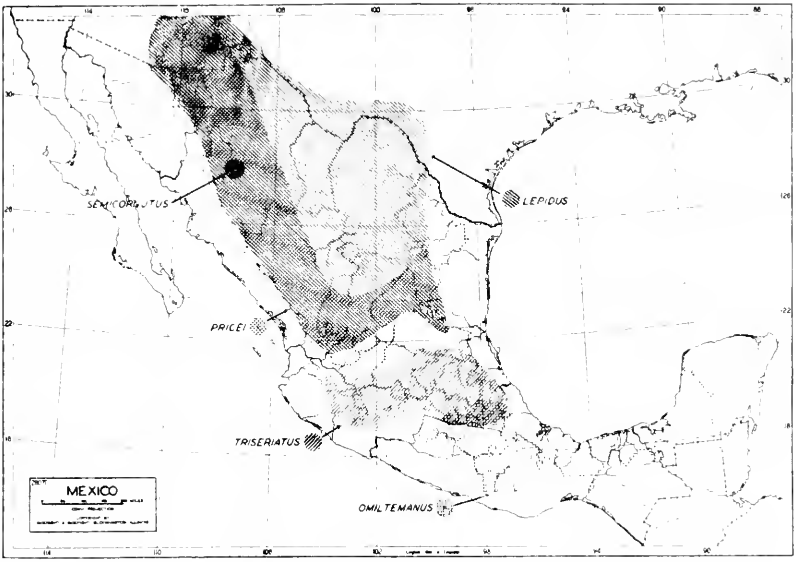


FIG. 19. Distribution in Mexico of the five subgroups of the *triseriatus* group.

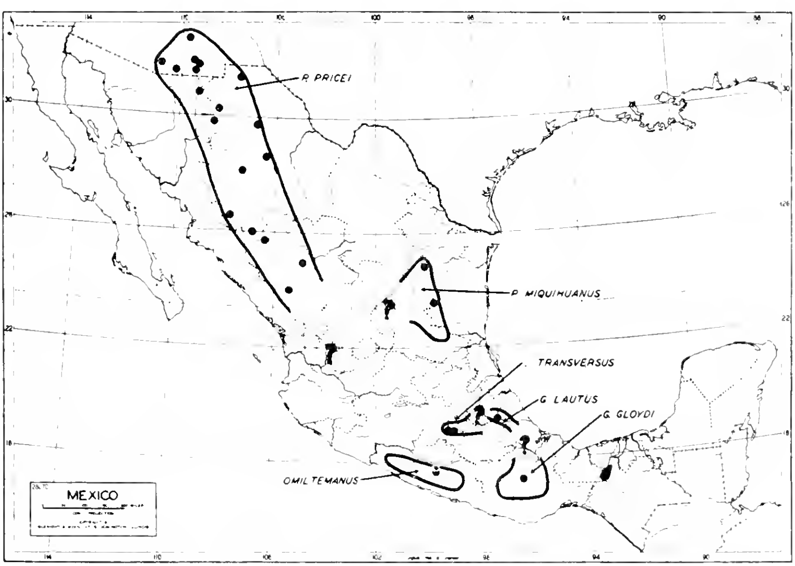


FIG. 20. Distribution of the members of the two primitive subgroups (*pricei* and *omiltemanus*) of the *triseriatus* group.

error. The succession is, however, fairly well established and it is only this that can at present be considered of significance.

Orthoevolution in scutellation. In each successive wave and wavelet of this migration an increasing modification of head scales and general external character is clearly evident. The members of the first wave (IA) are the least modified beyond a typical snake condition, while the member of the last wave (IIC) is the most highly modified of all. This is a trend which may be described as orthoevolutionary, for the modifications of each successive wave have been along the same lines almost without exception. The term orthoevolution is not used here as an explanation of the phenomenon but simply as a brief way of referring to the character of evolution in these particular features—a single-line evolution rather than a haphazard one. To what the phenomenon is due—whether selective mutation (orthogenesis) or selective elimination (orthoselection) —is not for speculation here. There is a suggestion, however, that regardless of the means, environment plays an important role in it.

The existence of an orthoevolutionary trend such as is evident in the scutellation of the *triscriatus* group cannot be explained as something inherent in the germ plasm of the group. Were that the case the oldest forms, of wave IA, would be the most highly modified of all. Clearly the modification must be dependent upon the geographic center of origin of the group. Thus the longer the animals remain in that center, the greater their modification along the specified line; and the sooner they leave, the less the modification will be. This statement agrees perfectly with the idea of waves of outward migration; members of wave IA, having left the center of origin earliest, were least changed, while that of the last wave (IIC) to leave that center was the most changed. Thus it is apparent that in this orthogenetic trend the most important factor is the existence of the animal *in a certain geographical area* in which the changes are being produced; outside of it the changes, at least in that direction, cease.

Pattern orthoevolution. There is a second orthoevolutionary trend, and that is in pattern. It is not so well defined as the trend in scutellation, but clearly exists. The members of wave I have relatively numerous and small blotches, with extremes in *omiltemanus, transversus* and *pricei.* The members of wave IIA have relatively fewer, but *anahuacus* closely parallels some members of wave IA. The forms of wave IIB have still fewer, and that of IIC least of all. The trend exists, but the direction of the trend—

whether from a primitive pattern with few blotches or one with many—is not immediately obvious. If the procedure in this case is like that in regard to scutellation, then the least modification occurs in the peripheral forms, the greatest in the most central.

But, I believe, the procedure has not been the same in pattern as in scutellation. If what is primitive in pattern were generally known, as is the primitive scutellation, there would be no doubt of

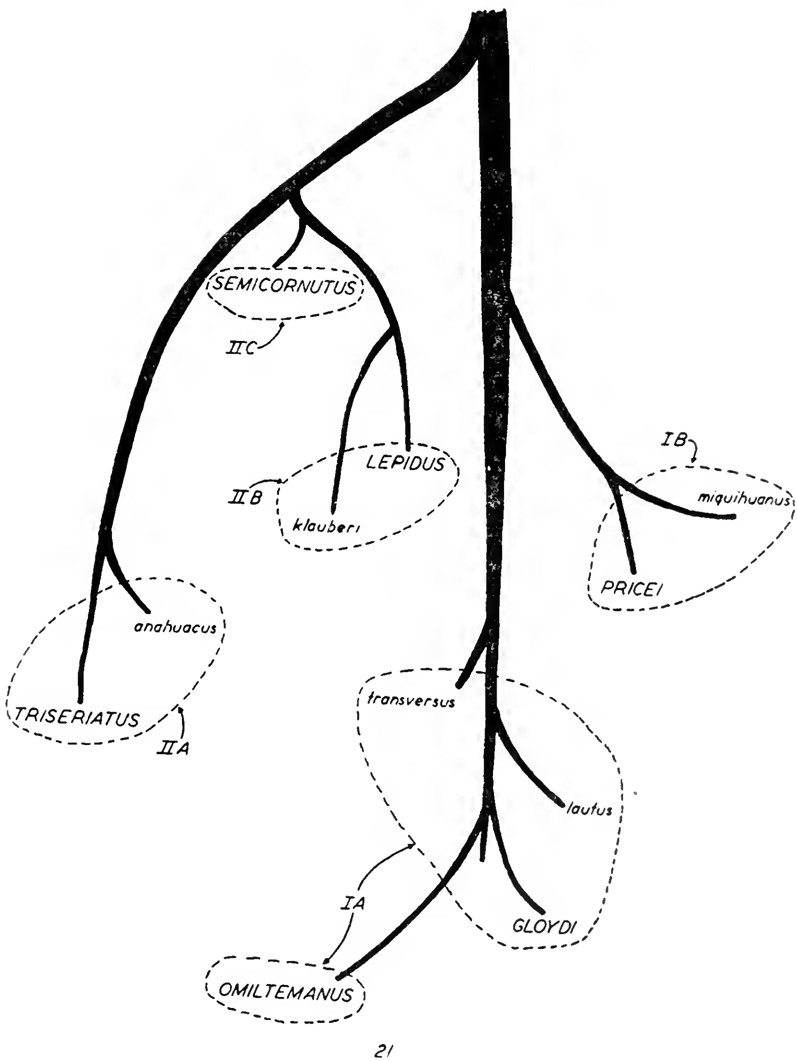
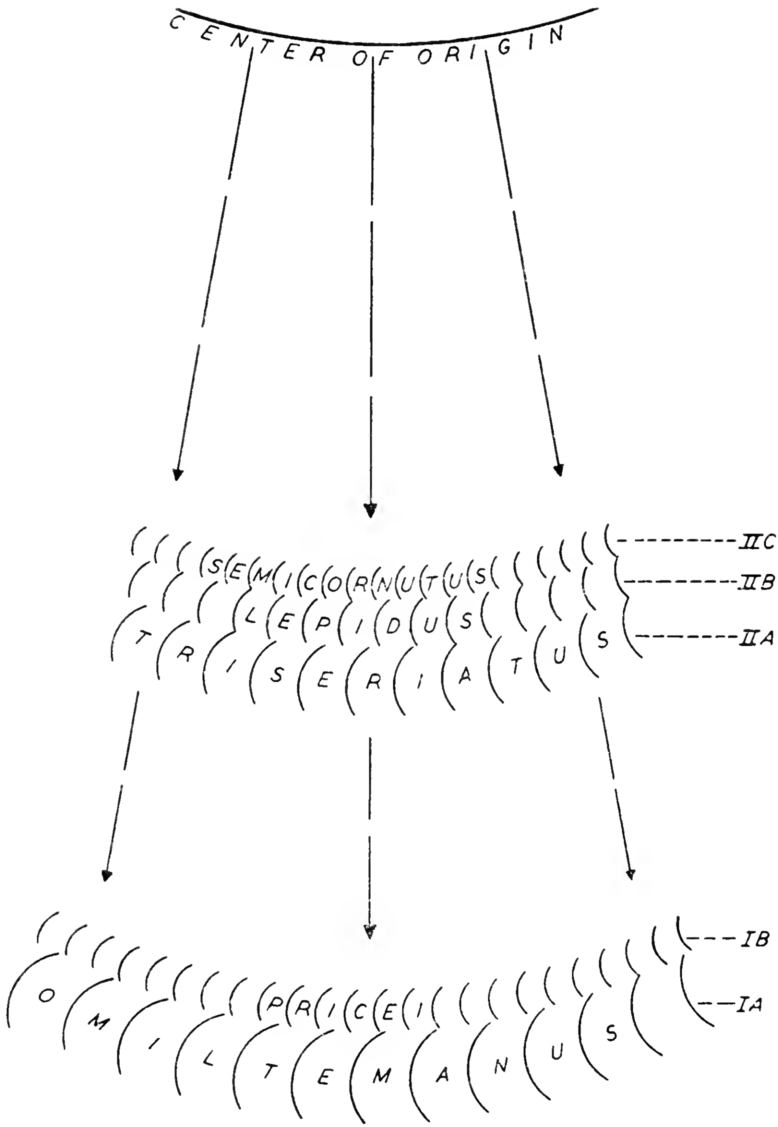


FIG. 21. Possible phylogeny of the forms of the *triseriatus* group.



22

FIG. 22. Diagram of migration waves in the *triseriatus* group.

the direction of the trend. Herpetologists have not generally agreed, however, upon the type of pattern that is primitive for snakes in general or for rattlesnake ancestors. In the absence of such knowledge we must try to determine what is primitive in the present case.

Three lines of evidence point toward the condition of few blotches as primitive.

First, there is little difference between some members of wave IIA and some of wave IA. *T. anahuacus*, for instance, is strikingly similar to *lautus* and *gloydi*. Yet waves I and II are strikingly different in scutellation. If the change was going on only in the center of origin (as in the case of scutellation) there would have been difference between the various waves equally as great in pattern as in scutellation. That there is not suggests that pattern changes occurred *after* migration away from the center of origin, although at different rates in the different waves. In such case it is reasonable to assume that the changes may continue at a more or less constant rate outside of the center of origin, and that the accumulation of change will be greatest in the forms which have been longest away from that center. By this line of evidence a primitive pattern of few blotches is suggested.

A second line of evidence is the lack of constancy of pattern within the members of one wave. In the *omiltemanus* subgroup, for instance, there is a rather considerable range of variation from almost the maximum number of blotches known in the group to a median number of some 34. Since these are all derived from one common wave-stock, it is clear that these changes in pattern occurred *after* migration to their present geographic zone. We know then that pattern evolution is not *limited* to the center of origin, and that it has progressed to a considerable degree outside of that area. Thus one is led to the same line of reasoning that was followed in discussion of the first point above.

Finally, those monographs which have dealt with the problem of pattern evolution in snakes have indicated that the trend, in blotched colubrids at least (from which the vipers presumably were derived) the primitive pattern is one of few, small blotches. The pigmented area tends to increase, either by increase in number or in size of the blotches. Increase in number may result only in a shattering and reduction in size of the spots (as in *pricei*), to preserve a certain constant of nonpigmented area (seemingly a very important factor in pattern evolution). On the other hand, it may result in a crowding and a *sudden* reduction in number of blotches by elimination of alternate marks. A second increase may follow, and then another sudden decrease in the same fashion, and so on. The blotches may expand laterally into rings instead of, or as well as, increasing in number. Should increase in *size* of the blotches be the direction of pigment expansion, instead of increase in number, then a longitudinal fusion and shattering may result, suddenly producing a striped pattern, which then goes through its own line of evolution. That all colubrids have followed this line of blotch evolution does not necessarily follow; that of *Coluber* and *Masticophis* is not readily comparable. But at least there is a parallel phenomenon in some Colubrids and in the *triseriatus* group; and that the parallelism may be of profound nature is a tempting speculation.

Positive and negative orthoevolution. If it be granted that the primitive pattern, for the *triseriatus* group, is one with few, small blotches, then it may be seen that the orthoevolutionary trend in pattern is the *reverse* of that in scutellation, for the earliest wave has the greatest instead of the least change, and the latest wave has the least instead of the greatest change.

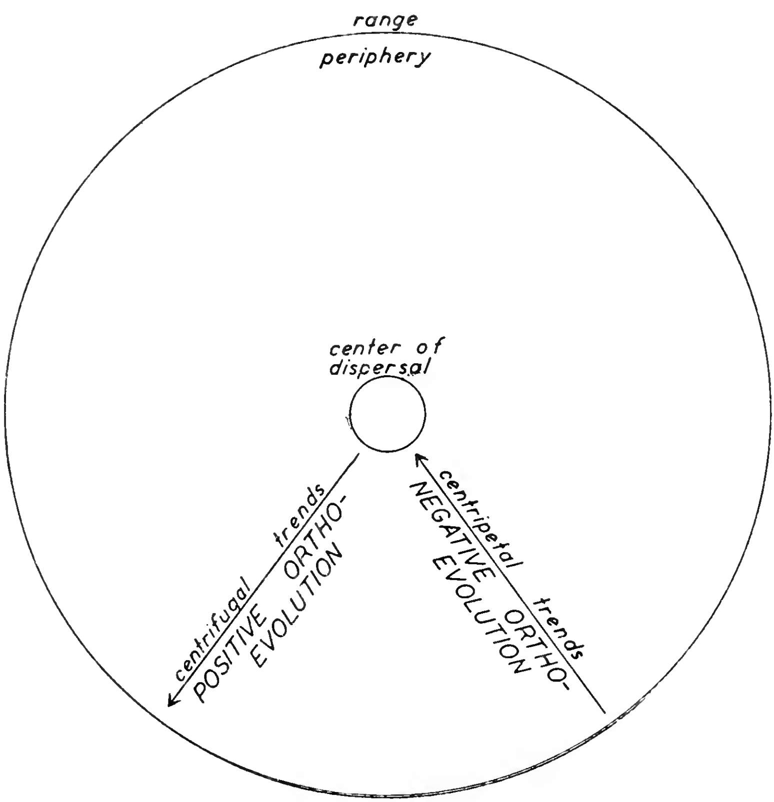


FIG. 23. Diagrammatic representation of the concept of positive and negative orthoevolution.

Thus we are concerned in pattern and scutellation with two phenomena of diametrically opposed nature—one which might be called "positive" orthoevolution (pattern), the other "negative" orthoevolution (scutellation) (Fig. 23). Negative orthoevolution may be defined as an evolutionary trend whose manifestation is dependent upon a certain limited environmental situation; it is of relatively localized occurrence. Positive orthoevolution is conceived as an evolutionary trend whose manifestation is independent of most (not necessarily all) environmental conditions; it is of relatively general occurrence.

Environmental effects. It is clear that pattern evolution continued outside the center of origin, while scutellation evolution did not. Pattern change did not occur at all times, *both* within and without the center of evolution, else all forms would be more or less alike. Given that the most primitive pattern occurs in or near the center of origin, it follows that pattern evolution occurred only or for the most part, *outside* the center of origin.

We conclude then that under the conditions existing over many thousands of years in the center of origin of the *triseriatus* group, and *only* within that area, a constant series of mutations occurred and were preserved to produce a steady orthoevolutionary trend in scutellation changes. In that area no pattern changes occurred. However, as the populations carrying these characters spread beyond the limits of this center of origin, the mutations for scutellation change ceased, and in their stead appeared another orthoevolutionary trend in mutations affecting pattern. Clearly some environmental factor operated in one place that did not in another, and its role was an important one in rattlesnake evolution. The means whereby its influence was effected is not evident.

It is interesting to conjecture that the mutation rate in the rattlesnakes discussed is more or less constant at all times, and that only the nature of the mutations is influenced by the environmental factors; and likewise that positive orthoevolution concerns survivally important characters, while negative orthoevolution involves characters of no selective value.

Matthew versus Adams. The main body of evidence derived from these rattlesnakes supports Matthew's main premise in Climate and Evolution of successive waves of migration from a northern center of dispersal. But it also shows that his second premise of peripheral occurrence of primitive forms is not wholly or always true. Certainly the peripheral forms are the earliest migrants; in this respect they are the most primitive. But Matthew did not use the term "primitive" in just that sense. He meant that the peripheral forms not only were of the earliest waves of migration but also carried the most primitive *characters*. From the above discussion it is apparent that this is not always so. Whether the peripheral forms are the most primitive in all respects depends upon the nature of the orthoevolutionary trends. If they have been in the past of local character (negative orthoevolution) then there will be no or little further change as the wave migrates peripherally. But, if positive orthoevolution occurs in some character, then the forms near the center will be the most primitive in that character. Peripheral modification, with a central primitive stock, is essentially the prime thesis of Adams' theory of group evolution. These two principles—of Adams and of Matthew—have been generally regarded as diametrically and unalterably opposed to each other. In reality they operate hand in hand, neither to the exclusion of the other, as two consistent phases of species evolution.

Primitive versus early. It is evident that the earliest migrants from the center of dispersal of the *triseriatus* group are not in all respects the most primitive. They are held in that light by most investigators because they actually are primitive in certain conspicuous characters that are usually held as important. Yet in other respects the *omiltemanus* subgroup is highly modified. The association of primitive with highly specialized characters in a single form or group is commonly known in many groups of animals, yet in spite of this fact they are continually referred to as "primitive" species. In reality the modified characters may be more numerous than the primitive ones; it is only the subjective evaluation of them that can lead one to assume that more characters, or more important ones, are primitive than modified. Obviously one should refer to primitive or modified *characters*, not primitive or modified *species*. The species is the carrier of the characters; it is neither primitive nor modified, although it may be referred to as such if its characters are preponderantly or notably of one type or the other. Actually the species should be referred to as an *early* or *late migrant* or *divergent;* in that expression is conveyed the expectation of a certain proportion of primitive or modified characters.

IV

SUMMARY

The *triseriatus* group of *Crotalus* consists of 11 forms, as known at present, belonging to 6 species and four subgroups. The most primitive subgroup includes *omiltemanus, gloydi gloydi, g. lautus,* and *transversus,* all forms at the southern periphery of the Mexican plateau. That section comprises the remnants of the first of a series of perhaps 5 successive waves of migration from a northern center of origin. The second wave, closely following the first and of next most primitive forms included what is now *p. pricei* and *p. miquihanus.* A third wave, at a considerably later date, included *t. triseriatus* and *t. anahuacus.* A fourth wave, closely following the third, included *l. lepidus* and *l. klauberi,* while a fifth wave, following closely the preceding, included *semicornutus.*

The ancestral stock remaining in the center of origin during the periods of occurrence of migration waves mutated in such a fashion as to produce an orthoevolutionary trend of scale modification; these changes ceased in any part of the stock which migrated peripherally, so that later waves had evolved farther in this respect than the earlier waves. However, as the scale mutations ceased, pattern changes were initiated and perpetuated thereafter at a more or less (not completely constant) rate, so that in this respect earlier waves evolved to a greater degree than later waves.

The course of scale evolution is considered an example of *negative orthoevolution,* defined as an evolutionary trend whose manifestation is dependent upon a certain limited environmental situation; it is of relatively localized occurrence. The course of pattern evolution is considered as an example of *positive orthoevolution,* defined as an evolutionary trend whose manifestation is independent of most (not necessarily all) environmental conditions; it is of relatively general occurrence.

Either or both types of orthoevolution may occur in the development and distribution of any group of animals; probably generally both types occur. Predominance of negative orthoevolution in the history of any given group would result in a peripheral concentration of predominantly primitive forms (Matthew's principle) while predominance of positive orthoevolution would result in peripheral concentration of predominantly "higher" forms (Adams' principle). Thus these two apparently opposing principles are, then, to be con-

sidered not as mutually exclusive ideas, but as coöperatives of equal importance in the history of animal evolution, although it may be true that Matthew's principle of negative orthoevolution is predominant in frequency of occurrence in the history of many given sets of characters (*i. e.*, species).

The primitive pattern of the *triseriatus* group is considered to consist of few, small, median dorsal blotches.

The term *subloreal* is introduced for the scales between the loreal and supralabials, and between the nasal and pit.

The two halves of the nasal are termed *seminasals,* the anterior half as the *preseminasal,* and the posterior half as the *postseminasal.*

V

KEY TO FORMS OF THE TRISERIATUS GROUPS*

1. No subloreals; loreal in contact with labials or, if separated from labials, the interposed scales are the nasal and scales entering the pit; posterior section of nasal in contact with 1 or 2 labials; scale rows 21-21-17 (15); keels scarcely evident on posterior dorsal head scales; head very small 2
   One to three subloreals intervening between loreal and labials; posterior section of nasal not in contact with labials, or only with 1st labial; scale rows usually 23 or more anteriorly or medially, seldom 15 posteriorly; keels usually distinctly more pronounced; head larger 5
2. Ventrals 172 to 183; dorsal spots small, 51 to 60; lower preocular widely separated from loreal .... *omiltemanus*
   Ventrals fewer; dorsal spots fewer; lower preocular (sometimes transversely divided) in contact with loreal or not 3
3. Nasal in contact with only 1st supralabial; postseminasal much reduced in size, ¼ or less the size of preseminasal; latter in contact with loreal above; lower preocular separated from loreal; latter in contact with 1st and 2nd supralabials. .*gloydi gloydi*
   Nasal in contact with 1st and 2nd supralabials; postseminasal large or small; preseminasal in contact or not with loreal above postseminasal; lower preocular rarely in contact with loreal; latter in contact with one or no labials; spots oval or transverse bands 4
4. Dorsal pattern consisting of small, transversely oval, median blotches; loreal generally (?) in contact with supralabials; lower preocular generally (?) divided. *gloydi lautus*
   Dorsal pattern of paired spots which may be expanded laterally into transverse bands, but which do not cross the median line; loreal separated from supralabials; lower preocular single .... *transversus*
5. Median dorsal bands or blotches less than 24 on body; upper preocular rarely not vertically divided; anterior section of nasal produced posteriorly below naris to a point beyond a line even with the posterior edge of the naris 6
   Median dorsal bands or blotches more than 24 on body; upper preocular usually not vertically divided; anterior section of nasal may be produced posteriorly below naris, but does not extend so far 8
6. Supraocular markedly elevated; dorsal spots 17 on body, not band-like (except the extreme posterior), each 5 to 8 scale rows in width, most about as long as broad; caudals 20 in a male .... *semicornutus*
   Supraoculars round; dorsal spots 14 to 23, all generally band-like, much broader than long when visible; caudals in males over 20; supraocular not elevated 7

* Based partly on Gloyd (*op. cit.*).

7. A dark stripe from orbit to angle of mouth; a pair of separate occipital blotches; body pattern of transversely expanded dark blotches or crossbands, interspaces frequently with secondary blotches or bands but little darker than ground color.
lepidus lepidus

Dark stripe from orbit to angle of mouth obsolete or absent; occipital blotches united; body pattern of conspicuous dark brown or black crossbands, interspaces greenish gray or bluish gray with small dark flecks or indistinct gray blotches.
lepidus klauberi

8. Ventral edge of prenasal extending as far posteriorly as dorsal, or farther; postseminasal in contact with both canthal and internasal; generally two or more subloreals; six or more supralabials to below posterior edge of orbit; pattern of median blotches, but general color sometimes very dark or very light; upper preocular sometimes split transversely; scale rows generally 23 medially....................... 10

Ventral edge of prenasal not extending as far posteriorly as dorsal edge; postseminasal not in contact with loreal, only with internasal; generally one subloreal; five supralabials to below posterior edge of orbit; pattern of small, paired dorsal spots, sometimes fused medially; upper preocular seldom divided transversely; scale rows 21 medially 9

9. Ventrals more than 150; general coloration usually gray; dorsal spots usually separate, in pairs ....*pricei pricei*

Ventrals less than 150; general coloration predominantly brown; dorsal pairs of spots often connected medially ....*pricei miquihuanus*

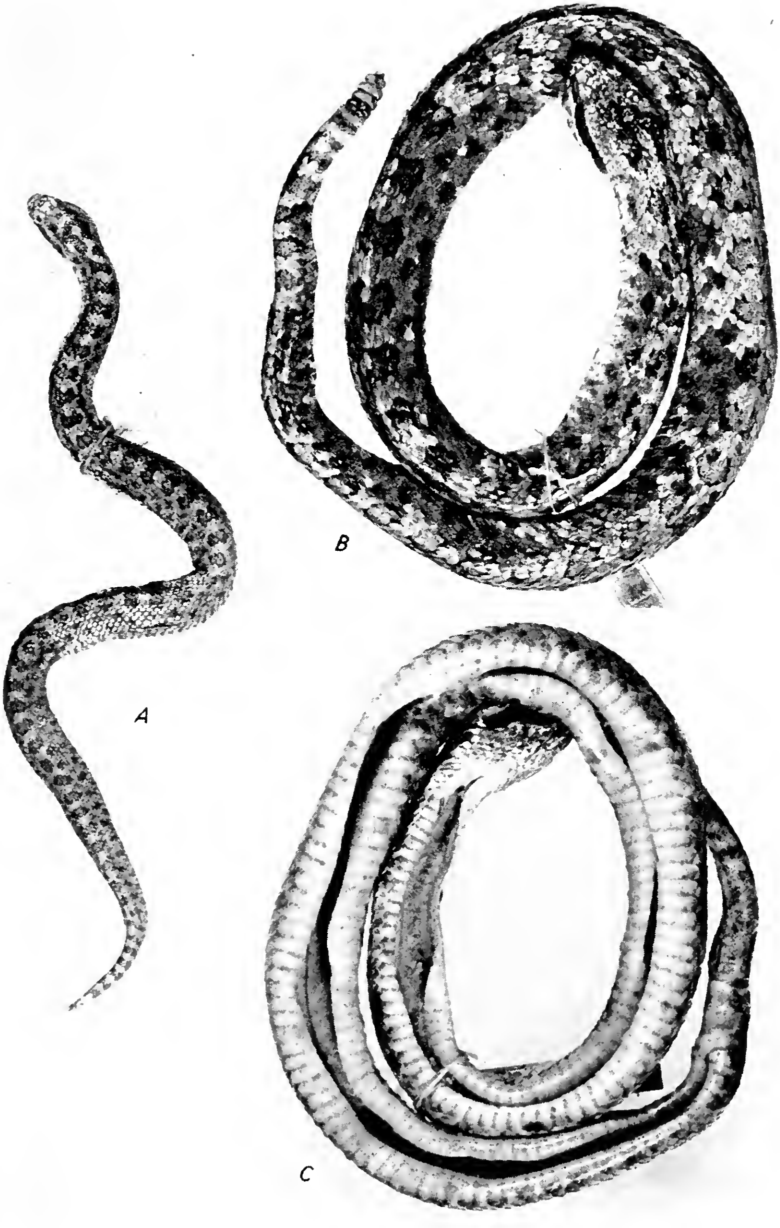
10. Body pattern of relatively large, quadrangular spots 25 to 46 in number, usually less than 40 ....*triseriatus triseriatus*

Body pattern small, elliptical spots (median) 39 to 57 in number.
triseriatus anahuacus

PLATE III

PLATE 1. *Crotalus gloydi lautus*. A, paratype, EHT-HMS No. 5475. B-C type, U.S.N.M. No. 110598.

PLATE III



THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN

VOL. XXXI, pt. I.] MAY 1, 1946 [No. 4

The Status of *Sceloporus floridanus* Baird

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ABSTRACT: Evidence is presented to show that the name *Sceloporus floridanus* Baird should be allocated with the Florida subspecies (*undulatus*) of *S. undulatus*, and not with the Texas relative (*S. olivaceus*) of *S. spinosus* as indicated by the Stejneger and Barbour Check List.

THE 1943 edition of the Stejneger and Barbour Check List of North American Amphibians and Reptiles presents a new interpretation of the identity and validity of Baird's *Sceloporus floridanus* (Proc. Acad. Nat. Sci. Phila., 1858, p. 253), whereby the discrepancy between the stated type locality (Pensacola, Florida) and the range concept which accompanies allocation of that name to the Texas relative of *Sceloporus spinosus* is explained by assuming an incorrect statement of the type locality. Since the Texas species referred to is not known east of Texas, identification of the type of *floridanus* (fortunately extant, U. S. National Museum No. 2874) with that species would necessitate either the above assumption or the very unlikely one that the Texan form does occur eastward to Florida but has simply not been collected east of Texas save for the type. While the name has long been associated with the Texan form (by most authors ever since Stejneger so identified it in 1893), only within the past ten years has the concurrent geographic discrepancy been generally apparent, and now for the first time is proposed a reasonable reconciliation of apparently inconsistent facts.

There is another means of reconciliation, however, by associating the name with the form of the *undulatus* group which occurs in the region of the type locality; this was first proposed in 1936 by Burt (Trans. Kan. Acad. Sci., vol. 38, pp. 277, 281). Subsequent articles by the same author (Papers Mich. Acad. Sci., Arts., Lett., vol. 22

1936 (1937), pp. 535-536; Trans. Kans. Acad. Sci., vol. 40, 1939, pp. 353-354) reveal a maintenance of the same opinion, and with the major premise concurrence of opinion was expressed by other authors, including myself (Occ. Pap. Mus. Zoöl. Univ. Mich., no. 387, 1938, pp. 7-8; Zoöl. Ser. Field Mus. Nat. Hist., vol. 26, 1939, pp. 110-116). Such an allocation releases the Texan form from the name *floridanus*, and makes valid for it the later name of *olivaceus* Smith. However the Stejneger and Barbour Check List uses the name *spinosus* for the Texan form, as did Burt, although it has been pointed out repeatedly that the Texan form (which occurs also in northern México) differs widely from *spinosus* of central México. The Check List therefore uses two names, *S. floridanus* and *S. spinosus*, for the same species. Since in the preceding (4th) edition the former name was used for the Floridan form, and *spinosus* for the Texan, it may be assumed that it was the intention of the authors to delete reference to *spinosus* upon reallocation of the name *floridanus*.

Since the type of *floridanus* is extant and in good condition, one might assume it would be a simple matter to determine which of two species as clearly distinct as *olivaceus* of Texas and *undulatus* of Florida it represents. The difficulty in making a definite statement is due largely to the unfortunate fact that there is no infallible morphological character known as yet that will distinguish the two (except size). The sharpest differences are chiefly in color; in addition *olivaceus* is much larger, but specimens of intermediate sizes are not to be determined by this character. There can be no question of the distinctness, as species, of the Florida and Texan forms, but individual specimens of moderate or small size (less than 80 mm. snout to vent) can be distinguished at present best by color.

The color of the type of *floridanus*, a male measuring 75.5 mm. snout to vent, fits the usual pattern of neither form very well. A male specimen of comparable size of either species should have the very clearly defined ventral markings characteristic of that sex, yet the belly of the type is "immaculate save a few black striations in the chest region and a longitudinal line between hind legs" (personal notes, 1934). Therefore we can assume with some degree of certainty that *some* fading has taken place, and the dorsal surface bears out this assumption, for "dorsal markings are absent, except the sides appear darker than the back; a vertical black mark from shoulder to lateral neck fold." However, of most importance is the *extent* of fading which would be necessary to bring a specimen of comparable size of either species to an appearance like that exhibited by the type.

Males of the Florida form seldom reach the size of the type, but I have seen two of approximately the same size, out of 81 examined (Univ. Mich. No. 76436, Natchez, Adams Co., Miss., 77 mm.; and Univ. Mich. No. 47585, Washington, Adams Co., Miss., 74 mm.). It is remarkable that in this form the males at least equal if they do not exceed the females in size; the largest female in seventy-three examined measured 72 mm. (Charleston Mus. No. 31. 233. Cottageville, Colleton Co., S. C.). In the larger series examined of the more northern race (*u. fasciatus*), several specimens of both sexes were found to equal or exceed 75 mm. Therefore on size alone the type cannot be excluded from identity with the Florida form. The Texan form, of course, reaches a still greater size (97.5 mm. recorded for males, 121 mm. for females). But males of the Florida form, at such a large size, would be extremely dark below, while those of the Texan form would have but few, scattered, black streaks in addition to the bluish lateral belly patches and throat. The amount of fading necessary to bleach a large Florida male would be much greater, then, than the amount required to bleach a specimen of *olivaceus*, and in fact it would seem well-nigh impossible to bleach an *undulatus* so completely without rendering it uniform white. Yet I believe this occurred, and the belief is based upon the presence of the dark shoulder blotch. This mark, clearly, must have been one of the darkest spots on the lizard to have remained while other pattern features were lost. Now *olivaceus* has no distinctive shoulder patch; a dark mark which does occur there is relatively small and is cut off dorsally by a light longitudinal band, is usually scarcely larger and darker than other blotches on the sides of the back, and generally does fade quickly in formaldehyde; *undulatus*, on the other hand, does have a very dark, large, unbroken shoulder patch, which is one of the earliest pattern marks to appear in development, and might well be expected to be among the last to disappear in the bleaching process.

Other notes taken on the type of *floridanus* are as follows:

Supraoculars 5-5, separated from median head scales, and from superciliaries by one row on one side and on the other by one complete and one incomplete row; frontal in contact with interparietal and median frontonasal; anterior section of frontal divided; two canthals, the first touching lorilabials on one side (fused with loreal); preocular not divided; lorilabials reduced to one row at a point below subocular; outer row of labiomentals not in contact with mental; auricular lobules elongate, 5-5. Scales on back rather strongly keeled, mucronate, denticulate; ventrals strongly notched; scales on posterior surface of thigh much smaller than preanals, smaller than those preceding femoral pores; pores 13-15. Dorsal scales, 31; scales around middle of body, 33; 53 ventrals; a few modified, porelike preanal scales; snout to vent, 75.5 mm.; snout to occiput, 13.5 mm.; snout to posterior border of ear, 17 mm.; hind leg, 57.6 mm.; fourth toe, 22.3 mm.; fifth toe, 10 mm.; tibia, 15 mm.; 5.7 dorsal scales to head length; lamellae on fourth toe 23-24; tail, 126 mm.

Three points mentioned in the above description are of special interest. First, in only 4 out of 100 *olivaceus* was the anterior section of the frontal found divided; it is frequently divided in *undulatus*, and is in the type of *floridanus*. Second, in 54 specimens of *olivaceus* 52 was the maximum ventral count; the type of *floridanus* has 53 (no data for *undulatus*, but a higher range is to be expected). And finally, according to my observations, the preanal scales are modified with porelike structures only in the very large and old males of a species; it is not a phenomenon of frequent occurrence in any *Sceloporus*. A snout-vent measurement of 77 mm. in *olivaceus* is that of a young male which would definitely not be expected to have preanal "pores"; while the same measurement in *undulatus* is that of a very large male, in which preanal "pores" could reasonably occur.

Therefore it may be concluded that, while completely convincing evidence is lacking, there is strong evidence on the basis of color, subdivision of the frontal, ventral count and preanal "pores" that the type of *floridanus* belongs to *undulatus* rather than to *olivaceus*, and that on no count is there a stronger indication toward *olivaceus* than toward *undulatus*. The type locality of *floridanus* is therefore to be accepted as stated, and the name should be considered a synonym of the older *undulatus*, based upon the same form. The proper name for the Florida form is then *Sceloporus undulatus undulatus* (Latreille), and that of the Texas form *Sceloporus olivaceus* Smith.

THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN
VOL. XXXI, pt. I.] MAY 1, 1946 [No. 5

A Review of the Genus Calipyrgula Pilsbry (Gastropoda: Amnicolidae)

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ABSTRACT: The seven species now assigned to the genus *Calipyrgula* Pilsbry are compared, figured to scale, and variations and measurements are given; locations of types, type localities, and horizons are recorded; and speculations upon the distribution of this unique Pliocene gastropod genus are included.

AT present seven species are assigned to the genus *Calipyrgula* Pilsbry which was proposed to accommodate three species of minute amnicolid snails found in the basal Tulare formation (of Upper Pliocene age), in the Kettleman Hills oil field of California. The remaining four species were discovered in the lower Pliocene beds of the Laverne formation in Beaver county, Oklahoma (Leonard and Franzen, 1944).

Although the entire series of species is similar with respect to body form, aperture, umbilical perforation, and distribution of spiral striations, giving the group an appropriate homogeneity, there is present among them a considerable degree of variation with regard to such characters as surface sculpture, depth of suture, and contour of whorls. The colorful qualities of this small group of snails, together with the fact that the two series of species were recovered from deposits of somewhat similar geologic age, but geographically separated by hundreds of miles of plains and rugged mountain terrain, lends peculiar interest to the genus. Furthermore, while the unity of this unique group of species appears to us well established, it seems prudent to call to the critical attention of others the various species now assigned to the genus *Calipyrgula*. With these concepts in mind, we present the following annotated list, with figures of each species drawn to the same scale.

GENUS CALIPYRGYLA

Pilsbry, 1934, Nautilus, Vol. 48, p. 15.
Pilsbry, 1934a, Pro. Acad. Nat. Sci. Phila., Vol. 86, p. 556.

"Minute, thin, very slender, perforate shells, with rather obtuse apex; of about 5 to 7 whorls which are strongly convex, rounded or carinate, and in known species, spirally striate. The aperture is elliptical or oval, blunt or rounded posteriorly, the peristome thin, columellar margin slightly expanded. Type, *C. carinifera*." (Pilsbry, 1934a).

Calipyrgula carinifera Pilsbry, Plate 1, fig. 4

Pilsbry, 1934, Nautilus, Vol. 48, p. 15.
Pilsbry, 1934a, Proc. Acad. Nat. Sci. Phila., Vol. 86, p. 556.

Type. United States National Museum.

Type locality. Kettleman Hills oil field, Sec. 30, Tp. 21 S, R 17 E, Fresno county, California.

Horizon. Basal Tulare formation, Upper Pliocene.

Calipyrgula carinifera Pilsbry, one of the minute species but exceeding slightly in height both *C. ellipsostoma* Pilsbry, and *C. stewartiana* Pilsbry, is characterized by its slender form, strongly convex whorls and deeply incised suture. A carina at the periphery accompanied by fine concentric striations below is typical.

Variations. The characteristic carina and fine concentric striations do not apear on the first two whorls. Of the remaining spiral whorls all are typically carinate and striate, although an occasional smooth and rounded whorl may appear at random among them. Among the specimens available for study,* the body whorl and one or more spiral whorls were characteristically carinate and striate. That specimens with the same number of whorls vary somewhat in size is shown in the table below.

U. S. N. M.	Height	Diameter	Aperture Height	Aperture Diameter	Number of Whorls
Type	3.24mm.	1.1mm.	0.9mm.	0.72mm.	6½
Paratype	2.7	1.08	0.81	0.58	5½
Paratype	2.16	0.81	0.63	0.45	5½
Paratype	2.0	0.85	0.67	0.54	5½

* We are grateful to Dr. Paul Bartsch, Curator of Cenozoic Invertebrates, United States National Museum, and to Dr. Henry A. Pilsbry, Curator of Mollusca, Philadelphia Academy of Natural Science, through whose generosity we were able to examine the specimens of *C. carinifera* and *C. ellipsostoma* from these institutions, including the types. We have not seen the type of *C. stewartiana*.

Calipyrgula ellipsostoma Pilsbry, Plate 1, Fig. 5

Pilsbry, 1934, Nautilus, Vol. 48, p. 15.
Pilsbry, 1934a, Pro. Acad. Nat. Sci. Phil., Vol. 86, p. 557.

Type. No. 12946, Academy Natural Science of Philadelphia.

Type locality. East side of North Dome, Kettleman Hills, Sec. 23, Tp. 23 S, R 18 E, Kings county, California.

Horizon. Basal Tulare formation, Upper Pliocene.

Calipyrgula ellipsostoma Pilsbry is similar in form to *C. carinifera*, but is less slender, the suture is less deeply incised, and a feebly developed carina appears above the periphery.

Variations. The only significant variation observed in the small series available to us was in the development of the carina which is obsolete in some examples.

	Height	Diameter	Aperture Height	Aperture Diameter	Number of Whorls
Type	3.1mm.	1.09mm.	0.9mm.	0.63mm.	6½
Paratype	2.5	0.99	0.81	0.63	5⅓
Paratype	2.25	0.9	0.72	0.63	4½

Calipyrgula stewartiana Pilsbry, Plate 1, Fig. 1

Pilsbry, 1934, Nautilus, Vol. 48, p. 15.
Pilsbry, 1934a, Pro. Acad. Nat. Sci. Phil., Vol. 86, p. 557.

Type. United States National Museum.

Type locality. East side Middle Dome, Kettleman Hills, Sec. 12, Tp. 23 S, R 19 E, Kings county, California.

Horizon. Basal Tulare formation, Upper Pliocene.

Calipyrgula stewartiana resembles *C. carinifera* in having the first two whorls smooth and convex, the remaining whorls of the spire carinate at the periphery and spirally striate below; but it differs from *C. carinifera* in the relative obesity of the body whorl.

Variations. The species is known only from the type.

	Height	Diameter	Aperture Height	Aperture Diameter	Number of Whorls
Type	2.9mm.	1.5mm.	0.95mm.	....	5½

Calipyrgula hibbardi Leonard and Franzen, Plate 1, Fig. 2

Leonard and Franzen, 1944, Univ. Kan. Sci. Bull., Vol. XXX. pp. 19-20.

Type. No. 980, Kansas University Museum of Natural History.

Type locality. 6½ mi. S, ½ mi. W, Gate, Beaver county, Okla.

Horizon. Laverne formation, Lower Pliocene.

This species is similar to *Calipyrgula ellipsostoma* Pilsbry but differs from it by its slightly larger size, more strongly convex whorls, with no more than a faint indication of a carina, deeply incised suture, conspicuous vertical striations, more delicately traced spiral lines below the periphery, and more broadly oval aperture. The deeply incised suture and the spiral lines are features which relate *C. hibbardi* to *C. carinifera.*

Variations. Upon individuals having the vertical striations coalesced into relatively strong ridges the spiral lines are concomitantly obscure. The slight variation in the height-diameter ratio is shown in the table of measurements.

	Height	Diameter	Aperture Height	Aperture Diameter	Number of Whorls
Type	4.1mm.	1.6mm.	1.0mm.	0.6mm.	7
Paratype	4.2	1.6	1.3	0.8	7
Paratype	4.1	1.58	1.1	0.7	7
Paratype	3.9	1.58	1.26	0.8	7
Paratype	3.7	1.5	1.17	0.8	7

Calipyrgula turricula Leonard and Franzen, Plate 1, Fig. 7

Leonard and Franzen, 1944, Univ. Kan. Sci. Bull., Vol. XXX, p. 20.

Type. No. 982, Kansas University Museum of Natural History.

Type locality. 5½ miles S Gate, Beaver county, Oklahoma.

Horizon. Laverne formation, Lower Pliocene.

Calipyrgula turricula has a narrowly conic shell, similar to *C. hibbardi,* but is distinguished from the latter by its larger size, larger number of whorls (maximum of eight) and by its relatively coarse vertical striations. Spiral lines are not prominent in either *C. hibbardi* or *C. turricula* but are distributed below the periphery as in *C. carinifera.*

Variations. The vertical striations vary from fine, evenly-spaced, raised lines to coarser lines approaching riblets; the development of the coarser vertical ridges tends to suppress the expression of the spiral threads. Occasional examples, apparently unworn, have neither well-developed vertical, nor well-defined spiral striations.

	Height	Diameter	Aperture Height	Aperture Diameter	Number of Whorls
Type	6.6mm.	2.2mm.	2.1mm.	1.1mm.	8
Paratype	6.5	2.5	2.0	1.4	7
Paratype	5.3	2.0	1.6	1.3	7
Paratype	4.8	1.8	1.3	1.2	7

Calipyrgula tumida Leonard and Franzen, Plate 1, Fig. 3

Leonard and Franzen, 1944, Univ. Kan. Sci. Bull., Vol. XXX, p. 20.

Type. No. 984, Kansas University Museum of Natural History.

Type locality. 5½ mi. S Gate, Beaver county, Oklahoma.

Horizon. Laverne formation, Lower Pliocene.

Calipyrgula tumida is similar to *C. turricula* but may be differentiated from the latter by its somewhat lesser height, smaller number of whorls, the obesity of the body whorl, more broadly conic profile and by the relatively larger and more elongate aperture. Spiral lines below the periphery are invariably inconspicuous and sometimes indiscernible.

Variations. There is perhaps a greater size range among individuals with the same number of whorls than is found among other known species of the genus. Vertical striations vary from closely spaced, fine, raised lines to aggregations which form low ridges, especially on the body and the penultimate whorls.

	Height	Diameter	Aperture Height	Aperture Diameter	Number of Whorls
Type	5.6mm.	3.7mm.	2.1mm.	1.5mm.	6½
Paratype	5.0	2.6	1.8	1.6	6
Paratype	4.5	2.3	1.7	1.2	6
Paratype	4.1	2.2	1.7	1.1	6

Calipyrgula senta Leonard and Franzen, Plate 1, Fig. 6

Leonard and Franzen, 1944, Univ. Kan. Sci. Bull., Vol. XXX, p. 21.

Type. No. 986, Kansas University Museum of Natural History.

Type locality. 6½ mi. S ½ mi. W Gate, Beaver county, Okla.

Horizon. Laverne formation, Lower Pliocene.

The distinguishing feature of *Calipyrgula senta* is a series of widely spaced, heavy, subconical spines, united at their bases by a spiral ridge slightly above the periphery, and paralleled by a second spiral ridge below the periphery. Vertical striations, varying from fine threads to coarse ridges, embellish all the whorls except the first one and a half. Spiral striations other than the two carinae mentioned are obscure or wanting. In general form *C. senta* is intermediate between the narrow, elongate *C. turricula* and the more broadly conic *C. tumida*.

Variations. The spines appear typically on the body and the penultimate whorls, but the series may extend over all the whorls except the first two, or may be limited to the body whorl. Rarely they are absent with only the carina remaining. Frequently the spines are buttressed below or above or both by a ridge parallel to the vertical striations. Occasionally the carina below the periphery is wanting.

	Height	Diameter	Aperture Height	Aperture Diameter	Number of Whorls
Type	4.8mm.	2.2mm.	1.5mm.	1.2mm.	7
Paratype	4.7	2.3	1.6	1.2	6½
Paratype	4.7	2.2	1.6	1.1	6½
Paratype	4.7	2.2	1.6	1.1	6

DISCUSSION

At the time Pilsbry described the three species of snails which he allocated to the genus *Calipyrgula*, the geology of the Kettleman Hills region was imperfectly known; however, on the authority of the geologists who collected the material, Pilsbry referred to these snails as "Pliocene species" (Pilsbry, 1934a, p. 556). The detailed studies of Woodring, Stewart and Richards (1940) have clarified the stratigraphic relations of the Tulare formation to a certain degree, but the nature of the deposits making up this formation, and the unfortunate lack of mammalian fossils makes it difficult to determine the age of the formation with certainty. The absence of discernible disconformities between the Tulare and the overlying Pleistocene and Recent alluvial deposits compelled Woodring and his colleagues to give the Tulare formation the age designation of "Pliocene and Pleistocene (?)". Nevertheless, they state unequivocally (op. cit., p. 104) that the basal Tulare is Upper Pliocene in age.

The lithology of the beds containing the *Calipyrgula* is described in their notes on a measured section, taken on the east side of northern Middle Dome, sec. 17, T. 23 S., R. 19 E., where they state (op. cit., p. 19) "Cross-bedded gray sand, containing oolites and scattered *Amnicola*, *Calipyrgula*, *Valvata*, *Pyrgulopsis*, and *Pisidium* (locality 14) alternating with discontinuous layers of imperfectly cemented brownish-gray sandstone as much as 2 feet thick. Base not exposed." This lower *Amnicola* zone, in which the *Calipyrgula* occur, is considered a freshwater lacustrine deposit, although during the previous San Joaquin time, an extensive arm of the sea reached the Kettleman Hills area. Even during early Tulare times the deposits were apparently laid down in brackish water during brief intervals, but there is no obvious reflection of this in the gastropod fauna of the basal Tulare.

The localities in the Laverne formation from which *Calipyrgula* have been recovered consist of deposits of shale, sandy-silt, interbedded with thin strata containing carbonized material and fossilized wood, and sometimes overlain with cherty limestone. An analysis of the probable ecological conditions points toward a lacustrine environment here, and there is some indication of brackish water existing at times during the formation of the Laverne deposits. Many of the contained diatoms are relatives of living forms restricted to saline or brackish waters (Leonard and Franzen, 1944, p. 31); furthermore, the development of the spinous excrescences on *Calipyrgula senta* is a possible reflection of brackish water conditions (op. cit., p. 33). That the brackish water may have been derived from upward migration of brines from the underlying salt beds of the Permian, as suggested by Frye (*vide* Leonard and Franzen, 1944, p. 34) is an idea to which credence is lent by actual observation in localities not far from the Laverne deposits. In southern Meade county, a few miles north of the type localities of the *Calipyrgula* species, such saline ponds were still in existence until recent floods along the Cimarron river buried them under sand (Hibbard, 1945). Since these ponds were limited in extent, and often lay adjacent to freshwater pools, the conclusion is that the saline pools were rendered so by upward migration of brines from deeper strata containing salt. Regardless of the mechanisms involved, the nature of the deposits and the associated fauna indicate very similar ecological conditions in the Tulare and Laverne formations at the time the snails were living.

The extreme paucity of reported gastropod faunules from Pliocene deposits in North America makes it inadvisable to indulge in conjectures concerning the center of dispersal and migration routes of the species of *Calipyrgula*, except for the obvious observation that the mountain barriers in North America indicate that the center of dispersal must have been as far south as the Mexican plateau. Furthermore, it is equally obvious that the species of the two localities have been separated long enough to have differentiated into two distinctive groups; the one in California tending toward small size and fine sculpturing of the shell, the other in Oklahoma characterized by generally larger size, and coarser shell sculpturing. Since the genus is yet so poorly known, it is not possible to learn whether these group characters are due to environmental influences, or to some inherent genetic qualities.

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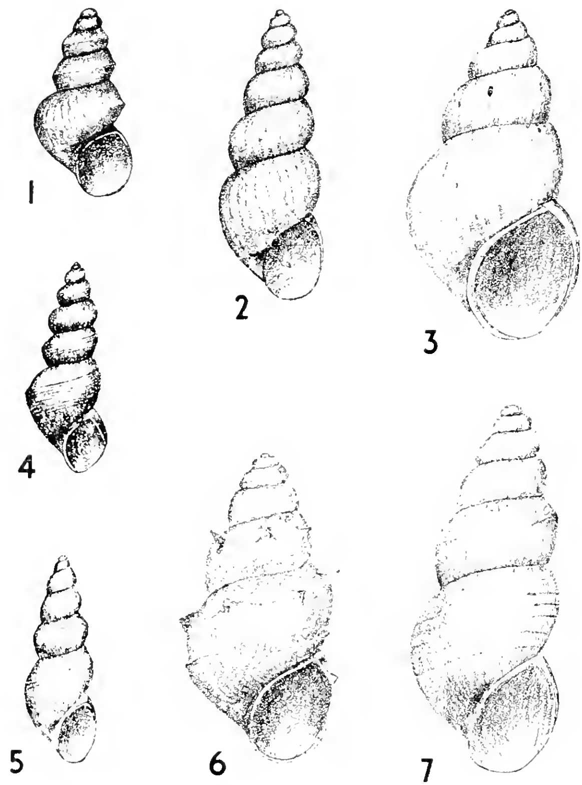

FIG. 1. *Calipyrgula stewartiana.* Redrawn to scale from Pilsbry, 1934a, Pl. 21, fig. 2.
FIG. 2. *C. hibbardi*, type.
FIG. 3. *C. tumida*, type.
FIG. 4. *C. carinifera*, type.
FIG. 5. *C. ellipsostoma*, type.
FIG. 6. *C. senta*, type.
FIG. 7. *C. turricula*, type.
(All figures reproduced on scale of × 10)

THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN

VOL. XXXI, pt. I.] MAY 1, 1946 [No. 6

Mollusca from Greenwood County, Kansas

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ABSTRACT: Sixteen species of unionid mussels, six species of aquatic gastropods, and nineteen species or subspecies of terrestrial gastropods are reported from Greenwood county, southeastern Kansas. The collecting stations are described, the species listed are briefly annotated, and comparisons are drawn between this fauna and known molluscan faunas from other parts of the state of Kansas.

ALTHOUGH the late R. Ellsworth Call first published on the mollusca of Kansas sixty years ago (Call, 1885) the native living fauna of the state is still but little known. Later published reports include the fresh-water mussels of the state (Scammon, 1906), the gastropods of Douglas county (Hanna, 1909), a preliminary study of the mollusks of Kingman county (Franzen and Leonard, 1942), the mollusks of the Wakarusa river and its valley (Franzen and Leonard, 1943), the mollusks of Clark and Meade counties (Leonard, 1943), and a list of new state records, comprising twelve forms of gastropods (Franzen, 1944). The present report deals with the mollusks in a region of the state not previously studied.*

Greenwood county lies on the eastern slopes of the Flint Hills, and is drained by Fall river, the Verdigris river, and their tributaries. Timber is not abundant on the grass-covered hills, but near streams there are stands of elm, oak, sycamore, maple and hickory, together with dense growths of native shrubs, which, with a moderately adequate supply of moisture, afford suitable habitats for terrestrial gastropods. The prevailing rock outcrops are limestones and shales, which provide a soil rich in the calcium needed by mol-

* We are grateful to Dr. C. W. Hibbard of the Museum of Natural History, Kansas University; to Mr. and Mrs. Charles Hibbard of Toronto; and to Dr. G. C. Rinker and his son Richard, of Hamilton, all of whom assisted in making the collections or otherwise facilitated our work in the county.

lusks, but occasional outcrops of sandstone produce local changes in environment. In general, erinaceous soils are almost devoid of mollusks, but there are certain exceptions, which will be noted below.

In the short time at our disposal, collections were necessarily restricted to a few selected stations.

STATION 1. Near the headwaters of Burnt creek, one mile north, one-half mile west of Reece, S. 6, T. 26 S, R. 8 E, in the western part of the county. Only a scant growth of trees, largely elm, occurs here, but by collecting in debris cast up by high waters, we obtained a rather large number of species at this locality.

STATION 2. Approximately one-fourth mile above the town of Fall River, S. 13, T. 28 S, R. 12 E, on the heavily timbered flood plain of Fall river, and the slightly higher, also timbered, ground above the flood plain. Deep leaf mold, fallen logs, deep shade and good moisture conditions produce an ideal habitat for terrestrial gastropods.

STATION 3. One mile east, two miles north of the town of Fall River, in hardwood timber along Shawnee creek. A good stand of oaks and hickory provided suitable cover. The creek has incised the Ireland sandstone which occurs as eroded blocks along the flanks of the floodplain. Contact springs assist in regulating moisture; mosses and ferns grow abundantly.

STATION 4. The steep rocky slopes along Carlysle creek, approximately nine miles north, two miles east of the town of Fall River, S. 32, T. 26 S, R. 13 E. The rock outcrops are limestone, the slopes of the ravine through which the creek runs are well drained, and bear a fair stand of oak, hickory, elm and sycamore trees.

STATION 5. The grass-covered slope of a treeless hill on the Hibbard farm, S. 5, T. 27 S, R. 13 E, approximately eight miles southwest of Toronto. Seeping springs provide abundant moisture which forms tiny pools in small depressions, such as cattle tracks, among the clumps of bluestem grass.

STATION 6. Shoals and bars of shingle and gravel in West creek, S. 21, T. 24 S, R. 11 E, four miles east, two miles south of Hamilton. Deep pools here are known to be abundantly populated with pelecypods, but since we visited this creek in late October when the water was very cold, collections were limited to shells, largely "dead" ones, found on gravel bars, or in the shallow water of shoals.

STATION 7. An artificial pond eleven miles west of Madison, S. 20, T. 22 S, R. 10 E. This pond is situated in a shallow depression at the foot of gentle slopes leading to the surrounding Flint hills.

No trees or shrubs are found in the near vicinity, but the shores of the pond support a luxuriant growth of grasses and sedges, and plant debris cast up by high water affords additional cover for small gastropods.

STATION 8. The headwaters of one of the tributaries to the Verdigris river, located in the treeless Flint hills, twelve miles west and approximately two and one-half miles south of Madison. Several small creeks rise here from numerous contact springs; since the creeks flow over gravel and shingle derived from limestone outcrops, the water is clear and free from silt. A sparse stand of elm, oak and sycamore trees occurs in the near vicinity of the creeks, but there is very little growth of native shrubbery, or other cover suitable for terrestrial snails. No mollusks were found in these streams, although a small colony of *Lymnaea bulimoides techella* thrived in an ephemeral pool on the flood plain, and two examples of *Physa hawnii* were found on watercress growing in the overflow from a spring. Since ecological conditions in these streams seem ideal for mollusks, the complete absence of both gastropods and pelecypods presents an unsolved problem. Salt water or oil flowing into these creeks from oil wells nearby may have exterminated any mollusks that may have lived in these waters, but at present there is no sign of contamination.

The molluscan fauna of Greenwood county as now known includes sixteen species of unionid mussels, six species of aquatic gastropods, and nineteen species and subspecies of terrestrial gastropods. These are listed below in the form of an annotated checklist; the numbers refer to collecting stations at which the several forms were found.

PELECYPODA

FAMILY UNIONIDAE

All from station 6.

Truncilla truncata (Say). Not common.

Lampsilis anodontoides (Lea). Typical forms; not abundant.

Lampsilis siliquoidea (Barnes). The most common *Lampsilis;* the shells tend to be unusually heavy, sometimes malformed.

Lampsilis ventricosa (Barnes). Least common *Lampsilis;* shells very inflated and heavy.

Ligumia subrostrata (Say). Common; typical.

Proptera cf *purpurata* (Lamarck). Common; shell characters make it difficult to assign these forms to a species with certainty, but in our opinion, these forms are closer to typical *P. purpurata* than to *P. alata*.

Leptodea fragilis (Swanson). Fairly common; shells unusually heavy for this species.

Tritogonia verrucosa (Say). Not numerous; typical.

Anodonta grandis (Say). Not numerous; shells smaller and less inflated than typical forms.

Lasmigona complanta (Barnes). Found abundantly; typical.

Uniomerus tetralasmus (Say). Not common; typical.

Amblema costata (Rafinesque). Numerous; development of ridges not typical, tending toward *A. peruviana*, but other characters typical of the species.

Quadrula quadrula (Rafinesque). Common; shells gigantic for the species.

Quadrula pustulosa (Lea). Common; pustules very poorly developed or absent.

Fusconaia flava (Conrad). Common; shells unusually large for the species.

Obliquaria reflexa (Rafinesque). Rare; this species is never found in numbers in Kansas streams.

AQUATIC GASTROPODA

FAMILY LYMNAEIDAE

Lymnaea bulimoides techella (Haldeman): 1, 4, 5, 7, 8. Although found breeding in pools, this form is seldom found in permanent water. It burrows beneath the mud during dry seasons.

Lymnaea humilis rustica (Lea): 4.

Lymnaea parva (Lea): 5. These two forms are small, and seem to prefer mud near water, rather than actual submergence.

FAMILY PLANORBIDAE

Helisoma antrosa (Conrad) (*-anceps*): 1, 4. Less common than *H. trivolvis*, apparently because of a closer restriction to habitat. It prefers clean running water.

Helisoma trivolvis (Say): 1, 4. Common in streams and ponds.

FAMILY PHYSIDAE

Physa hawnii Lea: 1, 2, 4, 7, 8. Common everywhere in streams and ponds.

TERRESTRIAL GASTROPODA

FAMILY POLYGYRIDAE

Triodopsis albolabris alleni (Sampson); 2. Confined to timbered areas, where good moisture conditions prevail.

Mesodon thyroidus (Say): 2. Never common in Kansas, and confined to heavily wooded areas.

Stenotrema monodon aliciae (Pilsbry): 2, 3, 7. These forms present taxononic difficulties; further elucidation of the *fraterna-monodon* complex in Kansas is needed.

FAMILY BULIMULIDAE

Bulimulus dealbatus (Say): 1, 2, 7. These large snails prefer to live on rocky slopes, but are frequently found living in drifts of plant material. Numerous at no. 7.

FAMILY ZONITIDAE

Retinella electrina (Gould): 3. Not common; found in leaf mold and under decaying logs.

Retinella indentata (Say): 1, 2, 3, 4, 5. More numerous than *R. electrina;* habitat similar.

Hawaiia miniscula (Binney): 1, 5, 7. Never numerous, but widely distributed in Kansas; prefers open grassland, but occurs in woodlands as well.

Euconulus chersinus cf *polygyratus* Pilsbry: 1, 3. A woodland species.

Zonitoides arboreus (Say): 1, 3, 4, 5. Common and numerous in woodlands; it thrives also in open grasslands.

FAMILY ENTODONTIDAE

Anguispira alternata alternata (Say): 2, 3, 4. Common in wooded areas. At No. 2 these snails were so numerous on the flood plain of Fall River that it was literally impossible to walk without crushing their shells at every step. At No. 3, where sandstone rocks outcrop strongly, the high-spired form of *A. alternata,* to which the subspecies name *eriensis* has been applied, occurs with the typical form. Since the two forms occur together, we regard the name *eriensis* as invalid, and consider the high-spired form of shell a phenotypic variant, produced in some way by the sandy substrate.

Helicodiscus parallelus (Say): 1, 3, 7. Never numerous; found near decaying stumps and in rock ledges.

FAMILY PUPILLIDAE

Gastrocopta armifera abbreviata (Sterki): 1, 2, 3, 4, 5, 7. These tiny snails are abundant in woodlands in leaf mold; they also occur in open grasslands.

Gastrocopta contracta (Say): 1, 3. Only a few examples of these tiny snails were found; it is probably more common than realized.

Gastrocopta procera sterkiana (Pilsbry): 1, 4.

Gastrocopta procera mcclungi (Hanna and Johnston): 1, 4. As far as known, both these forms are typically western in distribution in Kansas; only a few examples of each were found, and these from plant drift.

Pupoides marginatus (Say): 1, 3, 7. Found both in woodlands and open grasslands; widely distributed in Kansas and elsewhere.

FAMILY STROBILOPSIDAE

Strobilops labyrinthica parietalis Pilsbry: 3, 4. These snails, though minute, have exquisitely sculptured shells. Restricted to woodlands.

FAMILY VALLONIDAE

Vallonia costata (Müller): 1. A few shells recovered from drift are assigned to this species; the Kansas vallonias have never been adequately studied.

FAMILY SUCCINEIDAE

Succinia avara Say: 1, 2, 4, 5, 7. Found along streams in grass and sedges; not strictly aquatic.

DISCUSSION

Although Greenwood county lies approximately 100 miles southwest of Douglas county, the general character of the molluscan fauna is not unlike that of Douglas county as reported by Hanna (1909). While our list of species is less extensive than Hanna's, it is worthy of note that every form we list here is also known from Douglas county. A few genera reported by Hanna have not been found in Greenwood county. *Pupilla* probably does not occur in the Greenwood county fauna, nor have we found it resident in Douglas county; Hanna's specimens came from Kansas river drift, and were very likely Pleistocene fossils, since *P. muscorum* is abundantly represented in Smoky Hill river deposits. On the other hand, some species of *Vertigo* very probably is native to Greenwood county, but we failed to find examples. We found a species of *Amnicola* near No. 6, represented by shells found under conditions which make it appear that the species is extinct there. *Campeloma* may yet be found in Fall river; at the time we were collecting in the county, Fall river was near flood stage, and we did not find examples of the genus elsewhere. We did not find *Hendersonia occulta* (Say), but this species is notorious for its erratic, local distribution; a living colony has yet to be found in the state, though fossils are common in some Pleistocene deposits.

As far as can be ascertained from our studies, the relative abundance of the several species found in Greenwood county is not unlike that in Douglas county, with the exception of *Bulimulus dealbatus*, which is locally abundant in Greenwood county. This species, which is typically southern in its distribution, ranges from North Carolina to Texas. The greater abundance of the species in Greenwood county is thus the only evidence of the influence of a more southerly position in the state. However, such genera as *Goniobasis, Haplotrema, Mesomphix*, and *Polygyra*, which occur in the eastern and southern portions of Kansas are apparently missing from the Greenwood county fauna, although local conditions would seem not inimical to them, and the drainage pattern lends itself to migration in the direction of Greenwood county. In spite of the obvious fact that Kansas is a meeting-ground for both eastern and western, and southern and northern, species of mollusks, particularly gastropods, the data thus far accumulated indicate that the molluscan fauna of the state is much more conspicuously stratified in an east-west manner, than in a north-south manner. This is, of course, a reflection of the zonation within the state with reference to soil, rainfall and flora, all of which may be zoned more readily in an east-west direction than in a north-south direction. It is scarcely necessary to point out that the three factors mentioned are of prime importance in the distribution, not only of mollusks, but of all animals.

The list of pelecypods, represented only from the collections made in West creek, gives a very incomplete picture of the freshwater mussel population, not only because the list was compiled from a single collection, but because it is a creek fauna. River faunas are generally more varied; furthermore, certain forms are restricted to larger streams. It has been our fortune to find Fall river near flood stage each time we have been in the vicinity, making collecting in the stream quite impossible. When circumstances lend themselves to work in Fall river, the pelecypod fauna of the county will become more accurately known.

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Transmitted May 22, 1945.

THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN
Vol. XXXI, pt. I.] May 1, 1946 [No. 7

Description of a Presomite Human Embryo

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Abstract: The anatomy of a presomite human embryo of an estimated age of less than three weeks is described and figured by drawings and photomicrographs.

INTRODUCTION

THE first careful and detailed description of a human embryo was made by Jones in 1837. Since that time many human embryos were discovered, described, and made available for study. Since these embryos were obtained under unusual circumstances, by abortions, curettings, and operations, many of them were damaged, either in the process of obtaining them, or injured by post operative handling. Within the past twenty years, more human presomite embryos were described than in the entire preceding century. Our knowledge of human embryology has increased considerably over a period of years, for which we are indebted to many investigators and collectors, notably Grosser, Stieve, Florian, Fetzer, Teacher, and Bryce in Europe, and Hill, Streeter, Ingalls, Heuser, and Brewer in the United States.

Although a great deal of advancement has been made in human presomite embryology, there are many problems concerning development which can be solved by further study of additional embryos. Human embryology has arrived at a stage where duplication of ages is frequent, still, no two embryos show exactly the same degree of development. While embryos of the same age add nothing new to our knowledge of human embryology, they do, nevertheless, play an important part in substantiating observations made by investigators in previously described human embryos. The embryo on which this study was made, while contributing nothing new, corroborates the findings of earlier investigators.

CASE HISTORY

Unfortunately, the clinical history of this specimen is very meager. Additional clinical data would have made this study much more interesting, but, in this instance, more information could not be obtained because the physician failed to coöperate. This embryo was obtained through the coöperation of Mr. Robert W. Meyers, medical student, The University of Kansas, who obtained the specimen and presented it to the senior author. The label on the vial containing the embryo bore the following legend: "Ovum removed from uterus after hysterectomy. Patient 7 to 10 days past 'due.'" The comparison of this embryo with the Mateer, Ingalls and Brewer embryos, as well as a comparison with limited macaque material of known ages, has fairly well established its age. The elapsed time between the removal of the ovum and its fixation is not known. This interval must have been very short since the extra-embryonic structures are well preserved.

TECHNIQUE

The blastocyst was washed in several changes of distilled water, dehydrated for one hour in each of a series of alcohols ranging from 5 to 95 percent. It was further dehydrated in two changes of absolute alcohol, remaining in each alcohol for one hour. A slow process of clearing was also observed. The blastocyst was placed into a mixture of two-thirds absolute alcohol and one-third xylol, then into a mixture of one-third alcohol and two-thirds xylol and finally cleared in xylol. It remained in each of these solutions for one hour. The specimen was next infiltrated with paraffin for one hour, a change of paraffin having been made at the half time period. During the process of infiltration, the dorsal surface of the chorion collapsed slightly, giving it an elliptical appearance in section. The blastocyst was blocked carefully, sectioned at ten micra, and the sections were mounted on the slides. Whenever possible, two rows of sections were mounted on the slides. A total of 91 slides, containing both the chorion and the embryonic rudiment, was obtained. Because of incomplete infiltration, it was found necessary to reblock the vesicle. A few sections of the chorionic vesicle were necessarily lost in reblocking the specimen. In the process of staining and mounting, two sections of the embryo were lost. The sections were stained with haematoxylin-eosin and mounted in balsam. Seven slides of the chorion were refixed in Zenker-formol and stained with Mallory triple connective tissue stain.

METHODS OF STUDY

An approach to the study of this embryo was made by the study of the slides, by the construction, by the wax plate method, of a three dimensional model of the embryonic disc with the entodermal roof of the yolk sac, by a graphic reconstruction of the embryonic disc and its allied structures, and by the photographing of representative sections.

The model of the embryonic disc, together with the entodermal roof of the yolk sac, was made in the following manner: the length of section 60.1 was measured with a calibrated ocular micrometer and the figure obtained was calculated to a magnification of 200 diameters. Section 60.1 (not figured) was projected through a microprojector on a white sheet of paper at a magnification of 200 diameters. After the magnification was determined, each section of the embryo was projected and the outline was traced. These outlines were traced with carbon paper onto a large sheet of blotting paper. Three sheets of blotting paper were necessary to give the proper thickness for a magnification of 200 diameters. These were placed in hot paraffin and pressed tightly together. After cooling, the sections were cut out, placed together in their serial order, and stapled together. After all sections of the embryo were cut out and stapled together, a three dimensional model of the embryonic disc and the roof of the yolk sac was obtained. The amnion and yolk sac were cut a short distance above and below the disc, respectively.

The graphic reconstruction of the embryonic disc and its allied parts was made by drawing the outline of each section with a camera lucida at a magnification of 200 diameters. The shield, mesoderm and entoderm were drawn with blue, red and yellow colors, respectively. The length of each section, the distance of the structures from the caudal end, and the lengths of the structures, were measured with a calibrated ocular micrometer. The measurements thus obtained were magnified to 200 diameters and were plotted on graph paper, each small square representing one millimeter. Vertical lines on the graph paper represented the plane of section. By measuring the distance of each structure from the caudal end, and the length of each structure in each section in which it appeared, it was possible to determine the length and width of these structures and their relationships on the completed two-dimensional reconstruction. In this way, Hensen's node, head process and prochordal plate were located and reproduced graphically. Similarly, the course of the primitive streak and the plane of section were ascertained. A straight line through the primitive streak forms a 34 degree angle with the medial plane of section. Measurements of all structures were taken from this reconstructed graph.

The embryo was studied also from photographs of representative sections. As would be expected, greater detail is soon through the microscope than it is possible to see in a photograph. Descriptions pertaining to the photographs were made from the sections as observed through the microscope.

In the course of study, this embryo was compared with the Ingalls and Mateer embryos. Where it was thought expedient, a comparison of structures in our embryo was made with corresponding structures in the H. R. 1, Falkiner, Dobbin, Manchester, and Heuser embryos.

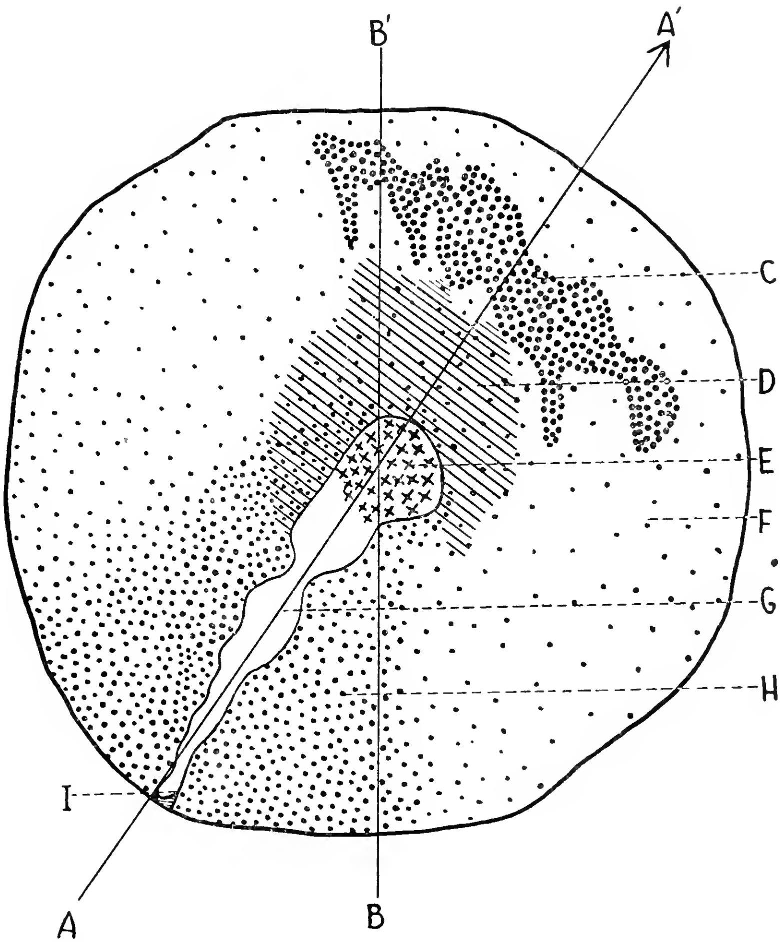
DESCRIPTION OF EMBRYO AND CHORION

A presomite human embryo consists of a germinal disc, a dorsal amniotic vesicle, a ventral yolk sac vesicle, and a body stalk. The ectodermal cells of the germinal disc thin out abruptly and turn upward where they connect with the ectodermal cells of the amnion. Below, the entoderm of the disc turns ventrad where it connects with the entodermal lining of the yolk sac. Mesoderm covers both the amnion and yolk sac; it is continuous with the mesoderm which lies between the ectodermal cells of the disc and the entodermal roof of the yolk sac. At its caudal end, the embryo is attached to the chorion by a broad mass of mesodermal cells.

Further differentiation in the embryo gives rise to axial structures. On the surface of the disc, an ectodermal thickening forms the primitive streak which terminates near the center in an elevation, known as Hensen's node. A forward growth from Hensen's node, below the disc, is known as the head process. Anterior to the head process, at the cephalic margin of the disc, the prochordal plate arises as an entodermal thickening. Posterior to the primitive streak, the fusion of ectoderm with entoderm gives rise to the primordium of the cloacal membrane. Caudal to the cloacal membrane, an evagination of the yolk sac into the body stalk forms the allantois.

THE EMBRYONIC DISC

In outline, the germinal disc is circular; it is slightly flattened in the cephalic region and moderately convex posteriorly, except in the caudal extremity where there is an acute ventral flexion. The disc is found in 77 sections. On its long axis, the greatest diameter is 0.82 mm., and its transverse diameter is 0.80 mm. The actual diameter is greater than 0.82 mm., since an error was unavoidably encountered in measuring the sections in the region of the acute ventral flexion. The generally regular contour of the disc is character-



TEXT FIGURE 1. Graphic reconstruction of embryonic disc.
A-A'. Longitudinal axis.
B-B'. Plane of section.
C. Protochordal plate.
D. Head process.
E. Hensen's node.
F. Lateral (loose) mesoderm.
G. Primitive streak.
H. Compact mesoderm.
I. Cloacal membrane.

ized by a series of slight elevations and depressions. Vertical clefts also are observed in the disc. A careful examination of the sections and the model revealed no elevations of the disc which might be interpreted as neural folds.

The disc is composed of tall columnar cells, in one, two or even more overlapping layers, with the nuclei placed at different levels within the cells. These nuclei are either oval or elongated. It is impossible to determine whether or not the difference in the shape of the nuclei is due to the plane of section. The entire embryonic disc is strongly basophilic; the cytoplasm as well as the nuclei take the basic stain. On account of this overstaining, it is difficult to interpret intracellular structures. In various areas, nuclei appear hazy, granular, or even display extensive fragmentation. Under these conditions neither nucleoli nor mitotic figures could be observed or studied with any degree of certainty. This does not, however, preclude the possibility that neither of these structures is present. Numerous intracellular vacuoles of different sizes were observed in the cells of the disc. They are localized chiefly in the anterior third of the disc, and are conspicuously concentrated in an area encircling the node, as well as within the node itself. In some sections, the columnar cells were cut at an angle in such a way as to appear polygonal. No evidence of the yolk sac is found in the first three sections, indicating that the germinal disc moderately overlaps the yolk sac; the yolk sac is detached from the embryo in the caudal region. Along the entire edge of the disc, there is an upwardly curved rim of ectoderm which forms the inner lining of the amnion. The anterior margin of the disc thins out abruptly into a single layer of cells while the corresponding posterior margin is several cells in thickness. This curving of the disc to form the amnion illustrates a gradual transition from the columnar cells to the characteristic spindle-shaped cells of the amnion.

The embryonic disc rests upon a thin noncellular membrane. It is prominent and distinct in the anterior region; it becomes less distinct posteriorly. Moreover, this basement membrane is found throughout the disc except in the region of the primitive streak and Hensen's node. Mesodermal strands one cell thick are attached as loops at intervals to the floor of the disc. In a few of the first sections, the ectodermal cells fuse with the intraembryonic mesoderm. A similar fusion of ectoderm occurs in the area of the prochordal plate, except that in this case, the fusion is with entodermal cells.

Primitive Streak and Hensen's Node

The primitive streak originates in the caudal region of the embryonic disc, courses in an irregular manner anteriorly to terminate a short distance in front of the center of the disc in an enlarged elevation, known as Hensen's node. The length of the primitive streak together with the node is 0.5 mm. The primitive streak is observed in 33 sections. Due to the plane of section, it is possible to observe the node and the lateral margin of the primitive streak in the same section. Hensen's node lies slightly to the right of the long axis of the embryo.

The primitive streak is very narrow at the caudal end of the embryo; it becomes increasingly wider as it approaches its terminus, Hensen's node. Throughout, it is shallow except in the middle third of the disc where it becomes a V-shaped groove. In section, the primitive streak is observed as an area where all three germ layers are indistinguishably fused. In section 62.7, the primitive streak is observed as a cone penetrating the germinal disc. Mesoderm has proliferated laterally from its base. In later sections, the primitive streak appears at the caudal extremity of the disc. This retrogression of the primitive streak in successive sections indicates that the streak was sectioned at an angle.

The superficial cells of Hensen's node are low columnar, and they stain faintly in most sections. Extensive vacuolization of these cells is characteristic for the node and the immediate surrounding area. Hensen's node has actively proliferated cells forward, between the embryonic disc and the roof of the yolk sac; this proliferation from the node has been identified as the head process.

The Head Process

An area of undifferentiated, compact cells arising from Hensen's node and growing cephalad between the germinal disc and the yolk sac, has been identified as the head process. It is 0.27 mm. long and 0.23 mm. wide. The broad caudal part of the head process extends posteriorly around Hensen's node. The head process is observed from section 60.4 to section 63.2. In the graphic reconstruction, it is skewed to the left of the median axis. The head process merges with mesoderm laterally, receives mesoderm from the primitive streak posteriorly, and is continuous with the prochordal plate anteriorly. Entodermal cells are indistinguishable in the region of the head process. Several desquamated entodermal cells, however, are observed to lie freely in the yolk sac below the head process. The head process is composed of two types of cells, undifferentiated round cells with round nuclei, and columnar cells with elongated nuclei. The former type predominates. Columnar cells, varying from 6 to 20 in number, were observed from section 61.11 to 62.5, below the basement membrane, on the anterior slope of Hensen's node.

THE PROCHORDAL PLATE

The prochordal plate is an entodermal thickening in the head region which in some lower forms gives rise to the premandibular somites, proliferates head mesenchyme, and contributes to the formation of the oral plate.

In this specimen, the prochordal plate is a crescentic area of thickened entoderm situated anterior to the head process and terminating near the cephalic margin of the disc. The plate was traced serially from section 58.12 to section 62.7. It has reached its greatest development in slides 61.1 and 61.2, where it is composed of typical entodermal cells, that is, large, round cells with a relatively small cytoplasm and with large round nuclei. Under high magnification, cytoplasmic strands, characteristic of mesodermal cells may be observed winding in and about these entodermal cells. Since the margins of the prochordal plate thin out gradually, it is impossible to differentiate between this structure and the mesoderm with which it is continuous. Its broad lateral extension indicates that it was actively proliferating mesoderm. Chromatophilic granules, sometimes found associated with the prochordal plate, were not observed. A slight overstaining of this structure may have obscured these granules so that they could not be identified. A fusion of the ectoderm of the germinal disc with the entodermal cells of the prochordal plate was observed.

THE AMNION

Since the embryo lies on the opposite side of the chorionic cavity from its original attachment (Fig. 1, plate IV) the caudal portion of the amnion is separated from the embryo and remains attached to the body stalk.

Along the lateral margins of the disc, the amnion is composed of a layer 6 to 8 cells in thickness; in the central region, it thins out to two layers of cells. The amnion is collapsed upon the germinal disc, thus, the amniotic cavity is practically obliterated. An acidophilic cellular detritus punctuated sparingly with basophilic granules and spherules was observed along the peripheral margin of the amnion.

The amnion of this specimen is characteristic of embryos in this stage of development. It is composed of an inner layer of cells originating from the ectodermal disc, and, of an outer layer of mesodermal cells. The former is continuous with the ectodermal disc, while the latter is continuous with the intraembryonic mesoderm. The ectodermal layer of the disc gradually transforms from tall columnar cells, to short columnar cells, rounded and fusiform cells, respectively. The outer mesodermal layer is composed of either rounded or spindle-shaped cells, the latter type predominating. Both of these layers, as a rule, are fused together, and occasionally some matrix is found between the two. Shrinkage spaces between these two layers of the amnion are common.

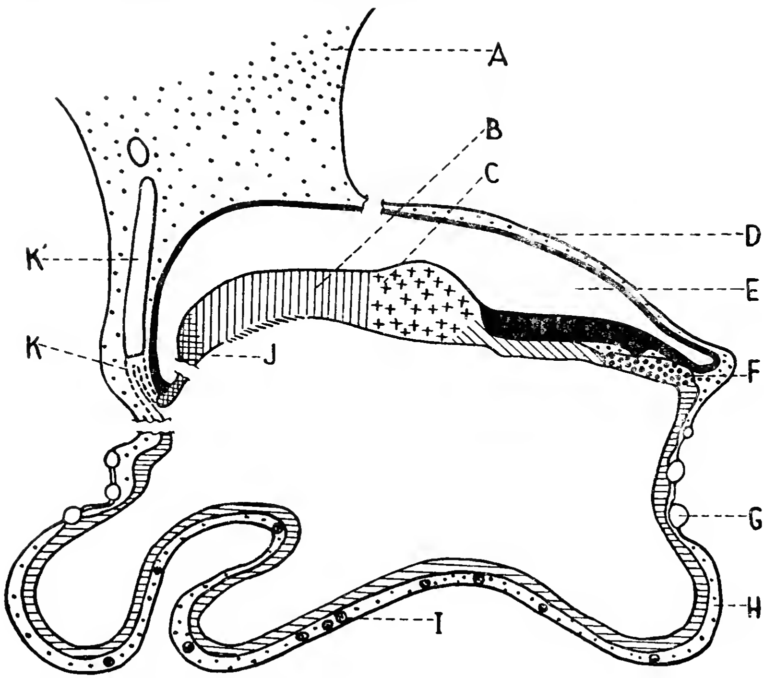
The amnion in the region of the body stalk becomes smaller until it is supplanted by a heavy infiltration of extraembryonic mesoderm. The two layers of cells of the amnion in the region of the body stalk and the inclosed cellular detritus are identical with the cell layers and detritus found in that portion of the amnion attached to the embryo. The amnion is smaller than the yolk sac.

The Yolk Sac

After separating from the body stalk, the embryo in its path to the opposite side of the chorion, drifted forward moderately; it rests upon the collapsed and folded yolk sac which is enmeshed in an acidophilic granular coagulum. Since the embryo drifted forward, the yolk sac trails behind the embryo for a considerable distance.

As interpreted from sections, the yolk sac is a vesicle lying beneath the germ disc. In succeeding sections, an isolated part of the yolk sac is observed anterior and ventral to the embryo proper. Eventually, these two vesicles become continuous to form the main body of the yolk sac. Posterior to the embryo, the yolk sac again appears as two separate vesicles, one of which is longer than the other.

The yolk sac is composed of two layers of cells, an inner entodermal layer and an outer mesodermal layer. The entodermal cells are typically large, round cells with a relatively small amount of cytoplasm and with large, round nuclei. The cell boundaries may or may not be distinct. The mesodermal covering is continuous with the intraembryonic mesoderm. Although the mesodermal cells may be either spindle-shaped or round, the former type predominates. As the yolk sac extends ventrally, the lateral and ventral walls become thicker; this additional thickness is due to an eosin-staining fibrillar matrix which is present between the entodermal and mesodermal layers. Mesodermal thickenings of various shapes and sizes, not particularly restricted to any one region, may be found in the lateral and ventral walls of the yolk sac. In section, they appear triangular, paddle-shaped or even as a solid ball of cells. The number of cells entering into the formation of these thickenings varies from 4 to 30, depending upon the stage of development. These thickened areas of mesoderm represent various stages of angiogenesis. In slide 62.8, several mesodermal cysts are observed in the



TEXT FIGURE 2. Idealized median section.
A. Body stalk.
B. Primitive streak.
C. Hensen's node.
D. Amnion.
E. Amniotic cavity.
F. Protochordal plate.
G. Mesodermal cyst.
H. Yolk sac.
I. Blood vessel.
J. Cloacal membrane (partially reconstructed).
K. Allantois (reconstructed).
K′. Allantois.

anterior wall of the yolk sac; these become increasingly larger as they approach the ventral pole. In some embryos, columnar cells have been observed in the yolk sac. A careful search revealed only 6 columnar cells in the entodermal lining of the ventral wall in section 66.5. A scant amount of eosin-staining coagulum, similar to the coagulum found in the chorionic cavity, is found within the yolk sac. Neither entodermal cysts nor septa were observed. Under the circumstances, it is impossible to determine whether or not the yolk sac, in its original position, was attached by mesodermal strands to the opposite side of the chorion. Several mitotic figures, in late telophase, were observed within the yolk sac cells.

The Body Stalk

The body stalk of this embryo is a solid, funnel-shaped mass of mesodermal cells, attached by its broad end to the chorion. A part of the amnion, separated from the caudal end of the embryo proper, is attached to the anterior part of the body stalk. In section, the amnion lies free near the chorion in the extraembryonic coelom. In succeeding sections, it becomes elongated and is attached at its broad, posterior margin to the chorionic mesoderm. A heavy infiltration of mesoderm cells in the posterior region of the amnion obliterates the cavity and it becomes continuous with the body stalk.

The body stalk is composed of several types of cells enmeshed between an acidophilic matrix. The cells are spindle-shaped, round, oval, and stellate, while the nuclei of these cells are either round, oval, or even angular.

The body stalk is attached to the chorion by an interweaving of the spindle-shaped cells of the chorion with the cells of the body stalk. The chorionic mesoderm has contributed actively to the formation of the body stalk, since these spindle-shaped cells may be observed intermingled among the round and stellate cells which constitute the greater part of the body stalk.

A part of the cloacal membrane, separated from the embryo proper has been observed to be attached to the ventral portion of the amnion. A solid core of cells within the body stalk has been identified as the allantois. Both the allantois and the cloacal membrane will be discussed in a later paragraph.

Cloacal Membrane and Allantois

The original relationships of the cloacal membrane and the allantois have been lost with the separation of the embryo from its body stalk. The cloacal membrane, however, may be observed in three distinct parts: (1) In its original position in the embryo proper, (2) in the body stalk, and (3) in the detached yolk sac. The distal end of the allantois is seen in the body stalk only.

The separated parts of the cloacal membrane are recognized by the proximity of the detached yolk sac to the region of the cloacal membrane of the embryo proper, and by the similarity of cells in the body stalk to the cells of the cloacal membrane in the embryo proper. In section 64.4, the cloacal membrane is recognized as the fusion of the ectodermal cells of the disc with the entoderm cells of the yolk sac. In this same section, the anterior part of the detached yolk sac, forms the caudal limit of the cloacal membrane, while the detached middle portion is found attached to the amnion in section 63.1.

A solid core of cells projecting half way into the body stalk is the distal part of the allantois. In section 63.8, it is observed as a small cord, enlarged in the following section, and, as two separate structures in section 63.11. These two parts are not connected.

The allantois is composed of closely packed round cells with round or oval nuclei and distinct cytoplasm.

MESODERM

Mesoderm may be classified in several ways. A convenient method is to divide the mesoderm into intraembryonic mesoderm and extraembryonic mesoderm. Intraembryonic mesoderm includes all mesoderm between the ectodermal disc and the roof of the yolk sac, whether it has originated as primitive mesoderm or primitive streak mesoderm. Extraembryonic mesoderm, consequently, form the covering of the amnion and yolk sac, lines the chorion, and forms the inner core of the villi and constitutes the bulk of the body stalk.

The intraembryonic mesoderm of this embryo is a continuous open meshwork of cells except in the median plane, between the head process and the prochordal plate. Where the limits between the ectodermal shield and the entoderm of the yolk sac are narrow, this space may be completely filled with mesoderm. In most sections, the mesoderm is attached by its processes directly to the basement membrane, or when it is absent, attachment is directly to the ectodermal plate above, and to the entodermal roof of the yolk sac, below. Looping strands of mesoderm are more numerous in the caudal region than in the cephalic region. Infrequently, the cells collect into a cluster to form a rosette pattern. The mesodermal cells form compact sheets lateral to the primitive streak. In this region, the entoderm is often indistinguishable and is intermingled with the mesodermal cells. On the caudal and cephalic margins where the mesoderm becomes continuous with the amniotic and yolk sac mesoderm, there is a tendency for the mesodermal cells, and probably too, some entodermal cells, to form into small masses or clumps. The cells of the intraembryonic mesoderm are of two types; large, round cells with large, spherical nuclei and with short cytoplasmic processes; and stellate cells with spherical or oval nuclei, and with very fine and exceptionally long cytoplasmic processes. The processes of both types of cells anastomose, and, in addition, are attached to the ventral surface of the disc and/or to the entoderm or the yolk to form a fine open meshwork.

The extraembryonic mesoderm of the amnion is composed of a single strand of continuous cytoplasm, studded with prominent, bulging, elongated nuclei. At the junction of the amniotic mesoderm with the yolk sac mesoderm, there is, very often, a concentration of mesodermal cells, it is impossible to distinguish between intraembryonic mesoderm and extraembryonic mesoderm in this region. The closely attached mesodermal cells following the upturned rim of the ectoderm have a tendency to be of the round rather than of the fusiform type so characteristic of the amnion. In areas where the amnion is several cells in thickness, the additional thickness is due entirely to the increase of ectodermal cells, rather than to an increase in the mesodermal cells. Both the mesodermal and ectodermal cells are fusiform in the thinned out portion of the amnion.

In the caudal and cephalic regions of the yolk sac where the mesoderm becomes continuous with intraembryonic mesoderm, the cells are typically round, and, as they approach the lateral walls of the yolk sac, are gradually transformed into characteristic fusiform cells. These fusiform cells are again transformed into large, round cells with indistinct cytoplasm in areas which give rise to blood islands.

The mesoderm of the body stalk has been described in an earlier section. The entire body stalk is composed of mesoderm from two sources, the mesoderm from the amniotic covering, and from the inner lining of the chorion. These cells are of two types; from the chorion are given off wavy, spindle-shaped cells with elongated nuclei, but the bulk of the body stalk is composed of large, round cells with nuclei of various shapes and sizes.

Chorionic mesoderm lines the entire cavity of the chorion and evaginates with the cytotrophoblast and plasmoditrophoblast to form the inner core of the villi. These cells abut against the trophoderm in rows, 2 to 3 cells deep with their long axes parallel to it. Where the trophoderm evaginates to form a villus, the strands of chorionic mesoderm increase in number, and become more loose and wavy. Within the villus, they thin out and develop cytoplasmic processes which give rise to angioblastic strands.

ANGIOGENESIS

Streeter, in describing angiogenesis in the Mateer embryo (1920) concluded that blood vessels were formed in two different ways: (1) In the chorion and villi, angioblastic processes of cells condense to form vessels, and (2) in the body stalk and yolk sac, the blood vessels are formed by mesodermal thickenings without the processes.

In the chorion and villi, angioblastic processes of adjacent cells condense and arrange themselves to form a circular or elliptical contour. These strands enlarge, become swollen and form intracellular vacuoles which later coalesce to form a continuous tube. This swollen mass disrupts, and its contents flow into the lumen. The liquid is plasma and the liberated cells are red blood cells. The intact outer margin of the vessels becomes endothelial in character and forms the blood vessel.

In the yolk sac and body stalk, however, blood vessels are formed by the anastomosis of mesodermal cysts (Fig. 7, Plate VI) or swollen angioblastic strands without cytoplasmic processes. These masses also form vacuoles containing liquid, and, after the wall disrupts, the contents of the masses are liberated into the lumen. Further differentiation is similar to angiogenesis in the chorion and villi.

In the villi of our specimen, all stages of development may be observed from the formation of angioblastic strands to the completed endothelial tubes. Development has reached a higher level in the older and longer villi than in the shorter and younger villi which have thinner endothelial tubes. Within these endothelial tubes, no inclusions were observed which may be interpreted as blood cells. While the development of blood vessels in the villi is primarily by the anastomosis of angioblastic strands, only a few vacuolated strands of doubtful interpretation were observed.

In the posterior wall of the body stalk, the blood vessels have reached the highest stage of development from the standpoint of their length, thickened endothelium and included blood cells. In section 63.2 several endothelial tubes may be seen both in cross section and in longitudinal sections. When traced serially, these tubes anastomose, and one vessel in the posterior part of the body stalk approaches the trophoderm. A few round cells and some coagulum may be observed in some of these vessels; these are undoubtedly blood cells and blood plasma. These vessels are formed by the anastomosis of angioblastic strands; vacuolization within these cells, if present, could not be observed.

In the yolk sac, all stages of blood vessel formation from the simplest monovacuolated cell to the completed endothelial tube filled with red blood cells may be observed. The older strands are very thick and filled with vacuolated cells, some of which have broken down to form a liquid or a mesh of fine strands. In the ventral region of the yolk sac, in section 64.12, a large endothelial tube composed of about 12 endothelial cells incloses 18 large red blood cells. This is the most highly developed blood vessel in the embryo.

Blastocyst and Chorion

The blastocyst was fixed in ten percent formaldehyde. It was slightly flattened on its resting side and measured 15 x 10 x 5 mm. The blastocyst was soft, spongelike, and light straw color. Under low power, narrow channels contained pinkish material, probably maternal blood, were observed over the surface.

The chorionic vesicle is an externally trabeculated shell which completely envelops the ovum. Generally, the inner lining is spoken of as a membrane, while the outer margin is considered as an incrustation. The inner chorionic membrane is composed of 2 layers of cells; (1) an inner cytotrophoblastic layer, and (2) an outer plasmoditrophoblastic layer. Both of these layers are ectodermal in origin. Mesoderm is closely applied to the cytotrophoblastic layer. Villi are formed as evaginations of the cytotrophoblast and plasmoditrophoblast together with the chorionic mesoderm. As the villi grow, the cytotrophoblast remains unchanged, while the plasmoditrophoblast becames syncytial in character, precedes the cytotrophoblast and wanders among the maternal tissues. The evaginated mesoderm forms the core of the villi and its branches. Where the villi are most numerous a fusion of the syncytial cells takes place to form the outer incrustation of the chorion. Spaces between the villi are intervillous spaces which are generally filled with maternal blood.

In our specimen, the chorion appears elliptical in section with a slight concavity on the side on which the embryo is located. The blastocyst was convex on one side before embedding, but, during the process of infiltration, it became somewhat collapsed.

The villi are equally well developed in all parts of the chorion and display dichotomous branching with as many as six branches arising from a single stem. Villi are in different stages of development, and, while their lengths vary considerably, the average length is about 0.7 mm. Although most villi appear as a uniform column of cells, a few are club-shaped; narrow at the base, distended at the tip. In regions where there is sufficient space to develop, the villi are long and narrow, and, when conditions are less favorable, the villi are short and wide.

The chorionic mesoderm is loose and wavy, and is composed of extremely elongated spindle-shaped cells closely applied to the cytotrophoblast, 5 to 15 cells in thickness. A greater concentration of mesoderm is observed at points of evagination into the villa, where it develops cytoplasmic processes. Although the differential staining reaction of the coagulum is similar to that of the cytoplasm of the mesodermal cells, no transition was observed between the nucleated cells and the non-nucleated coagulum.

The cytotrophoblast and plasmoditrophoblast are composed of cubical cells with nuclei of various shapes, alveolar cytoplasm and indistinct cytoplasmic walls. The cytotrophoblast and plasmoditrophoblast of a villus is distinguishable as two distinct layers, except at the tips of the villi where both layers merge together. At the tip of the villus the plasmoditrophoblast becomes enlarged into an alveolar mass containing many large nuclei. Occasionally, the plasmoditrophoblast is observed to originate from the lateral edge of a villus. In smaller villi, the plasmoditrophoblast has a characteristic "brush border."

Many large cells were observed within the syncytium with nuclei in various stages of pyknosis and karyorrhexis. The cytoplasm has shrunken away leaving a large, circular space around the nuclei.

Intervillous spaces near the peripheral incrustation are filled with unclotted blood, while the intervillous spaces near the trophoblast are empty and contain some well fixed and well stained red blood corpuscles.

Discussion: Embryonic Disc, Primitive Streak, and Hensen's Node

Human embryos of the same age and of different ages display a wide variety of shapes. In general, the younger forms tend to be bluntly oval, while older embryos grow more rapidly in the longitudinal axis than in the transverse axis. Thus, the Mateer embryo is oval, while the older Ingalls and Manchester embryos are elongated. As far as has been determined, all embryos show some degree of convexity. The H. R. 1 embryo is extremely convex in its longtitudinal and transverse diameters. Our specimen, because of a sharp posterior ventral flexion appears round when plotted graphically, while the model demonstrates that the germinal disc is slightly longer than broad. The model also displays a mild convexity with a slight marginal concavity where the ectoderm turns upward to form the amniotic ectoderm. The contour of this embryo is normal in every respect. Hensen's node is plainly visible as an elevated and prominent landmark on the disc. Anterior to the disc is a small semicircular depression, probably the primitive pit. No lumen is present.

The disc is composed of overlapping columnar cells with their nuclei placed at different levels within the cells. This modified pseudostratification is common to most embryos; it is specifically mentioned in the Falkiner, Ingalls and H. R. 1 embryos. Unlike the Mateer embryo, the surface of our specimen is not smooth. The contour is uneven and under magnification displays alternate elevations and depressions. In the greater part of the disc, the columnar cells are vertical to the surface; in the posterior flexion, they slant noticeably. The unevenness of the shield and the slanting of the cells is caused primarily by a rapid and uneven rate of growth coupled with a crowding action posteriorly where the flexion is greatest. As a whole, the disc shows an extreme affinity for the basophilic stain which affects both the nucleus and the cytoplasm. Since differentiation between nuclei and cytoplasm is vague, due to similarity of staining reaction, no mitotic figures were observed. Moderate vacuolization was noted in the superficial cells of the disc. Extreme vacuolization and nuclear fragmentation was confined to an area near Hensen's node. Vacuolization of the superficial cells of the germinal disc has been observed in many embryos, and, although considered by most observers as a degenerative phase, still, von Möllendorff (quoted by Johnston, 1940) in describing similar changes in the Ovum O. P., defended its title to normality.

The absence of mitotic figures, and the presence of vacuolization and nuclear fragmentation is indicative of degenerative changes. This degeneration could have taken place before the fixative had penetrated sufficiently. The detached embryo together with its folded yolk sac lies in the chorion upon a mass of coagulum, opposite its original place of attachment. Since the chorion and yolk sac are well fixed, it is possible that degeneration had set in before the fixative could penetrate the chorion, coagulum, yolk sac and embryonic disc.

The primitive streak in the Mateer embryo is relatively short. In the Ingalls embryo, its length is about a third of the longitudinal axis. Generally speaking, the primitive streak is characterized by the fusion of the ectoderm of the disc with the mesoderm and entoderm. Laterally, it proliferates solid mesoderm for a short distance and, for the remaining part of the disc, the mesoderm is in the form of syncytial loops attached at intervals to the ventral surface of the embryonic disc, and to the entodermal roof of the yolk sac below. The primitive streak of the Falkiner specimen stained intensely; this is at variance with the staining reaction of our specimen.

Hensen's node lies anterior to the primitive streak and slightly to the right of the longitudinal axis. This structure is absent in the Mateer and Ingalls embryos and, while no elevation is prominent in the H. R. 1 embryo, it has been described as the region of the fusion of the germinal disc with the mesoderm and entoderm. In our specimen, Hensen's node is a large and prominent structure.

THE HEAD PROCESS

Hill and Florian (1931-1932) have made detailed studies of the preblastoporic axial structures (head process and prochordal plate) of a considerable number of human embryos. Results of these studies demonstrate that the head process consistently arises as a forward growth from Hensen's knot accompanied by forward extensions of the primitive streak mesoderm. According to Hill and Florian, the head process is divided into three parts; a caudal part, assuming a typical chorda canal; a cranial, short but broad segment as yet undifferentiated; and, an intermediate segment with two lateral mesodermal bands which arise as forward extensions of the primitive streak mesoderm. The cranial part of the head process is undifferentiated and passes into continuity with the mesoderm of the prochordal plate. The intermediate part, in its early stages of development may have isolated lumena and ventral openings into the yolk sac. This intermediate structure transforms in a caudo-cranial direction into a canal by coalescence of the ventral openings and isolated lumena. It becomes continuous with the chorda canal of the caudal segment. The caudal part is characterized by a cylinder or rod of cells with a chorda canal and dorsal opening (blastopore) situated on Hensen's knot and opening into the amniotic cavity. Heuser (1932) observed that the chorda canal is of short duration because it is already in the process of obliteration before the entire structure is tunneled.

Florian (1930) states that the differences between the Dobbin and the Ingalls embryos are slight. The Dobbin embryo has three isolated lumena and two lateral bands of mesoderm in the intermediate segment, while, in the Ingalls embryo, in this same region (completion plate of Ingalls) one continuous canal is present. He suggests, moreover, that the three lumena in the intermediate segment of the Dobbin embryo would become continuous to form a canal similar to the one in the Ingalls embryo. Heuser (1932) considered the caudal part of the head process of the embryo which he described (The Heuser embryo) to be entirely notochord. The notochord of this embryo is a cylindrical mass of cells with a continuous chorda canal, its width not varying with the width of the node except in the region of the prochordal plate. The head process of the H. R. 1 and Manchester embryos is a very short structure, and, consequently, in an early stage of development. In the Falkiner Ovum, the head process is described as a solid uniform rod, composed of at least two layers of closely packed cells. The head process is absent in the Mateer embryo.

In the specimen on which this study was made, the head process is a long, broad, forward growth from Hensen's node. Its lateral margins together with the two caudal extensions are continuous with primitive streak mesoderm. Although the head process thins out before it approaches the prochordal plate, no sharp line of demarcation is found between these two structures. The head process is either continuous or very closely associated with the prochordal plate. It is impossible to distinguish segments or divisions in this head process. Lumena, ventral openings, axial thickening, and blastopore are absent. About a dozen columnar cells were observed in the anterior part of the node, but these cells did not extend beyond the anterior downward slope of the node.

From the comparisons made, it is evident that the head process of this embryo is in a later stage of development than in either the Manchester of H. R. 1 embryos, and definitely not as well developed as in the Ingalls and Heuser embryos in both of which the notochord is an axial thickening with a chorda canal.

THE PROCHORDAL PLATE

The axially placed and thickened patch of entoderm situated anterior to the head process is known as the prochordal plate. The prochordal plate has been studied and investigated extensively in both the vertebrate and invertebrate animals. According to Adelmann (1922), in the shark, the prochordal plate gives rise to the premandibular somites. It does not contribute to notochord material, and it is an important site for the proliferation of head mesenchyme. Aasar (1931), in his studies with the rabbit, came to the conclusion that the prochordal plate gives rise to the anterior wall of the foregut, to the homologue of the presomitic mass, and probably to a small part of the oral plate entoderm. He further noted that the prochordal plate is ultimately converted into mesenchyme. Hill and Tribe (1924), working with the cat, have verified the observations of Adelmann and Aasar, with the exception that the prochordal plate is continuous with the head process.

In the Dobbin embryo, the prochordal plate is relatively small and indistinct indicating that mesoderm is not being actively proliferated. The prochordal plate of the Ingalls embryo is continuous with the head process, and the transition between the two is gradual. It is composed of closely packed cells distinct from the entoderm and contains numerous chromatophilic granules. No prochordal plate is present in the Mateer embryo. A thickened patch of entoderm in the roof of the yolk sac has been described as the prochordal plate in the H. R. 1 embryo. It consists of 10 to 12 large, round cells. The cytoplasm is vesicular and indistinct and the nuclei are round or oval. Whether or not the prochordal plate is continuous with the head process was not established. According to the authors, the prochordal plate is probably present in the Falkiner embryo. The posterior end of the prochordal plate of the Heuser specimen, on the other hand, merges with the primordium of the notochord. The chordal canal terminates where these two structures merge. Four isolated cavities were also found in the prochordal plate. This prochordal plate was actively contributing to lateral mesoderm.

In our specimen, the prochordal plate has been identified as a crescentic area of thickened entoderm anterior to the head process. It is broader than in any of the embryos with which it has been compared, an indication that mesoderm was being actively proliferated. It cannot be said definitely that the prochordal plate is continuous with the anterior part of the head process. Both structures are distinct; the transition between the two is gradual. With the possible exception of the area in front of the head process, the peripheral margins of the prochordal plate merge with mesoderm. This prochordal plate consists of typical large entodermal cells with large, round or oval nuclei and with faintly outlined cytoplasm. Neither vacuoles nor chromatophilic granules were observed. This prochordal plate is indistinct from the entodermal roof of the yolk sac. In several instances, the ectodermal cells of the shield seem to fuse with the prochordal cells in the cephalic end of the embryo. The ectodermal cells of the embryonic disc do not enter into the formation of the prochordal plate, since no intermediate types of cells were observed between the short columnar cells of the disc and the typical round cells of the prochordal plate.

The Allantois

The allantois is generally a tubular diverticulum which arises as an evagination from the caudo-dorsal wall of the yolk sac. In older embryos, it extends into the body stalk. In recent years, however, it has been observed in a few embryos that the allantois may also arise as a solid cord of cells. It is possible that the allantois has a double origin, as an evagination from the caudo-dorsal wall of the yolk sac, and as a solid cord in the body stalk. Johnston (1940), in discussing the origin of the allantois, believes that it may arise either as a solid cord which later atrophies and disappears, its proximal end forming the site of the hollow allantoic canal, or, it may develop as a solid entodermal rod, or, as a small diverticulum which rapidly enlarges and grows into the connecting stalk.

In the Falkiner Ovum, the allantois is a very long, tortuous structure arising from the ventral compartment of the yolk sac. It terminates in a cone-shaped process growing towards the amnion. The allantois, in the Manchester embryo, arises behind the cloacal membrane as a small area of entoderm from the dorsal wall of the yolk sac. This small area is thickened and in its center is a minute funnel-shaped opening leading into a tubular diverticulum which enters into the body stalk. This opening is the allantoic canal. In the H. R. 1 embryo, the allantois is a solid cord of entoderm arising in the median plane from the apex of a funnel-shaped diverticulum near the caudal end of the yolk sac. An allantois is present in the Mateer embryo; its lumen is discontinuous. In the Ingalls embryo, the allantois emerges a short distance behind the cloacal membrane and enters the body stalk immediately. At one point the allantois comes in contact with the amnion and opens into the amnion. Ingalls states that this opening is the *canalis amnio-allantoidus*. In the Heuser embryo, the allantois is uniformly thick and is slightly enlarged at its distal end.

In our embryo, a new situation arises with reference to the allantois. The caudal part of the yolk sac, where the allantois is normally found, has been separated from the body proper and all original relationships are destroyed. The distal part of the allantois may be seen, nevertheless, as a solid straight cord of cells extending about half way into the body stalk. It is composed of closely packed rounded cells with oval or round nuclei and distinct cytoplasmic walls. The allantois is discontinuous; a small portion is detached from the main body of the cord, and is separated by mesenchymatous tissue.

Inasmuch as the allantois of this embryo was studied under unfavorable conditions, it is impossible to arrive at any definite conclusions. It is probable that the allantois in this embryo arose from two different sources. It arose as a solid cord in the body stalk and as an evagination from the caudo-posterior wall of the yolk sac. It is probable that the cells in the cord would separate from the center to form a lumen, a stage not yet reached by our embryo. At the place where evagination of the yolk sac would meet the cord, a plate would be formed. Later, this plate would break through and the lumen would become continuous. This postulation agrees with the different stages in the development of the allantois found in the following embryos: the earliest stage, that is, where the allantois is a solid cord, may be found in the H. R. 1 embryo; in the Mateer embryo, the allantois is discontinuous, and in the Manchester embryo, a plate and a small opening has been formed between the body-allantois and the body stalk-allantois; in the Heuser embryo, the allantois is complete.

If this is a true series, the development of the allantois of our embryo is in a stage between that of the H. R. 1 and the Manchester embryos.

The Cloacal Membrane

The cloacal membrane has been studied adequately by Florian (1933), who has drawn his conclusions from the study of this structure in a considerable number of human embryos. Although our present knowledge of the primordium of the cloacal membrane is by no means complete, the structure has been studied by different investigators in a sufficient number of human embryos to formulate a knowledge of its component parts, its origin and its individual variations.

The primordium of the cloacal membrane has been defined by Florian as the fusion of the ectoderm of the embryonal shield with the entoderm; this fusion occurs posterior to the primitive streak in the caudal most part of the embryo. Its position in the caudal median axis is an intermediate one. Florian has distinguished three important areas in this region; a caudal part, an intermediate part, and the primitive streak. The caudal part is an area where, in the earliest stages, some of the primary mesoderm is derived from the ectoderm. The intermediate part is the cloacal membrane which is separated from the primitive streak in the early stages of development. The third part is the primitive streak which appears before the development of the cloacal membrane.

In the H. R. 1 embryo the cloacal membrane has been located caudal to the shield and is associated with the terminal end of the allantoic cord. It extends between the allantoic cord and the amniotic covering of the body stalk, caudal to the shield. In the Heuser embryo, the cloacal membrane separates the amniotic ectoderm of the body stalk from the ectoderm of the germinal disc. The cloacal membrane is absent in the Mateer embryo, while in the Ingalls embryo, it is described as lying posterior to the primitive streak.

In this embryo, the cloacal membrane has been torn with the result that the original relationships, for the greater part, are lost. It is divided into three parts; the anterior part remains in its original position; the central part is found on the ventral part of the body stalk, and, the third part is distorted in a fold of the yolk sac. The first part of the cloacal membrane may be recognized as the fusion of the entoderm with the ectodermal cells of the embryonic disc, posterior to the primitive streak. The middle part which is in the region of the amniotic stalk is recognized by the similarity of cells to that of the anterior part of the cloacal membrane found in the embryo. The third part is badly distorted and may be recognized only by its similarity of cells, and, by its proximity to the embryonic disc.

ANGIOGENESES

An extensive study of angiogenesis and hemopoieses has been made during the past twenty years. Although the interpretations of results obtained by the different investigators are not in complete accord, most, nevertheless, agree on the fundamental points of the origin and formation of blood vessels and blood cells. Sabin (1920) has shown that, in the chick blood vessels, blood cells and plasma are derived from angioblasts, which differentiate from mesenchyme. Bremer (1914), in a study of the origin of umbilical vessels, concluded that the blood vessels in the body stalk arose as funnel-shaped ingrowths of mesothelium covering the body stalk. These primordia by growth and coalescence formed a vascular network. Hertig (1935), in his study of angiogenesis in human and macaque chorions, demonstrated that, in the human chorion, angioblastic masses and mesodermal cells may differentiate either from the central cells of the trophoblastic column during the formation or villi, or from the associated chorionic trophoblast.

According to Sabin, Streeter, and others, blood vessels are formed by anastomosis of the processes of angioblastic strands, and by vacuolization occurring within these angioblastic strands. Anastomosed angioblastic processes condense to form a contour or outline around a central space. Intracellular and probably intercellular vacuoles appear within the angioblastic strands, flow together and coalesce. The wall of the angioblastic strand nearest the lumen disrupts, liberating cells and fluid contained in vacuoles into the lumen. These liberated cells are the red blood cells, while the liquid is the plasma. Later, the intact remaining part of the angioblastic strand becomes endothelial in character to form the blood vessel. Streeter has shown that this method of blood vessel and blood cell formation occurs chiefly in the chorionic membrane and in the villi of the Mateer embryo. In the yolk sac, the blood vessels and blood cells are formed mainly by vacuolization of the angioblastic strands. Angioblastic processes of the type observed in the villi are absent in the yolk sac. In the yolk sac, early blood cell and blood vessel formation is restricted to the caudo-ventral part of the yolk sac.

In the H. R. 1 embryo, no blood islands are present in any part of the chorion; angioblastic strands and vascular spaces are doubtful. Angiogenesis is not well advanced in the Ingalls embryo. Neither blood vessels nor blood cells were found in the embryo proper. In the body stalk, however, are numerous blood vessels filled with nucleated blood cells. The villi contain anastomosing endothelial tubes and occasional angioblastic strands. No description of angiogenesis is made of the yolk sac because it is histologically less satisfactory. In the Mateer embryo, angiogenesis is considerably more advanced than in either the H. R. 1 or Ingalls embryos. In the chorion, all stages were found from simple multinucleated strands to the completed endothelial tubes. Within some of the villi a few round nuclei are attached to the endothelial wall or are suspended by slender threads between two endothelial tubes. These attached or suspended cells have been interpreted by Streeter (1932) to be erythrocytes. The body stalk attained the same degree of development as the chorionic membrane and the villi. The parietal mesoblast of the amnion also developed blood vessels. In the yolk sac, angiogenesis is limited to the caudo-ventral half of the yolk sac. All stages from the simple angioblastic strand to the completed tube are present and considerable liquefaction in the angioblastic strands may be observed.

In the embryo on which this study was made, blood vessel formation is found in the chorionic villi, body stalk, yolk sac, and, to a lesser degree, in the amnion. All stages of development may be seen in the villi from the simplest angioblastic strands to the completed endothelial tubes. It is difficult to determine in this early stage of development whether or not the endothelial tubes anastomose. In the older villi, the walls of the tubes are slightly thickened. The development in the villi of this embryo is not as far advanced as the development in the Mateer specimen, in which some of the endothelial tubes contained red blood cells and the angioblastic strands were undergoing extensive vacuolization. Blood cells are absent in the villi of our specimen, and, if the angioblastic strands have begun to form vacuoles, it could not be observed. Angiogenesis in the body stalk of our specimen, however, has attained a greater degree of development than the Mateer embryo. The endothelial tubes are interconnecting, branch freely and contain some few nucleated red blood cells; blood cells are absent in this same region in the Mateer specimen. Blood vessels are being actively formed in the amnion of the Mateer embryo, while this specimen shows little, if any, angioblastic development. On the other hand, our specimen shows greater development in the yolk sac than the

Mateer specimen. Streeter (1920) has confined the angioblastic development in the yolk sac to the caudo-ventral pole, and, in this embryo, angioblastic development is not restricted to any area, while the ventral region of the yolk sac shows the greatest development. All stages from the single monovacuolated strand to the multinuclear vacuolated strand may be observed in the yolk sac. Many solid cysts of mesoderm are also found. In the ventral pole of the yolk sac may be seen a large endothelial tube composed of twelve endothelial cells and inclosing about twenty nucleated red blood cells. This more advanced stage has not been found in the Mateer embryo.

Angiogenesis and hemopoieses in our embryo has reached a more advanced stage of development than is present in either the H. R. 1 or Ingalls embryos. In the Mateer embryo, development is more advanced in the chorionic villi and chorionic membrane, while, in this specimen, development is greater in the body stalk and yolk sac.

AGE OF THE EMBRYO

The method of determining the age of human embryos by comparing the sizes of the embryonic disc has been abandoned because embryos of similar ages varied considerably in the rate of development. Comparison of embryos of unknown age with embryos of known clinical age is a valuable aid but apt not to be correct, since the method employed to determine the age of the known embryo assumes that the clinical history as given by the patient is correct, and that the rate of development in all human embryos is identical. Recently, a new method of determining age has been devised whereby a human embryo is compared with a macaque embryo of known age. This last method basically assumes that the rate of development is identical in both the macaque and human embryo. While either of the last two methods is not a perfect index to the actual age, a combination of the two methods would probably be more accurate than either method alone. In the following discussion, both of these last two methods will be employed in order to ascertain the probable age of our embryo.

The only available clinical data pertaining to the age of this embryo states that menstruation was "7 to 10 days past due." Assuming, then, that the patient had a normal 28 days menstrual cycle, and, as Hartman (1936) has shown that ovulation in women generally occurs midway between the onset of the next menses, then, ovulation would occur on the 14th day. Assuming further that fertilization occurred on this same day and adding to this the 7 days, the lower limit after the expected appearance of menstruation, the fertilization age of the embryo would be 21 days. If, however, the upper limit of 10 were added to the 14, then the fertilization would be 24 days. Compared with macaque material and with embryos of known age, the upper limit of 24 days is incorrect, while the lower limit of 21 is probable.

Streeter (1920) has classified embryos according to the degree of development present. This classification is divided into 3 groups with 6 stages.

Group 1. Embryos in which primitive groove is present.
  Stage 1. Villi absent.
  Stage 2. Primitive villi present.
  Stage 3. Villi having simple branching.
Group 2. Embryos in which a primitive groove is present.
  Stage 4. Yolk sac larger than amnion. Allantoic duct present. First stages of angiogenesis in wall of yolk sac and chorion.
Group 3. In addition to the primitive groove, the embryo has a head process with contained canal.
  Stage 5. Prochordal plate and cloacal membrane present. Medullary folds recognizable.
  Stage 6. Further differentiation of neurenteric canal. Formation of chordal plate. Gut begins to constrict from the remainder of the yolk sac. Evidence of angiogenesis in body of embryo.

According to this classification, Streeter (1920) has placed the Mateer embryo (17 days old) in Group 3. Angiogenesis is more highly developed in the Mateer embryo than in other embryos in Group 2, and, for this reason, it may occupy a position between Groups 2 and 3. The Ingalls embryo is generally less developed than embryos in Stage 6, more especially since angiogenesis is absent in the embryo proper, it has been placed in Stage 5.

The presence of a head process, prochordal plate, allantois and cloacal membrane, and the absence of medullary folds, places our embryo between Groups 2 and 3, but nearer to Group 3 than to Group 2. Our embryo, therefore, is placed between the Mateer embryo with a fertilization age of 17 days and the Ingalls embryo with a fertilization age of 19 days, but nearer to the Ingalls embryo than to the Mateer embryo. If the fertilization ages of the Mateer and Ingalls were determined correctly, then the age of our embryo is between 17 and 19 days, but since it lies nearer to the Ingalls embryo than to the Mateer embryo, its probable age is 18 days Furthermore, the Jones-Brewer 1 embryo shows the same degree of development as our embryo with the exception that the Jones-Brewer 1 embryo has an early neurenteric canal. Its fertilization age, clinically determined, is 18½ days.

On the other hand, when our embryo is compared with macaque material, the fertilization age is correspondingly higher.

Hartman (1932) has developed a technqiue of determining the exact ovulation time in the macaque by recto-abdominal palpation. With controlled fertilization, then, the exact age of the macaque embryos was known. Streeter (1932-'33) observed that the macaque has a similar type of implantation and growth curve and concluded that macaque embryos provide a new means of determining the ages of human embryos. Development is parallel to the human up to the 35th day which corresponds to the human embryo of 12-14 mm., with the only difference in form being the possession of a longer tail. In the macaque, Hensen's node, notochordal process and primitive streak are well developed on the 20th day; on the 22d day, somites appear. Segmentation is rapid since 1 to 8 somites may be found on embryos of the same age.

Comparing our embryo, then, with this limited macaque material, the upper limit of 24 days for the fertilization age is incorrect, since somites which appear on the 22d day in the macaque are absent in our specimen. This fixes the upper limits of its age at less than 22 days. In the macaque, Hensen's node, notochordal process and primitive streak appear on the 20th day. Since these structures are well developed in our embryo, its lower age limit must be 20 days. The age of our embryo, then, would be between 20 and 21 days. Hartman (1936), comparing the Ingalls embryo with macaque embryos, placed its age at 21½ days. In this same compilation, the Mateer embryo remains as originally determined at 17 days. Since our embryo is less developed than the Ingalls embryo, its probable age is between 20 and 21 days.

The age of our embryo when compared with the Mateer and Ingalls embryo is determined to be between 17 and 19 days; when compared with the macaque and the corrected age of the Ingalls, its age is between 20 and 21 days.

SUMMARY

1. A normal human presomite embryo is described.

2. External measurements of blastocyst are 15 x 10 x 5 mm.

3. Angle of section is 34 degrees from the midsagittal plane.

4. Embryonic disc is slightly oval and contains: (a) Primitive streak and groove. (b) Hensen's node and primitive pit. (c) Cloacal membrane. (d) Prochordal plate. (e) An allantois which appears as a solid cord of cells in the body stalk.

5. The yolk sac is larger than the amnion.

6. Villi are well developed and arise as an evagination of the cytotrophoblast and plasmoditrophoblast together with the chorionic mesoderm which forms the core of the villi.

7. Angiogenesis is well developed in the body stalk and yolk sac; less developed in the chorion, villi and amnion.

8. Blood cells are found in the body stalk and yolk sac.

9. The age of the embryo when compared with the Mateer and Ingalls embryos is 17 to 19 days; when compared with macaque material of known age, its age is 20 to 21 days.

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PLATE IV

FIG. 1. General view of embryo as seen in section 62.1, showing ends of broken amnion, embryonic disc, and collapsed yolk sac. The embryo rests upon coagulum in chorionic vesicle. Sections of chorionic villi appear at lower left. × 100.

FIG. 2. Detail from section 63.4, showing upturned rim of amnion and gradual transition of the columnar cells of the germinal disc to fusiform cells on the inner lining of the amnion. Note also fusiform mesodermal cells on the outer covering of the amnion which are continuous with the intraembryonic mesoderm. × 560.

FIG. 3. Photograph of blastocyst, with millimeter scale below.

PLATE IV

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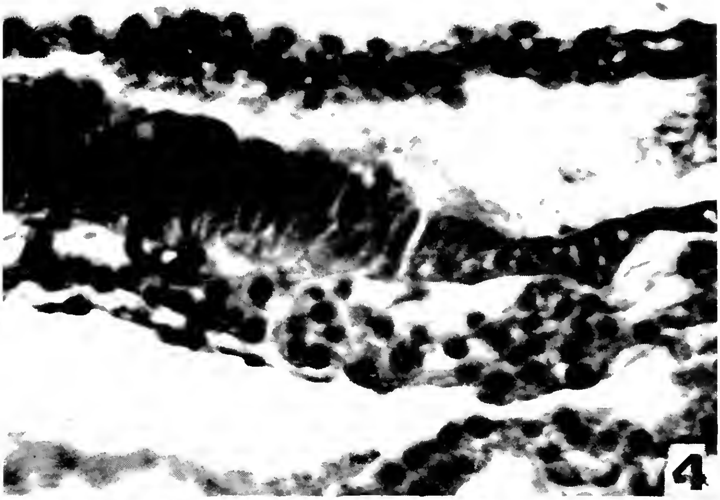
PLATE V

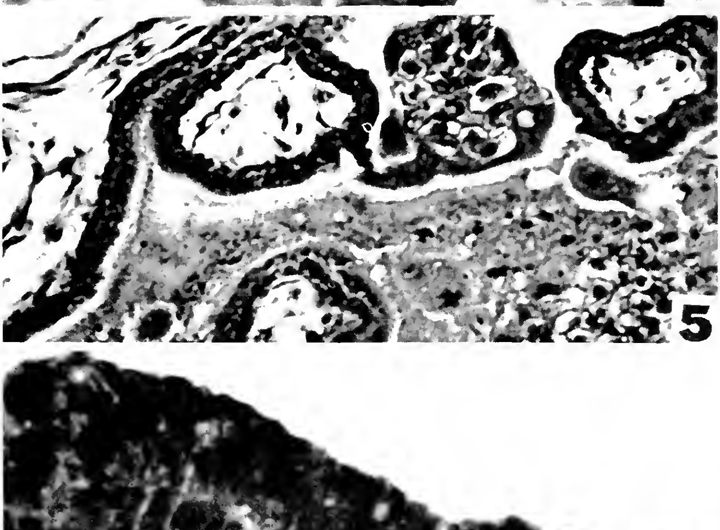
FIG. 4. Detail from section 61.1, showing the protochordal plate below the germinal disc. Note fusion of ectodermal pillar with the anterior part of the protochordal plate. The thickened strand of cells above the germinal disc is the amnion. Cellular detritus may be seen in the amniotic cavity. A part of the yolk sac appears at lower right. × 600.

FIG. 5. Detail from section 63.1, showing cross sections of chorionic villi and chorionic mesoderm. Note blood vessel formation within villi. A group of syncytial cells appears near upper center between two villi. × 250.

FIG. 6. Detail from section 61.11 showing head process and columnar cells below basement membrane of germinal disc and on anterior slope of Hensen's node.

PLATE V





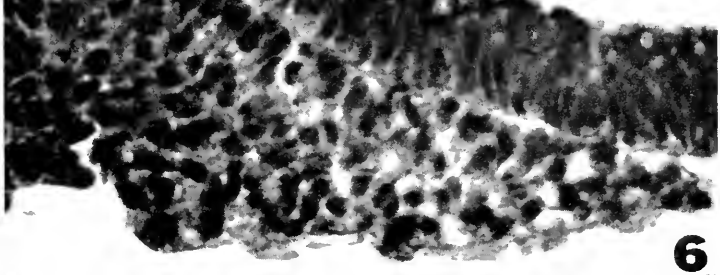
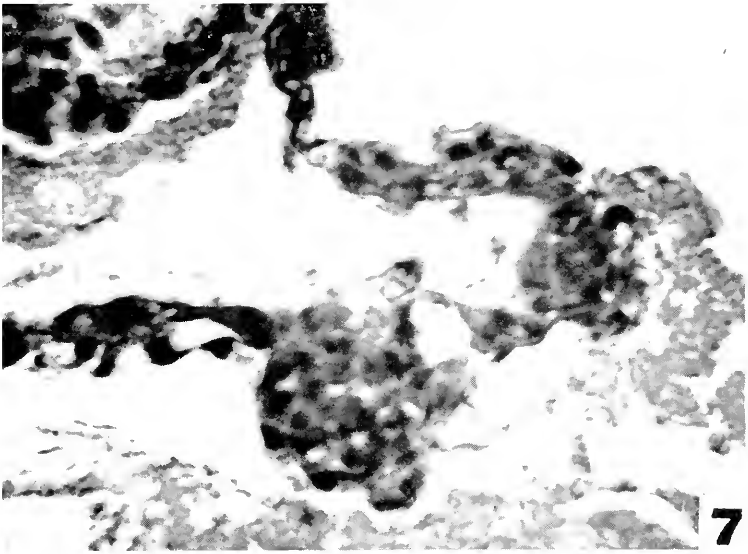


PLATE VI

FIG. 7. Detail from section 62.8, showing mesodermal cyst in the yolk sac. Note also coagulum within and below yolk sac. × 600.

FIG. 8. Detail from section 63.11 showing allantois as a solid cord of cells and an isolated part of allantois dorsal to the cord. Angiogenesis is more advanced in the posterior region of the body stalk than in the anterior region. × 230.

PLATE VI



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THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN

Vol. XXXI, pt. I.] May 1, 1946 [No. 8

Some Comments Upon the Structure of a Pycnodontid Fish from the Upper Cretaceous of Kansas

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ABSTRACT: One of the most complete examples of Pycnodontid fishes yet reported from the Western Hemisphere is described in detail. The specimen, originating from the basal portion of the Fort Hays Limestone Member of the Upper Cretaceous Niobrara Chalk Formation of Trego county, Kansas, consists of an obliquely and dorso-ventrally crushed head and antero-ventral body part. Referred to *Micropycnodon kansasensis* (Hibbard and Graffham), the specimen permits a valid elaboration to the definition of this genus.

While the structure of the cosmopolitan and closely related group of Pycnodontid fishes is still imperfectly understood, *Micropycnodon* is indicated to differ from all of the better known genera in the presence of a dermal, ornamented, sphenotic ossification in the skull roof; the failure of the descending pillar of the sphenotic to articulate with the basipterygoid process; the posteriorly, unkeeled venter of the braincase; and the nonfusion of the palato-quadrate complex with the ventral cranial basis.

The cranial structure of *Micropycnodon* is here interpreted in support of the recent theses by Westoll and Woodward of Pycnodontid descent through some deep-bodied Chondrostean stock rather than from any *Lepidotes*-like Holostean. This latter conclusion is based upon such characters possessed by *Micropycnodon* and all other Pycnodontids as the retention of the enlarged, preopercular cheek-plate; the short and posteriorly expanded parasphenoid; and the persistence of the large interorbital fenestra. The high supraoccipital crest; the shortness of the otic crest; the shallow posttemporal fossae; the reduction of the operculae; the apparent absence of a basisphenoid; and the form of the mesethmoid are explained as features developed in response to the deep-bodied adaptation. Such additional Pycnodontid features as the complete reduction of maxillae; the position of foramina for the internal carotid and first efferent pseudobranchial arteries; the position of the basipterygoid processes; and the absence of clavicles have been noted in other deep-bodied "Sub-holostean" fishes whose Chondrostean affinities are undoubted, and seem not unlikely explained as convergences to the typical Holostean condition. In conclusion, the high, coronoid-like processes on the dentary elements of the Pycnodontids strongly suggest the secondary maxillary articulation of the mandibular rami possessed by *Dorypterus* whose relationship with the Chondrostean *Bobasatrania* has received wide acceptance.

11—1586

INTRODUCTION

THE remains of Pycnodontid fishes have been known from North America since 1857, at which time they were reported by Emmons from North Carolina and by Leidy from the Cretaceous rocks of New Jersey. They have consisted chiefly of numerous isolated teeth and disassociated dentigerous splenial and vomerine plates, which students have assigned to a number of genera and many species. Insofar as the present writers have been able to determine neither a complete skull nor fish from this continent has been described or collected. Of interesting moment, therefore, was the recent discovery of the most complete example of one of these deep bodied fishes yet known from the Western Hemisphere in the possession of Mr. George F. Sternberg of Hays, Kansas. Promising to offer considerable morphological information this example has been purchased and is now among the large, important collection of Cretaceous fishes at the University of Kansas Museum of Natural History.

The specimen (KUMNH No. 7030), referred to *Micropycnodon kansasensis* (Hibbard and Graffham, 1941) (see Hibbard and Graffham, 1945) was recovered by Mr. Sternberg between 1934 and 1936 in sec. 21, Twp. 13 S., R. 21 W., Trego county, Kansas, or roughly 5 miles south and 4½ miles east of Ogallah, Kansas. The exact horizon from which the specimen was taken is doubtful, but apparently, as the type specimen, originated in the basal portion of the Fort Hays Limestone Member of the Upper Cretaceous Niobrara Chalk Formation.*

The preserved obliquely and dorso-ventrally crushed head and antero-ventral body part had been mounted in a plaster panel with the left side exposed. In preparation, the plaster was carefully removed from the embedded right side. The structures thus revealed not only add to our knowledge of this specific form but also present a number of morphological features at wide variance with those of the few Pycnodontids yet known in detail. Although certain observations are noted, any general phylogenetic conclusions are discouraged by an almost total lack of cosmopolitan comparative material. The following descriptive account is offered, mainly, in the hope that it may be of aid in some future revision of the entire family Pycnodontidae.

* Sternberg, G. F. *in litteris*, 1944.

DESCRIPTION

The skull shows well the characters of the Pycnodontid fishes. Its component elements have been unusually modified, presumably in response to the deep-bodied adaptation. No traces of the lateral line sensory organs can be detected preserved on the heavy bones. As a result of these two facts, the names here given the various ossifications are based solely on the bone's relative position and are not intended to imply conclusive homology with those of other Actinopterygians. Apparently about twice as deep as long, the frontal profile of the head continues, in a gentle convexity, the sharp angulation of the dorsal body ridge far antero-ventrally to the normally small and slightly uptilted cleft of the mouth. The present specimen possesses an approximately equal size with that of the type specimen (Hibbard and Graffham, 1941). The taking of exact overall measurements is not possible because of the oblique dorso-ventral crushing and consequent dislocation of parts. The following dimensions of individual structures, however, are offered for aid in establishment of general comparative proportions:

Median longitudinal length of the skull roof measured dorsally over the greater external curvature	111 mm.
Median longitudinal length of the ventral cranial basis, measured as preserved	89 mm.
Greatest overall length of the vomerine plate	30 mm.
Length of the principal row of vomerine teeth	18 mm.
Length of the principal row of splenial teeth	13 mm.

The primordial neurocranium is extensively ossified. Its bone is heavy and appears to be histologically composed of a very thin and delicate investment of dense lamellar bone upon a thick body of highly cancellous tissue. While there are some indications of radiating growth lines preserved upon the remnants of the external lamellar bone, no discrete sutures can be discerned with certainty, and any reference, therefore, in this paper, to separate endocranial elements is meant only to imply gross neurocranial regions. It may prove permissible to assume a complete fusion between all of the centers of ossification within this primary complex. Furthermore, in the temporal and occipital regions the neurocranium seems to be firmly attached to the dermal bones of the skull roof. No such fusion between the neurocranium and dermal bones is apparent anteriorly, however, and the primary sphenethmoids undoubtedly articulated with the skull roof, the parasphenoid, and the so-called fused prevomers through the intermediary of cartilage.

In general proportions the neurocranium is long and exhibits an almost uniform low height longitudinally because the forward tapering from the occipit to rostrum is slight. The apparent shortness of the skull results from the inclination of the ventral cranial basis, which roughly parallels the frontal profile of the head and is thus extended antero-ventrally from posterior articulation with the vertebral column in an angle of about 30 degrees from the horizontal. The greatest depth is attained posteriorly where in the parietal region the roof is produced in a high median longitudinal crest. The greatest width occurs in the transverse plane of the postorbital processes. In this latter plane the skull roof is broadened into an essentially flat frontal table. Forward from the preorbital processes the neurocranial roof lies almost vertically and rapidly narrows to its antero-ventral extremity in a roundly and externally convex ridge.

The ventral cranial surface is relatively narrow; being only a rounded ridge beneath the occipital and temporal regions and only slightly expanded beneath the orbital and ethmoidal portions of the braincase. The greatest ventral breadth is attained anteriorly but this is attributable to the expanded tooth-bearing portion of the dermal vomerine plate.

In a detailed description of the various neurocranial regions, the occiput, in posterior view, is irregularly quadrangular, with acute supraoccipital, obtuse basioccipital, and equal lateral exoccipital angles. The face is divided into subtriangular halves by a distinct median vertical crest. Each half is directed postero-laterally and a little upwardly. Such structural details as the foramen magnum and the notochordal pit have been obliterated by crushing. The former, however, appears to have been entirely surrounded by the exoccipitals. Immediately above the presumed position of this opening and on either side of the median crest two pairs of small foramina are well preserved which are here determined as points of emergence for some spino-occipital nerves. The vagal canals open far laterally on the exoccipitals behind the labyrinth region, and just above the lateral wall of the basioccipital. The post-temporal fossae appear as only shallow depressions situated ventro-laterally beneath the posteriorly projecting edge of the dermal roofing bones on the dorsal supra-occipital portion of the occiput. A deep postero-ventral groove on the body of the basioccipital part indicates the probable course of the efferent arterial canal. No distinct ventral keel is apparent upon this part.

The lateral wall of the primordial neurocranium is low, short, and its exposed external face is directed ventro-laterally. This surface is in rounded confluence with the posterior occipital face ventrally, but dorsally meets the latter in a sharp angle beneath the postero-lateral tips of the supratemporals. Dorsally, the median portion of the lateral wall is depressed to considerable extent beneath the overhanging edge of the temporal roofing bones. In contrast the descending lateral wings of the sphenotic anteriorly and of the supratemporal posteriorly stand out as prominent vertical strengthening pillars for the neurocranium. The articulatory facet for the hyomandibular extends across both the anterior and posterior prominences and into the central concavity as well. The proximal head of the hyomandibular exhibits a complementary development. Little or no space remains for the origin of the dorsal temporal muscles within the above described concavity and some reasonable doubt, therefore, may be expressed that it is the homologue of the lateral temporal fossa of related ray-finned fishes.

The proötic portion of the neurocranium appears to be restricted; being limited in front by the ascending wing of the parasphenoid which articulates dorsally with the sphenotic, and limited behind by the massive development of the basioccipital. One large foramen, to be identified as the posterior opening of the jugular canal, penetrates the lateral wall in this region. An antero-dorsal notch in the margin of this foramen indicates the hyomandibular branch of the seventh nerve, and a poorly preserved groove in the antero-ventral margin perhaps transmitted either a postpalatine branch of the seventh nerve or an orbito-nasal artery. The myodome is only slightly exposed through displacement of the parasphenoid. It appears to have been well developed in the normal relationship to the basioccipital, proötics and parasphenoid.

In the orbital and ethmoidal regions, the neurocranium is much compressed from side to side. The interorbital septum appears to have been extensively interrupted ventrally by a fairly large interorbital fenestra and by the anterior openings of the trigeminofacialis chamber and the myodome. The sphenoidal ossifications have been badly fragmented and no positive information can be offered concerning them. Each frontal, however, bears a ventral longitudinal flange which must surely have served as a dorso-lateral support for the sphenoidal bones. The primary mesethmoid is an excessively thin triangular element. Its antero-dorsal margin is firmly wedged between ventrally projecting flanges of the dermethmoids. The ventral margin, on the other hand, is grooved for the firm lodgement of the median dorsal and longitudinal crest of the parasphenoid and vomer.

The shape and arrangement of the dermal roofing bones may be seen in Figs. 1 and 2. The extrascapular series consists of presumably three pairs of short, wide elements. A transverse series of 4 bones occurs in the region normally occupied by the parietals: a median row of 2 and one lateral pair. The posterior of the 2 median plates is roughly twice as long as its greater anterior width. The smaller anterior median element is regularly rhomboidal with angles disposed anteriorly, posteriorly, and laterally. In longitudinal sequence these bones are here arbitrarily termed dermsupraoccipitals and are designated by the exponents 2 and 1, respectively. The paired lateral elements are situated in the position of parietals but are widely separated from contact with the frontals by a great posteromedian production of the intertemporals. The frontals are the largest bones of the skull roof. Their anterior widths are more than twice their posterior widths and this maximum breadth is contained twice in the greatest overall length of the bones. The dermethmoids are paired and are sharply depressed, laterally. A deep pit occurs low on each, ventro-laterally, into which the olfactory canals emerge. The antero-ventral extremities of these bones also exhibit a thickened, antero-laterally directed facet for an assumed articulation with an as yet unrecognized premaxillary.

Regarding the temporal bones, the anterior intertemporal is the next largest element in the roofing complex. It forms the superior border of the orbit and is extended far posteriorly, articulating with the frontal and anterior dermsupraoccipital mesially and with the second dermsupraoccipital and parietal posteriorly. In contact posterolaterally is a small dermsphenotic roofing the postorbital process, and a large supratemporal which forms the greater part of the short lateral temporal margin of the skull roof. The posterolateral angle of the latter plate is slightly embayed for an articulation with the suprascapular bone.

The dermal parasphenoid, flooring the primordial neurocranium, has been twisted and somewhat fragmented in its short postorbital part. It is evident, however, that this region is produced into a high lateral wing on either side which articulates dorsally with the sphenotic and forms more ventrally the antero-lateral edge of the myodome. Only a low, obtuse ventral keel is developed on this part constituting the floor of the eye muscle chamber. The basipterygoid process is a long, tumid prominence situated laterally on the ventral body of the element just below the ascending wing. The first

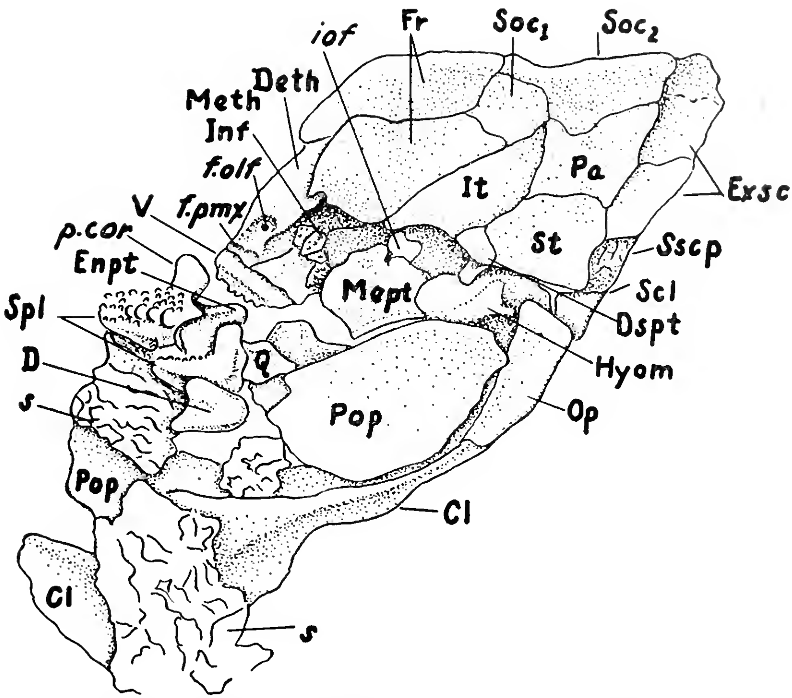

FIG. 1. *Micropycnodon kansasensis* (Hibbard and Graffham) (KUMNH. No. 7030). Habit sketch of the head and opercular regions from the left side. Reproduction approx. × ⅔.

Legend of Abbreviations: Cl, *cleithrum;* D, *dentary;* Deth, *dermethmoid;* Dspt, *dermsphenotic;* Enpt, *entopterygoid;* Exsc, *extrascapular;* f. olf, *olfactory foramen;* f. pmx, *articular facet for the premaxilla;* Fr, *frontal;* Hyom, *hyomandibular;* Inf, *infraorbital bone fragments;* iof, *interorbital fenestra;* It, *intertemporal;* Mept, *metapterygoid;* Meth, *mesethmoid;* Op, *operculum;* Pa, *parietal;* p. cor, *coronoid-like process on splenial;* Pop, *preoperculum;* Q, *quadrate;* s, *disassociated scales and plates;* Scl, *supracleithrum;* Soc_1 and $_2$, *anterior and posterior, respectively, dermsupraoccipitals;* Sscp, *suprascapular;* St, *supratemporal;* and V, *vomer.*

efferent psuedobranchial artery was transmitted along a groove antero-dorsally to this process. The anterior suborbital portion of the parasphenoid is long. It bears a relatively high dorsal keel, a low ventral keel, and somewhat expanded lateral edges. A distinct groove obliquely traverses the lateral margin for the passage of the anterior palatine nerve. The anterior extremity beneath the mesethmoidal overlies the postero-median limb of the vomer.

The vomer is a single bone. It has a stout anterior portion, ventrally expanded and tooth bearing; and an attentuated posterior extension which arises at no great angle from the forward body.

This is in contrast to the posteriorly notched, toothed plate of *Coelodus streckeri* Hibbard (1939). A median dorsal crest presumably extends longitudinally across both anterior plate and posterior limb which projects into a median ventral groove on both mesethmoid and dermethmoid. The character of the vomerine teeth have been adequately described (Hibbard & Graffham, 1941) but it may be stressed that the ovate plate is flat and is but little longer than wide. The teeth are arranged in five more or less regular longitudinal rows which regularly alternate with each other. Also those medially are smooth while the smaller lateral ones show a tendency for apical pits and radial crenulations.

The structure of the cheek bones apparently closely approximates that described for all of the Mesozoic Pycnodontid fishes. Pre-

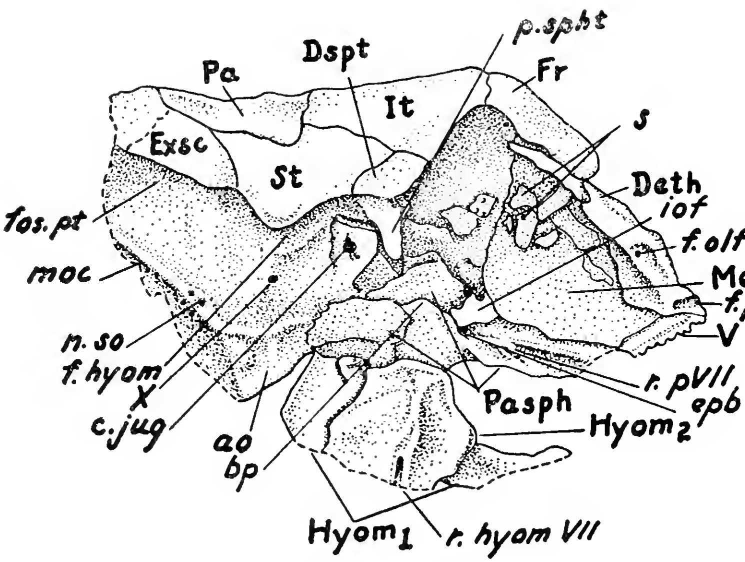

FIG. 2. *Micropycnodon kansasensis* (Hibbard and Graffham) (KUMNH. No. 7030). Habit sketch of skull and associated structures from the right side. Reproduction approx. × ⅔.

Legend of Abbreviations: ao, *canal for efferent arteries*; bp, *basipterygoid process*; c. jug, *posterior opening of the jugular canal*; Deth, *dermethmoid*; Dspt, *dermsphenotic*; epb, *notch for the first efferent pseudobranchial artery*; Exsc, *extrascapular*; f. hyom, *articular facet for hyomandibular*; f. olf, *olfactory foramen*; fos. pt, *posttemporal fossa*; f. pmx, *articular facet for premaxilla*; Fr, *frontal*; Hyom$_1$ and $_2$, *left and right, respectively, hyomandibulars*; iof, *interorbital fenestra*; It, *intertemporal*; Meth, *mesethmoid*; moc, *median occipital crest*; n. so, *foramina for spino-occipital nerves*; Pa, *parietal*; Pasph, *parasphenoid*; p. spht, *descending arm of the sphenotic*; r. hyom VII, *foramen for the hyomandibular branch of VII*; r. p VII, *groove for the palatine branch of VII*; s, *undetermined bone fragments*; St, *supratemporal*; V, *vomer*; *and* X, *foramen for vagus nerve*.

maxillaries and maxillae have not been recognized. A few small, polygonal and externally ornamented plates, however, remain crushed down upon the endocranial structures, and these undoubtedly represent the degenerate, subdivided infraorbital and suborbital bones. Of dorsal and ventral ossifications, the present fish retains only the ventral preopercular plate. This is greatly expanded, and tapers both above and below. The antero-mesial margin is thickened and vertically grooved, apparently for a firm articulation with the suborbital cheek scales. The reduced operculum is deep but very short, and is in wide contact with the antero-mesially lying hyomandibular. Subopercular and interopercular are, as normally, absent.

By reason of histological structure, two replacement ossifications of the visceral skeleton have been determined which are here tentatively referred to the mandibular arch and termed articular and quadrate because of their shape and relationship to the left splenial bone. The right splenial bears a vertical crest postero-mesially. The lateral face of this ridge is longitudinally rugose, indicating an overlapping articulatory area. The element here termed the articular occupies this position on the left mandible, although somewhat displaced, and is, posteriorly, dorso-ventrally constricted but transversely expanded into a concave facet. The so-called quadrate lies immediately behind the articular, and crushed laterally upon the left splenial. It is a triangular bone with a thickened apical condyle ventrally, and thin expanded dorso-mesial part. On this latter the posterior margin is produced into what may be arbitrarily called a symplectic process for supporting abutment against the hyomandibular.

The suspensorium is inclined far forward. The hyomandibular exhibits a great lateral compression but with a longitudinally expanded head and attenuated antero-ventral limb. The head is produced into a high peak for insertion into the lateral temporal indentation on the neurocranium and both the anterior and posterior slopes of the peaks are faceted for articulation with the vertical sphenotic and supratemporal prominences, respectively. The axis of the ventral limb is continued on to the lateral face of the proximal head in the form of a distinct and broad ridge whose faceted dorsal extremity constitutes a modified opercular process. The foramen for the hyomandibular ramus of the seventh nerve emerges in the middle of the element's height just anterior to the lateral strengthening ridge.

The dermal bones in each ventral half of the mandibular arch apparently numbers only two: a lingual splenial and a lateral dentary. The splenials are robust. Their symphysial margins are long and deep. Their outer labial edges diverge widely from the median line to enclose broad dentigerous dorsal tables. The dental batteries are flat in their anterior portions but postero-laterally the surface of the teeth are rotated and the individual denticles are directed upwardly and posteriomesially. The teeth are set in one principal row of 6 teeth on both the right and left splenial. The longer transverse axis of all the teeth of the principal row are at right angles to the antero-posterior line of the symphysis. The most posterior tooth of the principal row is considerably the larger and is transversely ovate in shape measuring 4.5 mm. in greatest diameter. The teeth decrease in size anteriorly. The anterior two are round in outline, and approximate 1.3 mm. in diameter. A small inner row of teeth is present lingual to the principal row. On the left splenial there are 5 teeth in the inner row which is parallel to the principal row, while on the right splenial the inner row consists of 6 teeth irregularly set. These inner rows of teeth begin at the anterior end of the splenial and extend backwardly one-half the length of the principal row. Paralleling the principal row of teeth labially is a row of 9 teeth on the left splenial and a slightly irregular row of 9 teeth on the right splenial. Along the outer edge of the left splenial is a row of 7 teeth while along the outer edge of the right splenial there is a row of 8 teeth. Crowded between the last four posterior outer teeth and the foremost posterior teeth of the row just labial to the principal row are 5 small teeth in the right splenial; while on the left there are 6 small rounded teeth crowded in between the three most posterior teeth of the two rows labial to the principal row. The teeth of the labial row on each splenial are rounded, more uniform in size than those of any other row. They are also larger than the other teeth except those of the principal row. The anterior tip of the splenials are missing and the presence of some of the teeth are known only from their broken bases. The small and medium sized teeth in all rows possess an apical pit with radial crenulations. The postero-lateral angle of the splenial is dorsally produced into a high, laterally compressed coronoid-like process. Between this and the postero-mesial crest described above occurs a deep notch which is the only preserved evidence of the Meckelian orifice. Ventro-laterally, the element is deeply excavated throughout its length by the Meckelian groove. The dentary is a free and externally ornamented plate which corresponds in outline to the lateral aspect of the splenial. The bone is ventrally thickened for an assumed ventro-mesial contact with the articular. No traces of teeth are to be seen on its oral border; the latter apparently in corollary to the degeneration of the cheek and lateral tooth-bearing bones of the upper jaw.

In the dorsal palato-quadrate half of the mandibular arch, both right and left bones are preserved which occupy the position of metapterygoids. Each bears mesially a longitudinally grooved projection which abuts against the basipterygoid process of the parasphenoid. In direct contact anterior to the displaced right metapterygoid is a weak ossification with thickened and produced mesial margin which may prove to be an entopterygoid.

Numerous small polygonal plates invest the gular region. As preserved these are disassociated and any branchiostegal rays, if present, cannot be distinguished. As stated in the introduction no evidences of lateral line sensory organs can be ascertained. All of the external bones of the head are ornamented with irregularly scattered, small conical tubercles of enamel. These in turn are radially striated and contain a hollow internal cavity at their bases.

The short, low suprascapular does not appear to possess a median dorsal supraoccipital attachment. A rounded anterior margin indicates only a postero-lateral supratemporal articulation. The supracleithrum is a short and simply deepened element largely covered by the opercular plate. The cleithrum is very high and presents only a short thickened ridge externally in its dorsal part but below the broad embayment for the pectoral fin is somewhat expanded. A frontally thin but transversely broad flange is developed mesially from the anterior margin of this bone. The primary shoulder girdle is largely covered but is well ossified. The pectoral fin is situated at moderate height upon the anterior flank of the fish. Its dermal rays bifurcate; are not in their proximal part at least articulated; and seem to far exceed in number the radial elements.

The preserved antero-ventral portion of the body is completely encased in heavy rhomboidal scales. These, however, break up into small plates near the origin of the anal fin and it may be that the caudal pedicle was unarmored. The central flank scales are about 3 times deeper than long but diminish in height both dorsally and ventrally. Considerable subdivision appears to have taken place in the most distal antero-ventral body part. The flank scales are widely imbricating. Their antero-dorsal angles are produced into stout pegs which are externally overlapped by the produced antero-ventral angles of the dorsally succeeding scales. These scutes are essentially smooth except for an occasional enameled tubercle. Heavy spinous ridge scales are developed ventrally.

REMARKS. With the single exception of *Gyrodus macrophthalmus cubensis* Gregory (1923) all of the numerous Pycnodontid fishes described from North America are based upon varyingly complete vomerine and splenial dentitions. These being generally disassociated, they offer slight insight into the breadth of structural variation within the group and any current attempt to decipher even taxonomic relationships is difficult. The dental characters of the associated vomerine and splenial plates of *Micropycnodon kansasensis*, however, appear to present a combination of features separate from all previously described American Pycnodonts except possibly *Gyronchus dumblei* (Cope, 1892 and 1894). The latter form may ultimately prove to belong to the genus *Micropycnodon* but is for the present considered a distinct species because of its greater regularity of the tooth row arrangement and because of the absence of a broad untoothed area between the symphysis and the principal tooth row posteriorly as displayed by *Micropycnodon kansasensis*.

The Pycnodontid fishes have been long recognized as a closely related group exhibiting marked variation of detail despite our still imperfect knowledge of many major points in their structure. *Mestrurus* (Woodward, 1895, 1896, and 1917) is the most completely described as regards the morphology of the head with a few features having been added from such European forms as *Gyronchus*, *Proscinetes*, *Gyrodus* and *Anomocodus*. *Micropycnodon* differs in many respects from characters apparently held in common by all of these better known genera. Among these differences possessed by *Micropycnodon* effecting the present definition of the group may be noted the presence of a dermal, ornamented, and roofing portion of the sphenotic; the descending ventro-lateral pillar of the sphenotic which while articulating with the ascending wing of the parasphenoid does not reach the basipterygoid process; the posteriorly unkeeled venter of the braincase; and the non-fusion of the palato-quadrate with the ventral cranial basis.

These deep-bodied fishes of the family Pycnodontidae were originally considered relatives of the Platysomidae. Later restudied by

Traquair and followed by Woodward, an alternate thesis was developed which postulated that the Pycnodont ancestors were to be found among the deep-bodied and small-mouthed *Lepidotes*-like Holosteans. The latter concept has never been realized and recently Westoll (1937, 1941) and Woodward (1939) abandoned it in favor of descent from deep-bodied Chrondrostean stock through some "Sub-Holostean" stage.

Their conclusions, based upon comparative osteological criteria, are strengthened in those few pertinent characters displayed by the present parital specimen of *Micropycnodon kansasensis*. These Chrondrostean features are, namely: the enlarged preoperculum which in retaining the essential nature of a cheek plate seems necessarily derived only from some condition similar to that suggested by the older genera *Bobasatrania, Cleithrolepis* and *Aetheodontus;* the development of the parasphenoid which is short but highly expanded in the posterior portion; and the persistence of a large interorbital fenestra. The supraoccipital crest; the shortness of the otic crest; the slight depression of the posttemporal fossae; and the reduction of the opercular apparatus following a probable anterior shifting of the branchial chamber seem to be changes in response to the deep-bodied modifications. The apparent absence of basisphenoid, and the form of the mesethmoid noted by Dyne (1939) as perhaps peculiar to *Amphicentrum* but noted also in this Pycnodont, may possibly prove more common in deep-bodied fishes than now known. Such Holostean-like characters displayed by this Pycnodont as the loss of the maxillae after the reduction from firm posterior articulation with the preoperculum; the position of the foramina for the internal carotid and first efferent pseudobranchial arteries; the position of the basipterygoid processes; and the absence of clavicles have been noted in other deep-bodied fishes of undoubted Chrondrostean affinities (Westoll, 1941). In the light of the recent studies by Brough, Stensiö, Westoll and others on the many "Sub-Holostean" lines of development these Holostean-like characters seem not unlikely explained as convergences.

As regard phylogeny, the suggested similarity between the Pycnodontid fishes and *Bobasatrania, Cleithrolepis* and *Aetheodontus* have been discussed by Woodward (1939). These genera, in part, have received some acceptance as Platysomid derivatives. Westoll (1941) called attention to the relationships of *Dorypterus* to *Bobasatrania* and further postulated some affinity, however distant, between *Dorypterus* and the Pycnodontid fishes. Some credence is given the latter concept by the structure of the lower jaw of *Micropycnodon* with a posterior articular and a more anterior coronoid-like process which is suggestive of the secondary maxillary articulation in *Dorypterus*. Maxillae remain unknown in the Pycnodonts but conceivably some ligamentous connection with another part of the palato-quadrate complex may have been retained. The designation of a definite Pycnodont ancestor, however, seems premature. The details of Pycnodont morphology are still too imperfectly known. In addition, there is no assurance that all deep-bodied Chondrostean stock is of monophyletic origin (Moy-Thomas and Dyne, 1938).

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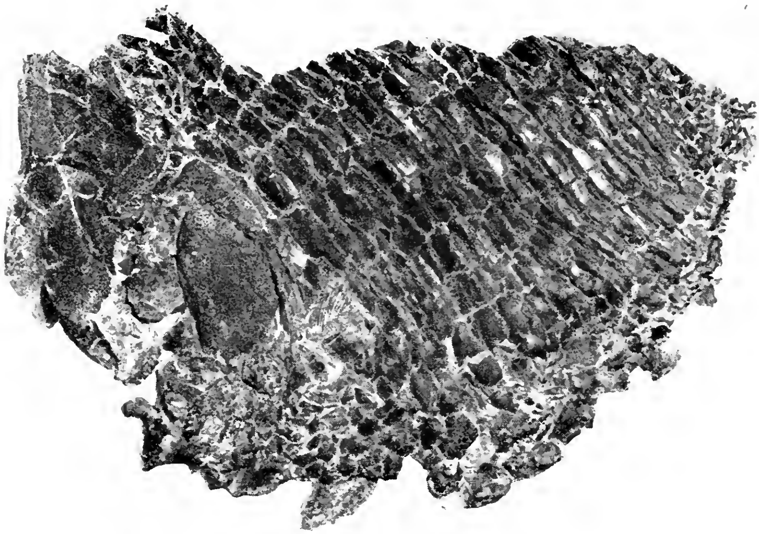
PLATE VII

Micropycnodon kansasensis (Hibbard and Graffham) (KUMNH. No. 7030)

UPPER. Photograph of the entire preserved portions of the specimen from the left side. Reproduction slightly more than × 2/5.

LOWER. The preparation of the head from the right side. Reproduction slightly more than × 2/3.

PLATE VII



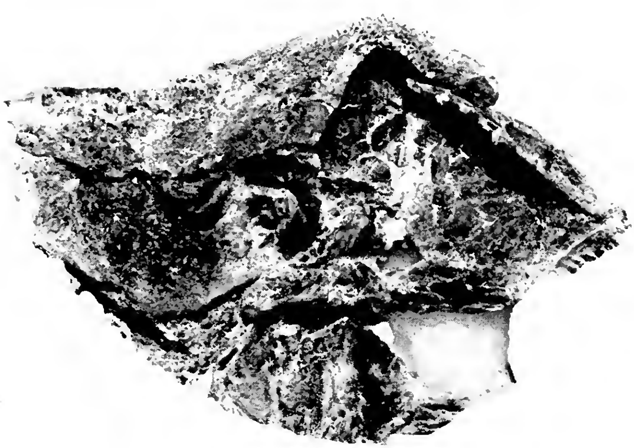


PLATE VIII

Micropycnodon kansasensis (Hibbard and Graffham) (KUMNH. No. 7030)

UPPER. Crown view of the left and right splenial bones. Reproduction approx. $\times 2\frac{1}{4}$.

LOWER. Ventral view of the left and right splenial displaying the displaced left dentary. Reproduction approx. $\times 2\frac{1}{4}$.

PLATE VIII

PLATE IX

Micropycnodon kansasensis (Hibbard and Graffham) (KUMNH. No. 1019F, Type Specimen)

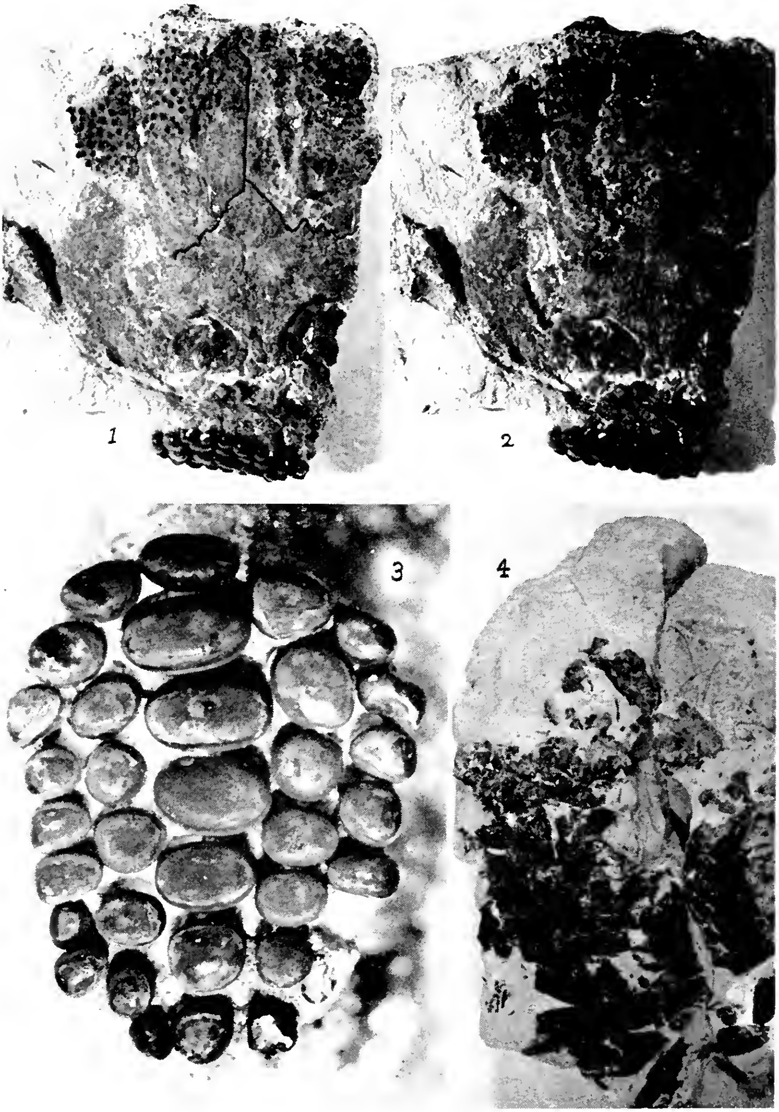
FIG. 1. Anterior part of skull with dermal covering removed showing suture between frontals and dermethmoids. Reproduction approx. × 1³⁄₁₇.

FIG. 2. Anterior part of skull with vomer. Reproduction approx. × 1³⁄₁₇.

FIG. 3. Vomer with dental battery. Reproduction approx. × 3¹³⁄₁₇.

FIG. 4. Disassociated scales from the opercular region. Reproduction approx. × ½.

PLATE IX



THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN

Vol. XXXI, pt. I.] May 1, 1946 [No. 9

Kansas Plants New to Kansas Herbaria

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Abstract: The following ten species are listed as new records for Kansas: *Botrychium dissectum* Spreng, *Eleocharis rostellata* Torr, *Scirpus occidentalis* (S. Walts) Chase, *Leersia lenticularis* Michx., *Erythronium americanum* Ker., *Lamium purpureum* L., *Physocarpa intermedia* (Rydb.) C. K. Schneider, *Chaetopappa asteroides* DC., *Bidens laevis* (L) B.S.P., and *Senecio glabellus* Poir.

Botrychium dissectum Spreng. Two specimens were found October 8, 1942, growing in wet forest-covered bottoms along the Marais des Cygnes river on the Hugh Whiteford ranch in Miami county. Subsequent searches in that area have not produced any additional specimens. This plant probably occurs in other places along the east edge of this state. It has been reported from Wyandotte county, but there is no specimen on file. It has been collected over an area extending from Maine and Virginia on the east to Minnesota, Iowa and Missouri on the west. These specimens extend the distribution farther west than any previous collection in the plains states.

Elocharis rostellata Torr. The first specimen of this plant was brought in from Meade County State Park by Doctor C. W. Hibbard in 1942. In September of 1944 it was found in the margins of the artesian-fed ponds and seepy places in several localities in that county. Other botanists have collected this plant in nearly all parts of the United States. The artesian spring-fed ponds provide an ideal place for this plant to grow and it should be found in other marshy places in Kansas.

Scirpus occidentalis (S. Walts) Chase. This plant was found on September 16, 1944, growing in the sandy bottoms along the Cimarron river in Meade county. It is so much like *Scirpus validus* Vahl that it has probably been mistaken for *S. validus* and thus missed. This plant has been collected on all sides of Kansas and should be found in other parts of this state.

Leersia lenticularis Michx. On September 20, 1938, this plant was first found in wet open places in the forest growth along the Marais des Cygnes river in Miami county, east of Fontana. It was collected in quantities in the same area on September 19, 1941. This wet river bottom is an ideal habitat for this plant which grows only in such places. It has been collected from Minnesota, Missouri, Texas and states east to Indiana, Virginia and Florida.

Erythronium americanum Ker. In May of 1940 this plant was found in Oklahoma just south of Cherokee county. In April of 1941 it was collected in quantities in several places along Shoal creek in Cherokee county. This brings its range a little farther west than has been previously reported. It has been collected from Minnesota to Texas, and east to the Atlantic Ocean. As it thrives only in moist habitat such as exist in the Ozark region of Cherokee county, it probably will not be collected very much farther west in this state.

Lanium purpureum L. This plant has been growing in an open woods just east of Lawrence for the past twenty-five years and probably longer. It was collected in quantities by R. L. McGregor on April 24, 1940. It has been collected in fields and waste places from Missouri east to North Carolina and Newfoundland. Here in Kansas it grows in a more sheltered place.

Physocarpa intermedia (Rydb.) C. K. Schneider. A few bunches of this shrub are growing in the southeast corner of Cherokee county in moist open woods where it was collected on May 8, 1943. Other collectors have found this plant in Colorado, North Dakota, Missouri and states east to western New York. The Ozark region of southeast Kansas provides an ideal habitat for this plant.

Chaetopappa asteroides DC. Collected on July 7, 1937, in a dry, sandy creek bed seven miles southwest of Neodesha in Wilson county. This plant grows in Missouri, Oklahoma, Texas and northern Mexico and probably will be found in other places in Kansas.

Bidens laevis (L) B.S.P. This plant has been reported from Kansas by other authors. It was collected on September 18, 1945, along a stream just below Lake Larrabee in Meade county and should occur in wet meadows and swampy places in other parts of this state, especially in the eastern part as it grows in similar habitats from Missouri east to Massachusetts and south to Texas.

Senecio glabellus Poir. Collected on May 7, 1943, along the highway in the Neosho river bottom just east of Chetopa in Cherokee county. There was a large colony made up of thousands of plants. I have not seen it in any other locality in Kansas, but it should be found elsewhere as other collectors have found it in Missouri, Oklahoma and in other states east to Florida and south to Mexico.

This work was supported in part by a grant from the Graduate Research Fund of the University of Kansas.

THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN

VOL. XXXI, pt. I.] MAY 1, 1946 [No. 10

Notes and Descriptions of Ambrysus Stal With an Account of the Life History of *Ambrysus mormon* Montd. (Hemiptera, Naucoridae)

By ROBERT L. USINGER, University of California

ABSTRACT: The genus *Ambrysus* is widely distributed in the temperate and tropical regions of the Western Hemisphere. *Ambrysus mormon* Montd. is the commonest species in the western United States. It prefers quiet or slow moving water along the edges of streams. Eggs are laid on pebbles. The life history from egg to adult required 105 days at Davis, California. Distributional records are given for *A. pulchellus* Montd., *pallidulus* Montd., and *pudicus* Stål. The following new species are described: *Ambrysus infuscatus, barberi, caliginosus, fossatus, hungerfordi, woodburyi, bohartorum, convexus, fuscus, buenoi, variegatus, sonorensis, lunatus, lundbladi, hintoni*, and *vanduzeei*.

Ambrysus Stål is the type genus of the subfamily Ambrysinae Usinger. Its position within the subfamily and its relationship to other Naucorids are discussed fully in an earlier paper (Usinger, 1941). *Ambrysus* is one of the dominant groups of water bugs throughout the Sonoran and Neotropical regions of the Western Hemisphere. It occurs from Argentina to Northern California and Wyoming but is replaced in the eastern half of the United States by the genus *Pelocoris,* which pertains to the subfamily Naucorinae.

The genus *Ambrysus* includes about thirty described species. This number could be doubled on the basis of material which is now before me, but I have chosen a conservative course, electing to describe only very distinctive forms which, in most cases, are represented by long series of specimens. With the addition of sixteen new species at this time the genus bids fair to become the largest in the family, and Montandon's two revisions (1897 and 1909) are rendered practically useless. However, a complete revision of the group must await much needed basic research on the limits of variation within such plastic groups as the *signoreti-mormon* complex. Without such a background it will be difficult to interpret the various degrees of differences seen in series of specimens from widely scattered localities.

ACKNOWLEDGMENTS

So many persons have assisted in the course of my twenty years of work on the Naucoridae that it is quite impossible to express my appreciation individually. By far the largest collection in the world is that accumulated by Dr. H. B. Hungerford and his associates at the Snow Museum, University of Kansas. This collection and the U. S. National Museum have been the chief sources of material other than my own collection. Dr. H. B. Hungerford heads the list of persons whose encouragement and coöperation have helped so much in the course of the work. Dr. H. E. Hinton was my companion on a collecting trip to the District of Temascaltepec in Southern Mexico during May, June and July, 1933, which netted several thousand Naucorids representing twenty-one species, six genera, and four different subfamilies. Dr. O. Lundblad of the Naturhistoriska Riksmuseum in Stockholm kindly compared a series of doubtful forms with Stål's types. To these and others mentioned in the course of the present work, I express sincere thanks.

Ambrysus mormon Montd.

This is the commonest and most widely distributed species in the Western United States. I have collected specimens from the type locality, St. George, Utah, which appear to agree in every respect with specimens from the central valleys and north coastal regions of California. To the north and east a smaller and slightly darker form, *heidemanni* Montd., occurs in the warm water streams flowing out from the hot springs of Yellowstone National Park. In California local forms have developed in special restricted habitats such as Clear Lake, Lake county, and Eagle Lake, Lassen county.

Mormon occurs typically in streams with pebble bottoms. In California the Eel river in the north coastal redwood region, the American river in the Mother Lode foothill region and Putah creek in the Sacramento Valley offer perfect conditions for this species. The bugs swim about amidst the pebbles, searching for their prey which includes various aquatic larvae. They prefer quiet or slow-moving water along the edges of streams, but may swim out into deeper water where the current is swift.

Eggs are glued to the surface of pebbles. They are laid by over-wintering females during the spring and early summer. They are suboval in form with a small buttonlike micropyle at the anterior end. When first laid they are creamy white in color. After about a week the color changes to gray and reddish eye spots can be seen through the chorion as development progresses. Hatching occurred within 47 to 52 days at Berkeley where it is cool during April, May and June and within 25 to 33 days at Davis where temperatures are much higher. Hatching occurs by bursting a crescent shaped tear at the micropylar end of the egg. An embryonic membrane is cast in the process of emergence from the egg.

The length of nymphal instars was determined in the laboratory at Davis during May, June, and July. Average figures are given. First instar 13 days, second 12 days, third 14 days, fourth 15 days, and fifth 22 days. The various stages in the life history are illustrated in Plate X.

Ambrysus pulchellus Montandon

The typical form of this species was collected in great numbers at Tejupilco, Temascaltepec, Mexico. It is a very dark species with subparallel sides and with a few punctures near the antero-lateral angles of the pronotum and a few very superficial wrinkles anteriorly at center of disk in some specimens as noted by Champion. Other specimens have the above characters more pronounced and break down at least those characters used by Montandon in his key to separate this species from *nitidulus*. Since my series is from much nearer the type locality of *nitidulus* (Guadalajara) than the type locality of *pulchellus* (Guatemala), an examination of the type of *nitidulus* in the light of present knowledge may synonymize the latter species.

Somewhat smaller and paler examples of *pulchellus* are at hand from Cochise county, Arizona, July 29, 1927, R. H. Beamer collector.

Ambrysus pallidulus Montandon

Described as a variety of *pulchellus* by Montandon. In a fine series which must belong here, taken by J. O. Martin at Roosevelt, Texas, April 21, 1924, the color varies but the dilation of the embolium is distinctive so that it would seem to be a good species.

Ambrysus pudicus Stål

This species has been recorded from a wide area including most of the southwestern United States and Mexico. However, I have never seen a determined specimen in any collection which rightfully belongs here and have only been able to place the species by sending a number of doubtfully related forms to Dr. Lundblad for comparison with Stål's type. One of these specimens proved to be "the real *pudicus* and to agree fairly well with the type." (Lundblad, *in litt.*)

Dr. Hinton and I took a series of this species at Tejupilco. In my specimens the interocular space is scarcely, if at all, wider behind than the length of the head. I know it only from Mexico.

Ambrysus infuscatus Usinger, n. sp.

Form broadly suboval, slightly attenuated posteriorly. Head very small, much less than half the width of pronotum behind, 24::56, the interocular space narrower behind than length of head, 13::17, its sides subparallel, narrower anteriorly; disk impunctate except for a row of punctures along the inner margin of each eye. Labrum rounded apically. Eyes moderately convex. Pronotum strongly transverse, over three times as broad as long on median line, the sides strongly dilated, antero-lateral angles very nearly right angles, lateral margins distinctly carinate, with long, depressed, medially directed, submarginal hairs; postero-lateral angles subrounded; disk smooth, polished and impunctate except for a few scattered punctures laterally, rather evenly, moderately convex. Embolium smooth and impunctate except on inner apical third which is shagreened, with a deep longitudinal impression on inner basal half, the margin carinate with long depressed submarginal medially directed hairs, the margin subrectilinear at middle, strongly rounded subapically. Connexivum rather broadly exposed, the posterior angles of segments produced into acute spines. Venter broadly, longitudinally elevated at middle, the first two segments carinate. Posterior margins of metasterna produced into subrounded lobes. Anterior femora less than two-thirds as broad as long, 13::22.

Color fulvous with obscure darker brownish marks on head and pronotum, scutellum and hemelytra infuscated, the basal and outer two-thirds of embolium fulvous, corium sublaterally beyond embolium somewhat paler and membrane black. Bases of connexival segments darker, eyes brown to black and with characteristic markings of thoracic pleura and sterna black.

Size: Male, length, 8.6 mm.; width, 5.5 mm. Female, length, 8.8 mm.; width, 5.8 mm.

Holotype, male, and allotype, female (California Academy of Sciences), Tejupilco, District of Temascaltepec, Mexico, June 15, 1933, H. E. Hinton and R. L. Usinger collectors. Three female paratypes, same data as the type.

Very close to *parviceps* Montd. and will run to that species in Montandon's key but uniformly darker, fulvous, the membrane black, concolorous, anterior margin of pronotum at middle not depressed, the interocular space subdepressed between moderately elevated eyes (eyes flattened in *parviceps*) and the sides of interocular space more nearly parallel. First two abdominal segments beneath with subprominent, carinate tubercles at middle.

Ambrysus barberi Usinger, n. sp.

Oblong oval. Head slightly narrower, eyes included, than half width of pronotum behind, 27::58; interocular space narrower behind than length of head, 15::17.5, rather evenly narrowed apically, 15::11, the inner margins of eyes scarcely concave; disk impunctate except for a row of punctures along inner margin of each eye. Labrum twice as broad as long, subrounded. Pronotum longer than head on median line, 20::17.5, almost three times as broad behind as long, 58::20. Antero-lateral angles scarcely more than right angles, lateral margins but feebly arcuate, the postero-lateral angles abruptly subtruncate; disk moderately, evenly elevated, impunctate, with fine transverse wrinkles anteriorly at center; laterally near the margins with a few large, ill-defined punctures. Embolia only moderately dilated, width, at this point, not so much greater than posterior width of pronotum, 67::58. Membrane reaching tip of abdomen and thus obscuring progressively more of connexivum apically. Connexivum rather broadly exposed, posterior angles of its segments sharp, but little produced, following well the curve of the abdomen. Posterior margin of metasternum roundly emarginate over posterior coxae, subangulately produced laterally. Front femora less than two-thirds as broad as long.

Color testaceous, the eyes black, markings of head and pronotum brown to black, the sides of scutellum, commissure of clavus, corium at inner apex of embolium and at middle of apical margin paler and basal ¾ of embolia yellow. Connexivum yellow, infuscated at the sutures. Beneath in great part yellow to light brown, the prosternum posteriorly, mesosternum and metasternum anteriorly darker. Legs tinged with green.

Size: Male, length, 8.58 mm.; width (embolia), 5.58 mm. Female, length, 9.16 mm.; width, 6.08 mm.

Holotype, male, and allotype, female (U. S. National Museum) Victoria, Tampico, Mexico, December 10, 1909, F. C. Bishopp collector. Two female paratypes, same data as type. I am pleased to dedicate this species to Mr. H. G. Barber to whom I am indebted for many kindnesses during the past few years.

Closest to *pudicus* Stål but considerably larger with the interocular space narrower behind than length of head and the head width, eyes included, only slightly less than half the width of pronotum behind, 27::58. In the remaining members of the group with polished pronotum and impunctate disk, *parviceps* Montd. has a much smaller head and broader pronotum with its sides more strongly arcuate and *nitidulus* Montd. and *pulchellus* Montd. have a much larger head and the pronotum strongly narrowed behind.

Ambrysus caliginosus Usinger, n. sp.

Form compact oval, rather strongly convex above. Head a little longer than width of interocular space behind, 18::15, its greatest width, eyes included, one-half the greatest width of pronotum. Inner margins of eyes converging in front on all their length, subrectilinear. Anterior margin distinctly surpassing level of anterior angles of eyes, strongly rounded laterally, subrectilinear at middle. Disk rather evenly and densely punctate throughout except narrowly on anterior margin which is faintly rugose. Labrum transverse, rounded apically. Subgenal plates scarcely produced, just visible from above. Pronotum subequal in length to head on median line, the disk subflattened at middle, evenly, rather finely punctate throughout, the transverse impression distinct but not very deep. Antero-lateral angles feebly produced, sharp, sides straight anteriorly, broadly rounded posteriorly and then very briefly, obliquely truncate at postero-lateral angles, the sides of pronotum minutely crenulate. Scutellum shagreened as on the hemelytra. Hemelytra scarcely attaining apex of abdomen, exposing a broad portion of connexivum on either side; emboliar margin abruptly but roundly angled anteriorly, then feebly arcuate to posterior third where it is more strongly rounded and then distinctly concavely sinuate at apex. Connexival angles scarcely produced, little more than right angles except on the last segment where they are distinctly, angulately produced. Prosternum moderately depressed and noncarinate posteriorly, the propleura closely appressed to prosternum where they meet over it.

Color rather dull brown to black, the apical two-thirds of head, broad marginal areas of pronotum, basal two-thirds of embolia, commissure of clavus, a small spot at middle of apical margin of each corium and posterior portions of connexival segments somewhat paler, fuscotestaceous to testaceous. Extreme ledged margins of pronotum and embolia dark brown. Scutellum except at angles and remaining portions of hemelytra black.

Size: Length, 8.7-9.3 mm.; width, 4.8-5.1 mm.

Holotype, male, and allotype, female (California Academy of Sciences) Tejupilco, District of Temascaltepec, Mexico, June 18-21, 1933, H. E. Hinton and R. L. Usinger. A series of paratypes taken at the same time and place as the holotype and allotype. This species was always taken in swift riffles of pebble-bottomed streams about Tejupilco.

Allied to *geayi* Montd. and *obscuratus* Montd. but differs from the former in the nonacuminate connexival angles and from the latter in the minutely crenulate pronotal margins.

Ambrysus fossatus Usinger, n. sp.

Elongate oval, dull. Head longer than width of interocular space behind, 24::20, less than half as wide, eyes included, as width of pronotum behind, 34::77, subequal in length to pronotum on median line. Inner margins of eyes subparallel posteriorly, moderately converging anteriorly, proportion of anterior to posterior interocular widths, 14::20. Anterior margin distinctly, arcuately produced before eyes. Disk with coarse scattered punctures on middle of basal half, densely and finely punctate in the shallow depressions along inner margins of eyes. Elsewhere almost impunctate, with a very few irregular and very obscure fine punctures. Labrum twice as broad as long, subtriangular, the apex rounded. Pronotum only feebly convex, subflattened and even a little depressed anteriorly on either side of center of disk. Disk coarsely punctate throughout, more finely so behind the rather ill-defined transverse impression. Antero-lateral angles but little produced, blunt, sides feebly arcuate, finely and very inconspicuously crenulate, the postero-lateral angles briefly, obliquely truncate, the posterior margin of pronotum feebly roundly produced over bases of hemelytra. Disk of scutellum very densely punctate with scattered granules intermixed. Hemelytra not quite reaching apex of abdomen, exposing a wide area of connexivum on either side. Embolium only feebly dilated, its margin more strongly arcuate on posterior half than anteriorly where it is subrectilinear. With a very deep fossa extending from base to beyond middle, widening and decreasing in depth posteriorly. Last 3 connexival angles very strongly produced, acuminate, the margins very faintly crenulate, except subapically on last segment where there are a few small but distinct teeth. Prosternum sharply carinate anteriorly, abruptly depressed posteriorly with the carina persisting as an elevated line; the propleural plates not closely appressed to sternum where they meet above it.

Color fulvous, somewhat paler on front legs and prostethium with the pronotum testaceous behind the transverse impression. Labrum, scutellum and underside darker, brown. Hemelytra shagreened, dark fuscous or fusco-piceous except on outer margins of embolia. Connexivum ochraceous with the margins narrowly fuscous. Eyes black.

Size: Length, 12.9-13 mm.; width, 7.1-7.2 mm.

Holotype, female (Snow Museum, University of Kansas) Tena., Vicinity of Oriente, Ecuador, March 29, 1923, collected by F. X. Williams in a wide, rather shallow and exposed stream of running water at an elevation of 1,800 feet. Allotype, male, and one male and four female paratypes, same data as holotype.

Allied to *peruvianus* Montd. but considerably larger and with the antero-lateral angles of pronotum only feebly produced, blunt, with a very deep fossa occupying more than half of the basal portion of the embolium at middle.

Ambrysus hungerfordi Usinger, n. sp.

A small suboval species with punctate pronotum. Suboval in form but slightly attenuated posteriorly, surface polished. Head rather small, transverse, 23::15.5, slightly less than half the width of pronotum at base; interocular space twice as broad at base as width of an eye, regularly narrowed anteriorly, 12::9, and longer than broad at base, 15.5::12, with a distinct fovea at anterior corner of each eye and a slightly depressed row of punctures along the inner margin of each eye as well as a few scattered punctures medially near base. Labrum almost twice as broad as long, evenly rounded. Pronotum only moderately elevated, strongly transverse, being three times as broad as long on median line; anterior margin typically trisinuate, subtransverse behind the eyes; antero-lateral angles a little less than right angles; lateral margins evenly arcuate, the postero-lateral angles abruptly rounded, disk distinctly punctate, even behind the moderately well-defined transverse impression, conspicuously wrinkled at middle. Scutellum over twice as broad as long, 32::14, the sides feebly sinuate, surface shagreened. Hemelytra excepting embolia anteriorly and laterally shagreened, the membrane clearly distinguishable from the corium. Embolium strongly expanded, coarsely and irregularly punctate anteriorly and laterally; width across embolia greater than width of pronotum behind, 57::49.5; lateral margin of corium evenly arcuate, forming a concave angle adjoining with corial margin which thenceforth follows an evenly, lightly rounded course exposing an ever decreasing connexival margin to apex but does not cover tip of genital segment. Postero-lateral angles of connexival segments produced into short, acute spines which follow well the curve of the abdomen. Beneath rather densely, finely pilose; posterior margins of metastethia deeply, roundly emarginate over coxae, then prolonged into long rounded lobes from whence they are obliquely rectilinear to lateral margins. Front femora over half as broad as long, 12::19.

Color flavous on the head, pronotum and basal two-thirds of embolium with brown markings characteristic of the genus on the head. Eyes black. Rostrum fuscous. Pronotum with two brown spots anteriorly at middle, an obscure arcuate series of brown to black punctures behind each eye directed toward postero-lateral angles, and various scattered brown spots covering the disk behind the anterior flavous region. The latter extends backward for a considerable distance either side of the middle, before the testaceous to luteous band and within in the broad immaculate lateral areas. Elsewhere dark brown to black, the scutellum paler at center, along lateral margins and at apex; clavus narrowly flavous at base with an obsolete pale area medially at basal third, its commissure pale at apex; corium obscurely mottled with fusco-testaceous or tinged with olivaceous, appearing decidedly paler beyond apex of embolium within the lateral margin to membrane. Connexivum testaceous, with fuscous at inner basal region of each segment. Beneath in great part fuscous to testaceous, dark brown to black anteriorly on prostethium, posteriorly on prosternum scarcely reaching lateral margins, on the mesosternum but not at all reaching the lateral margins and on the metasternum excepting the flavous posterior lobes, reaching the lateral margins. The base of each abdominal segment laterally is black and the venter is inclined to be fulvous toward the middle. Legs testaceous to green, the tarsi black apically.

Size: Male, length, 7.08 mm.; width (embolium), 4.75 mm. Female, length, 7.92 mm.; width, 5.5 mm.

Holotype, male, and allotype, female (Snow Museum, University of Kansas) San Antonio, Mexico, July 15, 1927, R. H. Beamer. A series of paratypes collected at the same place by both R. H. Beamer and P. A. Readio.

In addition to the topotypic series of 62 specimens, the following specimens exhibiting more or less variation in extent and intensity of color are before me: 24 specimens, Rio Mayo, Arroyo, San Bernardo, Sonora, Mexico, March 6, 1935, H. S. Gentry; 1 spec. Novajoa, Sonora, Mexico, March 5, 1930, Doris Wright; 1 spec. Agua Caliente, Lower Calif., Mexico, July 24, 1919, J. R. Slevin; 6 specimens, Tejupilco, District of Temascaltepec, Mexico, July 13, 1932, H. E. Hinton; and a series of several hundred specimens taken by myself at Tejupilco during June and July, 1933.

Hungerfordi is not closely related to any previously described species. It will run to *californicus* in Montandon's key but *californicus* is yellowish to luteous in color and much more elongate with a narrower pronotum. *Hungerfordi* approaches *pudicus* which, however, has a "shining and nearly impunctate pronotum the margins of which are nearly straight." It is a pleasure to dedicate this distinctive species to Dr. H. B. Hungerford.

Ambrysus woodburyi Usinger, n. sp.

Male. Form suboval, slightly attenuated behind, the surface polished, especially on head and pronotum. Head broader, eyes included, than half the width of pronotum behind, 27::50; two-thirds as long as wide; interocular space almost as broad behind as length of head, 17::18, much narrowed anteriorly, 17::12, the inner margins of eyes roundly converging apically; disk punctate throughout, the punctures rather sparse and ill-defined anteriorly. Labrum twice as broad as long, rounded but slightly more produced than a semicircle. Pronotum scarcely shorter than head on median line, with a broad depression behind anterior margin at middle and lighter depressions within the lateral margins; disk closely punctured throughout but especially laterally with a few rows of conspicuous wrinkles anteriorly at middle; behind transverse impression very finely punctate and minutely longitudinally rugose; antero-lateral angles sharp, a little less than right angles, lateral angles feebly rounded anteriorly, more strongly so posteriorly. Scutellum twice as broad as long, the lateral margins sinuate, surface finely punctate, almost granular. Hemelytra shagreened excepting the outer anterior two-thirds of embolia which are roughly indistinctly punctate. Emboliar margin moderately rounded, forming a slightly concave angle at apical junction with corial margin. Connexivum moderately exposed, particularly at middle, the hemelytra equalling tip of abdomen. Posterior angles of connexival segments produced into short sharp angles but not conspicuous. Posterior margin of metasternum distinctly emarginate over the posterior coxae, produced into a short subangular lobe. Front femora two-thirds as broad as long.

Color fulvous, somewhat paler, testaceous on the interocular space excepting basally and medially where the characteristic brown markings are conspicuous. Pronotum paler laterally and just behind distinct transverse impression, with conspicuous brown spots except on the subtriangular central area. Basal two-thirds of embolium and connexival segments, except for fuscous bases, appendages and under side of head, testaceous. Eyes black, hemelytra excepting as above, fuscous to black. Under side in great part brown.

Female larger and considerably paler, the tip of commissure of clavus, inner anterior angle and anterior margin at middle of corium testaceous.

Size: Male, length, 7.83 mm.; width (embolium), 5 mm. Female, length, 8.83 mm.; width (hemelytra slightly expanded), 6.33 mm.

Holotype, male, and allotype, female (California Academy of Sciences) Zion National Park, Utah, A. M. Woodbury collector. Two paratypes, same data as type. One paratype same locality as type, Sept., 1925; one, same but July 9, 1927, R. V. C.; one Moab, Utah, W. S. Gertsch; and one, Sunnyside, Nevada, C. T. Brues Hot Springs Expedition, 1930, species number 94. I collected an additional series of specimens in the run-off from a small spring a few feet from the banks of the Virgin river in Zion Canyon, Utah, June, 1941.

The paratypes exhibit unusual variation in size and coloration, one topotypic female being only 7.08 mm. long and 4.4 mm broad and having entirely dark brown to black hemelytra excepting on basal two-thirds of embolium. Another frequent variation from the above description is a marginal black band on the connexiva.

Three specimens are at hand from Cave creek, Cochise county, Arizona, June 20, 1929, J. O. Martin collector, which differ only slightly from the type. In these the head is slightly narrower, being subequal or slightly narrower than half the width of pronotum behind. The pronotum is feebly depressed either side of the middle. The connexival angles are scarcely acute, the hemelytra are dark brown to black and the membrane exceeds the tip of the abdomen.

Allied to *hungerfordi* but easily distinguished by the depressed median pronotal region and more generally punctate head.

Ambrysus bohartorum Usinger, n. sp.

Head one-half as broad, eyes included, as width of pronotum behind, two-thirds as long as wide; interocular space narrower behind than length of head, 17::20; inner margins of eyes subparallel on basal half, then convergent to apex which is much narrower than base, 13::17; surface impunctate anteriorly with a transverse fovea near apex of each eye; irregularly, inconspicuously punctate basally and laterally. Labrum twice as broad as long, rounded. Pronotum as long on median line as width of interocular space behind; three and one-half times as broad as long, 59::17, the lateral margins broadly rounded; disk subdepressed within the lateral margins, strongly depressed laterally along distinct transverse impression; antero-lateral angles almost right angles; surface distinctly but irregularly punctate, more closely so laterally, transversely wrinkled anteriorly at center. Embolia rather strongly dilated, width at this point one-fifth greater than pronotum behind. Connexivum broadly exposed, posterior angles of segments strongly produced, those of the fifth segment blunt. Posterior margin of metasternum emarginate over posterior coxa, moderately produced and subrounded laterally and thence obliquely and slightly sinuately continued to margin. Anterior femora a little less than two-thirds as broad as long.

Color green laterally, the eyes black, characteristic markings of head, hemelytra excepting basal two-thirds of embolium and a minute pale spot at center of apical margin of corium and bases of connexival segments dark brown to black. Scutellum lighter brown, irregularly mottled, with testaceous basal angles and with black spots on base one-fifth of the total width from each lateral angle. Pronotum with very ill-defined fuscous marks in the central area not forming any pattern other than the characteristic one. Beneath in great part brown, the appendages green.

Size: Length, 9.16 mm.; width, 6.16 mm.

Holotype, female. (California Academy of Sciences) Austin creek, near Cazadero, Sonoma county, California, April 30, 1935, R. M. and G. E. Bohart collectors. Four paratypes, same data as the type.

Near *californicus* Montandon but suboval in form, the pronotum much broader and embolia more strongly dilated. Posterior angles of connexival segments except the last segment prolonged into long, acute spines slightly suggestive of small examples of *mormon* Montd. However, *mormon* is more elongate with the pronotum proportionately much narrower and with characteristic longitudinal markings which are wanting in *bohartorum*.

Ambrysus convexus Usinger, n. sp.

Elongate-oval, moderately convex, very densely, distinctly punctate above. Head transverse, 30::19, a little longer than width of interocular space behind, 19::17, the inner margins of eyes converging anteriorly on all their length but subparallel on basal half, ratio of interocular width at base and apex, 18::14; disk densely punctate except at extreme apical margin. Labrum twice as broad as long, rounded apically. Pronotum three times as broad at base as long on median line and equal in length to head; antero-lateral angles a little more acute than right angles but not sharp; sides strongly divergent, evenly feebly arcuate to postero-lateral angles which are broadly rounded and then feebly emarginate before base of corial margin; disk quite strongly elevated; sides uniformly, densely punctate throughout their length, disk distinctly wrinkled anteriorly at middle. Scutellum twice as broad as long, moderately convex. Hemelytra reaching just to apex of abdomen, commissure of clavus little more than half as long as scutellum; embolium moderately dilated, abruptly rounded at base, with sides regularly arcuate to apical fourth where they are more strongly rounded and convergent to point of joining with corium where a very feeble, concave angle is formed. Connexivum rather evenly exposed at least on second, third and fourth segments, the postero-lateral angles not acute, little more than right angles, except on fourth and fifth segments. Beneath with the venter rather strongly tumid longitudinally at middle, the first two segments feebly carinate. Front femora almost two-thirds as broad as long.

Color testaceous with markings of head and pronotum conspicuously fuscous. Scutellum dark fuscous except for pale apex. Hemelytra largely pale fusco-testaceous, the claval commissure, three obscure longitudinal marks from apex of embolium to apex of corium one of which is marginal, apical third of embolium and membrane darker, fusco-ferrugineous to almost black; a pale spot at middle of apical margin of corium. Eyes and inner bases of connexival segments black. Beneath in great part dark brown to black anteriorly, lighter brown posteriorly, the margins, underside of head, prosternal carina and appendages ochraceous to fulvous.

Size: Male, length, 8.75 mm.; width (embolium), 5.58 mm. Female, length, 9.58 mm.; width (embolium), 6 mm.

Holotype, male and allotype, female (California Academy of Sciences) Real de Arriba, District of Temascaltepec, Mexico, May 25, 1933, H. E. Hinton and R. L. Usinger. A long series of paratypes, same data as the type.

This was the commonest Naucorid at Real de Arriba and ranged from 6,000 ft. up to "LaCumbre" at 9,000 ft. where it was found in a small stream less than a foot in width and only two inches in depth, flowing through a meadow.

Ambrysus convexus, n. sp., is related to *dilatus* Montd. but is smaller, darker in color, with the postero-lateral angles of the pronotum rather broadly rounded and the embolium more dilated. From *hybrida* Montd. it may be distinguished by its smaller eyes, the longer head which exceeds the width of interocular space behind, and which, together with pronotal length on median line, is much more than half the width of pronotum behind. It is much broader than *mexicanus* Montd. in which the pronotum is only two and one-half times as broad as long and the embolia are but little dilated.

Ambrysus fuscus Usinger, n. sp.

Oval in form, more narrowed posteriorly than anteriorly. Head transverse, 31::21, slightly longer than width of interocular space behind, one-half as broad as pronotum behind and scarcely longer than pronotum on median line; inner margins of eyes subparallel posteriorly, distinctly converging anteriorly, ratio of posterior to anterior width of interocular space 18::14; disk elevated at center, broadly depressed on either side near the eyes, the surface distinctly punctate except on extreme anterior margin. Labrum almost twice as broad as long, evenly rounded. Pronotum three times as broad as long, the disk strongly elevated within depressed lateral borders, with a distinct depression before the anterior margin at middle; disk densely coarsely punctured except behind transverse impressions where the punctures are somewhat finer; coarsely wrinkled along entire median depression; antero-lateral angles slightly more than right angles but not sharp; sides evenly arcuate and strongly divergent to postero-lateral angles which are suddenly rounded, minutely emarginate and thence feebly arcuate on posterior margin before base of clavus. Scutellum twice as broad as long, the sides scarcely sinuate, with a distinct transverse subbasal impression. Hemelytra almost or quite attaining apex of abdomen. Emboliar margin strongly, rather evenly arcuate, a little more strongly converging at edge of connexivum, forming a distinct concave angle with corial margin. Claval commissure one-half as long as scutellum. Connexivum moderately exposed. Postero-lateral angles little more than right angles, scarcely produced. Front femora three-fifths as broad as long.

Color fuscous, the interspaces between markings of head and pronotum and extreme anterior and lateral margins and posterior margin behind transverse impression of pronotum, basal three-fourths of embolia, angles of scutellum and connexival segments except at inner bases paler, fusco-testaceous to testaceous. A number of very distinct small round plates forming the brown pattern on elevated disk of pronotum. Elsewhere on scutellum and hemelytra dark brown to black. Beneath in great part, smoky dark brown to black, the legs somewhat paler.

Female distinctly more rounded in general outline than male, broader at emboliar level.

Size: Male, length, 9.25 mm.; width (embolium), 5.59 mm. Female, length 10.84 mm.; width (embolium), 6.5 mm.

Holotype, male, and allotype, female (California Academy of Sciences) Real de Arriba, District of Temascaltepec, Mexico, July 10, 1933, H. E. Hinton and R. L. Usinger. Thirteen paratypes, between June 24 and July 10, 1933, same locality as the type.

These bugs were not at all abundant. They were found very rarely in company with *Ambrysus convexus* and more commonly in the flume which supplies water to the Rincon Mine just above Real de Arriba.

A very distinct species related to *convexus* n. sp., *dilatus* Montd., and *hybrida* Montd. but differing from all of these in its darker coloration with concolorous corium and its broader pronotum and more strongly dilated embolia.

Ambrysus buenoi Usinger, n. sp.

Very evenly oblong-oval. Head transverse, 28.5::19, longer than width of interocular space behind, the ratio of interocular widths posteriorly and anteriorly, 17::12, the inner margins of eyes subparallel on basal half and strongly convergent on apical half; interocular space but little elevated at middle, slightly depressed near the eyes, the disk irregularly finely punctate except on anterior margin. Labrum strongly transverse, 8::3, rounded apically. Pronotum as long as head on median line, twice as broad as head including eyes; rather evenly convex throughout, the disk irregularly punctured throughout and coarsely wrinkled anteriorly at middle; antero-lateral angles rather sharp, sides evenly arcuate, moderately dilated posteriorly; postero-lateral angles abruptly rounded, minutely emarginate; posterior margin almost imperceptibly arcuate before base of clavus. Scutellum almost twice as broad as long with a sinuate transverse impression sub-basally; sides feebly sinuate; apex subacute. Hemelytra not quite reaching tip of abdomen; embolium only moderately dilated, its sides feebly arcuate except at extreme base and apical fourth, forming a small but distinct concave angle at junction with corial margin, less than one-third as wide posteriorly as long, 9::31. Commissure of clavus approximately one-half as long as scutellum. Connexivum broadly exposed, postero-lateral angles of second, third and fourth segments, moderately acutely produced. Front femora about three-fourths as broad as long.

Color obscure fulvous to testaceous, the markings of head and pronotum ill-defined, brown, the transverse impression fairly distinct, behind which the pronotum is testaceous. Scutellum reddish brown, paler at the angles. Hemelytra generally infuscated with numerous ill-defined paler spots on the clavus and corium, especially at inner apex of embolium and middle of apical corial margin. Embolium pale on basal three-fourths, membrane mottled, fusco-testaceous to darker. Connexivum yellow with segments darker basally or submarginally. Eyes dark. Under side of body generally brown but paler laterally on abdominal segments with the legs fulvous.

Size: Male, length, 8.92 mm.; width (embolium), 5.25 mm. Female, length, 10.17 mm; width (embolium), 6.17 mm.

Holotype, male (U. S. National Museum) Rio Grande, Brewster Co., Texas, June 13-17, 1908, Mitchell and Cushman collectors. Allotype, female, and a male and female paratype, same data as type. There is also a female specimen from Neville Springs, Texas, Geo. M. Green collection, which may belong here although it differs in having a less strongly transverse labrum and in several other particulars. Likewise a female from the same series as the type is considerably darker in color and broader posteriorly.

The type bears an identification label "*Ambrysus mexicanus* Montd., Det. J. R. de la T. Bueno," and it gives me great pleasure to dedicate this species to Mr. Bueno. *Buenoi* is perhaps closest to *mexicanus* but with the pronotum three times as broad as long, the head slightly longer than broad between the eyes in back, and the connexival angles very shortly but acutely produced.

Ambrysus variegatus Usinger, n. sp.

Elongate oval, the head broad, pronotal margins feebly arcuate, not strongly dilated posteriorly, connexival segments with angles sharp but scarcely produced.

Head strongly transverse, 41::26, only slightly longer than width of interocular space behind, 26::24, the interocular space with sides subparallel on posterior two-thirds, converging anteriorly, the ratio of posterior to anterior width, 24::19; disk but little elevated, depressed on either side near inner margins of eyes, where it is more coarsely punctate than elsewhere. Labrum twice as broad as long, evenly rounded anteriorly. Pronotum almost twice as broad posteriorly as width of head including eyes, 79::41; longer than head on median line, 30::26; and distinctly less than three times as broad as long; antero-lateral angles much less than a right angle but only subacute, extending beyond level of middle of eyes; sides feebly sinuate anteriorly, then slightly arcuate to postero-lateral angles which are suddenly rounded and then minutely emarginate before straight posterior margin; disk rather strongly, evenly convex, punctate throughout and anteriorly transversely wrinkled at middle. Scutellum a little more than twice as broad as long, moderately, evenly elevated. Hemelytra not quite attaining tip of abdomen, commissure of clavus two-thirds as long as scutellum; emboliar margin moderately, evenly dilated, three and one-half times as long as greatest width, forming a slightly concave angle at junction with corial margin. Connexivum with angles little more than right angles, scarcely produced. Front femora a little less than two-thirds as broad as long.

Color yellow, the markings of head and pronotum distinct, brown, the scutellum dark fuscous except at angles and longitudinally along middle. Hemelytra fuscous to black with clavus yellow transversely at base, along sutures, commissure and broadly at middle; the embolium yellow on basal two-thirds; corium with an obscure pale spot near inner apical angle of embolium and an elongate spot at middle of apical margin, these spots on either side anteriorly divergent. The corium may be paler submarginally and near the clavus. Membrane small, black. Connexivum yellow, fuscous at the base of each segment within clear margin. Beneath in great part yellow the venter fulvous margined with fuscous.

Size: Male, length, 12.84 mm.; width (embolium), 7.25 mm. Female, length, 13.4 mm.; width (embolium), 7.9 mm.

Holotype, male (California Academy of Sciences) West of Cartago, Costa Rica, C. A., 4,700 ft., June 10, 1932, B. S. Kaiser. Allotype, female, (California Academy of Sciences) near Santa Maria Dota, Costa Rica, C. A., 5,000 ft., June 23, 1932, B. S. Kaiser. Paratypes, 16 specimens from West or South of Cartago, near Santa Maria Dota, and near Tajar, Costa Rica, June 10-23, 1932, B. S. Kaiser, and 4 specimens, San Jose, Costa Rica, June and July, 1931, Heinrich Schmidt, from Dr. H. B. Hungerford.

Near *bergi* Montd. but with the antero-lateral angles not so conspicuously sharp, the length of head and pronotum together much greater than half the width of pronotum behind, 55::40. The hemelytral margin shallowy, angulately sinuate at apex of embolium. *Variegatus* is superficially very similar to *guttatipennis* Stål in which, however, the head is obviously smaller, less than half the width of pronotum behind, the embolium strongly rounded at base, and the general form slightly broader.

I have a series of 8 specimens from Mexico which average smaller in size with the head as broad or broader than in the Costa Rica specimens and with the pronotal margins more nearly parallel. I have not assigned a name to this Mexican series because all of the characters break down when compared with the variable Costa Rica series.

Ambrysus sonorensis Usinger, n. sp.

Oval, widest a little behind middle. Embolia strongly rounded posteriorly, connexival angles strongly produced, sharp. Connexival margins finely serrate. Color very dark, the markings black, the under side yellowish with the legs highly polished.

Head broad, 47::29, the interocular space almost as broad behind as length of head, 28::29, strongly narrowed anteriorly, particularly on anterior half, ratio of posterior to anterior widths, 28::22; disk irregularly punctate throughout, more strongly so in the submarginal depressions which are slightly convergent posteriorly, thus parting from the inner margins of eyes toward the base of head. Labrum twice as broad as long. Pronotum almost twice as broad posteriorly as width of head, 92::47, a little more than two and one-half times as broad as long, 92::35, considerably longer than head on median line, 35::29; antero-lateral angles a little less than right angles, sharp; sides narrowly carinate, feebly arcuate; postero-lateral angles subtruncate, the posterior margin straight or almost imperceptibly arcuate; disk strongly elevated, subdepressed at middle and laterally before margins; surface punctate throughout, transversely wrinkled anteriorly at middle, rugosely punctate on depressed sides; transverse impression very superficial. Scutellum over twice as broad as long, its sides wrinkled transversely to the direction of the margins. Hemelytra attaining tip of abdomen; commissure of clavus two-thirds as long as scutellum; embolium moderately strongly dilated, three times as long as greatest width, its margin rather evenly rounded at middle, more strongly so narrowly at base and on posterior fourth, margin feebly sinuate at apex of embolium. Connexivum with postero-lateral angles acutely produced, margins finely evenly serrate. Front femora two-thirds as broad as long.

Color mostly black above, the head paler, ochraceous to fulvous except for characteristic brown markings and an anteriorly widening marking with pale center on either side of central longitudinal markings, as well as two semicircular markings anterior to these, black. Labrum pale on basal half. Rostrum black. Pronotum with characteristic markings of the genus very prominent, conspicuously yellow at center and on lateral margins posteriorly. Testaceous just behind black transverse impression but dark brown along entire posterior margin. Sides narrowly ferrugineous. Scutellum with pale margins and angles as well as a longitudinal line at middle. Hemelytra with ill-defined light brown spots on coria near inner posterior angles of embolia, basal two-thirds of embolia yellow. Connexivum brown, black at the sutures, and yellowish near corial margin. Beneath in great part yellow to fulvous, the legs highly polished and curiously variegately streaked with black, brown, gray, and yellow.

Size: Male, length, 13.2 mm.; width (embolia), 9 mm.

Holotype, male, (California Academy of Sciences) San Bernardo, Rio Mayo, State of Sonora, Mexico, March 2, 1935, H. S. Gentry collector.

This species is not to be confused with any species known to me. It belongs to the *signoreti* group but differs from all of its relatives in color and in the serrate connexival margins.

Ambrysus lunatus Usinger, n. sp.

Elongate, oval, widest behind middle and rather strongly narrowed anteriorly. Embolia strongly dilated, connexival angles strongly, acutely produced. Color pattern distinct, the coria each with a conspicuous anteriorly divergent vitta from middle of anterior margin.

Head transverse, 35::24, a little longer than width of interocular space behind, 24::21; inner margins of eyes converging both anteriorly and posteriorly, the widths posteriorly, just before middle, and at apex, 21::22::18; disk rather regularly punctate at middle, more coarsely and irregularly so in lateral subdepressed areas. Labrum a little less than twice as broad as long, subtriangular in outline, the apex rounded. Pronotum a little less than twice as broad as head including eyes, three times as broad as long and subequal in length to head on median line. Antero-lateral angles a little less than right angles, subacute; sides feebly arcuate, the postero-lateral angles abruptly rounded; disk moderately elevated, slightly depressed behind eyes and anteriorly at middle where it is strongly transversely wrinkled; transverse impression sinuate either side of the middle; surface conspicuously punctate throughout. Scutellum twice as broad as long, its sides sinuate, apex subacute, commissure of clavus two-thirds the length of scutellum. Hemelytra almost attaining tip of abdomen; embolium strongly dilated, especially at base and on posterior two-thirds, three times as long as broad, its margin scarcely concavely angled at junction with corial margin. Connexivum with postero-lateral angles strongly posteriorly produced, acute. Front femora a little less than two-thrids as broad as long, 19::31.

Color yellowish testaceous, the characteristic markings of head and pronotum distinct, brown as is the scutellum at middle. Hemelytra fuscous, the corium with a broad testaceous spot near inner apex of embolium projecting inwardly and anteriorly and with anteriorly divergent vittae from middle of apical margins of coria not quite touching the median spots. Elsewhere with inner apical angles of coria, the commissure of the clavus and the claval bases as well as along inner margin and broadly at middle of clavus pale. Embolia yellow on basal two-thirds. Membrane almost black with an obscure pale mottled area near middle. Connexivum yellow, the bases of segments black. Beneath generally yellow, the venter fulvous, the apices of tibiae brown and tip of rostrum black. Eyes silvery black.

Size: Male, length, 10.84 mm.; width (embolia), 7 mm. Female, length, 12 mm.; width (embolia), 7.42 mm.

Holotype, male, and allotype, female (Snow Museum, University of Kansas) Tom Greene county, Texas, July 15, 1928, R. H. Beamer collector. Paratypes: 4 specimens, same data as type; a long series from Eddy county, New Mexico, July 9-12, 1927, R. H. Beamer; Ft. Stockton, Texas, July 5, 1917, H. H. Knight; Kerr county, Texas, July 21, 1928, Jack Beamer; and Roosevelt, Texas, April 21, 1924, J. O. Martin collector.

In the series of paratypes, the Ft. Stockton series in particular is very much paler than the others. In some cases a submarginal pale area extends posteriorly from the apical margin of the embolium, adding to the distinctive coloration of this species. Also the brown discal spot of scutellum may be divided longitudinally at middle.

This species is quite distinct from any species known to me. It is perhaps closest related to *mormon* Montd. with the same narrow pronotum but differs greatly from this species in color and other characters.

Ambrysus lundbladi Usinger, n. sp.

Elongate-oval, widest slightly behind middle. Pronotum twice as broad as head including eyes. Embolium moderately strongly dilated. Connexival angles sharply produced posteriorly. Color pattern distinctive.

Head transverse, 38::24, a little longer than width of interocular space behind, 24::22; inner margins of eyes subparallel or slightly converging posteriorly on posterior two-thirds, distinctly converging anteriorly, the ratio of basal to apical width, 22::17, disk irregularly, distinctly punctate, especially on lateral subdepressed areas. Labrum twice as broad as long, apically rounded. Pronotum twice as broad as head including eyes, scarcely longer than head on median line and a little less than three times as broad as long; antero-lateral angles a little less than right angles, acute; sides moderately arcuate; postero-lateral angles abruptly rounded, the posterior margin feebly sinuate laterally, very slightly produced posteriorly over bases of clavi; disk moderately evenly convex, transversely wrinkled but scarcely depressed anteriorly at center, distinctly, irregularly punctate throughout. Scutellum twice as broad as long; disk slightly elevated, sides sinuate, the apex subacute. Hemelytra attaining tip of abdomen; commissure of clavus two-thirds as long as scutellum; embolium rather strongly dilated, the margin a little more strongly rounded at base and at level of margin of connexivum; forming a small concave angle at point of junction with corial margin; over three times as long as broad, 43::13. Connexivum broadly exposed, the postero-lateral angles of segments distinctly, posteriorly produced, acute. Front femora two-thirds as broad as long.

Color yellowish testaceous, the characteristic markings of head and pronotum distinct, brown, scutellum and hemelytra dark brown except for testaceous markings subbasally at sides, apically and longitudinally at middle of scutellum, transversely at base, on commissure, on sutures at margins and broadly at middle of clavus, on basal ¾ of embolium and corium near inner apex of embolium, at middle of apical margin, as well as laterally near margin and at inner apical angle of apical margin. The markings at middle of apical margins of coria diverge anteriorly, reaching the pale spots at inner apices of embolia, corium light brown submarginally beyond embolium. Connexivum ochraceous with fuscous spots at bases of segments within narrow testaceous margin. Beneath in great part yellow, the venter and legs more fulvous. Eyes black.

Size: Female, length, 12.09 mm.; width (embolia), 7.66 mm.

Holotype, female, (California Academy of Sciences) State of Morelos, Mexico, May 30, 1897, Koebele collection.

Similar in size and shape to *ochraceus* Montd. from Bolivia but with a distinct color pattern and with the posterior angles of the connexival segments moderately prolonged posteriorly, sharp. Named after Dr. O. Lundblad who kindly compared this and other Naucorids with types in the Naturhistoriska Riksmuseum, Stockholm.

There is a male specimen before me from the U. S. National Museum which is very much faded and badly eaten by museum pests. It bears Montandon's label "*Ambrysus ochraceus* Montd., var. 1909" and is from "Mexico."

A unique female before me from San Jose del Sacare, Chalatenango, El Salvador, C. A., March 14, 1927, R. A. Stirton, may likewise belong here although its color markings are darker, black rather than brown, its head is a little larger and the subgenital plate is a little differently shaped apically. A series of specimens will be necessary to place this correctly.

Ambrysus hintoni Usinger, n. sp.

Oblong-oval, moderately convex, the head half as broad as pronotum behind, embolium moderately dilated, connexival angles not produced.

Head transverse, 34::21, slightly longer than interocular space behind, 21::19, the interocular space subparallel on posterior two-thirds, converging anteriorly, the ratio of posterior to anterior width, 19::14; disk scarcely elevated at middle, irregularly finely punctate except for anterior impunctate margin and lateral subdepressed areas near eyes which are more densely, coarsely punctate. Labrum over twice as broad as long, rounded apically. Pronotum a little less than twice as broad as head including eyes; scarcely longer than head on median line and three times as broad as long; disk evenly elevated, scarcely depressed at middle, irregularly punctate throughout and transversely wrinkled anteriorly at middle; antero-lateral angles a little less than right angles but not sharp, sides only feebly arcuate, the postero-lateral angles abruptly rounded; posterior margin feebly sinuate laterally where it extends very slightly posteriorly over bases of clavi. Scutellum a little more than twice as broad as long, its sides feebly sinuate, its apex subacute. Hemelytra reaching tip of abdomen; embolium moderately strongly dilated posteriorly, rather evenly arcuate beyond abruptly rounded base; a little more than three times as long as greatest width, forming a distinct concave angle at junction with corial margin; commissure of clavus two-thirds as long as scutellum. Connexivum with postero-lateral angles a little less than right angles, especially posteriorly, but not sharp. Front femora almost two-thirds as broad as long.

Color yellowish ochraceous, the characteristic markings of head and pronotum distinct, brown, the scutellum, except angles and a median longitudinal line, clavus except basally, on commissure and along sutures especially at middle, embolium on apical fifth, corium except near inner apex of embolium, middle of apical margin and more or less submarginally behind embolium, membrane and inner bases of connexival segments dark fuscous to black. Beneath in great part yellow with light brown markings on meso and metasterna and the venter brownish with the bases of the segments laterally black. Eyes black.

The female is broader posteriorly, being less narrowed along connexival margins.

Size: Male, length, 10.09 mm.; width (embolium), 6.09 mm. Female, length, 11.25 mm.; width (connexivum), 6.58 mm.

Holotype, male and allotype, female (California Academy of Sciences) Tejupilco, District of Temascaltepec, Mexico, June 30, 1933. A series of paratypes, same locality as type, June 15, 1932, and a series of paratypes, same locality as the type, June 15-20, 1933, H. E. Hinton and R. L. Usinger and one specimen, July 13, 1932, H. E. Hinton collector.

Very near *mexicanus* Montd. but with a much larger head and broader pronotum. The allotype was compared with Montandon's type and found to be different.

Ambrysus vanduzeei Usinger, n. sp.

Oblong-oval with the head broad, pronotum but little dilated posteriorly, connexival segments sharply angled but scarcely produced posteriorly. Female genital plate tremendously prolonged posteriorly, extending well beyond tip of abdomen.

Head transverse, 28::19, longer than posterior width of interocular space, 19::15, its surface distinctly punctate posteriorly and on slight depressions laterally near inner margins of eyes; ratio of posterior to anterior widths of interocular space, 15::11, the inner margins of eyes subparallel or slightly anteriorly convergent on posterior half and more strongly so anteriorly; eyes with a faint suggestion of lateral lobes. Labrum not quite twice as broad as long, rounded apically. Pronotum less than twice as broad posteriorly as head including eyes, 52::28, almost three times as broad as long and much less broad than twice length of head and pronotum together; antero-lateral angles subacute, a little more than right angles; sides only feebly arcuate, not strongly dilated posteriorly; postero-lateral angles rather abruptly, roundly angled; disk rather evenly, moderately convex, densely punctate, especially laterally, and distinctly, transversely wrinkled anteriorly at center. Scutellum twice as broad as long, its sides sinuate and its apex subacute. Commissure of clavus over one-half as long as scutellum, 11::18. Hemelytra exceeding tip of abdomen in the male, the emboliar margin rather evenly arcuate, moderately dilated, strongly roundly converging posteriorly and forming a distinct concave angle with corial margin; three times as long as greatest width, distinctly punctate laterally on basal two-thirds. Connexivum with the postero-lateral angles sharp but scarcely produced, almost right angles with a few very long hairs on margins. Beneath with the venter broadly elevated longitudinally at middle, carinate on basal two segments. Front femora three-fifths as broad as long.

Color yellowish testaceous, the characteristic markings of head and pronotum more or less distinct, brown. Scutellum brownish except for pale angles and narrowly along sides and often longitudinally at middle. Hemelytra brown with the basal two-thirds of embolium, more or less on clavus, claval commissure, and corium usually at inner angles of embolium and middle of apical margin, pale testaceous. Connexivum testaceous, more or less infuscated. Beneath rather uniformly ochraceous, the venter brownish, its margin often black. Prolongation of female genital plate fulvous. Eyes black, distinctly margined with yellow along inner sides and sometimes posteriorly as well.

Females with the sixth visible ventrite longer than broad, 20::16, its sides abruptly narrowed at basal third and extending backward one-fourth of its length beyond level of apices of pleurites, rounded at apex.

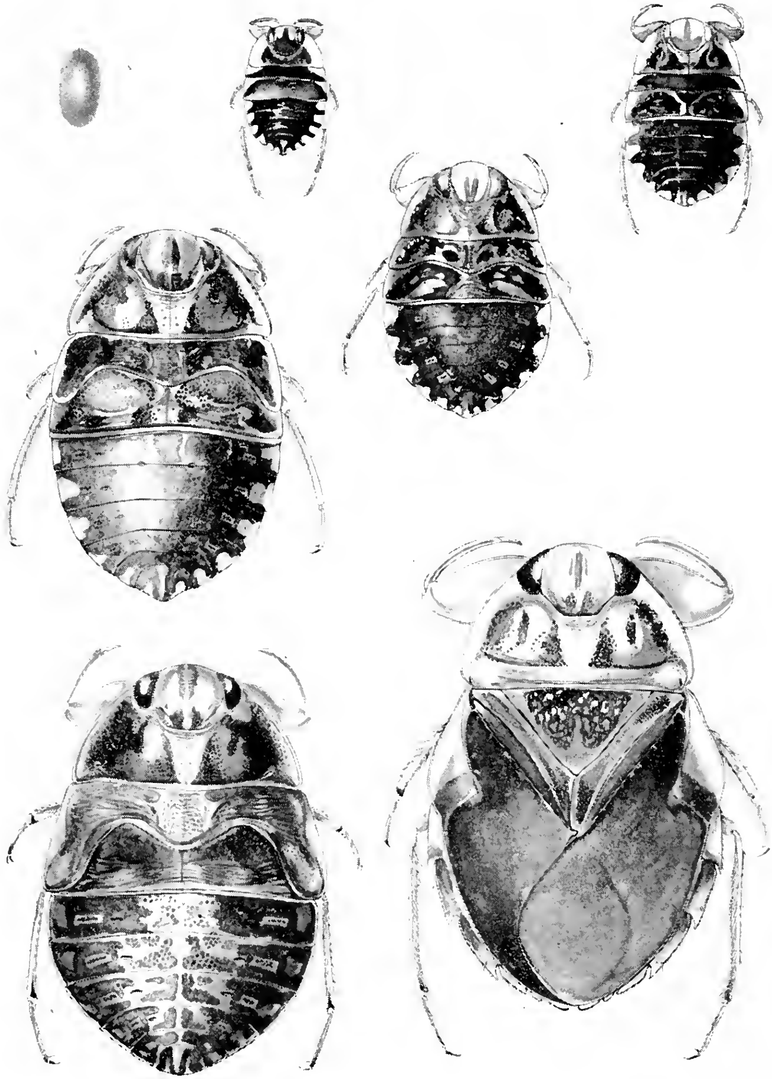
Size: Male, length, 8.42 mm.; width (embolium), 5.25 mm. Female, length, 10.42 mm.; width (embolium), 6.09 mm.

Holotype, male and allotype, female (California Academy of Sciences) Mulege, Baja California, May 14, 1921, E. P. Van Duzee. A series of paratypes, same data as type.

There is a single specimen in the U. S. National Museum, P. R. Uhler collection, labeled "San Ramundo, Lower Calif., Mex., Chas. D. Haines, April 1889."

This species will run to *hybrida* Montd. but has a much longer head and pronotum than in that species and differs from all of the species known to me in the tremendously prolonged sixth visible sternite in the female.

PLATE X



Ambrysus mormon Montd. Egg, five nymphal stages and adult.

THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN

VOL. XXXI, pt. I.] MAY 1, 1946 [No. 11

The Relative Weights of the Major Divisions of the Brain and the Cord in Several Species of Animals

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ABSTRACT: The weights of the prosencephalon, the mesencephalon, the cerebellum and the medulla, expressed as percentages of the entire brain weight have been assembled, for the frog, chicken (both newly hatched and adult), albino rat, turtle, cat (fetal, newborn and adult), dog and man.

The relative weights of the prosencephalon increase with the increase in complexity of the animal, the relative weights of the mesencephalon decrease and the relative weights of the medulla decrease in the higher forms but this change is not quite so regular as in the first two parts of the brain. The percentage weights of the cerebellum are the most irregular.

The weights of the spinal cords, expressed as percentages of the total brain weight show a general decrease from the lower animals up to man. This does not apply to the adult chicken, and the turtle cord. The turtle cord is 120 percent of the weight of the turtle brain.

The relative weights of the prosencephalon and the percentage weights of the cord illustrate very well the cephalization of the nervous system in this small group of animals.

DURING the latter part of the last century and the early years of the present century, there has been a marked change in the methods of studying the brain and also in the emphasis on the basic units of morphological structure. Before this time, the brain was thought of as a series of segmental parts, each with its functions, and more or less united with the parts anterior and posterior to it. The "American School of Neurology", as it has been called by Herrick (1943), has revolutionized the approach to the study of the brain, both human and comparative, by the substitution of the longitudinally arranged functional divisions, in place of the former segmental, or developmental, units. This change has been brought about to a very large degree by Herrick's first paper on "The cranial and first spinal nerves of Menidia" published in 1899, and by a long series of subsequent papers. This new method is, without doubt, the best method for studying the structure of the brain, but it is difficult to get quantitative measurements of these tracts without long and tedious methods. The study of the segmental divisions does give some idea of the changes in proportions in the brains in different groups of animals. It may be impossible to differentiate quantitatively between the frontal lobe of a male or a female brain, or to distinguish these lobes in a white or a colored brain, as has been stated by Mall (1909), yet there are very significant and very instructive differences between the various major divisions of the brains of different species of animals.

Detailed studies of the quantitative structure of some of these brains have already been published (see references), but it seemed best to collect them together for more adequate comparisons. This summary does not mean that these studies are completed, for this is merely a beginning and many more studies of the relative proportions of the major divisions of the brains of various species of animals are needed to complete the picture. In addition to these studies of the gross divisions of the brain, we need more quantitative studies of the layers of the brain, the dimensions and relative weights of the tracts and nuclei and other finer details of brain structure studied by means of quantitative methods. Neurology for some time has been a descriptive science and more recently it has entered the experimental field and the next advance should be a more exact or statistical study of the various parts of the brain.

The weight of the entire brain in man and also in many animals has been determined many times and no attempt will be made to review this very voluminous literature. There is a much smaller number of studies on the weights of the various parts or divisions of the brain, either human or comparative, and an even smaller number of weights of the spinal cord. The meagerness of the weights of the cord may be due in part, at least, to the arduous task of removing all of the cord from a vertebrate animal.

One of the earlier studies on the weights of the parts of the brain was made by Marshall in 1892. The knowledge that we have today of the quantitative anatomy of the nervous system of the albino rat is due largely to the leadership of H. H. Donaldson. In 1909 he assembled the then known quantitative data on the growth of the brain and in subsequent years published a series of papers on the quantitative anatomy of the nervous system. In 1924 he again gathered the results of his work and that of many others in a very complete quantitative description of the various systems of the albino rat.

In the work of Dunn (1921 and 1926) we have an excellent description of the quantitative growth changes in the human brain during the fetal period. Stewart (1918) has studied the weights of the parts of the brain in the rat, both in control and in experimental animals. Mall (1909) has studied the various measurements of the frontal lobe of the human brain and has published a series of weights of the cerebellum in both white and colored males and females. Ellis (1920) has reviewed the earlier literature on the growth of the cerebellum and has reported the changes in the cerebellum with advanced age. The careful accurate work of Craigie (1924, 1925, and 1931) and Drummond (1944) on the vascular supply of various parts of the brain must not be omitted from the list of quantitative studies on the nervous system. More studies like the preceding are needed and also studies on the finer details of the brain, like that of Sugita (1917) on the thickness of the cortex of the albino rat, and Suitsu (1920) on the growth of the corpus callosum of the rat.

PARTS OF THE BRAIN

Unfortunately there have been some differences in the methods of dividing the brain for these quantitative studies, but still the relative weights of most of the major divisions can be compared, for most of the animals.

The weights of the prosencephalon, the mesencephalon, the cerebellum, and the medulla expressed as percentages of the entire

TABLE 1. Weights of the parts of the brain and of the spinal cord as percentages of the total brain weight

	Prosencephalon	Mesencephalon	Cerebellum	Medulla	Spinal cord
Frogs (Rana pipiens)	50.5	24.0	†.......	†25.5	46.39
Chickens, newly hatched	48.81	27.38	14.29	9.52	19.05
adults	55.29	21.75	13.90	9.84	89.73
Rat, albino (Donaldson)	66.48	*.......	14.23	*19.29	36.14
Turtles (Chrysemys elegans)	67.5	11.7	5.2	15.7	120.22
Cats, early fetuses	53.79	24.55	5.05	16.61	19.12
new born	83.04	5.27	5.72	6.10	8.29
adult males	74.79	4.07	14.39	6.57	22.41
Dogs, males	82.54	2.67	9.60	5.19	18.77
Man (Donaldson)	87.29	*.......	10.58	*1.95	1.91
(Marshall)	‡87.19	‡.......	10.76	2.06	....
(Mall)	....	....	12.40	....	....

†—Cerebellum and medulla weighed together.
*—Mesencephalon and medulla weighed together.
‡—Weight of mesencephalon included with prosencephalon weight.

brain weight are given in table 1. The source of the data for each type of brain is given in the first column together with the species of the animal. Those without any reference were described by the author. The data for the albino rat brains were computed from the weights in grams given by Donaldson (1924) for his older rats. The last column of this table shows the weight of the spinal cord as a percentage of the brain weight. The brains of the frogs, chickens, turtles, cats, and dogs were all dissected by the same person and the method was as uniform as possible. In the study of the brains of the cats and the dogs, more than these parts were weighed but the smaller subdivisions are not given here, for this is an attempt to show the changes in the same major divisions of the brain in the various species of animals.

The olfactory bulbs, the telencephalon and the diencephalon were all weighed together, or the sum of these divisions is given as the weight of the prosencephalon. The separation between the mesencephalon and the caudal end of the diencephalon was made by an incision starting just anterior to the anterior corpora quadrigemina on the dorsum of the brain and emerging inferiorly just posterior to the mammillary bodies and the stalk of the hypophysis. This incision was probably the most difficult to make in a constant manner. All of these dissections were made by the same person and this should help to insure a slightly more constant result. The cerebellum was removed by cutting the cerebellar peduncles on a level with the upper margins of the walls of the medulla. Thus the weight of the pons is included with that of the medulla. The constricted isthmus rhombencephali is a most excellent landmark for the separation of the mesencephalon and medulla. The medulla and cord were divided at the level of the occipital condyles. The head was cut from the body by an incision passing as close as possible to the occipital condyles thus dividing the cord from the medulla at the level of the roots of the first spinal nerve. In the frogs the cerebellum was so small that it was not separated from the medulla and the two were weighed together.

The data on the rat brains give no percentages for the mesencephalon, for the mesencephalon and the medulla were weighed together, and listed as brain stem. The data for the human brain as taken from Donaldson's data (1909) likewise includes the weight of the midbrain with that of the medulla. Marshall (1892) has included the weight of the midbrain with that of the prosencephalon.

The only part of the data given by Mall (1909) which would fit in with the percentages given here was that for the cerebellum.

The data were arranged to show the increasing percentage weights of the prosencephalon in the adult animals. The prosencephalon increases from about half of the total brain weight in the frog to a little over 87 percent of the total brain weight in man, or the prosencephalon in man is 72.67 percent greater in relative weight than that of the frog.

The mesencephalon decreases in relative weight in these adult forms. From the frog to man the mesencephalon decreases 88.88 percent. The newly hatched chick and the early fetal cat are the only forms with a relatively larger mesencephalon than that of the frog, and in both of these the relative weight of the mesencephalon decreases with age, as shown in the earlier papers (Latimer, 1925 and 1938), so that the percentages of the mesencephalon form a series decreasing with the development of the animal.

The cerebellum varies from 5.2 percent of the weight of the brain in the turtle to a maximum of 14.39 percent in the adult cats. It has been shown that there is a certain correlation between the growth of the cerebellum and the musculature in the postnatal development of the chicken (Latimer, 1925) and if we compare the relative size of the cerebellum and the relative weight of the musculature in those adult forms for which the weight of the musculature is known, we will find an interesting relationship. We have the weights of the musculature for the cat (Latimer, 1944), the rat (Jackson and Lowrey, 1912) and man (Scammon, 1933). The muscles of the cat form 50 percent of the weight of the body and the relative weight of the cerebellum is 14.39 percent of the brain weight; in the rat the muscles form 45.4 percent of the body weight and the cerebellum, 14.23 percent of the brain weight and in man the muscles form from 40 to 45 percent of the body weight and the cerebellum forms but 10.67 percent of the total brain weight. Of course there should be more forms available to make definite conclusions, but from these data it would appear that there is a relationship between relative weights of the muscles and the cerebellum. It would appear that with a relatively greater amount of muscles a relatively larger cerebellum is necessary. The disparity between the percentage weights of the cerebellum in the dog and the cat is interesting. One would think them about equal in activity and muscular development. The difference may be explained, in part at least, by the relatively greater weight of the prosencephalon. Unfortunately there are no known data on the weights of the musculature in the dog.

In his study of some of the parts of the brain, Mall (1909) has given the weights in grams for the cerebellum in several white and black males and in 22 black females. He did not study these statistically but we have determined the averages, the coefficients of variation and the significant differences for these absolute weights and for a smaller number of percentage weights, and these are shown in table 2. The percentages were calculated from his data. The smaller number of percentages is due to the failure to give the total brain weight for all of his specimens. The difference of 0.80 between the cerebellar weights in the white and black males of course is not significant. The difference of 3.75 between the weights of the cerebellum in the black males and females is statistically significant. A study of the weights of these cerebelli as percentages of the total brain weight likewise shows no significant difference between these percentages in the males of the two groups but there is a probably significant difference of 2.15 for the percentages of

TABLE 2. Average cerebellar weights, coefficients of variation and significant differences computed from the original data of Mall, for white males (W. M.), black males (B. M.) and black females (B. F.).

NUMBER OF CASES	Average weight in grams	Coefficient of variation	Significant difference
W. M. 39	166.82 ± 1.96	10.89 ± 0.84	
			0.80
B. M. 54	164.78 ± 1.62	10.68 ± 0.70	
			3.75
B. F. 22	154.41 ± 2.24	9.85 ± 1.04	
	Average percentage weights		
W. M. 26	12.40 ± 0.18	10.78 ± 1 02	
			0.063
B. M. 41	12.41 ± 0.16	12.36 ± 0.93	
			2.15
B. F. 14	13.08 ± 0.26	10.76 ± 0.14	

the cerebellum in the two sexes of the black race. The number of cases is not very large but these figures do show that in the black race the male cerebellum is statistically heavier in absolute weight than the female cerebellum, and also that the female cerebellum probably forms a larger part of the total brain weight.

The coefficients of variation for all of these weights, both the weights in grams and the percentage weights are remarkably similar, and they are fairly low, indicating a rather low degree of variability. There is not the difference between the coefficients for the absolute weights and the percentage weights which one usually finds. The lowest coefficient is that for the weight in grams of the cerebellum in the black females, and the highest is for the percentage weights of the black male cerebellum. This maximum coefficient is but 1.25 times the smallest coefficient. The average of the three coefficients for the absolute weights is 10.47 and that for the three coefficients for the percentages is larger or 11.30. The percentage weights of the parts of the dog brain were also more variable than the absolute weights (Latimer, 1942).

A most excellent study by Larsell and von Berthelsdorf (1941) shows that there is a very definite relationship between the surface areas of the divisions of the ansiform lobe of the cerebellum and the weights of the musculature of the fore, and the hind limbs in six species of mammals.

Table 1 shows the medulla of the rat as heavier than any of the other forms but this weight includes the weight of the mesencephalon, small though it may be. In the frog, the cerebellum and medulla were weighed together. The medulla of the turtle is possibly the greatest in relative weight and the medulla of man forms the smallest proportion of the brain weight. The postnatal growth of the chicken medulla follows the increase in total body weight very closely. The percentages for the cat show that in the fetal period, the medulla decreases from 16 to 6 percent of the brain weight. There is less change in the postnatal period than in the fetal period. We have no data for the changes in the postnatal growth of the cat nervous system, but there is little change between the percentage weight of the medulla at birth and in the adult cat.

The cephalization, or the increase in the relative size of the prosencephalon, in this small series of animals, has been shown above. The development of the suprasegmental parts of the brain, or the relative weights of the prosencephalon and the cerebellum taken together, show even better the changes in these brains. The weight of the diencephalon is included with that of the hemispheres in the weight of the prosencephalon in all of these animals. If it were listed with the brain stem it would change the results but slightly. The increase in the percentages of the suprasegmental parts of these brains is as follows: frog, 50.5; adult chicken, 69.19; turtle, 72.70; rat, 80.71; adult cat, 89.19; dog, 92.14; man, according to Donaldson's data, 97.87, and man according to the data given by Marshall, 97.95 percent. The entire brain stem, or the mesencephalon and the medulla together, shows a corresponding decrease from 49.5 percent in the frog to 1.95 percent in man. In this series, based on suprasegmental percentage weights, the turtle falls into what is probably its proper sequence, or between the chicken and the albino rat, rather than the place it has in table 1, which is based on the relative size of the prosencephalon alone.

In the chicken, the suprasegmental parts increase from 63.10 to 69.19 between hatching and maturity. In the cat, the percentages are 58.84 in the early fetus; 88.76 in the newborn kitten, and 89.18 in the adult cat. These percentages as well as the more detailed data in table 1, show the prosencephalon and the suprasegmental parts of the brain are relatively heavier in the better developed animals.

These percentage changes in the four parts of the brain are shown graphically in figure 1. This shows very clearly the relative increase in the prosencephalon (1 in figure 1) in these various species of animals. The relatively smaller proportion of the prosencephalon in the young of the chicken and of the cat are well shown in this figure. The corresponding decrease in the relative size of the adult mesencephalon (2 in figure 1) is well shown and also the relatively larger mesencephalon in the young of the chicken and the cat. The medulla (4 in figure 1) decreases also in relative weight with increase in complexity of the animal form, but this change is not so regular. With the exception of the turtle, the cerebellum (3) is the least variable in the adult forms.

SPINAL CORD

The last column of table 1 shows the weight of the spinal cord expressed as a percentage of the weight of the brain. There is more variation in these percentages than in any of the other columns. They range from 1.9 percent of the brain weight for the human cord to 120 percent for the cord of the turtle. For the rat, the cat, the dog, and man there is a perfect inverse ratio between the relative size of the prosencephalon and the relative weight of the cord. If the percentage weights of the prosencephalon and the spinal cord are compared in these four species, we find that the prosencephalon is 1.84 times the weight of the cord in the rat; 3.34 times, in the cat; 4.40, in the dog and 45.70 times the weight of the cord in man. Thus there is shown the cephalization of the nervous system, not only in the increase in the relative weight of the prosencephalon, as described above, but in the relatively greater weight of the entire brain compared to that of the spinal cord.

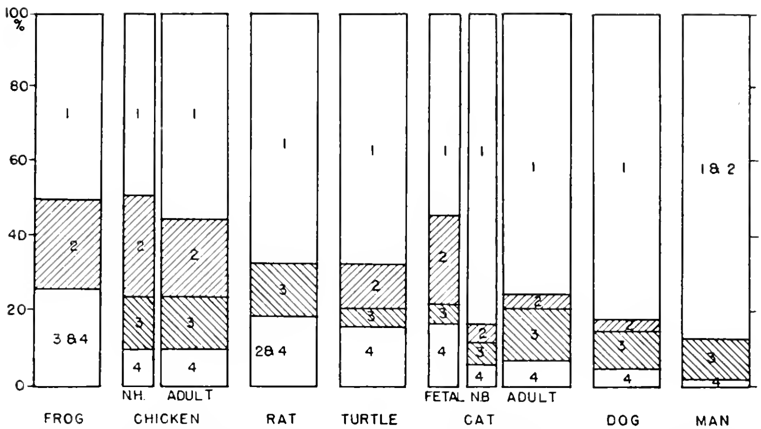

FIG. 1. The weights of the four major divisions of the brain shown as percentages of the total brain weight. 1, represents the percentage weight of the prosencephalon; 2, the mesencephalon; 3, the cerebellum and 4, the medulla. The numerical values of the percentages shown graphically here are given in table 1.

The relatively heavy cord in the turtle may possibly be explained by the powerful musculature necessary for moving the heavy shell, together with the relatively undeveloped brain. The relatively large cord in the chicken is unexpected. As a rule the chicken is thought to be more highly developed than the frog. The prosencephalon of the chicken is but slightly heavier than that of the frog (1.09 times greater) but the cord is nearly twice the relative weight of the cord

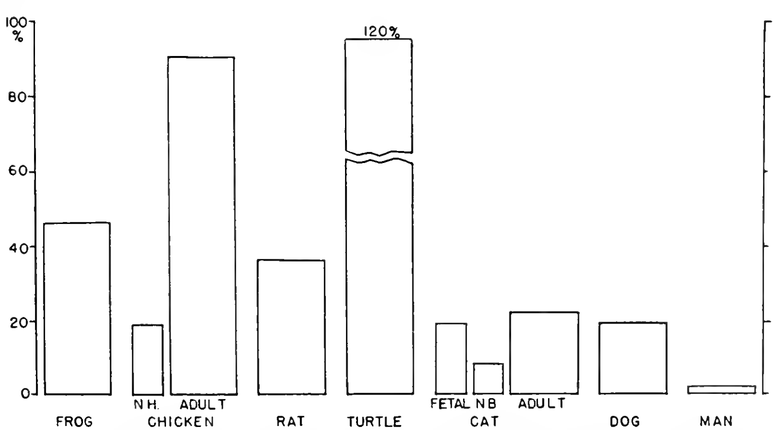

FIG. 2. The weights of the spinal cord expressed as percentages of the brain weight are shown graphically. The numerical values of these percentages are given in table 1.

of the frog (1.93 times). Does this perhaps mean that there are many more, and also more complicated, reflex activities in the chicken which are centered in the cord?

These weights of the cord, shown as percentages of the brain weight, are represented graphically in figure 2. This figure does not present the regular and consistent changes shown in the preceding figure, especially for the percentages of the forebrain. If the percentages of the cord in the adult chicken and the turtle are omitted, then there is a fairly regular decrease in the weight of the cord, compared to the total brain weight.

SUMMARY

The weights of the prosencephalon, the mesencephalon, the cerebellum and the medulla, expressed as percentages of the entire brain weight have been assembled, for the frog, chicken (both newly hatched and adult), albino rat, turtle, cat (fetal, newborn and adult), dog and man.

The relative weights of the prosencephalon increase with the increase in complexity of the animal, the relative weights of the mesencephalon decrease and the relative weights of the medulla decrease in the higher forms but this change is not quite so regular as in the first two parts of the brain. The percentage weights of the cerebellum are the most irregular.

The weights of the spinal cords, expressed as percentages of the total brain weight show a general decrease from the lower animals up to man. This does not apply to the adult chicken and the turtle cord. The turtle cord is 120 percent of the weight of the turtle brain.

The relative weights of the prosencephalon and the percentage weights of the cord illustrate very well the cephalization of the nervous system in this small group of animals.

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University of Kansas Science Bulletin - Vol. XXXI - Part II

November 1, 1947

Lawrence, Kansas

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Vol. XX—October 1, 1932.
Vol. XXI—November 27, 1934.
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Vol. XXIII—August 15, 1936.
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Vol. XXV—July 10, 1939.
Vol. XXVI—November 27, 1940.
Vol. XXVII, Pt. I—Dec. 30, 1941.
Vol. XXVIII, Pt. I—May 15, 1942;
Pt. II—Nov. 12, 1942.
Vol. XXIX, Pt. I—July 15, 1943;
Pt. II—Oct. 15, 1943.
Vol. XXX, Pt. I—June 12, 1944.
Vol. XXX, Pt. II—June 15, 1945.
Vol. XXXI, Pt. I—May 1, 1946.

UNIVERSITY OF KANSAS

SCIENCE BULLETIN

DEVOTED TO

THE PUBLICATION OF THE RESULTS OF
RESEARCH BY MEMBERS OF THE
UNIVERSITY OF KANSAS

VOLUME XXXI, PART II

UNIVERSITY OF KANSAS PUBLICATIONS
LAWRENCE, NOVEMBER 1, 1947

PRINTED BY
FERD VOILAND, JR., STATE PRINTER
TOPEKA, KANSAS
1947
21-6002

15—6002

CONTENTS OF VOL. XXXI, PART II.

THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN

VOL. XXXI, pt. II.] NOVEMBER 1, 1947 [No. 12

The Skeleton of the Lizard *Xenosaurus grandis* (Gray)

By SHIRLEY BARROWS and HOBART M. SMITH

ABSTRACT: The skeleton of the lizard *Xenosaurus grandis* (Gray) is studied in detail. As a result of the study, the validity of the family XENOSAURIDAE is confirmed. Its closest relatives are in the family ANGUIDAE. Otoliths and palpebral bones are reported for lizards.

INTRODUCTION

ALTHOUGH a few scattered notes on the osteology of *Xenosaurus* Peters have appeared (as in Cope, 1900, and Camp, 1923), in the 90 years since the genus was made known (first species described in 1856), the skeleton has received little attention and has never been fully described. In view of the strange appearance of the animal this lack of knowledge probably is to be attributed to the scarcity of specimens. Prior to 1937 very few specimens had been collected. In that year, however, Doctor Edward H. Taylor discovered a locality in Veracruz at which the species is abundant, and numerous specimens were obtained. During parts of 1938 and 1939, the junior author secured about a hundred specimens of the species during tenure of the Walter Rathbone Bacon Travelling Scholarship of the Smithsonian Institution. The present study is based upon a few specimens of that series and certain ones of the Taylor series.

Fossil remains of *Xenosaurus* are unknown, and its origin can be determined only by the indications afforded by the morphology of the living species. Until recently only one species, *Xenosaurus grandis* (Gray) was known (pl. 11, figs. 1, 2); it has been recorded from a small area near Orizaba in central western Veracruz, Mexico (Cuautlapan, Córdoba, Huanusco, Orizaba), and from "Tehuantepec," Oaxaca. In 1941 Stuart described a very closely related species, *X. rackhami,* known from Chiapas and Guatemala, which differs, at least externally, only in minor scale characters. These two are the only species known in the genus.

No known genera are closely allied to *Xenosaurus*. Its species resemble superficially certain members of the family Xantusiidae (as for instance species of *Lepidophyma*), but there is no close relationship between them. As concluded by Gilmore (1928) the true relationship is with the superfamily Anguioidea, to which belong the families Helodermidae, Anguidae and Anniellidae. The extent of the relationship with the Helodermidae has been a subject of some conjecture; and it has been suggested that *Xenosaurus* is more closely related to that family than to any others now known. Whatever may be the extent of this relationship, it has generally been the custom to assign *Xenosaurus* to a family of its own.

The object of this study has been the description of the skeleton of this hitherto poorly known species; to reëstimate its taxonomic (especially family) ranking; and to evaluate its relationship to other groups of the superfamily Anguioidea.

MATERIALS

Five specimens of *Xenosaurus grandis*, from the E. H. Taylor-H. M. Smith collection, obtained at Cuautlapan, Veracruz, furnished the basis for the present study. One entire specimen had already been skeletonized by the use of dermestids; another was stained with toluidine blue (specific for cartilage), and alizarin red (specific for calcium of bone and cartilage). Two skulls were cleaned and disarticulated by boiling in dilute (.1%) sodium hydroxide for ten minutes. One skull, after preliminary removal of the bulk of the muscles, was stained for cartilage only with toluidine blue. The remaining portions of the specimens were reserved for dissections.

One mounted skeleton of *Heloderma suspectum* from Arizona, in the University of Rochester collection, and several skeletons of various species of gerrhonotine lizards, including *Gerrhonotus imbricatus* Wiegmann, *G. coeruleus* Wiegmann, *G. gramineus* Wiegmann, and *G. liocephalus* Wiegmann, have been available for direct comparisons with *Xenosaurus*.

For information supplementary to that revealed by these specimens we have found most useful the articles by Camp (1923), Gilmore (1928) and Shufeldt (1890).

Since we have made no attempt at a complete study of the soft parts of *Xenosaurus*, we have depended on the works of DeBeer (1937), DuBois (1943), Gilmore (1928), Watkinson (1906), and

Young (1942) for naming such features as the nerve and blood vessel foramina, and certain other parts associated with the skeleton.

ACKNOWLEDGMENTS

We are indebted to Doctor Edward H. Taylor for the loan of a skeleton and other specimens of *Xenosaurus,* and for suggestions during the course of the study. The skeletons of *Gerrhonotus* were made available by Doctor Joseph Tihen, to whom we are indebted also for a number of suggestions. For financial assistance in the preparation of drawings we are indebted to the University of Rochester, through the kindness of Doctor Curt Stern and Doctor Sherman C. Bishop. Most of the drawings were made by Jean Adolph; a few are the work of Natt C. Jacobs, medical illustrator of the University of Rochester Medical School. Others to whom we are indebted are Miss Barbara Leonard, Mrs. Jean Palmer, Doctor Arnold Grobman, and Doctor Claude Hibbard. Miss Barbara Leonard and Mrs. Jean Palmer have our gratitude for their generous and careful supervision of most of the staining operations.

CRANIUM

For convenience of treatment the cranium is considered apart from the lower jaw. The former is treated in two sections, the (1) bony cranium and (2) cartilaginous cranium.

BONY CRANIUM

Five unpaired bones (premaxilla, frontal, parietal, otoccipital and sphenoid) are present in the cranium; the otoccipital and sphenoid are fused in old adults, separate in juveniles and young adults. (Pls. XII, XIII.) Eighteen paired bones occur (nasals, maxillae, septomaxillae, prefrontals, lacrimals, palpebrals, jugals, postorbitofrontals, squamosals, tabulares, quadrates, prevomers, palatines, pterygoids, ectopterygoids, epipterygoids, columellae and otoliths), in addition to 2 pterygoid sesamoids, and about 20 sclerotic bones in each orbit making up each sclerotic ring. The total number of bones is 41 excluding the sclerotics and sesamoids, about 83 with them.

Premaxilla: The premaxilla is a single median bone articulating with the prevomer, septomaxilla, maxilla, nasal, and frontal. In anterodorsal view it is an elongate triangular bone having its base at the tip of the skull, and its sides sharply indented at two points equidistant from each other and from the end of the bone; in lateral view the anterior tip is blunt while the posterior two-thirds forms an obtuse curve. The exterior is covered by coössified osteoderms except a thin smooth border above the teeth. A sharp posterior tip overlaps a similar tip on the frontal. The maxilla articulates with the premaxilla along its lateral border as far back as the posterior indentation. From this point to the posterior extremity the bone is bordered by the nasals.

On the ventral side, at the point of the first indentation a shelf (palatal process) protrudes posteriorly, forming the extreme anterior floor of the skull. In the center on the ventral side of the shelf is a blunt, knobbed, sometimes bilobed, incisive process projecting ventrally. A sharp median ridge extends from the posterior point of the bone forward to the palatal process. Nine pleurodont teeth are present; the bases of the teeth are pierced by small foramina. Seven labial foramina are visible externally at about the level of the bases of the teeth; these foramina terminate the superior premaxillary canals which radiate from a pair of larger foramina on the internal face of the bone dorsal to the palatal processes; four labial foramina are connected with the right internal foramen, and three with the left. Immediately below the posterior foramina of the superior premaxillary canal are the openings of the small inferior maxillary canals, which terminate ventrally on either side of the incisive process.

In the articulated skull the premaxilla is narrowly separated from the frontal (by contact of the nasals) in dorsal aspect, while in ventral aspect it is narrowly in contact with the frontal.

Nasals: The nasals are paired, dorsal roofing bones articulating with the premaxilla, maxilla, frontal, septomaxilla, prefrontal and with each other. They form a small portion of the border of the external nares posteromedially. The dorsal surface is covered with osteoderms except for a median anterior projection extending under the premaxilla and not visible in dorsal view of the articulated skull.

Viewed separately in dorsal or ventral aspect the nasal appears roughly rectangular with a pointed projection at its posterior end overlapping the frontal, and another at the anterior end underlying the premaxilla. In the skull the medial side of the bone is placed at a 30° angle with the adjacent edge of the opposite nasal. The bones articulate with each other along their median borders at a point ⅔ the distance from their anterior ends; anteriorly they are separated from each other by a posterior projection of the premaxilla and posteriorly by a smaller anterior projection of the frontal. The nasal articulates with the maxilla and the extension of the prefrontal underlying the maxilla along the anterior two-thirds of its lateral border, and with the frontal posteriorly.

In ventral view, the pointed projection under the premaxilla is seen to extend ventrad from the general level of the remainder of the bone, and barely to reach the level of the dorsal surface of the anterior end of the septomaxilla; the median edge of this process is straight and involves ½ of the median length of the bone. Posterior to this straight edge, the rough protuberance for articulation with the other nasal is seen. The actual articulation is not visible ventrally in the articulated skull, as it is covered by a junction of the frontal and the premaxilla. Posterior to this protuberance the bone is concealed by the frontal, in ventral view.

The exposed ventral surface of the nasal forms the dorsal roof of the nasal capsule. It is accordingly smooth and has a median longitudinal shallow concavity, the median and lateral edges of which are slightly elevated.

Frontal: An unpaired median element articulating with the postorbitofrontal, parietal, nasal, premaxilla and prefrontal.

It is a roughly triangular bone with a narrow, elongate forward apex separating the orbits from each other. Its dorsal surface, where exposed, is covered by coössified osteoderms. The posterior base of the triangle, nearly straight, forms a suture along its entire length with the parietal. The lateral wings slightly overlap the postorbitofrontal and fit into a notch in the latter bone. About ⅔ of its total lateral margin borders the orbit in front of the postorbitofrontal. A suture with the prefrontal occupies most of the lateral border anterior to the middle of the frontal (measured along the median line). The pointed posterior ends of the nasals overlie the entire anterior margin of the frontal save for a very narrow median tip which underlies the premaxilla. The frontal is slightly overlapped by all bones which contact it anteriorly.

On the ventral surface (pl. 14, fig. 4) a rounded ridge borders the posterolateral margins. Anterior to a point just back of the portion bordering the prefrontal, the ridges become sharper and more elevated and enclose a conspicuous, narrow, longitudinal median groove expanding somewhat anteriorly. The ridges become narrow (laterally compressed) anteriorly and are continuous with the prefrontal to form the anterior (internal) border of the orbit.

Parietal: A single bone articulating with the frontal, postorbitofrontal, tabulare, squamosal, and otoccipital. It is extensive, quadrangular with concave sides, and forms the median posterodorsal roof of the cranium. Most of its dorsal surface is roughened by numerous coössified osteoderms, but these markedly decrease in prominence toward the lateral edges of the bone and disappear entirely in two semicircular regions on the posterior border. Near the anterior end of the bone at the midline is the parietal ("pineal" *auct.*) foramen. The lateral concave edges bound the supratemporal fossa along its entire median border. The anterolateral projection very slightly overlies the postorbitofrontal, sharing subequally with the posterolateral corner of the frontal a notch in the medial edge of the postorbitofrontal. The posterolateral projection curves slightly ventrad as it articulates with the minute tabulare along its posterolateral border, with the squamosal immediately posterior to the supratemporal fossa, and with the occipital at its extreme posterior tip. The posterior edge is concave and free, while the anterior edge forms a nearly straight suture with the frontal.

The ventral surface of the parietal (Pl. XIV, fig. 5) possesses four obtuse ridges. Two of them, the anterior ridges, converge posteriorly from the anterolateral projections, merge on the median line about $\frac{3}{5}$ the distance from the anterior margin, and continue as a median ridge to the posterior border. The posterior ridges are lower, converge anteriorly from the posterolateral projections and meet the anterior ridges a short distance in front of the latter's union, or in other words at a point equidistant from the anterior and posterior borders. The epipterygoids and anterolateral dorsal processes of the otoccipital nearly contact the parietal at the point of union of the anterior and posterior ridges. A middorsal anterior projection of the otoccipital likewise nearly contacts the parietal at the point of union of the anterior ridges.

Maxilla: This is a paired bone articulating with the jugal, premaxilla, prefrontal, nasal, lacrimal, ectopterygoid, palatine, prevomer, and septomaxilla. The maxilla forms the major part of the upper jaw and is its chief dentigerous bone. It is elongate, tapers slightly at its posterior end and has a large triangular dorsal (nasal) process arising from the anterior half. Its external face is covered with coossified osteoderms everywhere above the level of the labial foramina. Its posterior extension is separated from the lateral border of the orbit by the anterior overlying process of the jugal, and by the lacrimal. Ventrally, however, the medial palatal process projects under the jugal and forms the ventral anterolateral portion of the orbital wall. The palatal process at its posterior limit touches the ectopterygoid. Farther forward, at the midpoint of the base line of the bone, the process widens and joins the lateral wing of the palatine. At this point, on the dorsal surface of the process, appears the inferior alveolar canal opening opposite the infraorbital foramen in the palatine; the canal divides inside the maxilla and opens externally by numerous (11) labial * foramina situated about even with the bases of the teeth. The anterior opening of the canal appears just posterior to the septomaxilla. Anteriorly the process forms a socket into which the premaxillary fits, the palatal process of the maxilla overlapping that of the premaxilla. On the median side of the anterior end of this process, the maxilla articulates with the anterior end of the prevomer. Immediately posteriorly it articulates with the septomaxilla. At its anterior external dorsal end, anterior to the nasal process, the maxilla shares the borders of the external naris with the premaxilla and the nasal. A socket-like indentation of the maxilla in the lower part of the nasal pit receives the septomaxilla. The nasal process extends between the external naris and a posterior suture with the lacrimal. The crest of this dorsal process is parallel with the base line and articulates with the lateral edge of the nasal. The bone bears 17 pleurodont teeth each of which opens basally by a very small foramen.

Septomaxilla: The septomaxilla (Pl. XIV, fig. 1) is a paired bone articulating with the prevomer, nasal, maxilla, and premaxilla. It forms the anteroventral limit of the nasal capsule. From the dorsal side it appears as a concave bone fitted on top of the suture between the maxilla and prevomer. On its median anterior border it is raised as a ridge which articulates anteriorly with the ventral side of the premaxillary and the tip of the nasal under the premaxilla, and posteriorly with the septomaxilla of the other side of the skull. Beneath this ridge is a canal which pierces the bone completely, and which in some parts is closed ventrally by the prevomer. This canal is continuous with that which penetrates the premaxilla and opens externally by the labial foramina. Posterior to the ridge, the bone has two small posterior projections lying along the median line which also articulate with the septomaxilla of the opposite side. The posterior border of the dorsal side is concave. Where it joins the medial surface of the maxilla

* DuBois (1943, p. 416) terms these foramina, "which allow small twigs of the superior alveolar branch of the fifth nerve to pass out of the bone laterally and to supply innervation to the glandular tissues in the membranes of the upper lip," the "maxillary foramina." Since however like structures occur on the premaxilla and dentary, and all serve the labial glands, they are better known as "labial" foramina.

laterally, the septomaxilla projects above the maxilla so that it is seen from the exterior above the depression of the latter bone at the nasal pit. At $\frac{1}{3}$ of the distance from its posterior end as viewed from the exterior, this part of the septomaxilla above the maxilla has a little knob projecting outward and extends forward until it meets the median ridge near its anterior end. The two ridges join in a point and continue anteriorly as a vertical ridge extending ventrad to the point at which the palatal process of the maxilla overlaps that of the premaxilla.

On the ventral side, the vertical ridge seen from the dorsal side splits into two ridges forming a v-shaped configuration with the vertical ridge at its apex. The median of these two ridges borders the median edge of the bone. Next to this ridge the bone is roughened into lobules and grooves. The lateral ridge extends in a straight line at an angle of 75° from the median ridge. It borders the lateral edge of the bone for $\frac{1}{2}$ its length anteriorly while lateral to its posterior $\frac{1}{2}$ the bone flares out to form the part which can be seen from the exterior at the nasal pit. Between the two ridges the bone is slightly depressed. Along the vertical edge of the median ridge the septomaxilla articulates with the prevomer in the anterior depression on the dorsal side of that bone.

Prefrontals: Paired elements articulating with the palatine, frontal, lacrimal, jugal, maxilla, palpebral and nasal. It is a roughly triangular bone forming most of the anterior limit of the inside of the orbit. The anterior apex and median border of the triangle overlap the frontal, form the anterior half of the median dorsal border of the orbit, and bear coössified osteoderms. From its most anterior dorsal border a broad triangular process projects forward from the orbit, overlapping the pointed posterior end of the nasal and bordering a dorsal extension of the maxilla. The tip of the posterodorsal process forms the second apex of the triangle. From this point the bone has a ventral concave base which extends to the third, lateroventral apex. At the midpoint of this base is a small projection directed posteromedially. Along $\frac{1}{2}$ of the lateral part of this base, the bone articulates broadly with the dorsal extension of the palatine. The tip of the third apex barely touches the anterior tip of the jugal. The side between the third and first apices forms a broad articulation with the lacrimal; the midline of this base is indented to form a part of the wall of the lacrimal foramen. On the medial aspect of the bone beneath the first apex is a large concavity extending from the first apex to the ventral border. This indentation is bounded posteriorly by a slight ridge extending from the first apex to the projection at the midpoint of the ventral border.

From the smooth dorsal anterior edge of the prefrontal, the triangular palpebral projects backward over the orbit.

Lacrimals: Small paired bones articulating with the prefrontal, maxilla and jugal (Pl. XIV, fig. 1). Each is rectangular and forms the lateral part of the anterior limit of the interior of the orbit. Its external surface is rough and bears a ridge, bordering the orbit, continuous with a like ridge on the jugal. Its medial surface is smooth. At its anteroventral border it articulates broadly with the maxilla. Its posterior end narrows somewhat where it overlaps the anterior projection of the jugal. Its median border, in the orbit, is irregular; the prefrontal meets it at a broad suture, in the middle of which near the dorsal limit of the median border of the lacrimal bone is the lacrimal foramen. The anterior end is overlapped by the dorsal process of the maxilla.

Palpebral: This is a paired, triangular bone articulating with the prefrontal and extending over the anterior end of the orbit. The short median base of the triangle articulates with the prefrontal along its whole length. The lateral base is free and is the longest of the three sides. The posterior base is also free and is slightly concave. The dorsal surface is smooth except for a slight depression along its lateral base. The ventral surface is concave.

Sclerotics: A series of about 20 thin, overlapping bony plates forming a ring-like structure in each orbit, attached to the skull by membranes.

The sclerotic ring is in a nearly vertical position and is convex laterally; the circular hole in its center is about half the total diameter of the ring.

Jugal: Paired elements forming sutures with the maxilla, ectopterygoid, squamosal, postorbitofrontal, lacrimal, prefrontal and palatine bones. It is a roughly chevron-shaped bone with the anterior limb much more slender than the posterior, and with an asymmetrical, obtuse ventral process at the apex. Osteoderms are coössified with it on its external surface.

The external orbital border is marked by a protruding ridge. The bone articulates with the maxilla beneath the middle of the orbit, where the slender, pointed anterior projection from the jugal extends onto the medial side of the maxilla inside the orbit. The extreme anterior tip of the same projection narrowly contacts the lacrimal, the prefrontal and the palatine bones. The ectopterygoid protrudes narrowly to the external surface where it interrupts the extreme posteroventral portion of the maxilla-jugal suture at the labial border. Posterior to the ectopterygoid a short, blunt, labial process of the jugal extends posteroventrally to form the posterior portion of the labial border, in line with that of the maxilla. When the jaws are closed, this labial process lies immediately external to the coronoid process of the lower mandible. The posterodorsal portion of the jugal expands somewhat dorsally, where it meets the postorbitofrontal and, narrowly, the squamosal. Its posterior edge is slightly serrate.

Two foramina pierce the inner face of the jugal at its angle, near or in the labial process.

Postorbitofrontal: This name is suggested for the fused postorbital and postfrontal, a composite bone of occasional occurrence among Lacertilia. It is paired, has sutures with the parietal, frontal, jugal and squamosal, and forms the anterolateral border of the supratemporal fossa and the posterior border of the orbit. Its dorsal surface is somewhat rugose but no clearly defined osteoderms are fused with it. The jugal contacts the anterior half of the nearly straight lateral margin, the squamosal the posterior half. The anterior tip of the lateral margin is expanded into small dorsal and ventral knobs. The posterior edge, bordering the supratemporal fossa, forms an acute angle with the lateral edge, and is slightly concave. The anterior border, facing the orbit, forms an obtuse angle with the lateral edge, and projects medially, around the border of the orbit, farther than any other part of the bone. A rather deep, right-angled notch, the posterior arm shorter than anterior arm, is present on the medial edge; the notch receives a portion of the frontal and parietal, whose common suture bisects the angle of the notch.

Squamosal: Paired elements articulating on each side with the parietal, jugal, postorbitofrontal, tabulare and quadrate. Each is a smooth, arched bone forming the posterolateral border of the supratemporal fossa and of the skull. The superior surface, unlike that of other dorsal roofing bones, bears no coössified osteoderms. Its posterior extremity is a narrow process arching ventrally to make a narrow contact with the quadrate and articulating laterally with the tabulare (posteriorly) and the parietal. The bone is broadest near its middle, at the posterior border of the supratemporal fossa, where it joins the parietal. It gradually tapers anteriorly from this point, forming along its anteromedial border a long suture with the fused postorbital and postfrontal, and terminating anteriorly at a narrow suture formed with the jugal. The bone is somewhat thickened at its outer border, but becomes rather thin toward its parietal edge.

Tabulare: A paired bone, articulating with the otoccipital, squamosal, parietal and quadrate. It is a very small, smooth, arched, sliverlike element very narrowly in contact by its posterior end with the quadrate between the squamosal and otoccipital. Over half its dorsal surface (Pl. XIV, fig. 2) underlies the posterolateral edge of the parietal. Its dorsal exposed surface is very narrow and elongate, wedged chiefly between the squamosal along its external border, and the otoccipital and parietal which share equally its medial border.

Quadrate: Paired bone articulating with the tabulare, squamosal, pterygoid, otoccipital. It is a pinna-shaped bone at the posterolateral limit of the skull. On its anterior side it is smooth and flat except for slight concavities near the center. Its outer border describes a convex curve while its inner border is concave. The bone is broader at its dorsal than at its ventral end. Its ventral edge is flattened and slightly grooved where it articulates with the lower jaw. Its dorsal surface is broad, flat and L-shaped, the base of the L being median and directed posteriorly. The roof of the skull covers the base of this L, but does not touch it. Posteriorly the L dips ventrad and broadens laterally. At its posterior extremity it forms a triangular knob with which it articulates with the rest of the skull. The squamosal joins one side of the knob, adjacent to the tabulare, which lies mesad. On the median side of the triangular area, part of the otoccipital joins the quadrate. A thickened ridge curves ventrolaterally along the posterior face of the quadrate, originating at the dorsal articular surface and disappearing near the mandibular fossa. The depression on the anterior face of the wing is shallow. The anterior edge of the bone, in lateral profile, is placed at a 75° angle.

Prevomer: The prevomer is a paired bone articulating with the maxilla, premaxilla, septomaxilla and palatine. It is an elongate bone forming the ventral limit of the nasal capsule. Accordingly it is concave on its dorsolateral side. Viewed from this direction it appears oblong in shape, with a deeply grooved projection at its posterior end where it articulates with the palatine; anteriorly the curve of the lateral edge of the oblong indents and continues forward in a straight line from the indentation to the anterior tip of the bone. At the indentation begins a transverse ridge extending from the lateral edge to the midline of the dorsal surface. At this point it turns sharply caudad and continues as a lesser ridge of the same length at right angles to the transverse ridge. At the lateral edge of the tip of this posterior ridge is a foramen. Anterior to the transverse ridge a concavity in the bone marks the point at which the convex surface of the septomaxilla articulates. Obliquely situated, with its most anterior limit median, is a rough ridge which provides articulation with the anterior limit of the palatal process of the maxilla.

In ventral aspect the prevomer is seen to articulate at its anterior median border with the prevomer of the other side of the skull. The two prevomers are easily separable except at their anterior ends. The suture between them appears as a crevice lined by the dorsally curving median borders of the two bones. Posteriorly they diverge slightly laterally. From the median suture to the articulation with the palatine the bone presents a posteriorly enlarging rounded ridge which elevates itself ventrally to articulate with the palatine. Lateral to this ridge the bone is broad and flat. The lateral border curves gently from beneath the ridge in an arc which terminates anteriorly where the septomaxilla can be seen articulating underneath the prevomer along the anterior ¼ of the length of the latter.

At ⅓ of the distance from the place where the prevomer diverges from its mate to its anterior limit a ridge arises in the midline of the bone. It is a sharp ridge, concave laterally and convex medially, rising suddenly from the flat surface of the bone, curving slightly mediad, and terminating anteriorly where the prevomer touches the maxilla at the suture of its palatal process with the premaxilla. Median to this ridge, the bone is depressed, the depression being increased by a foramen under the posterior ⅓ of the ridge. Lateral to the anterior half of the ridge, the bone is elevated to the height of the palatal process of the maxilla with which it articulates. Anterior to this articulation the prevomer is depressed in a region continuous with the depression median to the anterior ridge. This depression articulates with the part of the palatal process of the maxilla which projects underneath the palatal process of the premaxilla. A small median anterior projection of this area articulates with the palatal process of the premaxilla near its midpoint.

Palatine: The palatine is a paired ventral bone articulating with the maxilla, prevomer, prefrontal, pterygoid, and jugal. Viewed from the ventral side it appears as a Y-shaped bone, while from the dorsal surface it appears as a broad, smooth bone tapering somewhat toward its posterior end. The lateral arm of the Y has a broad suture with the palatine process of the maxilla. At the posterior limit of the suture a small flat process projects under the shelf of the maxilla and through the two bones at this point passes the superior alveolar nerve; its opening through the palatine bone is the infraorbital foramen, while in the maxilla it enters the superior alveolar canal. The median arm of the Y is slender and laterally compressed; it tapers to a fine point under the prevomer. The two arms are joined dorsally by a concave lamina of bone which articulates with the prefrontal. The body of the bone is a dorsoventrally flattened column that extends posteriorly and slightly laterad to form a V-shaped suture with the pterygoid.

Pterygoid Sesamoids: A very small sesamoid bone is present in the tendon at its point of attachment to the ventrally directed process at the union of the pterygoid and ectopterygoid.

These are not homologous with Taylor's (1940) "palatal" sesamoids, which are located at the suture between the pterygoid bones and the pterygoid processes of the basisphenoid.

Pterygoid: This is a paired bone articulating with the palatine, ectopterygoid, epipterygoid, quadrate, and sphenoid. It is a long Y-shaped ventral bone linking the other bones on the ventral side to form a complete structure. The two pterygoids are widely separated from each other medially as are the palatines, which they join anteriorly. They diverge posteriorly only slightly through the anterior ⅖ of their length, but at the junction with the sphenoid they form a rather abrupt angle and diverge strongly toward the quadrate. The articulation with the palatine is formed by a median projection of the pterygoid and a lateral projection of the palatine so that the suture is oblique. Posteriorly from this articulation, the pterygoid broadens out into a flat triangular lamina in the crotch of the two arms of the Y, its base median and its apex joining the ectopterygoid. The posterior side of this lamina is elevated into a ridge, which at the juncture with the ectopterygoid forms a small knob. Lateral and dorsal to this knob, behind the ectopterygoid, is a triangular, pointed process on the pterygoid. The ectopterygoid lies on top of this smaller triangle, and sends a slender process posteriorly to lie on the dorsal face of the crotch formed of the two anterior arms of the pterygoid.

Posterior to this crotch, the pterygoid diverges laterally in a slender process. The ventral, lateral, and dorsal sides of this posterolateral extension are flattened or concave, so that the process would appear triangular in cross-section. A ventrolateral wing from the occipital region, the sphenoid, articulates with the pterygoid at the anterior end of the posterior process. The epipterygoid fits in a socket on the dorsal side of the pterygoid immediately adjacent (laterally) to the articular surface of the sphenoid. Tapering slightly posteriorly, the posterior process is applied to the median surface of the quadrate just above the articular surface for the lower jaw.

Ectopterygoid: This is a paired lateroventral bone articulating with the jugal, maxilla, and pterygoid. At its most exterior point it receives the end of the palatal process of the maxilla in a small socket. A small portion of the lip on the median side of this socket is continuous with the palatal process of the maxilla. The lateral part of the socket extends as a knob to the exterior between the jugal and the maxilla at the ventral extremity of this suture. From this socket the bone extends posteromedially, sending one slender process to overlie the dorsal surface of the crotch in the pterygoid, and another process, more blunt and stout, to underlie the ventral surface of the lateral arm of the pterygoid.

Epipterygoid: This paired bone articulates with the pterygoid and otoccipital. It is a simple straight bone appearing as a strut between the pterygoid and the roof of the skull, the latter of which, however, it does not quite reach. It extends from a socket on the dorsal side of the pterygoid, external to its suture with the otoccipital, to the dorsal edge of the lateral surface of the anterodorsal portion of the otoccipital. Where the epipterygoid joins the pterygoid it is expanded slightly to a knob. Where it joins the otoccipital it curves very slightly laterad.

Otoccipital: The otoccipital is a single compound bone forming the ventral median posterior region of the skull and articulating with the squamosal, tabulare, quadrate, parietal, epipterygoid, and sphenoid.

Viewed from the posterior aspect, the large foramen magnum occupies the center of the bone. Its ventral limit is formed by the kidney-shaped occipital condyle. The center of the condyle is the basioccipital and the lateral protuberances are the exoccipitals. Ventrolateral to the condyle and slightly anterior, the basioccipital sends ventrolaterally 2 small processes, the basioccipital tubera. The exoccipital sends posterolaterally the broad paroccipital processes which articulate with the squamosal, tabulare, and quadrate on the anterior and ventral sides of their expanded ends. The dorsal part of the foramen magnum is formed by the supraoccipital.

From the dorsal aspect (Pl. XIV, fig. 6), the supraoccipital is seen to present a low crest on the median line. The anterior end of this crest almost but not quite articulates with a small ridge on the posterior part of the midline of the parietal. Lateral to this spine are the two slight bulges of the auditory capsules fused with the occipital. Anterior to these bulges the otoccipital projects dorso-anteriorly in a vertical lamina which nearly reaches the 2 lateral anterior ridges on the ventral side of the parietal. On the sides of the anterior ends of these sheets the otoccipital articulates with the epipterygoids.

An anterior view (Pl. XIV, fig. 3) shows the large auditory capsules bulging into the dorsal portion of the cranial cavity. On the dorsal anterior edge of the otoccipital, three small concavities facing forward mark the points of attachment of parts of the cartilaginous chondrocranium; one point is on the median line, the others halfway between the median line and the anterodorsal extremity of the bone.

Sutures can be distinguished on the otoccipital which divide it into several regions. However, these sutures are not complete enough to justify considering the individual components as distinct elements.

The supraoccipital is distinguished by no sutures whatever, but is known by its general position, forming the dorsal border of the foramen magnum and the median dorsal roof of the otoccipital.

The opisthotic and the exoccipital are indistinguishably fused. The exoccipital forms the lateral borders of the foramen magnum and the paroccipital processes, while the opisthotic forms the region ventroanterior to these processes. The junction of this fused element with the supraoccipital on the lateroanterior part of the roof of the otoccipital cannot be seen, nor is its dorsal suture with the pro-otic evident, supposedly somewhere along the paroccipital process. The lateral articulation with the pro-otic can be seen, however. It is a short curved suture extending ventroanteriorly from the ventro-anterior border of the fenestra ovale to a point anterior to the fenestra ovale and apertura lateralis and on a line midway between these two. The more dorsal articulation of the opisthotic with the basioccipital is seen in this region also. It extends in a curve from the ventral limit of the suture between the pro-otic and this element to the posterior dorsal border of the apertura lateralis. The posterior articulation between the opisthotic and the basioccipital is probably from the posterior border of the apertura lateralis to near the edge of the foramen magnum above the occipital condyle.

The basioccipital is the region of the otoccipital forming the ventral border of the foramen magnum, constituting the ventral floor of the compound bone and bearing the basioccipital tubera. Its posterior lateral border in the region of the fenestra ovale, of which it forms the ventral border, is bounded by the opisthotic. Anterior to the suture with the opisthotic in front of the fenestra ovale the line of the bone drops ventrad. For a short distance it articulates with the pro-otic. Anterior to this, it has a clear articulation with the posteriorly directed processes and the straight posterior border of the sphenoid.

The pro-otic is a large element forming the lateral part, the lateroventral part, and the laterodorsal part of the otoccipital. Its ventral border touches largely the sphenoid and has a small articulation with the basioccipital. The ventral posterior border underneath the apertura lateralis articulates with the opisthotic. However, the dorsolateral and posterodorsal fusions with the exoccipital and supraoccipital are quite indistinguishable. Probably the pro-otic extends posterolaterally on the dorsal side of the paroccipital process for about one-half of its length.

A tiny bone at the dorsal edge of the tip of the paroccipital process, in contact with the tabulare and parietal, is almost unquestionably the same as the bone figured by Camp (1923: 481, fig. 109) in *Xestops* and labelled "paroccipital." This name was retained by Gilmore (1928: 141), who regarded Camp's specimen as representative of a genus and species (*Melanosaurus maximus* Gilmore) different from the ones to which Camp referred it. Regardless of actual identity, the name paroccipital seems scarcely admissible since it is now generally accepted as a synonym of the opisthotic, a bone which is fused with others and forms a large part of the otoccipital bone in *Xenosaurus* as well as in other lizard genera.

While the element in *Xenosaurus* and *Melanosaurus* is situated at the dorsal edge of the tip of the paroccipital process, it seems very similar to the element at the ventral edge of the same process found by Beddard (1905: 6, 7, fig. 3) in *Uromastix* and by Versluys (see Camp, 1923: 348) in some 13 other lizard genera of various families. According to Camp, Versluys "shows it to be essentially a cartilaginous epiphysis on the tip of the paroccipital process formed partly *in situ* and largely from the columellar and epihyal cartilages which extend dorsally to form paroccipital connections that persist in certain forms. . . ." We accordingly tentatively identify the element in *Xenosaurus* and *Melanosaurus* as separately ossified epiphyses of the paroccipital processes.

The otoccipital has many foramina which aid in orienting the positions of the fused elements.

The apertura lateralis is dorsal to the basioccipital tubera and is bordered by the basioccipital and the opisthotic. It is narrowly elliptical in shape with its long axis directed ventroanteriorly. From the anterior, the apertura medialis can be seen on the interior as an elliptical foramen near the floor of the foramen magnum continuous with the apertura lateralis.

The foramen ovale is dorsal and slightly anterior to the apertura lateralis. It is a broader ellipse with its long axis directed anteriorly and posteriorly. It is bordered by the opisthotic and the pro-otic.

Through the fenestra ovale can be seen the foramen perilymphaticum, a round hole near the lateral border of the fenestra ovale, joining the auditory capsule with the apertura lateralis and medialis.

The pro-otic incisure, enclosing the ganglion of the trigeminal nerve, is on the ventral part of the anterior border of the pro-otic.

The facial foramen lies on the anterior part of the pro-otic, about 2/5 of the distance from the pro-otic incisure to the fenestra ovale, and ventral to the level of the crista parotica; it is partially concealed by an overhanging ridge (for the hyomandibular nerve) continuous with the carotid fossa posteriorly, and with the ridge overhanging the palatine nerve anteriorly.

The anterior acoustic foramen can be seen by looking through the foramen magnum from the anterior end. It is a small foramen, hidden by a bulge in the bone, dorsal to the facial foramen.

Posterior to the anterior acoustic foramen is the large oblong posterior acoustic foramen, easily seen from anterior aspect.

Externally from the posterior aspect four small foramina are seen lateral to the occipital condyle. The largest, dorsal one is the jugular foramen. The three smaller ventral ones, the two lateral of which are joined by a groove, are the hypoglossal foramina; they are visible on the interior of the brain case, where they form a nearly straight horizontal row under the posterior edge of the otic capsule.

Through the anterior end of the foramen magnum can be seen the foramen endolymphaticum near the dorsal limit on the median side of the bulge of the auditory capsule.

The Vidian canal, abducens foramen and carotid foramen are described below.

Sphenoid: The fused parasphenoid and basisphenoid bone is called the sphenoid. It is a V-shaped bone in the median region of the ventral side of the skull forming the connection between the otoccipital and pterygoids. It is closely fused with the occipital and will not disarticulate from it, but the sutures between the two bones are clearly traceable in their entirety in the smallest of 3 skulls of adult specimens. Two lateral projections from the posterior edge of the sphenoid lie on the ventral surface of the otoccipital. Anterolaterally the bone bears two stout, elongate projections which articulate with the pterygoids by a broad expansion at their tips. These projections represent the indistinguishably fused parasphenoid, the rest of the bone being basisphenoid.

From the anterior view a deep depression, the sella turcica, is seen in the sphenoid dorsal to the pterygoid processes. This depression is bounded by a thin lamina dorsally and laterally, and ventrally by a thicker lamina which bears two knobs on its free anterior edge. Between these two knobs the sphenoid articulates with the cartilaginous trabecula cranii. The bone terminates posteriorly in a nearly straight transverse suture visible from either dorsal or ventral aspect.

A small abducens canal pierces the lateral surface of the sella turcica and emerges on the dorsal surface of the bone, near the lateral edge, at about the middle of the base. The larger Vidian canal for the palatine nerve opens posterolaterally at the base of the pterygoid processes, where it is shared with the internal carotid artery, and anteriorly terminates by two foramina, one immediately posterior to the knob in the ventral border of the anterior fossa (for the palatine nerve) and the other at the dorsomedial edge of the base of the pterygoid process.

Columella: The columella consists of the bony stapes and the extracolumella. The former is a small, straight, slender, paired element expanded slightly at each end, extending from the extracolumella near the tympanic membrane to the membrane stretched across the fenestra ovale.

Otoliths: Two white oval otoliths, one in each auditory capsule, can be seen through the fenestra ovale. They are present in all three skulls examined.

CARTILAGINOUS CRANIUM

A single skull stained for cartilage only, with toluidine blue, reveals most but not all the features of the cartilaginous cranium in the adult. The nature of the cartilaginous portion of the nasal capsule is not evident. Otherwise the parts are fairly clear. The chief remnants in the adult are in the orbital and temporal regions; most evident among these are the interorbital septum, planum, supraseptale, taenia marginalis, taenia medialis, pila accesoria, pila antotica, pila metoptica, subiculum infundibuli, trabecula communis, trabecula cranii, processus anterior tecti, and a very small part of the processus ascendens (Pl. XV, fig. 1). These remain in varying degrees of degeneration; the planum supraseptale and subiculum infundibuli are poorly developed, and the pila antotica and pila metoptica are very short and incomplete. Other portions are dimly evident. The stain is not perfect, however, so that some very thin cartilaginous areas are not stained differently than the membranes that occlude the fenestrae; thus the full extent of the cartilage may not have been realized.

Aside from that present in the orbitotemporal and nasal regions, the only cartilage remnants are Meckel's cartilage and the extracolumella. These parts are described in detail in the following.

The Orbitotemporal Cartilage. At the dorsoanterior margin of the otoccipital bone are three points of attachment of the cartilaginous chondrocranium. One point is in the middle, and the other two on either side (Pl. XIV, fig. 6). From the median point of attachment a small cartilaginous bar extends dorsoanterior a short distance, terminating at a point of attachment on the ventral surface of the parietal bone immediately in front of the union of the two anterior ridges (Pl. XIV, fig. 6). This cartilage is the processus anterior of the synotic tectum.

From the lateral points of attachment arise the taenia marginalia, slender cartilaginous rods which pass anterodorsally along the dorsal border of the otoccipital; reaching the anterior tip of the bone, opposite the point of union of the anterior and posterior ridges of the parietal, they leave the otoccipital and pass forward in contact with the anterior ridges of the parietal. As they reach the frontal they converge toward each other strongly, following now the posterior ridges of the frontal. The taenia disappear in the interorbital septum shortly before they reach the point at which the posterior ridges of the frontal turn forward to course parallel to each other. A horizontal ventral membrane completely floors the cavity in the frontal formed between the parallel ridges.

The trabecula communis is a rod-like cartilage attached at two points on the sphenoid (Pl. XIV, fig. 6). It bifurcates posteriorly, enclosing a small hypophyseal fenestra which is closed by a membrane.

The two roots (trabeculae cranii) of the trabecula communis fuse a very short distance in front of the sphenoid, and from that point anteriorly but a single structure is evident.

Extending between the taenia marginalia and the trabecula communis is a membrane forming the anterior wall of the brain cavity. The membranes on the two sides unite anteriorly along a line extending diagonally posteriorly from the anterior end of the taenia to the trabeculae cranii. Anterior to this point the median, vertical, interorbital septum passes forward to the nasal cavity. Its lower edge curves dorsad as it passes anteriorly, thus approaching the frontal at the nasal capsule. The anterior ventral edge of the interorbital septum is at a point about half the distance from the frontal to the medial ventral edges of the palatines. Grossly the interorbital septum appears to occlude about the dorsal half of the space between the orbits. Except for elements described in the following, the anterior cranial wall appears to be membraneous; the interorbital septum appears to be a very thin cartilaginous partition.

The thickened (and stained) trabecula communis does not follow the lower border of the interorbital septum (which is not stained in the specimen at hand) throughout its length, but leaves it at about the middle of its length, and passes anteriorly through the septum toward the middle of the frontal. The trabecular mass becomes more diffuse as it passes through the septum, disappearing before it reaches the frontal.

The optic foramen pierces the anterior walls of the cranial cavity near their union with the interorbital septum, and just above the trabecula communis. It is surrounded by a membrane which occludes the remainder of the large optic fenestra. In front of the fenestra a faintly-stained cartilaginous mass extends dorsally from the trabecula communis to the point of union of the anterior cranial walls. At this point of union appears a narrow median band of even more faintly stained cartilage, the planum supraseptale. The latter cartilage is a single median mass, but expands somewhat anterodorsally to enclose the anterior portion of the cerebral hemispheres.

The planum supraseptale bifurcates above the fenestra ovale to form two faint cartilaginous strands, the taenia medialia, which pass a short distance posteriorly along the middle of either cranial wall, and soon arrive at a small quadrangular mass of cartilage from which project three cartilaginous bars. The most distinct is the dorsally-directed pila accessoria, which reaches and joins the taenia marginalis. Directed posteriorly is a short arm which terminates blindly before extending more than a fourth of the distance to the otoccipital; this is the pila antotica. The third arm is directed posteroventrally toward the posterior border of the fenestra optica; it shortly disappears, but in line with it appears another cartilage, the subiculum infundibuli, immediately posterior to the fenestra optica, where it joins the trabecula communis.

The processus ascendens, in which is ossified the epipterygoid, remains cartilaginous only at its dorsal tip, where it terminates freely on the side of the anterior tip of the otoccipital. The dorsal tip of neither the otoccipital nor the processus ascendens touches the taenia marginalis.

Extracolumella: The extracolumella at the tympanic wall consists of four branches which are best seen on the internal side of the membrane. The body of the extracolumella extends from the junction of the four parts to the stapes, and comprises about $\frac{1}{3}$ the length of the columella. Of the branches on the tympanum, the pars inferior is long and broadly oval-shaped and extends anteroventrally. The pars superior (best seen from the exterior) is the same length as the pars inferior but is narrower. It projects posteromedially and connects by a ligament with the lower edge of the paroccipital process. The short tapering pars accessorius posterior projects ventrally and the similar pars accessorius anterior projects dorsally. Very near the juncture of the extracolumella and stapes is the processus internus which runs forwards to a minute pocket on the median edge of the posterior surface of the quadrate. The processus dorsalis is apparently absent.

The middle ear is somewhat degenerate. The tympanum is present but completely concealed by thick skin which is not obviously different from that on adjacent nuchal regions, but which is less rugose. The tympanum is also partly concealed posteriorly by the depressor mandibulae muscle. The structure of the columella has been but little involved in the degenerative process, however.

Meckel's Cartilage: The cartilage is present and extends from near the posterior end of the compound bone to near the anterior end of the dentary. Its exact posterior limit was not determined, but is apparently near the articular surface of the mandible. It is visible from the exterior in the elongate Meckelian groove on the medial surface of the compound bone immediately posterior to its articular surface with the coronoid. The cartilage is situated in the extreme ventral portion of the groove, where it is protected laterally on the ventral half by a ridge of the compound (prearticular portion) bone; no or only a slight bony ridge encloses it dorsally. The cartilage passes through the inferior alveolar foramen with the nerve of the same name. For a short distance it is bounded ventrally by the angular, and for a longer distance by the splenial. Anterior to the end of the splenial (at about the level of the 7th tooth) the cartilage is exposed on the ventral surface of the dentary, which it follows in a shallow groove to very near its anterior extremity. It maintains a nearly uniform diameter throughout most of its length, but tapers distinctly anteriorly. Its diameter is about 0.3 mm., or about half that of one of the teeth near the middle of the dentary.

LOWER JAW

Only five separate bony elements occur in each lower jaw. As is typical in lizards the prearticular and articular are fused with each other, but in addition the surangular is fused with them. The whole element is termed the compound bone; and in addition to it occur the angular, coronoid, splenial and dentary (Pl. XIII, figs. 2, 3).

Compound Bone: This bone consists of the fused articular, prearticular, and surangular. It is a large bone, articulating with the dentary, angular, coronoid, and splenial, forming the posterior $\frac{2}{5}$ of the lower jaw. The posterior extremity is comprised of the fused prearticular and articular, but no sutures can be distinguished. Anteriorly, however, the suture between the prearticular and surangular are very clear, in a disarticulated jaw, underneath the lower extremity of the posterior arm of the coronoid, and it can be traced on the portion of the ventromedial surface of the bone which is concealed by the angular. In the articulated jaw none of these sutures is evident. The bone is dorsoventrally flattened, presenting its most extensive surfaces ventrolaterally and dorsomedially. In ventrolateral aspect it is seen as a broad element tapering and curving medially toward its truncate posterior tip. Its maximum width, just in front of a process protruding from the lateral border, is somewhat more than $\frac{1}{4}$ its length (in a straight line). The aforementioned process is the only irregularity visible in this aspect; the articulation with it is short and curves dorsally. The anteromedial border is extensively invaded by the angular, whose anterior edge extends scarcely farther forward than that of the compound bone, and its posterior edge nearly to the middle of the latter element. The anterior edge of the compound bone, above the angular, forms a broad right angled projection articulating with the dentary. Anterolaterally it articulates with the coronoid, and this suture continues onto the medio-dorsal face of the bone as a nearly straight vertical line nearly reaching the ventral border. At this point, however, a narrow, elongate process extends forward underneath the coronoid to articulate briefly with the anterior leg of that bone. This coronoid process articulates along the anterior ⅔ of its length with the splenial, and with the angular posteriorly. A deep, narrow Meckelian groove is visible near the medial edge of the bone terminating with the large inferior alveolar foramen (through which passes Meckel's cartilage as well as the inferior alveolar nerve) at the anterior end, and at its posterior end with the small medial foramen of the cutaneous recurrent canal; the anterior foramen immediately follows the lower end of the coronoid bone, while the posterior one is in direct line with the lateral process mentioned previously. Halfway between this groove and the lateral border is a prominent, rounded, elongate ridge extending from the coronoid bone to the condyloid process. The latter, scarcely elevated, is situated about ⅓ the total length of the bone from its posterior end and bears on its dorsal face a pair of shallow concavities preceded by a short dorsal protuberance. A ridge extends from the inner border of the condyloid process to the posterior terminus of the bone, while posterolaterally the process is bordered by a shallow fossa. The extremity of the bone, posterior to the condyloid process, is of nearly equal width throughout, but is only half as broad as the rest of the element.

The term "compound bone" is in common usage for lower jaws of the snake genera *Typhlops, Anomalepis,* and *Helminthophis,* for an element generally considered to consist of the fused articular, prearticular, and surangular. Since presumably the same elements are involved in *Xenosaurus* we conclude the terminology should be the same in each case. The fusion of these elements in these snakes and in lizards is not assumed as an indication of relationship.

The bone is pierced by several canals, some of which have already been mentioned. The canal of the chorda tympani pierces the bone immediately posterior to the articular fossa, near its medial edge; it opens into the dorsal surface of the inferior alveolar canal immediately anterior to the posterior opening of the same.

Another canal, opening near the exit of the chorda tympani canal, extends dorsally through the bone, finally reaching the external surface near the lower lateral edge of the coronoid bone; it is the external cutaneous canal.

At the extreme posterior edge of the fossa below the arms of the coronoid bone, and partially concealed by the anterior edge of the posterior arm, is a foramen leading into a canal which communicates with the narrow cavity of the bone; presumably the canal conducts a blood vessel.

The lateral opening (sometimes paired) of the cutaneous recurrent canal is situated on the ventral surface of the bone very near its lateral edge, immediately in front of the articular fossa; the medial opening was described above.

The inferior alveolar canal, which is shared by Meckel's cartilage, begins as described above, but is completely enclosed by the compound bone only in a very short area below and just posterior to the posterior arm of the coronoid bone. The compound bone forms the dorsal border of the inferior alveolar canal to the anterior extremity of the former, at which point the bone is notched to form the posterior half of a large foramen, shared with the dentary, which leads into the common marrow cavity of the dentary and compound bone. The remainder of the inferior alveolar canal is bordered above by the dentary, and below by the angular posteriorly, the splenial anteriorly.

Angular: The angular articulates with the surangular, splenial, dentary. It is a small, elongate bone at the midpoint of the ventromedial edge of the lower jaw. It is diagonally placed, so that its anterior edge is on the ventromedial surface of the mandible, while its posterior edge is within the medial border of the compound bone. The anterior third of its length is a pointed process bordered medially by the splenial, laterally by the dentary. Along the remainder of its length it articulates exclusively with the compound bone. On its medial surface near the anterior end it is pierced by the mylohyoid foramen, for the nerve of the muscle of the same name.

Coronoid: The coronoid articulates with the dentary, surangular, and splenial. It forms a moderately prominent coronoid process near the midpoint of the lower jaw. In medial aspect it is V-shaped with the apex of the V dorsal. The anterior leg of the V forms a ridge continuous with the lingual process of the dentary and joins the splenial in a short suture parallel to the ventral surface of the jaw. At the most posterior part of this suture, an elongate anterior extension of the surangular narrowly contacts the coronoid. The posterior leg of the V also forms a ridge, continuous with a ventromedian ridge of the surangular. This ridge differs from the preceding in that it does not form the border of the bone but rather lies along the midline of this leg. These two ridges meet in an obtuse point to form the apex of the V.

In lateral aspect the coronoid is more or less triangular, and has a poorly defined, rounded vertical ridge extending from the apex to its base line. The anterior angle of the bone projects forward into a small notch in the dentary, which in turn projects into a narrow notch in the anterior border of the coronoid.

The ventral border forms a nearly straight line, articulating largely with the dentary and, posteriorly, also with the surangular. The posterior angle of the lateral aspect of the bone is truncate, as the edge forms a transverse suture with the surangular at the dorsal crest of the jaw, then continues ventrally and is seen on the medial aspect of the coronoid as the posterior border of the corresponding leg. In the posterior angle, on the lateral aspect, is the external (lateral) foramen of the external cutaneous canal.

Splenial: The splenial articulates with the dentary, surangular, coronoid, and angular. It is a long slender bone forming the lower half of the medial side of the lower jaw. It tapers gradually to a point at the anterior end, reaches its greatest width at ⅔ its length posteriorly, and narrows again sharply at its posterior end. Along its dorsal suture it articulates with the dentary at a ventral ridge (lingual process) of that bone. Along this suture, slightly anterior to the middle of the splenial is the large, elongate, lingual foramen. Another foramen, below the preceding, pierces the splenial almost exactly in its center; it is the genioglossal foramen for the ramus muscularis et glandularis of the inferior alveolar nerve which supplies the genioglossal muscle and glands under the tongue. At its broadest point, the splenial has a short suture with the coronoid. As it tapers posteriorly, the splenial extends underneath a forward process of the surangular. At the sharp angle of the ventromedian edge of the jaw, the splenial forms a long suture, the posterior 6th involving the angular, the remainder, the dentary. The bone terminates a short distance from the end of the jaw, opposite the 7th tooth of the dentary.

Dentary: The dentary articulates with the splenial, coronoid, surangular, and angular. It is the longest bone of the lower jaw and bears 22 pleurodont teeth. Its external side is vertically rounded and smooth except for a row of 8 to 10 labial foramina parallel to the row of teeth and equidistant from the dorsal and ventral borders of the bone. Its medial side projects as a ridge (lingual process), above which are placed the teeth along the midline of the jaw. At this ridge, the dentary forms a long suture with the splenial. This ridge extends backwards about ⅖ the length of the jaw, sloping gently upwards, and is continuous posteriorly with the sharply ascending ridge of the coronoid. Here the teeth end. The dentary forms a suture with the coronoid in front of the coronoid ridge. On the dorsal border of the jaw, the dentary extends backwards into a small pointed notch in the coronoid. Under the edge of the coronoid the bone continues posteriorly, meeting the surangular at a broad, obtusely notched suture. At its posteroventral extremity the bone articulates with the angular which projects forward into a short, acute notch between the dentary and splenial. The angular-dentary suture is continuous anteriorly with a long splenial-dentary suture that fails to reach the tip of the dentary by only $1/6$ the length of the latter. This anterior portion of the dentary to the exclusion of all other bones, forms the entire tip of the jaw.

TEETH

The teeth are pleurodont, polyphyodont, and homodont. They are slender, being in general five or six times as long as they are wide. Viewed in cross section a separate tooth would appear oval with the compression mediolateral. The base of the tooth is slightly broader than the tip, which is irregularly rounded. The teeth are hollow, each being pierced by a foramen at the median side of its base. The median surface of the teeth is slightly convex. Some show a very slight concavity near the tip. The lateral surface is also convex, more so than the median surface, so that the tip of the bone is sharp.

The number of teeth ranges between 80 and 87. There may be 14 to 17 teeth on each maxilla, the modal number being 16. The premaxilla bears 8 or 9 teeth, and 22 is the only number discovered for each dentary. These three bones are the only dentigerous elements of the skeleton; no evidence of teeth on palatines or pterygoids is present.

Tooth replacement is alternate, new teeth arising between the bases of the teeth of the preceding set.

HYOBRANCHIAL APPARATUS

The hyobranchial apparatus is anterior to the pectoral girdle and ventral of the trachea (Pl. XV, fig. 4). It is composed of 5 parts, two posterior processes, each 1.5 cm. long, 2 lateral processes each 1.7 cm. long, and a single anterior process 1.2 cm. long. Each of these processes is enlarged at its point of articulation with the other processes. The anterior process, the hyoid copula (basihyal), is straight and tapering; the anterior end extends into the tongue. The lateral process, the hyoid cornu, branches latero-anteriorly for .5 cm. and then curves posteriorly for 1.2 cm. The anterior part is the ceratohyal, the posterior the hypohyal. The curves of the two hyoid cornua are .8 cm. apart. The posterior part of the lateral process extends dorsal to the posterior process in the muscles of the neck and end dorsal to the end of the posterior process. This process is the most slender of the three processes, becoming threadlike after it has curved posteriorly. The branchial cornu (ceratobranchial and epibranchial I) is the thick posterior process, which tapers slightly towards its distal end. It extends latero-posteriorly and gradually curves dorsal into the muscles of the neck. Its distal end is hooked so that it extends directly caudad. The ends of the branchial cornua are 1.4 cm. apart measured in a straight line through the trachea. The epibranchial portion is extremely short.

VERTEBRAL COLUMN

The vertebral column consists of 68 procoelous vertebrae; 6 cervical, 22 thoracic, 1 lumbar and 2 sacral vertebrae comprise the trunk series, while about 37 are present in the caudal region. The convex posterior surface of the centrum of each vertebrae articulates like a ball and socket with the concave anterior surface of the succeeding (posterior) vertebra. There is no zygantrum-zygosphene articulation. Beneath the postzygapophyses the centrum is slightly excavated to provide the anterior wall of the intervertebral foramen, a passageway for spinal nerves; these foramina become progressively smaller posteriorly throughout the length of the vertebral column. Small subcentral foramina are present on part (middle and posterior portions) of the caudal series of vertebrae but are absent elsewhere on the vertebral column.

CERVICAL VERTEBRAE

There are 6 cervical vertebrae, the posterior three of which bear ribs. The posterior two lack hypapophyses, while the others have them; these processes are situated immediately anterior to the condyle on the posterior face of the vertebrae. The third cervical vertebra bears a short, solid pleurapophysis.

Atlas: The atlas is the ring-like first vertebra which supports the skull by articulation with the occipital condyle. Dorsally, it is composed of 2 flat oblong plates which compose the neural arch and are separable in the midline and are overlapped by a forward projecting process on the neutral spine of the axis. Laterally these plates are constricted, and each bears a short posteriorly directed transverse process. The posterior side of the plate is expanded medially and from the expansion arises a postzygapophysis, situated median to the aforementioned process.

The anterior face of the atlas is obliquely slanted, its dorsal border being posterior to the ventral border. The anterior aspect shows the triangular shaped neural canal with its thin roof, the curved depressed surface, ⅔ as large as the neural canal, for articulation with the occipital condyle, the lateral downward projecting pleurapophysis near the base of the articulating surface, the median ventral, forward-projecting spine on the hypocentrum. The ventral posterior edge of the hypocentrum is concave and articulates with the pleurocentrum of the atlas fused with the axis.

Axis: The axis is the large second vertebra composed of pleurocentrum, hypocentrum, and the fused pleurocentrum of the atlas which forms the odontoid process. The axis has a large, laterally compressed neural spine which projects forward over the neural arch of the atlas as well as backward like the neural spines of the other vertebrae. Like the atlas, it has a pleurapophysis. In other respects it is similar to the other cervical vertebrae.

THORACIC VERTEBRAE

There are 22 thoracic vertebrae, all articulated with movable ribs. The neural spines become increasingly elevated toward the anterior end of the series. Beneath and slightly posterior to the prezygapophyses is a short diapophysis bearing a costal facet for rib attachment. The facet, particularly on the anterior vertebrae, usually is convex dorsally and concave ventrally. The zygapophyses of the anterior vertebrae are broader than those of the more posterior thoracic vertebrae.

LUMBAR VERTEBRAE

The single lumbar vertebra is anterior to the sacral vertebra. Its neural spine is low. The pleurapophyses are short.

SACRAL VERTEBRAE

There are two separate sacral vertebrae. These have no haemal arches. Their neural spines are lower than the spines of the caudal vertebrae immediately posterior to them. Their pleurapophyses are larger, the anterior ones being thicker than the posterior ones. The ends of these processes join distally (without fusing) to provide a broad articulating surface for a thin cartilaginous (calcified) plate which in turn articulates with the pelvic girdle. These and the rest of the vertebrae are proportionately less elongate and broader than the caudal vertebrae.

Caudal Vertebrae

There are 37 caudal vertebrae which decrease in size and sharpness of features posteriorly (Pl. XIV, figs. 7, 8). The caudally projecting, low neural spines diminish in prominence until at the tip of the tail the vertebrae are merely rounded on the dorsal surface. Lateral to and beneath the neural spine are the broad, posteriorly projecting, paired postzygapophyses articulating by their flat undersurfaces with the upper surface of the anteriorly projecting paired prezygapophyses of the vertebra immediately posterior. From the lower half of the anterior end of the vertebra the broad pleurapophyses project anterolaterally, representing the fused rib and rib attachments. The posterior border of these processes forms a slightly oblique angle with the centrum. On the posterior ventral side of the vertebrae immediately in front of the posterior condyle, are two paired facets facing obliquely posteriorly. These articulate with the V-shaped haemal arch which projects posteriorly. The chevrons are thus attached to the centrum, but in the primitive intercentral position. These arches decrease in length posteriorly and disappear on the last four vertebrae.

RIBS

There are 25 pairs of ribs, consisting of 2 parts, the curved dorsal bony section and the ventral cartilaginous section. There are 5 anterior thoracic ribs which attach to the sternum (on the 7th to the 11th vertebrae inclusive). They are about 3/7 cartilaginous, while the following ribs are provided with cartilaginous sections decreasing in size posteriorly; the last ones have only a small tip. There are 3 pairs of cervical ribs; they are compressed anteroposteriorly, rather strongly expanded at the distal bony tip, and are less than half the length of the anterior thoracic rib; the cartilaginous portion of the anterior rib is about 1/4 the length of the bony portion, while that of the last is nearly equal to the length of the bony portion. The cartilaginous portions are calcified, as indicated by the heavy staining with alizarin red.

No ventral ribs (either gastralia or abdominal ribs) are present.

PECTORAL GIRDLE

The pectoral girdle is an anterior ventral structure supporting the forelimbs at the glenoid fossae, and articulating with the sternum. (Pl. XV, figs. 3, 5, 6.) It is composed of 7 elements: suprascapula, scapula, coracoid, precoracoid, epicoracoid, interclavicle, and clavicle, of which the suprascapula and epicoracoid are cartilaginous. The unpaired interclavicle and paired clavicles are the median elements by which the relatively freely movable, overlapping halves of the remainder (scapulocoracoids) of the girdle articulate with each other and with the sternum.

Interclavicle: The interclavicle is a single, slender, anchor-shaped bone applied to the ventral surface of the pectoral girdle and the sternum. It consists of 4 narrow processes. The longest is a flattened, median posterior process 1.1 cm. in length, which articulates along it sides with the epicoracoid, and underlies the anterior half of the midline of the sternum. It joins anteriorly a pair of lateral processes, 6.3 mm. in length, which form the "hooks" of the anchor, curving diagonally posteriorly and paralleling the clavicles. The anterior process is very short (1 mm.) and overlies the median ventral ends of the clavicles; it is the only portion of the interclavicle which extends dorsal to another portion of the girdle.

Clavicle: The clavicle is the slender anterior bone of the girdle. It is paired and meets its mate in a point on the midline of the girdle; at that point they immediately overlap and completely conceal in ventral view the anterior process of the interclavicle. The two clavicles diverge from the median line in a broad V with the apex directed anteriorly. After extending laterally for 7.5 mm., parallel to the interclavicular "hooks" the bone curves dorsally and slightly caudad for a nearly equal distance (6.5 mm.) The clavicles articulate with the interclavicle only at its anterior apex. In normal position, the clavicles are overlapped at their apices on the dorsal side by the broad anterior ends of the epicoracoids. The dorsal tip of each clavicle articulates with the suprascapula. This articulation is of great importance, functioning as the swivel from which the scapulocoracoids rotate in a narrow arc, guided by the groove on the front edge of the sternum.

Epicoracoid: The epicoracoid forms the median posterior and most of the anterior (as far laterally as the scapula) borders of the movable halves (scapulocoracoids) of the pectoral girdle. The ventral ends of the scapulocoracoids lie dorsal to the anterior end of the sternum, and to the clavicles and interclavicle. The anterior end of the epicoracoid normally articulates broadly with the dorsal surface of the clavicles near their median ends; the anterior median edges overlap each other (the left over the right) and the outwardly curving posterior edges appear normally to slide in a groove on the outer anterior edge of the sternum. The element borders the coracoid bone along its entire median limit, and becomes broader anteriorly, where it forms the anterior margins of the coracoid fenestra and meets the precoracoid bone lateral to that fenestra. A narrow extension of the epicoracoid extends from that point to the anteromedial corner of the scapula, thus forming the anterior border of the scapulocoracoid foramen.

All of the epicoracoid is composed of calcified cartilage except for a narrow border of hyaline cartilage on the medial edge of the element.

Coracoid and Precoracoid: The coracoid lies lateral to the epicoracoid; it is bordered by the latter in all directions except laterally. It forms the lateral border of the ventral part of the girdle from the glenoid fossa posteriorly. From its posterior union with the epicoracoid the lateral border of the coracoid extends anteriorly to the glenoid fossa, having a large indentation in the midpoint between its posterior limit and the fossa. From the midline of the fossa the suture separating the coracoid and the scapula supposedly extends anteriorly to the median posterior border of the coracoscapular fenestra although this suture cannot be distinguished. The coracoid then extends forward in a narrow tongue, called the precoracoid, to meet a posteriorly directed tongue of the epicoracoid. Together these processes form a separating bridge between the coracoscapular fenestra and the coracoid fenestra. Posterior and median to the precoracoid is the supracoracoid foramen. Median to the precoracoid, the coracoid curves posteriorly and then anteriorly, meeting the epicoracoid and forming the posterior and most of the lateral and median borders of the coracoid fenestra.

Scapula: The scapula is the relatively thick, dorsally directed, lateral bone of the girdle. It is narrow in width and thickened where it meets the coracoid in the glenoid fossa. From here it expands gradually as it extends anterodorsally. The bone forms the posterior and lateral borders of the coracoscapular fenestra and part of the posterior edge of the girdle, and is indistinguishably fused with the coracoids. Its dorsal edge is broadly expanded and articulates with the suprascapula. Its anterodorsal edge closely approaches the dorsal portion of the clavicle. Near the dorsal margin of the glenoid fossa is the small supraglenoid foramen.

Suprascapula: This is the large, flat, rounded element on the most dorsal part of the girdle. It articulates with the dorsal edge of the scapula and with the median side of the dorsal process of the clavicle. It arches over the ribs toward the vertebral column. Except for a narrow vertebral border of hyaline cartilage the element consists entirely of calcified cartilage.

STERNUM

The sternum is the large, sheet-like ventral element which supports the ribs (Pl. XV, figs. 3, 5). It articulates with the interclavicle, epicoracoid, and ribs. The posterior edge of the sternum forms a right angle with the apex directed posteriorly. It is free from articulations except with the ribs, with which there are four cartilaginous attachments of which the median is branched, or sometimes there may be 5 separate rib attachments. This edge appears scalloped with the rib attachments on the crests of the scallops. The anterior edges form a right angle on either side with the posterior edge. The edge is deeply grooved for articulation with the epicoracoid. This anterior edge does not continue medially to complete a square but curves gently anteriorly, enclosing a rather broad anterior process. A large notch in this process receives part of the interclavicle, the posterior third of which emerges ventrally from the notch and extends posteriorly in contact with the ventral surface of the sternum.

The sternum consists of calcified cartilage, as is indicated by its reaction to alizarin red.

FORELIMB

Humerus: The proximal bone of the forelimb is 1.7 cm. long. It is a narrow rounded bone (Pl. XVI, fig. 4) expanded at both ends to provide articulation with the pectoral girdle and the radius and ulna. The proximal end is expanded horizontally and compressed and bent slightly upwards from the level line of the bone. Viewed dorsally this expansion appears fan-shaped. On the median half of the curve of the fan it is expanded into a surface for articulation with the pectoral girdle. Lateral to this surface the curve of the fan indents. From the ventral view this expansion appears depressed in the middle with a ventrally projecting knob on the lateral edge.

The distal end of the bone is expanded and compressed vertically at an angle of 70° to the compression of the proximal end. The compressed part of the bone spreads wider ventrally than dorsally. On the lateral side of this compression are two knobs, the larger dorsal one, the radial condyle, for articulation with the radius, the smaller ventral one, the ulnar condyle, for articulation with the ulna. Immediately proximal to the larger condyle is a groove with a nutritive foramen. A supracondyloid foramen occurs lateral to the radial condyle.

Radius: A thin elongated bone forming the preaxial half of the distal part of the forelimb (Pl. XVI, fig. 4). It is 1.1 cm. long. It is expanded at its proximal end to form a cuplike articulation with the larger knob on the humerus. On the side of the bone posterior to this socket the radius articulates with the side of the ulna. The distal end has a small expansion for articulation with the radiale of the wrist.

Ulna: The ulna is a thin elongated bone, slightly thicker than the radius, forming the postaxial half of the distal part of the forelimb (Pl. XVI, fig. 4). It is 1.3 cm. long. The proximal end is expanded and indented to articulate with the smaller condyle on the humerus. The distal part of the bone is expanded into a malleolus which articulates with the ulnare and the intermedium of the wrist. The posterior edge of the bone next to this malleolus is flattened for articulation with the pisiform. No ulnar patella is present.

Wrist Bones: The wrist bones are small, irregularly shaped little bones serving to connect the radius and ulna with the phalanges (Pl. XVI, fig. 8). They consist of ten elements, including the small lateral pisiform (Pl. XVI, fig. 4), articulating with the ulna and the ulnare; the large cuboid ulnare, articulating with the ulna, the pisiform, the intermedium, a centrale, and carpalia V and IV; the small intermedium, articulating with the ulnare, radiale, centrale and ulna; the elongate radiale, articulating with the radius, the intermedium, carpale I, metacarpal I, and centrale; the small cuboid centrale articulating with the radiale, intermedium, ulnare, carpalia I, II, and III; the respective carpalia, articulating with the corresponding metacarpals.

Digits: Metacarpal III is the longest, IV is nearly as long, and II, V and I are succeedingly smaller. The formula for the phalanges is 2, 3, 4, 5, 3. The phalanges articulate with each other by condyles, the anterior end of each phalanx being knoblike and the posterior end depressed. The proximal end of each phalanx extends under the distal end of the preceding one. All the digits are clawed. A small sesamoid bone is present at the dorsal base of each claw.

THE PELVIC GIRDLE

The pelvic girdle acts as a means of attachment between the hind limbs and the vertebral column by union in a cartilage plate of the ilium with the two sacral ribs, and by articulation of the femur in the imperforate acetabulum. It is composed of 5 elements (Pl. XV, fig. 2; Pl. XVI, fig. 7): pubis, ilium, ischium, hypoischium, and epipubis. The latter two are composed of calcified cartilage, the others of bone.

Pubis: The pubis is the anterior bone of the girdle. From the lateral edge of the girdle it is directed ventrally and forward at an angle of 20° to the perpendicular on the vertebral column. Its ventral side is convex, its dorsal side slightly concave. It does not meet its mate in the midline but is separated from it by the small cartilaginous epipubis. The anterior end is expanded and rounded slightly. It is overlapped at its tip by the epipubis so that it does not form the anterior limit of the girdle. At its lateral limit, the pubis sends ventrolaterally a wing terminated by a knob-like thickening. Posterior to this wing the bone is indented on its lateral side and then protrudes again immediately in front of the sharp edge of the acetabulum. The median edge curves from its laterally directed course and turns posterior just median and anterior to the acetabulum. The curve of the pubis is continuous with the curve of the anterior border of the ischium and forms with it the anterior, lateral, and posterior border of the ischiopubic fenestra. If the acetabulum is imagined to be triangular with its longest base ventral, the suture of the pubis with the ischium in the acetabulum can be said to bisect the ventral base of the triangle and the suture with the ilium to bisect the anterior side of the triangle. The suture with the ischium can be traced on the ventral side of the girdle from the acetabulum to the place where the curve of the ischiopubic fenestra is sharpest on its lateral edge. Dorsally neither the suture with the ischium nor with the ilium can be distinguished. The obturator foramen pierces the pubis on its ventral side in the middle of the bone between the suture with the ischium and the lateral wing on the pubis.

Epipubis: A small, triangular, cartilaginous element wedged between the anterior ends of the two pubes. The sides of the triangle are concave so that the apices are long and tapering. Two of these apices overlap the anterior edges of the pubes, the third is directed posteriorly between the pubes. Here it is joined in life to the hypoischium by the puboischiadic ligament forming the median border of the two ischiopubic fenestrae.

Ischium: The median posterior pair of bones of the pelvic girdle. From its lateral edge it is directed slightly ventroanteriorly. It is a broad bone, expanded at both ends, its curved anterior border forming the posterior border of the ischiopubic fenestra. It is separated from its mate of the opposite side by the cartilaginous hypoischium. At 1/3 of the distance from the lateral limit along the posterior border, the ischium sends posteroventrally a broad process. The bone is flat except for the thickening at the acetabulum. Its suture with the pubis bisects the ventral border of the acetabulum and continues on the ventral side of the girdle to the place where the lateral border of the ischiopubic fenestra has its sharpest curve. Dorsally this suture cannot be distinguished. The suture with the ilium bisects the posterior border of the acetabulum and cannot be seen dorsally.

Hypoischium: This is a cartilaginous element wedged between the two ischia and extending forward to form the median border of the ischiopubic fenestrae with the puboischiadic ligament. It also extends backward in a narrow tapering process for a distance equal to the entire antero-posterior length of the girdle. The anterior process is broad between the anterior parts of the two ischia and tapers sharply to a point joining the ligament.

Ilium: The ilium is the narrow, posterior, dorsal bone of the pelvic girdle joining the sacral ribs. It articulates anteriorly with the pubis and the ischium in the acetabulum. From this socket it curves slightly dorsad and shortly continues directly caudad for the rest of its length, tapering slightly at its posterior end. Its dorsal edge has a small rough ridge just behind the acetabulum. The articulation with the broad ends of the sacral ribs occurs on the medial half of the middle 1/3 of the length of the bone.

HIND LIMB

Femur: The long proximal bone of the hind limb (it is 1.9 cm. long) articulating with the pelvic girdle and the fibula and tibia (Pl. XVI, fig. 5). At its proximal end it is compressed laterally. On the median side of this compressed region is a large anteriorly projecting knob, the head, for articulation with the pelvic girdle. Lateral and posterior to the head is the trochanter, a lesser knob for muscle attachment. On the ventral side of the bone, between the trochanter and the head, the femur is slightly depressed. The shaft of the bone curves slightly (ventrally) from the proximal to the distal end.

At the distal end the bone curves slightly laterally and expands to articulate with the tibia and fibula. At this point occurs an extraordinary complement of 6 sesamoid bones (Pl. XVI, figs. 1, 3). On the anterior side of the femur, near the beginning of the expanded part, there is a smooth area where the small round scalelike patella tibialis is attached. On the anterior side also, between the femur and the tibia and fibula, are wedged three small interarticular sesamoid bones. These three elements seem to be attached between the long bones to two more, similar, sesamoid elements wedged into the joint on its posterior side. One or two of these 5 elements may represent the fibular interarticular sesamoids. The posterior side of the femur presents two scroll-like condyles. The fibula articulates with the smooth lateral side of the larger dorsal condyle. The tibia articulates with the rounded edge of the smaller ventral condyle and the whole distal edge of the larger condyle. Proximal to the midpoint of the larger condyle the femur is slightly depressed for a short distance.

Tibia: The tibia is the larger of the two bones of the distal end of the hind limb (Pl. XVI, fig. 2). It is 1.3 cm. long. It is broadened for about $1/3$ of its length at the proximal end. Here it expands greatly to articulate broadly with the femur. The posterior edge of this articulating surface is indented slightly to articulate with the side of the fibula. The shaft of the tibia curves slightly caudad. The distal end of the tibia is expanded to only $1/2$ the width of the proximal end. The tip is cupped to provide articulation with the astragalus. A small anteroventral projection of the tip extends along the side of the astragalus.

Fibula: The fibula is the smaller bone of the distal part of the hind limb (Pl. XVI, fig. 2). It is 1.3 cm. long. The shaft of the bone curves slightly caudad. The proximal end is expanded slightly and articulates on its side with the side of the large dorsal condyle of the femur and with the notch in the end of the tibia. The distal end is also slightly enlarged and has an oblong, slightly convex surface for articulating with the calcaneum.

Ankle Bones: The astragalus and calcaneum are fused (the astragalocalcaneum of Schaeffer). The calcaneum is the posterior element, the larger of the two, and may be distinguished from the astragalus by an indentation between the two articulating facets, the calcaneum articulating with the fibula and the astragalus articulating with the tiba (Pl. XVI, fig. 6). If the face of the oblong facet of the calcaneum is observed in direct view, the face of the larger round astragalus facet by comparison is slanted slightly more dorsal and anterior. The ventral side of the fused bone is slightly concave, except for a lump raised on the distal edge of the calcaneum. The distal border of the fused bone is wavy and articulates with metatarsals I and II, and tarsalia 3 and 4.

The tarsalia are only two in number. IV is an irregularly shaped element, about the size of the calcaneum, wedged in between the fused astragalus and calcaneum, the metatarsalia IV and V, and tarsale 3. Tarsale 3 is represented by small element closely applied to metatarsal III. This element bends over the proximal end of metatarsal II so that it is oblique to the straight line of metatarsal III. Tarsalia I and II appear to be fused to the proximal ends of the corresponding metatarsalia.

Digits: The digits are five in number, I being the smallest and the lengths increasing progressively to IV which is the longest digit (Pl. XVI, fig. 6) V is intermediate in length between I and II. Metatarsal V is out of line with the other metatarsals and is peculiarly modified. It is expanded at its proximal end so that it comes in contact with the posterior face of tarsale IV, reaches the astragalocalcaneum, and underlies metatarsal IV. It is also much shortened. On the ventral side near its distal end, the bone has a small protuberance. The phalangeal formula is 2, 3, 4, 5, 4. All the digits are clawed. A small sesamoid bone occurs at the dorsal base of each claw.

DISCUSSION

Little of strikingly unusual nature was discovered in the skeleton. Perhaps the most noteworthy discovery was the presence of otoliths, which heretofore have not been recorded above amphibians and are definitely not present in the related genera *Heloderma* and *Gerrhonotus*. They were found on both sides in all three skulls examined for them, in which they could best be seen through the fenestra ovale; they lie loose in the otic capsule, where they roll about freely as the skull is tilted at various angles.

Apparently unusual also are the palpebral and sclerotic bones. The former are not recorded in any other lizards, and the latter in very few (e. g., *Lacerta*).

We were at first inclined to regard the astonishing complement of 6 sesamoid bones at the knee as another unique characteristic, but a like number was discovered in both *Gerrhonotus* and *Heloderma*, in each of which the arrangement is very much like that of *Xenosaurus*.

While well known in many groups of lizards, the function of the curious incisive process on the premaxilla remains unknown. In *Heloderma* it is reinforced by a pair of like processes on the anterior tip of the prevomer. The structure is of such wide occurrence and constancy that some important function for it is suggested.

Subcentral vertebral foramina, said by Camp to be absent in the higher Anguimorpha, are present in the anterior caudal vertebrae not only of *Xenosaurus* but also *Gerrhonotus*. They are absent elsewhere in the vertebral column. Their presence in *Heloderma* could not be determined in the specimen available.

RELATIONSHIPS OF XENOSAURUS

In tabular form the contrasting characters of *Xenosaurus, Heloderma* and the Anguidae are summarized. No mention has been made of characters similar in the three groups.

It is clear that *Heloderma* is very widely different from those forms with which it is compared. The grooved teeth; the curious ventral fusion of the frontals below the olfactory lobe of the brain; the absence of the postorbital bone and supratemporal fossa, and very great reduction of the squamosal; the presence of 8 cervical ribs and 2 lumbar vertebrae; the absence of the scapulocoracoid and coracoid fenestrae; the complete separation of the pelvic bones; the median cartilaginous plate between the bony lateral halves of the sternum; the exclusion of the maxilla from the infraorbital fossa and resultant contact of ectopterygoid and palatine bones; absence of a parietal foramen; contact of prefrontal and postfrontal; the short stapes; the separate surangular; the absence of cervical hypapophyses; the presence of vomerine incisive processes; the contact of pterygoid and jugal; and the curious dorsal trunk scutellation, among other lesser peculiarities, thoroughly validate the segregation of the genus as a separate family. It is far less closely allied to either *Xenosaurus* or the Anguidae than the latter two are to each other.

TABLE OF COMPARISONS

Feature	*Xenosaurus*	*Heloderma*	*Anguidae*
Nasals	paired	paired [1]	paired
Frontals	fused	paired	fused or paired
Ventral groove on frontal	open ventrally	closed ventrally	open ventrally
Frontal and premaxilla	very narrowly contact ventrally, separated dorsally	separated widely	widely separated to broadly in contact
Parietal foramen	present	absent	present
Maxilla and prevomer	clearly in contact	not or barely in contact	clearly in contact
Septomaxilla	with a sharp dorsal ridge	not prominently ridged	not prominently ridged
Prefrontal and postfrontal	no contact	narrowly in contact dorsally [2]	no contact
Postorbital	fused with postfrontal	absent	separate
	contacts squamosal	separated from squamosal	contacts squamosal
Palpebral	paired	absent	absent
Sclerotics	about 20	absent	absent
Jugal	broadly contacts squamosal	broadly separated from squamosal	narrowly or broadly separated from squamosal
Supratemporal fossa	present	absent	present
Supratemporal arcade	very well developed	absent	weak
Tabulare	very small	enlarged, flattened	moderate
Squamosal	very large, broad	extremely minute, vestigial [3]	slender
	contacts parietal, jugal	contacts neither	contacts neither

1. According to Shufeldt the nasals are fused, but Camp and Gilmore both correct this statement.

2. Gilmore states that the contact of prefrontal and postfrontal excludes the frontal from the orbital border, but this is not so in the specimen examined. In it a narrow projection of the frontal underlies the common suture of the prefrontal and postfrontal, and forms a short part of the supraorbital line.

3. Generally considered absent, an extremely small nodule lying on the lateral surface of the suture between the tabulare and quadrate, in the single specimen examined, is interpreted as the squamosal. There are two other bony nodules distal to the squamosal on the edge of the quadrate, whose identities are not known

Feature	*Xenosaurus*	*Heloderma*	*Anguidae*
External naris	not bordered by osteoderms	bordered in part by osteoderms	not bordered by osteoderms
Prevomer	no incisive process	an incisive process	no incisive process
Palatine and ectopterygoid	widely separated	generously overlapping	widely separated
Posterior palatine vacuity	bordered by maxilla	not bordered by maxilla [4]	bordered by maxilla
Pterygoid	no contact with jugal	barely contacts jugal	no contact with jugal
	toothless	toothed	toothed or not
Ectopterygoid	reaches labial border	does not reach labial border	does not reach labial border
Carotid fossa	shallow	very shallow	very deep
Sphenoid	separate in young adults	fused with otoccipital	separate in young adults
Otoliths	present	absent	absent
Stapes	very nearly reaches tympanum	does not reach quadrate level	nearly reaches tympanum
Surangular	fused with articular and prearticular	separate	fused with articular and prearticular
Teeth	blunt, bases not swollen, smooth	sharp, elongate, reduced in number, bases swollen, many grooved on anterior medial edge	blunt, bases not swollen, smooth
Branchial arch II	no vestiges	no vestiges	epibranchial present
Cervical vertebrae [5]	6	8	8
Cervical hypopophyses	present	absent	present
3rd cervical vertebra	ribless	ribless	ribbed
Sternal ribs	5	4	5
Lumbar vertebrae [6]	1	2	0

4. Gilmore states that the maxilla forms a part of its border, but this is apparently a lapsus.

5. For convenience all vertebrae in the neck region whose ribs, if any, fail to reach the sternum are considered cervical vertebrae.

6. Posterior trunk vertebrae without ribs (or with the ribs fused) are regarded as lumbar vertebrae.

Feature	*Xenosaurus*	*Heloderma*	*Anguidae*
Scapulocoracoid and coracoid fenestrae, and distinguishable precoracoid	present	absent	present
Clavicle	unforked	unforked	forked or unforked
Interclavicle	subcruciform	rod-like	cruciform
Sternum	cartilaginous	halves bony, separated by a median cartilage plate	cartilaginous
Epicoracoid	reaches scapula	fails to reach scapula	reaches scapula
Intermedium	large	very small [7]	extremely minute
Knee sesamoids	6	at least 4, probably 6	6
Pelvic bones	fused at acetabulum	entirely separate	fused at acetabulum
Tympanum	concealed	exposed	exposed
Dorsal trunk osteoderms	absent	present	present
Dorsal scales	minute, granular	large, nodular	large, imbricate
Head scales	small, irregular	irregular	regularly arranged

Characters peculiar to *Xenosaurus*, within the limits of the present comparisons, are: the unique otoliths, sclerotic bones and palpebrals; the very strong postorbitosquamosal arcade, with articulation of the squamosal with the jugal and parietal; the subcruciform interclavicle; the large intermedium; the penetration of the ectopterygoid to the external, lateral labial border, at the maxillojugal suture; concealed tympanum; and the curious granular, dorsal body scales lacking osteoderms.

Characters peculiar to the Anguidae include an extremely deep carotid fossa; absence of lumbar vertebrae and presence of ribs on the 1st postaxial vertebra; cruciform interclavicle; the presence of the epibranchial of branchial arch II; large, imbricate dorsal trunk scales; and distinctive head plates.

The retention of the family Xenosauridae, distinguished from its closest relatives the Anguidae and Helodermidae, appears to be amply justified by the characters differing between the three groups.

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7. Generally said to be absent, the intermedium is clearly present, though small, in the skeleton examined. It is present although extremely minute in a single specimen of *G. imbricatus* examined for it. Camp records its existence in both these genera, but erroneously says it is absent in *Xenosaurus*.

The family obviously is most closely related to the Anguidae. All three families appear to have been derived from some common stock, rather than any one from the other. Retaining the least number of unique primitive characters is *Heloderma*, with only the separate surangular and pelvic bones in that category. Its specializations are many and except for the reduction of the postorbitosquamosal arcade, do not follow the line of evolution indicated by the Anguidae. Of course they likewise do not parallel the Xenosauridae, which is quite primitive in many respects. The latter family possesses the most primitive postorbitosquamosal arch of the three groups, and likewise the large intermedium is primitive. Yet the curious scutellation, fusion of the surangular, and the development of sclerotic and palpebral bones, cannot be considered primitive.

The Anguidae possesses more unique primitive characters than either of the other families. Among them are the possession of a portion of arch II, large imbricate dorsal scales, absence of lumbar vertebrae, presence of ribs on the 3rd cervical vertebra, and presumably the cruciform interclavicle. Yet the reduction of the postorbitosquamosal arch is greater than in *Xenosaurus;* it has the greatest development of the carotid fossa; and it is not as primitive as *Heloderma* (but like *Xenosaurus*) in the distinctness of the surangular and pelvic bones.

It may be concluded that the Anguidae is the most primitive family of the Anguioidea, but that the several members of that superfamily are not to be derived from the Anguidae directly, at least as that family is now known, but from a common stock probably not greatly different from its primitive members.

CONCLUSION

Otoliths are recorded for the first time from reptiles, and palpebral bones for the first time in lizards. The family Xenosauridae is regarded valid and more closely related to the Anguidae than to any other family. The "paroccipital" of Camp and Gilmore's *Melanosaurus maximus* is regarded as identical with an element in *Xenosaurus* interpreted as a separately ossified epiphysis of the paroccipital process.

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PLATE XI

FIG. 1. *Xenosaurus grandis* (Gray), dorsal view. Cuautlapan, Veracruz. From the E. H. Taylor—H. M. Smith collection. Somewhat reduced.

FIG. 2. Same, ventral view.

PLATE XI

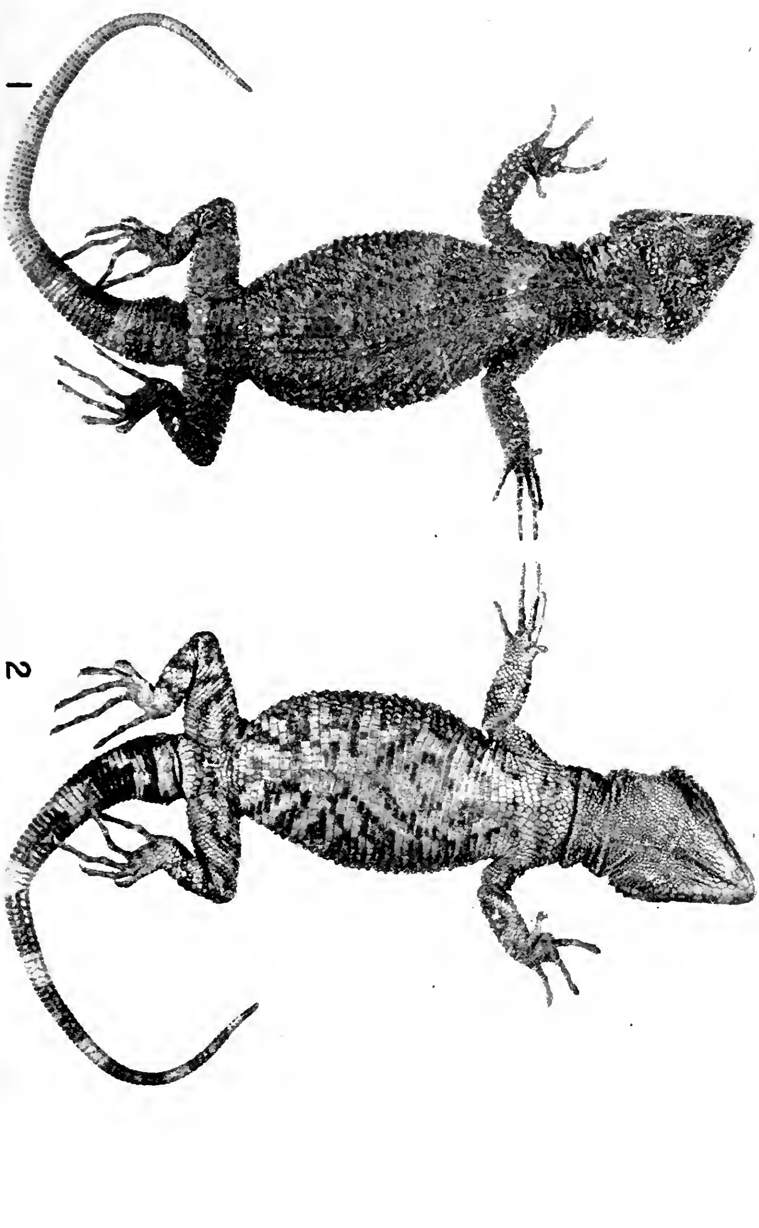

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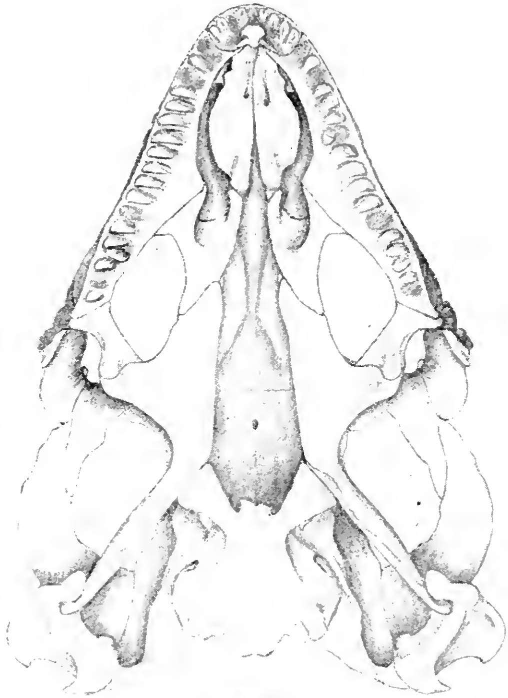
PLATE XII

Skull of *Xenosaurus grandis* (Gray), much enlarged.

FIG. 1. Ventral view.

FIG. 2. Dorsal view.

PLATE XII



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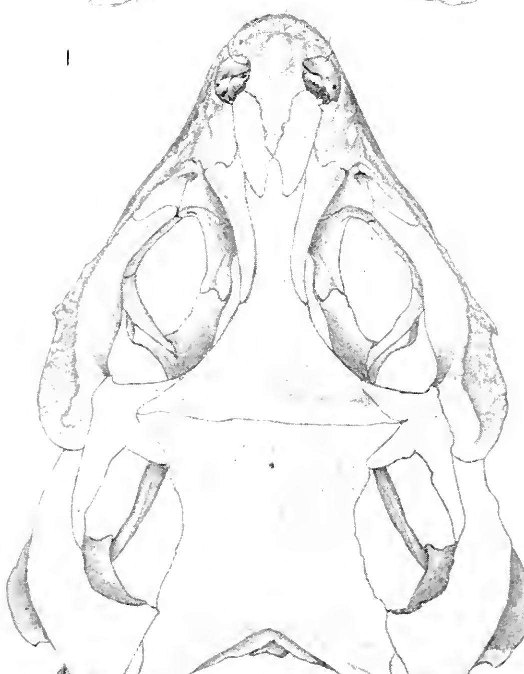

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PLATE XIII

Skull of *Xenosaurus grandis* (Gray) much enlarged.

FIG. 1. Posterior view of skull.

FIG. 2. Median view of lower jaw.

FIG. 3. Outer lateral view of lower jaw.

FIG. 4. Skull lateral view.

PLATE XIII

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PLATE XIV

FIG. 1. Dorsal view of maxilla, septomaxilla and associated bones; premaxilla, nasal and frontal removed. Labels: *lac*, lacrimal; *m*, maxilla; *pref*, prefrontal; *prev*, prevomer; *septm*, septomaxilla.

FIG. 2. Tabulare, dorsal view.

FIG. 3. Otoccipital, anterior view. Labels: *ab f*, abducens foramen; *att t c*, point of attachment of trabecula communis; *basioc t*, basioccipital tubera; *f end*, foramen endolymphaticum; *i c f*, internal carotid foramen; *p a f*, posterior acoustic foramen; *paroc pr*, paraoccipital process; *pro*, proötic; *pt pr* pterygoid process; *sph*, sphenoid.

FIG. 4. Frontal, ventral view. Surface labelled: *con pref*, contacts prefrontal; *und n*, under the nasal; *und prem*, extends under premaxilla.

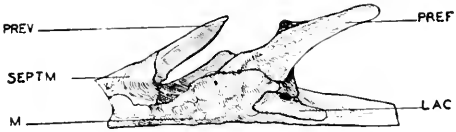
FIG. 5. Parietal, ventral view. Labels: *a r*, anterior ridge; *con eppt*, contacts epipterygoid; *p a*, point of attachment of processus anterior of synotic tectum; *par f*, parietal foramen; *p r*, posterior ridge.

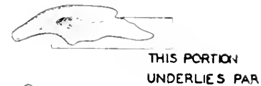
FIG. 6. Otoccipital, dorsal view. Labels: *ab f*, abducens foramen; *att t c*, point of attachment of trabecula communis; *cp*, carotid fossa; *p a*, point of attachment of processus anterior of synotic tectum; *paroc pr*, paroccipital process; *p u f*, vidian canal; *pt m*, pterygoid process; *sph-otoc* sphenoid-otoccipital suture; *supraoc*, supraoccipital; *tm*, point of attachment of occipital.

FIG. 7. Two basal caudal vertebrae, the first with its chevron; ventral aspect. Labels: *cen*, centrum; *ch*, chevron; *pl*, pleurapophysis; *postz*, postzygapophysis; *prez*, prezygopophysis; *sub f*, subcentral foramen.

FIG. 8. Same as fig. 17, dorsal aspect. Labels: *ne sp*, neural spine; other labels as for fig. 17.

PLATE XIV





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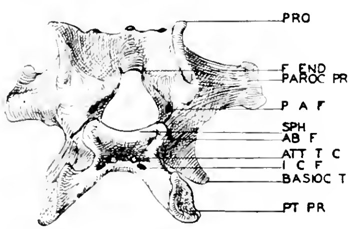

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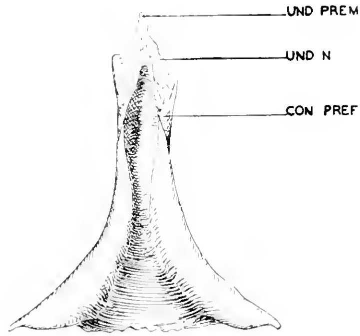

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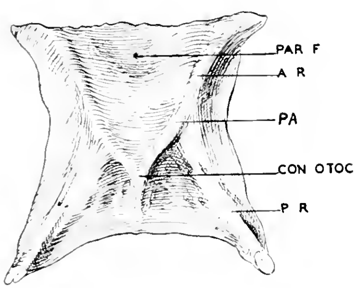

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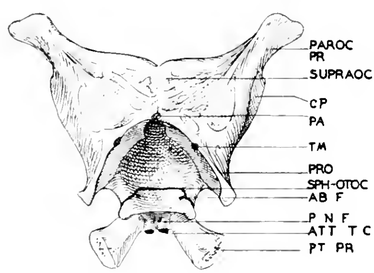

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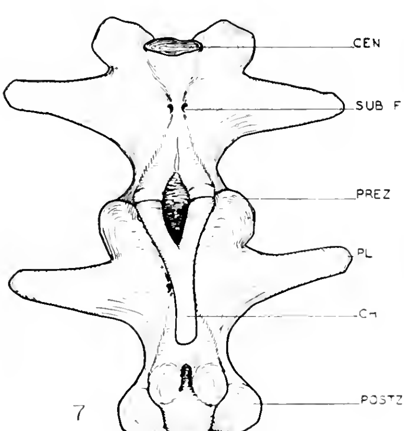

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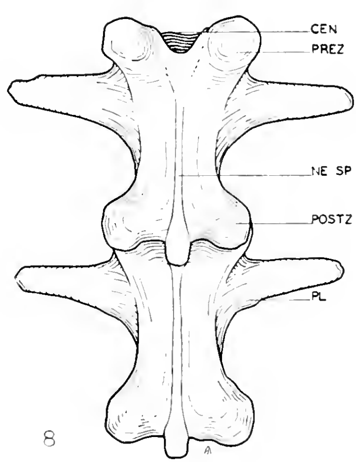

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PLATE XV

FIG. 1. A phantom figure of the cranium. Blackened areas are heavily stained; stippling indicates lighter staining; short lines indicate membranes. Labels: *fo*, optic foramen; *is*, interorbital septum; *ju*, jugal; *of*, optic fenestra; *oo*, otoccipital; *pa*, processus ascendens; *pac*, pila accessoria; *pao*, pila antotica; *pas*, processus anterior of synotic tectum; *pm*, pila metoptica; *ps*, planum supraseptale; *siu*, subiculum infundibuli; *tc*, trabecula communis; *tm*, taenia marginalis; *tme*, taenia medialis.

FIG. 2. Pelvic girdle, lateral aspect. Labels: *acet*, acetabulum; *hypois*, hypoischium; *il*, ilium; *is*, ischium; *pub*, pubis.

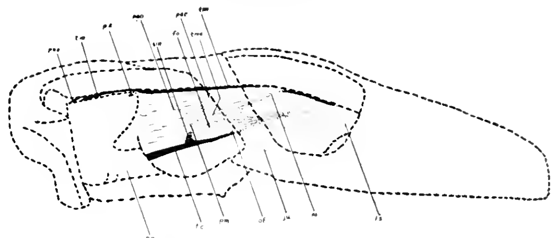
FIG. 3. Pectoral girdle and sternum, ventral aspect. Evenly dotted areas are of calcified cartilage; diagonal lines indicate bone; and irregular dots indicate hyaline cartilage. Shading is the intent of the darker areas; for example, both portions of the girdle overlie the sternum (in this aspect), while the right half of the girdle overlies the left half, etc.

FIG. 4. Hyobranchial apparatus. Labels: *cer*, ceratohyal; *hyp*, hypohyal; *br*, branchial cornu (ceratobranchial); *e*, epibranchial I, *hy cop*, hyoid copula.

FIG. 5. As in fig. 19, dorsal aspect. Shading indicates the same as in fig 19.

FIG. 6. Right half of pectoral girdle, in lateral aspect. Shading as in fig. 19.

PLATE XV



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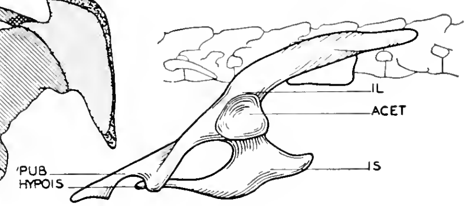

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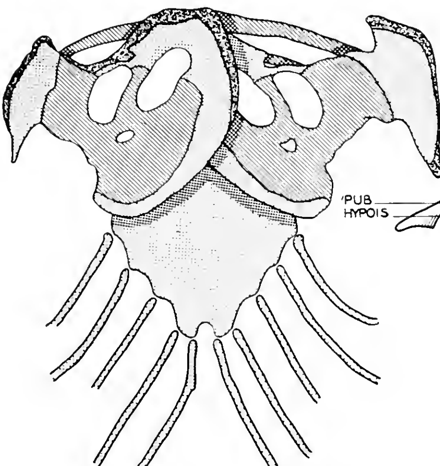

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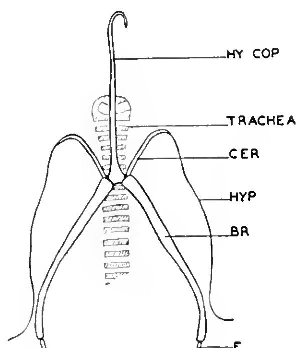

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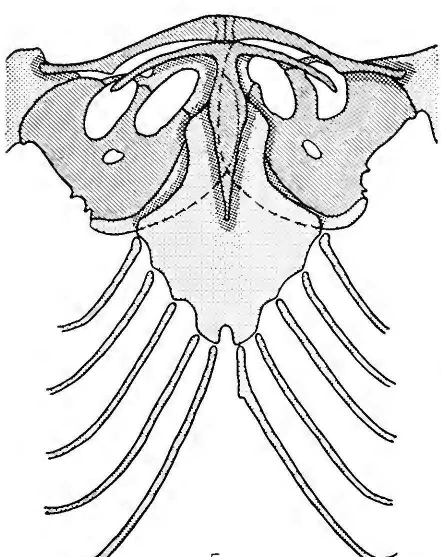

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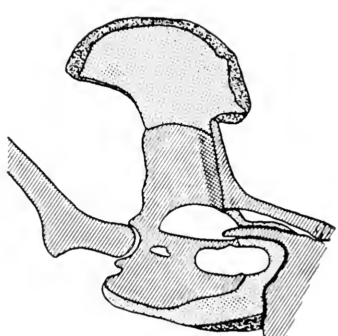

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PLATE XVI

Fig. 1. Knee joint, in dorsal aspect. Labels: *fe*, femur; *fib*. fibula; *ses*, sesamoid; *t*, tibia.

Fig. 2. Posterior aspect of left fibula and left tibia.

Fig. 3. Knee joint, somewhat separated in dorsal aspect. Labels: *fe*, femur; *d ses*, dorsal sesamoids; *v ses*, ventral sesamoids; *t*, tibia.

Fig. 4. Foreleg showing dorsal aspect of humerus (*h*), ulna (*u*), radius (*r*), and pisiform (*pis*).

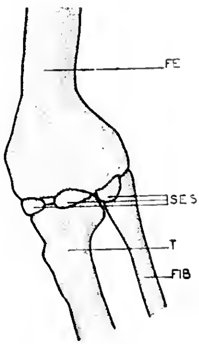
Fig. 5. Left femur, dorsal aspect and anterior aspect.

Fig. 6. Left foot, dorsal aspect. Labels: *ast*, astragalo-calcaneum; *ta*, tarsalia.

Fig. 7. Pelvic girdle, ventral aspect; cartilage stippled. Labels: *epub*, epipubis; *hypois*, hypoischium; *il*, ilium; *is*, ischium; *pub*, pubis; *sac v*. sacral vertebra.

Fig. 8. Left hand, dorsal aspect. Labels: *car*, carpalia; *ct*, centrale; *int*, intermedium; *pis*, pisiform; *r*, radius; *rd*, radiale; *u*, ulna; *ul*, ulnare.

PLATE XVI



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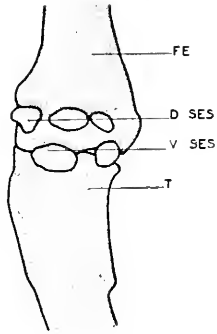

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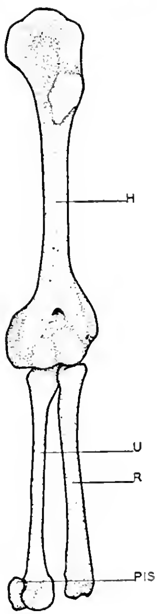

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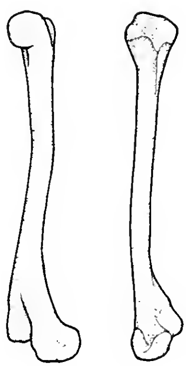

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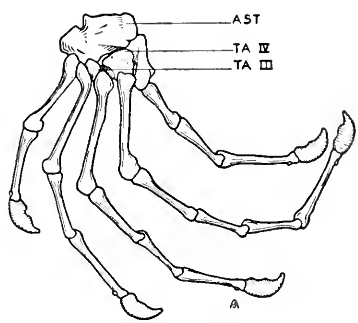

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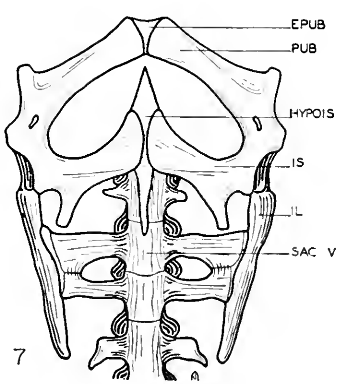

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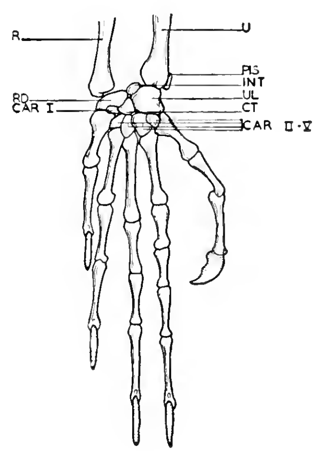

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THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN

VOL. XXXI, pt. II.] NOVEMBER 1, 1947 [No. 13

Comments on Ceylonese Snakes of the Genus *Typhlops* with Descriptions of New Species

By EDWARD H. TAYLOR

ABSTRACT: Five new species of the small blind snakes of the genus *Typhlops* are described from the Island of Ceylon. These are *Typhlops lankaensis, T. violaceus, T. malcolmi, T. tenebrarum*, and *T. veddae*. Five other forms are reported also. These are *Typhlops braminus, T. porrectus, T. mirus, T. ceylonicus*, and *T. leucomelas*.

THE most recent review of the snakes of Ceylon, is included in a recent volume by Malcolm Smith, which deals with the fauna of India and southeastern Asia.* In this entire region 19 species belonging to the genus *Typhlops* Oppel are recognized, one of the species being represented by two subspecies. Of the 19 species, five are reported from the island of Ceylon. Three of these have not been found elsewhere and are presumed to be endemic. The species are:

1. *Typhlops mirus* Jan, a species described about 85 years ago, but known from very few specimens, and from the single definite locality—Peradeniya. Endemic.
2. *Typhlops leucomelas* Boulenger. Known from two specimens. Endemic.
3. *Typhlops ceylonicus* Smith. The type is the only known specimen. Endemic.
4. *Typhlops porrectus* Stoliczka. This species occurs in India and Burma. It was recorded for the first time from Ceylon in 1897 by Méhely. Smith reports a specimen from Punduloya, Ceylon.
5. *Typhlops braminus* (Daudin), a widely distributed species, long known from Ceylon.

* The Fauna of British India, Ceylon and Burma, including the whole of the Indo-Chinese Sub-Region; Reptilia and Amphibia, Vol. III, Serpentes, Dec. 1943, London pp. 1-XII, 1-583, text figs. 1-166, 1 map.

In the Edward H. Taylor-Hobart M. Smith Collection there are 36 examples of these diminutive, "blind" snakes from Ceylon. Most of the specimens were obtained in the region 12 miles north of Trincomalee where the land is only about three to five meters above sea level. Two are from the mountainous region near Peradeniya. Of these two specimens, one belongs to the well-known *Typhlops braminus*, the other is an example of the rare *Typhlops mirus*.

Of the 34 specimens from the region north of Trincomalee, not one seems to belong to a described species; but they are separable into several distinct forms which are here described as new. All were obtained in sandy soils. Several were found within a few feet of high-water mark on the shore of a saltwater lagoon, in debris left by the waves. The soil was disturbed to a depth of only 3 to 4 inches while looking for them. Others were found by systematically moving accumulations of leaves on the forest floor, or debris from about the base of coconut trees.

Typhlops porrectus Stoliczka

Typhlops porrectus Stoliczka, Journ. Asiat. Soc. Bengal, Vol. XL, 1871, p. 426, pl. XXV, figs. 1-4. (Type locality, Bengal, India); Méhely, Termes. Fuzetek, Vol. XX, 1897, p. 62 (Kala-wewa, Ceylon); Smith, Fauna British India, Ceylon and Burma including the whole Indo-Chinese Sub-region; Reptilia and Amphibia, Vol. III, 1943, p. 46 (Punduloya, Ceylon).

This species is widespread in India but apparently it is uncommon in Ceylon. Two records, that of Méhely in 1897, and that of Smith in 1943 are the only specimens that have been reported.

The characteristics of this species, 18 scale rows, diameter of body in length 50-60 times, an incompletely divided nasal and the 400-440 transverse scale rows, clearly separate it from other known Ceylonese forms.

Typhlops mirus Jan

Typhlops mirus Jan, Iconegraphie Générale des Ofidiens, livr. 1, 1860, p. 9, pls. 5 & 6, fig. 7 (Type locality, Ceylon); Günther, Reptiles of British India, 1864, p. 176, pl. 16, fig. II; Theobald, Descriptive Catalogue of the Reptiles of British India, 1876, p. 126; Boulenger, The Fauna of British India including Ceylon and Burma, Reptilia and Batrachia, 1890, p. 240; and Catalogue of the Snakes in the British Museum (Natural History), Vol. 1, 1893, p. 52; Wall, Ophidia Taprobanica or the Snakes of Ceylon, 1921, pp. 7-9, fig. 1; Journ. Bombay Nat. Hist. Soc., XXIX, 1923, p. 348; Smith, The Fauna of British India including Ceylon and Burma, Reptilia and Amphibia, Vol. III, Serpentes, Dec. 1943, p. 55. (Ceylon. Known definitely from Peradeniya.)

A single specimen, EHT-HMS No. 30094, from Peradeniya, Ceylon, is in the collection. It may be well to record the characters of this specimen in some detail.

Head rounded in lateral profile, the nostrils ventrolateral, not visible from above; the width of the rostral equal to half (or slightly more) the width of the head, and not enclosed by the nasals;† a suture completely divides the nasal, and reaches to the second labial; the area of the anterior (inferior) portion is equal to one-sixth the area of posterior (superior) portion; preocular a little smaller than ocular; no trace of eye discernible; subocular presént‡ as large as ocular; dorsal head scales larger than body scales, but frontoparietal, frontal, interparietal, supraoculars and parietals smaller than ocular or preocular; first labial smaller than second; second larger than third, but much smaller than fourth; three posterior labials in contact with the subocular.

Mental distinctly larger than adjoining scales; three (or two) lower labials (second and third may be partially fused) wholly concealed when the mouth is closed. Tail lacking the terminal sharp-pointed spine, but having a low rounded elevation.

Brown above; the snout and lower parts yellowish with a sparse amount of pigment.

Scale rows about the body, 18; transverse scale rows around body, about 317;§ on tail 14. Total length, 131 mm.; tail length, 4 mm.; head width, 2.4 mm.; body width, 3.1 mm.; body width in total length, about 42 times.

There is some irregularity in the shape and size of the caudal scales. Smith (*loc. cit.*) gives the range of transverse scales as 330-360; and the maximum length, 140 mm.

Typhlops ceylonicus Smith

Typhlops mirus Wall (part), Ophidia Taprobanica or the Snakes of Ceylon; Colombo, 1923, p. 7. (In one place, in a table the nasals are reported as meeting behind rostral. At the bottom of the page he states "sometimes in contact behind the rostral.")

Typhlops ceylonicus Smith, Fauna of British India, Ceylon and Burma, including the whole of the Indo-Chinese Sub-Region, Reptilia and Amphibia Vol. III, Serpentes, Dec. 1943, pp. 55-56. (Type locality Peradeniya, Ceylon.)

Smith's description of the unique type follows:

"Snout rounded, strongly projecting; nostrils lateral; rostral nearly half the width of the head; nasal completely divided, the lower suture passing to the second labial, the posterior shield very large, in good contact with its fellow behind the rostral; ocular and preocular small the latter separated from the labials by a subocular, which is wedged in between them above, and is in contact with the

† Wall, *loc. cit.* notes that the nasals are sometimes in contact behind rostral. This is the condition in *T. ceylonicus*. The specimen showing this condition may be the type of that species.

‡ Boulenger, *loc. cit.* in the "Catalogue," page 14, (key) attributes two suboculars, erroneously, to this species.

§ Counts vary within limits of two or three scale rows on most specimens of *Typhlops*, depending upon which side or which particular row is counted.

2nd, 3rd and 4th labials below; no visible eye, the ocular shield in contact with the 4th labial only; tail blunt, without terminal spine; 18 scales round the body, the diameter of which is 35 times in the total length; about 330 transverse rows of scales. Brown above yellowish-white below. Total length: 140 mm.

"Known from a single specimen obtained at Peradeniya, Ceylon. Type in the Indian Museum."

Smith points out two distinctive characters by which this differs from *mirus;* the union of the nasals behind the rostral and the stouter proportions. The diameter is contained in total length 35 times (as compared with 40-50 times in *mirus*).

Wall has regarded this form as a variant of *Typhlops mirus* Jan. I have seen no specimens.

Typhlops leucomelas Boulenger

Typhlops leucomelas Boulenger, The Fauna of British India including Ceylon and Burma, Reptilia and Batrachia. London, 1890, pp. 237-238 (Type locality Haycock Mountain, 40 mi. from Galle, Ceylon, 2,000 ft. elevation.); and Catalogue of the Snakes in the British Museum (Natural History). Vol. 1, 1893, pp. 18-19, pl. 1, fig. 4; Wall, Ophidia Taprobanica or the Snakes of Ceylon, 1921, pp. 13-15, fig. 4; and Spolia Zeylanica, Vol. XII, 1922, p. 253, and Journ. Bombay Nat. Hist. Soc., XXIX, 1923, p. 350; Smith, The Fauna of British India, Ceylon, and Burma including the whole of the Indo-Chinese Sub-Region; Reptilia and Amphibia Vol. III, Serpentes, Dec. 1943, p. 50.

Boulenger's description follows:

"Snout rounded and moderately projecting; nostrils lateral. Rostral narrow, its upper portion about one third the width of the head, extending to between the eyes; nostril between two nasals, the anterior of which is in contact with the first and second labials and extends to the upper surface of the head; a praeocular, nearly as large as the ocular, in contact with the second and third labials; eyes distinct; upper head-scales a little larger than the scales on the body; four upper labials. Diameter of body 32 times in the total length; tail slightly longer than broad, ending in a point; 22 scales round the body. Blackish brown above, pure white inferiorly.

"Total length 130 millim."

The figures four, a, b, c, Plate I, show the following additional characters: Supraoculars and parietals equal in size to, or smaller than, the frontonasal; suture of supraocular and ocular not crossing eye; second labial two-thirds as large as the third; third labial as large as fourth; three preanals present. No posterior parietal distinguishable; two postoculars; rostral narrowed almost to a point on the labial border.

M. Smith's statement concerning *leucomelas* (*loc. cit.*): "Differs from *jerdoni* as follows: Breadth of rostral above that of head;

diameter of body, etc." is not clear. It is either a *lapsus* or certain words have been accidentally dropped by the printer.

Typhlops lankaensis sp. nov.

Type: EHT-HMS No. 30062, collected 12 miles north of Trincomalee, Ceylon, Sept. 13, 1944, by Edward H. Taylor.

Paratypes: EHT-HMS Nos. 30060-30061; 30064-30071; 30073-30078; 30080-30085; 30088, 31258, all topotypes.

Diagnosis: Head oval, seen from above; suture, dividing nasal completely, reaches to preocular; 20 scale rows about body; rostral somewhat less than one-third greatest width of head; transverse scale rows about body, 229-261; generally brown to gray-brown above with very dim longitudinal dorsal lines, the median most distinct; under side of head very largely cream color.

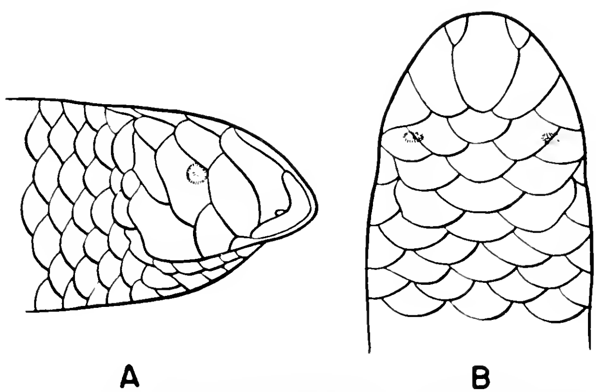


FIG. 1. *Typhlops lankaensis* sp. nov. A, lateral view of head; B, dorsal view of head. Much enlarged. From the type EHT-HMS No. 30062.

Description of type: Head oval in outline when seen from above; rostral between one-fourth and one-third the greatest width of head, failing to reach back to level of eye by a distance less than half the width of the prefrontal; nasal completely divided, the suture emerging at preocular, the upper (posterior) part distinctly longer and about a fourth larger than lower (anterior) part; median head scales wider than long, the prefrontal smaller than the frontal; latter scale smaller than the interparietal; the scale following interparietal, is wider but shorter than that scale; supraocular larger than any of the median scales, and likewise larger than parietals.

Four labials, the first two-thirds of second; fourth two and one-half times the size of third; ocular shorter but wider than preocular;

a single postocular; three lower labials, or the second may be partially fused with third which is large and concealed when mouth is closed.

Body scales in 20 longitudinal rows; individual scales usually wider than long, the median ventral series slightly wider and slightly larger than adjoining rows throughout the greater part of length. Transverse scale rows about 256 around body, 12 on tail; five somewhat enlarged, transparent anal scales, the outer, lateral, larger than the medial scales.

Color: Above light brown, darker dorsally, lighter laterally and ventrally; ventral and lateral parts of head immaculate cream; subsquamous glands on head distinctly outlined forming an intricate pattern; scales on 9 dorsal rows slightly lighter on the edges, so that 7 (or 9) dim, scarcely discernible lines are formed on dorsal longi-

Table of scale counts and measurements of *Typhlops lankaensis*

Number	Transverse scale rows body	Transverse scale rows on tail	Longitudinal scale rows	Total length	Tail length	Body width
30060	231	14	20	101	4.45	3.5
30061	244	11	20	82	3.0	3.0
30062	256	12	20	117	3.0	3.8
30064	254	13	20	103	3.5	3.5
30065	243	13	20	116	4.7	3.3
30066	253	13	20	112	3.3	3.8
30067	258	15	20	116	3.9	3.85
30068	261	13	20	119	3.0	3.5
30069	240	14	20	96	4.3	3.0
30070	240	14	20	91	3.3	3.15
30071	254	13	20	101	4.3	3.7
30073	243	14	20	96	3.8	3.2
30074	245	13	20	103	4.5	3.0
30075	258	12	20	130	3.8	3.9
30076	229	15	20	97	4.35	3.4
30077	259	14	20	116	4.5	3.8
30078	257	14	20	114	4.0	3.8
30080	255	13	20	78	3.5	2.6
30081	246	13	20	100	3.2	2.7
30082	253	14	20	104	4.0	3.3
30083	240	14	20	102	4.1	3.3
30084	249	11	20	115	3.2	3.5
30085	237	13	20	92	3.3	3.0
30088	240	13	20	104	4.0	3.3
31255	245	13	20	67	2.4	2.3

tudinal scale rows. An unpigmented area about vent, cream; the terminal tail spine grayish.

Measurements: Total length, 117 mm.; tail length, 3 mm.; width of body, 3.8 mm.; width in total length, about 30 times.

Remarks: The very low number of the transverse rows of scales seems to distinguish this species from other Ceylonese species as well as from the continental forms.

The ancient name for the island of Ceylon is Lanka. It is from this that the specific name has been derived.

Typhlops violaceus sp. nov.

Type: EHT-HMS No. 30091; collected 12 miles north of Trincomalee, Ceylon, Oct. 5, 1944, by Edward H. Taylor.

Diagnosis: A small *Typhlops* with eyes dim, but discernible; the nasal completely divided; the nostril lateral but not visible above, the suture dividing nasal touching the preocular far from the labial; 20 longitudinal scale rows; none or only a very small terminal spine; 245 transverse scale rows on body; body width in total length about 31 times. Color, dull violet to lavender, almost the same above and below.

Description of type: Head somewhat truncate-oval seen from above, the snout rather bluntly wedge-shaped in lateral profile, the top of head flattened; rostral tongue-shaped, failing to reach back to eye level by a distance equal to about two-thirds width of the prefrontal; nasal completely divided, the suture reaching the preocular at some distance from the labial, the upper part being about a fifth greater in area than the lower, and its greatest width a little more than that of the preocular; the lateral sutures formed by the rostral with the anterior part of the nasal show slight depressions noticeable when seen from below; preocular larger than the ocular, and much longer; prefrontal scarcely wider than long; frontal and first interparietal about equal in size, both larger than prefrontal but distinctly smaller than the second interparietal; supraocular largest of these scales and more irregularly shaped, its lower edge crossing the eye, the suture with the preocular much in front of eye; parietals, both anterior and posterior, about equal to last interparietal; body scales following are smaller (less than half) than head scales; four upper labials, first two-thirds of second; second about a half area of third; third a little more than half of fourth. Preanal scales, five, the outermost much enlarged; apparently no terminal spine or at most only a diminutive one (terminal scale shed). Terminal part of tail not bent down strongly.

Scales on body rather strongly rounded behind, in 20 longitudinal rows; transverse rows, 245 about body, 13 on tail.

Color: Above and below dull violet to lavender, only slightly lighter below; scales about mouth light, with some very slight pigmentation.

Measurements: Total length, 111 mm.; tail, 2.5 mm.; diameter of body, 3.6 mm.; body width in total length about 31 times.

Typhlops braminus Daudin

Eryx braminus Daudin, Histoire Naturelle générale et particulière des Reptiles, Vol. VII, year XI (= 1803), pp. 279-280. Based on Russel's *Rondou-Taloulou-pam* in, An account of Indian Serpents collected on the Coast of Coromandel, Vol. I, p. 48, pl. XLIII (Type locality Vizagapatam, India).

Typhlops braminus Boulenger, Catalogue of the Snakes in the British Museum (Natural History), Vol. I, 1893, p. 16; Wall, Ophidia Taprobanica or the Snakes of Ceylon; Colombo, 1921, pp. 7, 9-13 (figures apparently represent another species); Smith, The Fauna of British India, Ceylon and Burma, including the whole of the Indo-Chinese Sub-Region; Reptilia and Amphibia, Vol. III, Serpentes, Dec. 1943, pp. 46-48, fig. 14, head.

This very widespread species, *Typhlops braminus* has been reported by Wall as being "very abundant" in Ceylon. Boulenger, *loc. cit.* lists three Ceylon specimens. In the EHT-HMS collection is a specimen from Peradeniya, Kandy District (No. 30093). Although it is somewhat faded it agrees with *T. braminus* in the scale characteristics and counts.

I strongly suspect that Wall (*loc. cit.*) has confused more than one species with *T. braminus.* The figures he gives, if correctly drawn, cannot belong to this species, but represent an undescribed form. The rostral widens anteriorly instead of narrowing; the character of the dorsal head scales is different; three instead of five preanal scales are shown. It may be that the species here described as *T. lankaensis* was likewise confused with *T. braminus* by Wall since superficially they resemble each other, and it is likely that specimens of that species are present in the collections that Wall examined.

The specimen, No. 30093, has 317 transverse scale rows about the body, and 15 about the tail. The total length is 123 mm., the diameter of the body (3.1 mm.) about 40 times in length. There are 20 longitudinal scale rows on the body. The rostral is a little less than a third the width of the head, widest near the posterior end, narrowing anteriorly; the suture of the completely divided nasal reaches the preocular. Under part of the snout, the anal region and the terminal spine cream or whitish. In life the dorsal coloration is blackish or blackish brown above and somewhat lighter on the ventral surfaces. There is no subocular present.

The range of the transverse scale rows (ventrals) for *Typhlops braminus* is given by Smith, *loc. cit.* as 290-320; the diameter of the body, contained in total length, varying between 30-45 times; greatest length 170. Smith points out that the internasal suture which usually touches the preocular may sometimes touch the second labial, noting that certain forms in India previously described as new, should be regarded merely as synonyms. This may be true in certain cases, but in others not only the condition of the nasal suture, but other characters as well might warrant a separation. The matter should be reëxamined when more material is at hand.

Typhlops malcolmi sp. nov.

Type: EHT-HMS Nos. 30072; collected 12 miles north of Trincomalee, Eastern Province, Ceylon, Nov. 1944, by Edward H. Taylor.

Paratype: No. 30090, same data, Oct. 5, 1944.

Diagnosis: A small bicolored snake having 20 longitudinal scale rows. 261-273 transverse scale rows around body; fourth labial twice as large as third, notched behind; a single postocular present; brown above and cream below with a brownish pigmented band crossing throat. Glands on head form a distinct, lighter pattern.

Description of the type: Rostral rather elongate, reaching back to level of the middle of the eyes, beginning to narrow at the most posterior point of lower nasal; nasal completely divided by a suture which terminates at the second labial; the lower, anterior portion somewhat more than one-half the area of the upper, posterior part; posterior nasals not in contact behind rostral; prefrontal slightly smaller than ocular, followed by a frontal slightly wider but of the same shape; the suture of the ocular with supraocular crosses the eye; suture between the supraocular and the preocular barely touches the anterior edge of the eye; two parietals and two interparietals, the anterior parietals largest; preocular as wide as ocular but higher.

Four labials, first about one-half area of second; second two-thirds the area of the third; third a little less than half the area of the fourth; latter slightly notched on its posterior border; a single postocular present; lower lip bordered by a very tiny mental and two labials, a small anterior and a greatly elongated and narrow posterior reaching to angles of the mouth; tail ending in a blunt spine; five preanal scales, the outer one on each side, largest.

The transverse scale rows on the body 262, those on tail 11. Longitudinal scale rows 20; length 107 mm.; width 3.45 mm.; width in total length about 31 times. Tail length 4.5 mm.; head width 2.8 mm.

Color in life: Above brown on the eight dorsal rows, the color heaviest on the median dorsal rows, and lighter on the sides; two other lateral rows with some pigment; lower lateral and ventral rows dull cream to flesh color lacking pigment save for a light brownish band several scales wide crossing the throat.

The paratype, No. 30090, has 273 transverse scale rows on body and 9 on the tail; there are 20 longitudinal rows around the body. The total length is 81 mm., the tail 2.2 mm., head width 2 mm., width of body 2.6 mm., width into body length about 31 times.

The coloration conforms to that of the type save that it is definitely lighter. The band of pigment crosses the throat as in the type. The terminal spine is without pigment.

The relationship appears to be with *Typhlops leucomelas*, but it may be distinguished by the smaller number of longitudinal scale rows, lighter color, the band of color about throat and the different labials.

This is a lowland species living in sand on the forest floor.

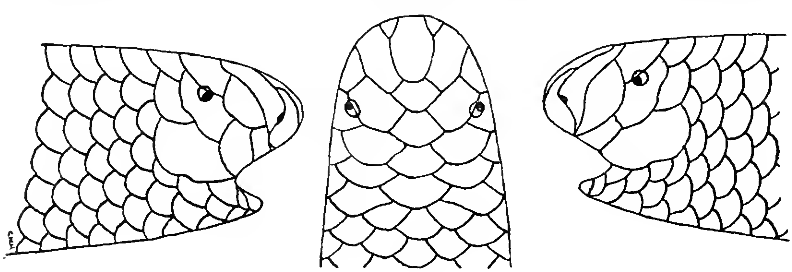
The species is named for Malcolm Smith, now of the British Museum of Natural History, who has published widely on the herpetology of Southern Asia.

Typhlops tenebrarum sp. nov.

Type: EHT-HMS No. 30063; collected 12 miles north of Trincomalee, Ceylon, Oct. 5, 1944, E. H. Taylor, collector.

Paratypes: EHT-HMS Nos. 30079, 30086, 30087, all topotypes.

Diagnosis: A very slender *Typhlops* with the nasal suture com-



A B C

FIG. 2. *Typhlops tenebrarum* sp. nov. Views of head. A, lateral view; B, dorsal view; C, lateral view of left side, showing presumed abnormal condition. All figures much enlarged. From the type EHT-HMS No. 30063.

pletely dividing the nasal and reaching the second labial; width contained in length from about 43 to 56 times; number of transverse scale rows about body from about 298 to 326 rows; 12 to 14 on tail; 20 longitudinal scale rows about body; light brown above, lighter below and on sides; scales bordering the mouth cream color.

Description of the type: Seen from above, the head is rounded anteriorly; greatest width of rostral one-third (or slightly less than) greatest width of head; rostral widest where scale touches most posterior (upper) part of the anterior (lower) nasal, then narrows, the sides being parallel almost to the border of mouth; the suture which completely divides the nasals emerges at the second labial, the lower part much more than half the area of the upper part; prefrontal about as wide as long, separating upper nasals, about the same size and shape as the frontal, and the anterior interparietal; posterior interparietal larger than other scales of the median row; supraocular larger than the prefrontal or frontal, its lower edge crossing eye near middle; preocular a little larger than ocular; a single postocular; eye rather indistinct, seen as a rather blackish spot (somewhat more distinct in younger specimens); four upper labials, first about a third the area of second; latter much less than half of third; fourth labial nearly double area of third (on left side the second labial is anomalously missing, partially fused to preocular, partly to third labial, the suture reaching the reconstructed third labial); three lower labials but the second and third apparently almost completely fused, concealed when mouth is closed.

Scales in 20 longitudinal rows; transverse scale rows about 320 on body, 12 on tail; preanals five, largely transparent, the outer scales largest.

Measurements: Total length, 111 mm.; tail, 2 mm.; width of body, 2.5 mm.; body width in total length, about 44 times.

Table of variation for *Typhlops tenebrarum*

Number	Transverse rows, body	Transverse rows, tail	Longitudinal scale rows	Total length	Tail	Diameter of body
30063	320	12	20	111	2.0	2.5
30079	300	13	20	112	3.0	2.0
30086	298	14	20	70	1.9	1.55
30087	326	13	20	65	1.8	1.5

Color: Above brownish to dull chestnut, the pigment more dense on the nine dorsal rows, lighter on lower laterals and ventrals; scales about mouth cream color.

Variation: The three topotypic paratypes show certain variations. The following table indicates variation in scale counts and measurements:

In all the specimens the suture of the nasals reaches to the second labial; a small terminal spine is present, sometimes blunt.

No. 30079 shows a singular variation in having the ocular and the supraocular fused for the greater part of the common suture, and the eyes are distinct; the tail curves sharply down at tip.

No. 30086 has the second interparietal abnormally broken.

Typhlops veddae sp. nov.

Type: EHT-HMS No. 30089; collected 12 mi. north of Trincomalee, Ceylon, Sept. 29, 1944, by E. H. Taylor.

Diagnosis: A very slender *Typhlops* having 20 scale rows, no subocular, the nasal suture to the second labial, the rostral short failing to reach back to eye level by a considerable distance; head somewhat narrowed, and truncate anteriorly; the transverse scale rows about body 295; 14 caudal rows; body width in length about 60 times.

Description of type: Width of the rostral about one-third the width of head at the level of eyes, failing to reach anterior level of eyes by three-fourths the width of prefrontal; nostril between two completely divided nasals, the upper nearly double area of the lower but not meeting its fellow behind rostral, the suture reaching

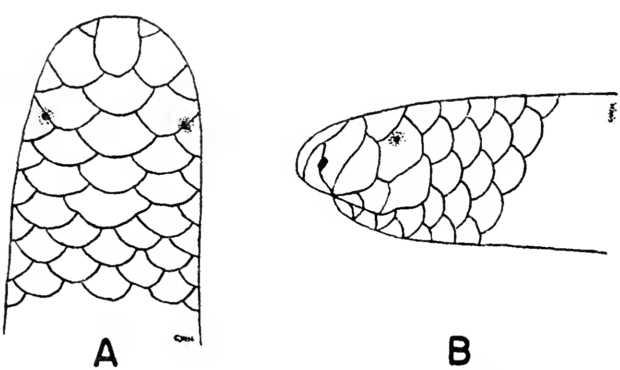


FIG. 3. *Typhlops veddae* sp. nov. A, dorsal view of head; B, lateral view of head. From the type EHT-HMS No. 30089. Much enlarged.

to the second labial; median head scales, the prefrontal, frontal, and interparietals, all about the same size and all broader than long; supraoculars, anterior and posterior parietals of nearly same shape but a trifle smaller than head scales of the median row; the fourth scale in this series not or only slightly enlarged; four upper labials, the fourth about one and one-third times larger than third; suture from the nostril reaching second labial which is about half as large as third; two lower labials on each side, concealed when mouth is closed; preocular about as large as the ocular, their common suture distinctly in front of eye; suture between the ocular and supra-ocular crosses upper edge of eye; scales of head all showing minute spinules. Eye a dim black spot, easily discernible.

Head seen from above tapers slightly to the somewhat truncate snout; in lateral profile the snout slopes downward from posterior part of nostral but the tip of the snout is rounded; subsquamous glands of head scarcely discernible, save along the edges of rostral.

Scales about body in 20 longitudinal rows and in about 295 transverse rows; 13-14 rows around tail; preanal scales five, somewhat enlarged; tail terminating in a small, rather indistinct spinelike scale.

Color: Lavender-gray throughout, with some trace of darker markings on scales when studied under a lens (especially on ventral scales); no trace of lighter areas on head, anal region, or tail. Total length, 90.5 mm.; body width (average), 1.51 mm.; head, 1.5 mm.; tail, 2.75 mm.

Remarks: The species, judging by its very slender habitus, and the large number of transverse scale rows is related to *Typhlops braminus,* and to *Typhlops tenebrarum,* described herein. It differs from the former in coloration, characteristic pattern of glands, in having the nasal suture touch the labial rather than the preocular. The shape of the head and particularly the shape of the snout, is quite different; the eye is dim, and the diameter of the body is contained into its length 60 instead of "30-45" times and the tail is proportionally longer.

The type was taken from decaying wood debris, in second growth forest.

The Veddas are an ancient people of Ceylon, now represented by small groups occupying a few villages in the wilder parts of the island.

DISCUSSION

Of the five new species described here, *Typhlops lankaensis* has probably been collected before, but its superficial resemblance to *T. braminus* may have caused it to be confused with that species. In the past many herpetologists have failed to make counts of transverse scale rows in these snakes and as a consequence they have overlooked striking differences in forms they have regarded as conspecific.

Fortunately there is a good series of *T. lankaensis* from a single locality, and the variation that obtains cannot be attributed to geographical variation. It is a common species but considerable effort is necessary to find it.

In passing, it may be said that in this species and perhaps many other species of *Typhlops* there are two transverse scale rows for each vertebra rather than a single one, such as is true for the greater number of snakes. However in some forms, *T. beddomei* Boulenger for example, with an extraordinarily low count of only 190-200 transverse rows perhaps only a single scale now corresponds to a single vertebra; and in a form such as *T. thurstoni* Boettger with the remarkable count of 550-600 transverse rows, perhaps more than two rows correspond to a vertebra. No specimens of these forms are available to me for examination.

Typhlops malcolmi with 20 longitudinal rows is clearly distinguished from *T. leucomelas* with 22 longitudinal rows. It may also be distinguished by color differences—black dorsally in *T. leucomelas* and brown in *T. malcolmi*. There are also differences in the relative sizes of the labials. *T. malcolmi* has a band of pigment across the throat, lacking in *leucomelas*. It would appear that *T. leucomelas* is a mountain form, while known specimens of *T. malcolmi* are from the sandy northern lowlands.

The "key" differences between *Typhlops violaceus* and *T. lankaensis* may seem unimportant. However the shape of the head, and the resultant changes in scale proportions make for distinct differences that are rather hard to put into words. In *violaceus* the snout extends farther in front of the mouth, and the point at which the nasal suture reaches the preocular is about double the distance from the edge of the mouth as the same point in *T. lankaensis*. The part of the rostral visible above in *T. violaceus*, especially the anterior narrowed part, is very much longer than the same part in *T. lankaensis*. Color alone will separate the species, and numerous other differences become obvious when individual scales are compared.

The two species *Typhlops veddae* and *T. tenebrarum* resemble *T. braminus* in the counts of the transverse scale rows, and by this same character are separable from *T. lankaensis* and *violaceous.*

They both differ from *T. braminus* in having the terminus of the nasal suture at the first labial rather than at the preocular, thus bringing the point of contact close to the mouth with the resultant differences in scale proportions and relationships. The body in these two species is distinctly slenderer than the body in *T. braminus.* The distinctions between T. *veddae* and *T. tenebrarum* are pointed out in the key.

One must not overlook the possibility that certain Indian forms now in synonymy may prove to be distinct species when sufficient specimens are available to prove them part of distinctive populations and not anomalies.

It is more or less consistent behavior of genera of burrowing species of snakes to diversify in greater extent than more terrestrial or arboreal forms thus less handicapped in movement. Burrowing habits make for lack of mobility and serve in a measure as an isolating factor.

KEY TO THE SPECIES OF TYPHLOPS IN CEYLON

1. Scales in 18 longitudinal rows about body; nasal variable.................... 2
   Scales in 20 or 22 rows about body; nasal divided.......................... 4
2. Nasal incompletely divided, the suture to 2d labial; no subocular; small terminal tail spine; eye distinct; 330-360 transverse scale rows; length 285 mm.: Blackish brown above, paler below..............................*T. porrectus*
   Nasal completely divided, the suture to 2d labial; a subocular present; no terminal tail spine; eye usually not visible.................................... 3
3. Upper (posterior) nasals separated behind rostral; 330-360 transverse scale rows on body, brown above paler below, length 140 mm.; head partly or almost entirely cream ....*T. mirus*
   Upper (posterior) nasals forming a median suture behind the rostral; 330 transverse scale rows on body; brown above, yellowish white below; length 140 mm., *T. ceylonicus*
4. Scales in 20 longitudinal rows about body.................................. 5
   Scales in 22 longitudinal rows about body; eye distinct; nasal suture to 2d labial; (260-280 scale rows, said to agree with *jerdoni*). Black above, whitish below, the colors meeting in a clear line of demarcation; length 130 mm., *T. leucomelas*
5. Nasal suture goes to the preocular.. 7
   Nasal suture goes to second labial.. 10
7. Transverse rows of scales on body more than 280........................... 9
   Transverse scale rows on body less than 275............................... 8
8. Transverse scale rows, 229-261 on body; subsquamous glands on head forming distinct pattern; eye distinct; underside of head largely cream; part of rostral visible above shorter; length 130 mm..........................*T. lankaensis*
   Transverse scale rows on body, 245; subsquamous glands on head not visible; eye rather indistinct; part of rostral visible above much elongate; snout somewhat truncate at tip; dull violet to lavender; length, 111 mm......*T. violaceus*

9. Transverse scale rows on body, 290-330. Pattern of subsquamous glands distinct; eye normally distinct; blackish brown above, paler below; length 170 mm. .... *T. braminus*
10. Body more attenuated; transverse scale rows on body above 290.............. 11
    Body less attenuated; transverse scale rows 261-273, body brownish above, the pigment becoming less on sides; venter cream save for a pigmented band on throat; eye distinct; width into body length, about 31 times; length, 107 mm., *T. malcolmi*
11. Transverse scale rows, 298-326; width of the body into length about 43 to 56 times; light brown above, lighter below. Scales bordering mouth cream; snout rounded anteriorly; upper nasal one-third larger than lower. 3d labial about half area of fourth; length 112 mm.................................. *tenebrarum*
    Transverse scale rows 295; body width into total length about 60 times; head truncate, subsquamous glands not or scarcely discernible; length 90 mm...*veddae*

THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN

VOL. XXXI, pt. II.] NOVEMBER 1, 1947 [No. 14

A Review of the Mexican Forms of the Lizard Genus *Sphaerodactylus*

By EDWARD H. TAYLOR

ABSTRACT: The four forms of *Sphaerodactylus* described from Mexico are discussed. *Sphaerodactylus glaucus* Cope and *Sphaerodactylus torquatus* Strauch are regarded as valid forms belonging in the Mexican fauna. *Sphaerodactylus anthracinus* Cope, is valid but its Mexican origin may be questioned. The status of *Sphaerodactylus inornatus* must be regarded as doubtful both as to its place of origin and its validity as a species.

THE diminutive lizards of the genus *Sphaerodactylus* have been known definitely from Mexico since the publication of the description of *Sphaerodactylus glaucus* Cope, in 1865. Nevertheless they have remained rarieties in collections, at least until recently. Barbour who reviewed the genus in 1921, said of *S. glaucus:* "It appears in so very few of the many collections made in Mexico and Central America that it must be very rare."

In 1936 Doctor Hobart M. Smith obtained in Campeche a series of 82 specimens belonging to the species *Sphaerodactylus glaucus.* Doctor Norman Hartweg and Doctor James Oliver succeeded in obtaining a series of 56 specimens of *S. glaucus* in Tehuantepec. Of these they state "vicinity of Tehuantepec; Quiengola Mountain UMMZ. Nos. 82292-82303 (56). All except three of the specimens seem to be typical *glaucus;* the 3 each have a dark collar on the neck." (Hartweg and Oliver 1940.)

Four species have been described from type localities in Mexico. These are *Sphaerodactylus anthracinus* Cope, "Mexico" [Jalapa?], December, 1861; *Sphaerodactylus glaucus* Cope, near Mérida, Yucatán, 1865; *Sphaerodactylus torquatus* Strauch, "Mazatlán," Mexico, May, 1886; and *Sphaerodactylus inornatus* Peters, "Mexico," 1873. Barbour who reviewed the genus in 1921 regarded *anthracinus* as a valid species but one not occurring in Mexico; *torquatus* as a synonym of *glaucus;* and *inornatus* as a synonym of *lineolatus,* but from some locality, not Mexican. The status of these four forms is discussed in the following pages.

Sphaerodactylus anthracinus Cope

Sphaerodactylus anthracinus Cope, Proc. Acad. Nat. Sci. Philadelphia, Dec. 1861, p. 500 (Type description; type locality, "Mexico," [Jalapa?] Mus. Philadelphia); von Müller, Reisen in Vereinigten Staaten, Canada und Mexico, vol. 3, 3rd pt., 1865, p. 599 (listed from Mexico; no specimen, Cope cited); Cope, Bull. U. S. Nat. Mus., No. 32, 1887, p. 27 (listed from Mexico); Peters, Monatsb. König. Akad. Wiss. Berlin, 1869, p. 874 (listed from Puebla); Boulenger, Catalogue of the Lizards in the British Museum (Natural History), vol. 1, 1885, p. 225 (Mexico; San Domingo, one specimen); Günther, Biologia Centrali-Americana, 1885, p. 83 (no specimens); Barbour, Mem. Mus. Comp. Zoöl. Harvard College, Vol. 47, No. 3, Dec. 1921, pp. 258-259 (Andros Island).

Cope believed that the types of *Sphaerodactylus anthracinus* came from Mexico, and listed Mexico as the type locality for the species. Barbour, who had available two specimens from Middle Bight, Andros Island, Bahamas, the types of *Sphaerodactylus asper* Garman, found the two species to be synonymous, and concluded that the type of *anthracinus* must have originated on Andros Island. He states (Barbour 1921 p. 258): "The original description stated that the type came from Mexico. This has been copied by Boulenger and others. It seemed at once highly improbable that a sphaerodactyl of this style should occur upon the mainland. The type-specimen was, therefore, carefully examined and found to be absolutely identical with examples from Andros Island in the Bahamas. It has not been rediscovered in Mexico, and the locality is certainly erroneous."

Contrary to the statement that the form had not been rediscovered in Mexico, is the published statement of Peters (1869) who records a specimen from Puebla (presumably from near Izucar de Matamoros in the southern part of the state). This collection made by Hr. Berkenbusch, was sent from Mexico and there seems to be little chance of a mix-up of data. Whether it is misidentified is another question; but the size, the unusual iron gray color and the character of the large scales seem to preclude the chance of its being confused with the small smooth scaled *torquatus* or *glaucus.* This reference seems to have been overlooked by Barbour. Boulenger lists a British Museum specimen from San Domingo, a reference either overlooked or not mentioned by Barbour.

Perhaps one would be unwise to state definitely that the species occurs in Mexico on the basis of the two published records. However there is certainly as strong a possibility that it does occur as that it does not. Careful search made in the cities of Jalapa, Veracruz, and Matamoros, Puebla, as well as in their surroundings may bring about its rediscovery. The fact that the species has not been taken in recent collections is certainly no proof that it does not occur.

The following type description is brief but the characters given are diagnostic.

"S. anthracinus Cope.

Size large, (head and body 1 inch, 9 lines); muzzle elongate acute; labials four above, two large and three small below; supranasal plates small, superior; frontal scales keeled; the dorsal strongly keeled, rounded, in ten rows on each side, extending for a considerable distance on the tail. Gular scales smooth. Color black, the large dorsal scales tinged with blue.

Hab. Mexico. Mus. Philadelphia."

Sphaerodactylus inornatus Peters

Sphaeriodactylus inornatus **Peters, Monatsb. König. Akad. Wiss. Berlin, 1873, p. 738 (type description; type locality Mexico, "Zwei exemplare aus Mexico; aus der Uhde'schen Sammlung; No. 4589. M. B.")**

This species was questionably referred to the synonymy of *Sphaerodactylus glaucus* by Boulenger (1885) and it also appears in the synonymy of the species in Günther (1885). Apparently no change in this status was suggested until Barbour (1921) placed the form in the synonymy of *Sphaerodactylus lineolatus* Lichtenstein. He writes as follows of *lineolatus*: "This species seems to range widely through Lower Central America while *glaucus* is more northern in its range. Both species are known from Guatemala. Peters' type of *inornatus*, apparently a synonym of this species, is said to have come from Mexico far from the known range of *lineolatus*. It is more probable that the locality is incorrect than that Peters so noted for his precise and careful observing would have missed the peculiar dorsal squamation of *glaucus*."

The description of *S. inornatus* as given by Peters, follows:

"Sehr nahe verwandt mit *Sph. punctatissimus* D. B., aber die Schnauze ist kürzer, ohne Canthi rostrales, das Rostralschild is ebenfalls kürzer und merklich höher, die Supranasalia sind kleiner und die ganze Beschuppung is etwas feiner. Die sehr kleinen Rückenschuppen sind flach und glatt, ebenso wie die merklich grösserer Bauchschuppen. Labialia jederseits vier oben und unten.

Graubraun mit einzelnen kleiner schwarzen Punkten namentlich an den Körperseiten. Mit der Lupe betrachtet sind die einzelnen Rückenschuppen mit zwei bis drei kleinen dunkeln Pünktchen versehen.

Zwei Exemplare aus Mexico; aus der Uhde'schen Sammlung. (No. 4589 M. B.)"

Whether Boulenger or Barbour is correct regarding the synonymy cannot be stated at the present time. It is significant that Peters describes a species with markings unlike the Mexican *glaucus* and states concerning the squamation "Rückenschuppen sind flach und glatt." This is very different from the described squamation of *lineolatus* of which Boulenger says: "slightly keeled;" and Barbour: "extremely small juxtaposed granules, the centre of each swollen into what might be considered a keel." Until more material of this presumed species is discovered in Mexico, *inornatus* (or *lineolatus*) must have only a doubtful right to a place in the Mexican faunal lists.

Sphaerodactylus torquatus Strauch

Sphaerodactylus torquatus Strauch, Mem. Acad. Imp. Sci. St. Petersboug 1887, 7th ser. vol. 35, No. 2, May 1886, pp. 35-36 (type description; type locality, Mazatlán; No. 3268, Mus. Petrograd. 3 specimens. Hr. Salmin 1871 coll.); Günther, Biologia Centrali-Americana 1885, p. 82 (no specimens); Taylor, Univ. Kansas Sci. Bull., vol. 24, No. 20, 1936 (1937) p. 506, no specimens; listed for Sinaloa.

Sphaerodactylus glaucus (part.) Barbour, Mem. Mus. Comp. Zoöl. Harvard Coll. vol. 47, No. 3, 1921, pp. 240-241 (*torquatus* placed in synonymy).

The discovery of 25 specimens of *Sphaerodactylus* in Tehuantepec having characteristics of the species described by Strauch as *torquatus*, suggests the wisdom of removing this species from the synonymy of *S. glaucus* where it was placed by Barbour.

The illustrations of the color pattern of nearly equal-sized specimens of *torquatus* and *glaucus* on the somewhat conventionalized body outlines show the characteristic differences in the markings of the young of the two species. Of the numerous young of *glaucus* in the EHT-HMS collection, all specimens fit the pattern as depicted for that form. See fig. 2.

The type description of this species follows:

"*Sphaerodactylus torquatus* n. sp.

3268. Mazatlan. Hr. Salmin 1871, (3 Ex.).

Zunächst mit *Sphaerodactylus glaucus* Cope verwandt, mit dem er die kleinen, nicht gekielten Rumpfschuppen und das mässig grosse Rostralschild gemein hat, von dem er sich aber durch den viel gestreckteren Kopf, die gestrecktere, mehr zugespitzte Schnauze und die verschiedene Färbung und namentlich Zeichnung unterscheidet.

Die Schnauze unbedeutend länger, als der Zwischenraum zwischen Ohröffnung und Orbita. Die Ohröffnung klein und ausgesprochen horizontal gestellt. Das Rostrale von mässiger Grösse,

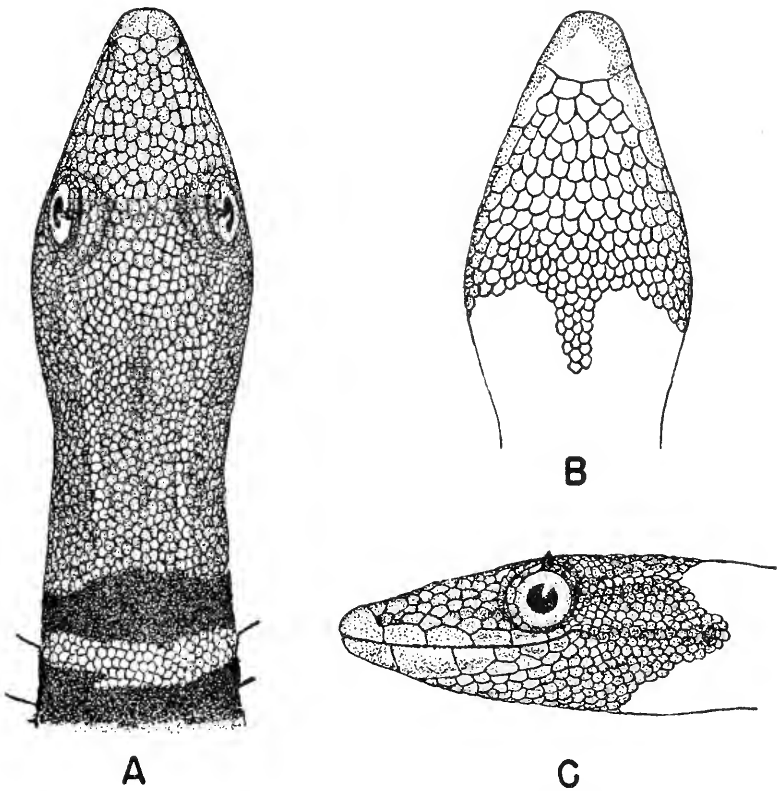


FIG. 1. *Sphaerodactylus torquatus* Strauch. A, dorsal view of head and neck; B, ventral view of head; C, lateral view of head (all greatly enlarged and slightly diagrammatic).

genau so beschaffen, wie Boulenger es auf Tafel XVIII, Fig. 3 von *Sphaerodactylus glaucus* Cope abgebildet hat. Jederseites 6 Supralabialia, die letzten sehr klein. Das Mentale gross, bedeckt die Spitze des Unterkiefers und besitzt einen leicht bogenförmigen Hinterrand; zu jeder Seite desselben stehen 6 Infralabialia, von denen die 3 vorderen sehr gross, die 3 hinteren dagegen sehr klein sind. Zwei grosse neben einander liegende Submentalia und hinter denselben 3 etwas kleinere in einer Querreihe; hinter diesen letzteren noch 2 oder 3 Querreihen von Schildchen, die successive an Grösse ab-, an Convexität aber zunehmen und so allmählich in die Kornschuppen der Kehle übergehen. Das Augenlid hat in der Mitte seines Oberrandes einen kleinen, nach hinten gerichteten Dorn. Die Oberseite aller Theile mit kleinen flachen Schuppen bedeckt, die auf dem Hinterkopfe besonders klein, kornförmig sind. Die Kehlschuppen sind, wie schon bemerkt, klein und convex, die Bauchschuppen dagegen plan, etwa doppelt so gross, wie die Rückenschuppen, und dachziegelförmig gelagert.

Die Oberseite zeigt auf hellen braunlichgelben Grunde braune Vermiculationen, die auf dem Kopfe in der Längsachse des Thiers verlaufen, während sie auf dem Rumpfe mehr der Quere nach gerichtet sind. Die Oberseite das Halses ist mit einem weissen, breit schwarz gerandeten Halsbande versehen, d. h. es finden sich daselbst drei gleichbreite Querbinden, eine vordere schwarze, die vor die Schulter liegt, eine mittlere weisse, welche die Schulter berührt, und eine hintere schwarze, welche hinter der Schulter liegt und in die Achselhöhle herabsteigt. Der Schwanz ist bei den beiden grösseren Exemplaren reproducirt und erscheint fast einfarbig bräunlich gelb, da die braunen Vermiculationen daselbst nur andeutungsweise vorhanden und sehr vereinzelt sind. Bei dem kleinen Stück dagegen, dessen Schwanz viel länger und sehr dünn ausgezogen, also augenscheinlich nicht reproducirt ist, zeigt er in seinem Enddrittel ähnliche Zeichnungen, wie sie nach Boulenger bei *Sphaerodactylus glaucus* vorkommen. Die äusserste Spitze ist nämlich weiss, vor derselben findet sich ein breiter schwarzbrauner Ringel; vor diesem Ringel sieht man auf der Oberseite in gleichen Abständen noch mehrere weisse Flechen, die mehr oder weniger deutlich braun gesäumt sind und nach der Schwanzbasis zu immer undeutlicher werden. Die Unterseite aller Theile ist sehr hell bräunlichgelb.

Maasse. Totallänge 49 mm.; Länge des Kopfes—8 mm.; des Rumpfes—21 mm.; des Schwanzes—20 mm. Bei dem kleinen Exemplar, dessen Schwanz, wie schon bemerkt, nicht reproducirt ist, beträgt die Länge dieses letzteren etwas mehr, als diejenige von Kopf und Rumpf zusammengenommen."

Whether "Mazatlan" the type locality of *Sphaerodactylus torquatus* is the port of that name on the west coast of Mexico is not certain. However it has generally been presumed that this seaport was meant. I searched for the species in 1934 while collecting in the vicinity of Mazatlán, Sinaloa, but found neither this species nor two other gekkoes that are mentioned by Strauch (1886) as having been taken at the same locality. These latter appear as follows in the same work:

"*Phyllodactylus tuberculosus* Weigmann
2688 Mazatlan Hr. Salmin 1870

2689 Mazatlan Hr. Salmin 1870 (2 ex.)
2690 Mazatlan Hr. Salmin 1870 (3 ex.)
Phyllodactylus galapagensis Peters
3257 Mazatlan Hr. Salmin 1871"

The presence of this latter species seems to be an error of identification or of locality—possibly both.

The possibility that the name "Mazatlan" refers to some other locality has been considered. In Mexico there is a "Mazatlán" in Jalisco and one near Chilpancingo, Guerrero. In the state of Oaxaca there is a Mazatlán San Cristobal near Teotitlan, and Mazatlán San Juan near Tehuantepec. There are at least two species of *Phyllodactylus* (*magnus* and *muralis*), known from this region and the present species *Sphaerodactylus torquatus* likewise occurs there. Whether Hr. Salmin ever visited Oaxaca or obtained specimens from there I cannot say. In other works of Strauch I find specimens accredited to Salmin at about this time from Montevideo and Neu-Freiburg.

If this material can be examined and the actual identity of the two *Phyllodactylus* determined it may be possible to fix the type locality of *torquatus* with greater certainty. I very strongly suspect the locality, if intended for Mazatlán, Sinaloa, is either incorrect or the presence of the species there is to be accounted for by introduction by man.

Sphaerodactylus glaucus Cope

Sphaerodactylus glaucus Cope, Proc. Acad. Nat. Sci. Philadelphia, Oct. 1865, pp. 192-193 (type locality, near Mérida, Yucatán; Comision Cientifica under Arthur Schott, coll.; several specimens); Cope, *ibid,* May 1866, p. 125 (types mentioned as collected by Arthur Schott; and a specimen from Tabasco collected by Dr. Berendt); Cope, *ibid,* Oct. 24, 1871, p. 216 (a specimen from Tehuantepec, "collected by the U. S. Expedition to survey the Isthmus of Tehuantepec, by T. Hale Street, M. D."); Bocourt, Mission Scientifique au Mexique et dans l'Amérique Central; Etude sur les Reptiles, Livr. 2, 1873, p. 46, (no specimens); Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1876, p. 118; Bocourt, Journ, de Zoöl. Paris, vol. 5, 1876, p. 401 (Tehuantepec specimen collected by F. Sumichrast); Sumichrast, Bull. Soc. Zoöl. France for 1880, vol. 5, p. 173 (habits; Tehuantepec); and Sumichrast, La Naturaleza, vol. 6, entrega 3, 1882, p. 35 ("de ambos costas de la República"); Boulenger, Catalogue of Lizards in the British Museum, (Natural History), vol. 1, 1885, p. 221, pl. 18, fig. 3 (figure showing end of snout, upper view × 2; adult specimen from Verapaz, Guatemala (low forest) and half grown from Veracruz, Mexico, collected by F. D. Godman and O. Salvin); Günther, Biologia Centrali-Americana; Reptilia and Batrachia, 1885, p. 82 (records include Teapa in Tabasco, Belize and Stan Creek, British Honduras; Petén, Quatemala); Cope, Bull. U. S. Nat. Mus. No. 32, 1887, p. 27 (locality list); Strauch, Mem. Acad. Imp. Sci. St. Petersbourg, ser. 7, vol. 35, No. 2, May 1886, p. 35 ("No. 4292, Fundort? Hr. H. Shilling 1876"); Dugès, La Naturaleza, 2d ser. vol. 2, pt. 2, 1896, 479, 484 (occurs in "Tierra Caliente"); Gadow, Proc. Zoöl. Soc. London, June 6, 1905, p. 194, 211 ("Sphaerodactylus sends only three species into Mexico; *S. glaucus* to Salina Cruz [Oaxaca] and into the state of Veracruz, etc."); Barbour, Mem. Mus. Comp. Zoöl. Harvard College, vol. 47, No. 3, Dec. 1921, pp. 240-241, (lists types, and redescribes one cotype, M. C. Z. No. 13,570 formerly part U. S. N. M. No. 6,572); Allen, Copeia, No. 169, 1928, p. 98-99 (specimen of uncertain provenance, carried in bananas); Barbour and Loveridge, Bull. Mus. Comp. Zoöl. Harvard Coll. 49, No. 10, 1929, p. 342 (condition of cotype); Gaige, Carnegie Institution Washington Publication No. 457, 1936, p. 295 (color description of one specimen from Tuxpena Camp, Campeche); Smith, Occ. Papers Mus. Zoöl. Univ. Michigan, No. 388, Oct. 31, 1938, p. 13 (*Part.*) (specimens from Campeche): Ciudad del Carmen (10), Balchacaj (72), Apazote (1); Hartweg and Oliver, Misc. Publ. Mus. Zoöl. Univ. Michigan, No. 47, July 13, 1940, p. 14, (part.) (56 specimens; vicinity of Tehuantepec; Quiengola Mountain "all except 3 of the specimens seem to be typical *glaucus*. The three each have a dark collar on the neck)."

The rather brief type description of this species follows.

"*Sphaerodactylus glaucus*.

Dorsal scales very small, but flat, rounded, smooth; about ninety series round the body; abdominals larger, rounded, about forty-four rows from vent to axilla, continued larger on under side of tail (not reproduced in this specimen). Labials 4/4, three scales bordering mental. Supraorbital mucro (*sic*) present, orbit equal from its border to, or little beyond, nostril; muzzle and front gradually acuminate. Auricular meatus smaller than digital pallette. Above light brown, "greenish stone color or glaucus" in life, with minute paler spots and dark vermiculations; below whitish. Tail in life orange, more intense toward tip; in spirits with two yellow black-edged spots near tip, and one on each side the origin. Limbs and digits annulated with yellow, black bordered.

Muzzle to axilla, 5.5 lines; Muzzle to vent, 11.6 lines; vent to end of tail, 10.4 lines.

Habitat.—Near Merida, Yucatan. Coll. Comision Cientifica under Arthur Schott.

Allied to the cinereus and sputator, and somewhat intermediate between them. The second from Mexico."

The coloration of the young and half grown specimen (after preservation in formalin and alcohol) is of a somewhat uniform brownish, variable in shade, but growing lighter on the sides and gradually merging in the cream white of the venter. Anterior to a line joining the point of insertion of the arms is a median dark spot, flanked on each side with a cream spot; on each side of the body are two indistinct series of tiny cream spots; usually five or six are discernible and these tend to alternate with one another. There may be a more or less indistinct medial hair-line of darker pigment on occiput and also a hair-line on each side running back from eye on the occiput; some specimens (all perhaps to a greater or lesser degree) show an indefinite, darker canthal line which extends behind the eye on to the side of neck. Labials, both upper and lower, with darker areas.

On the arm there is a distinct cream spot on the elbow and a

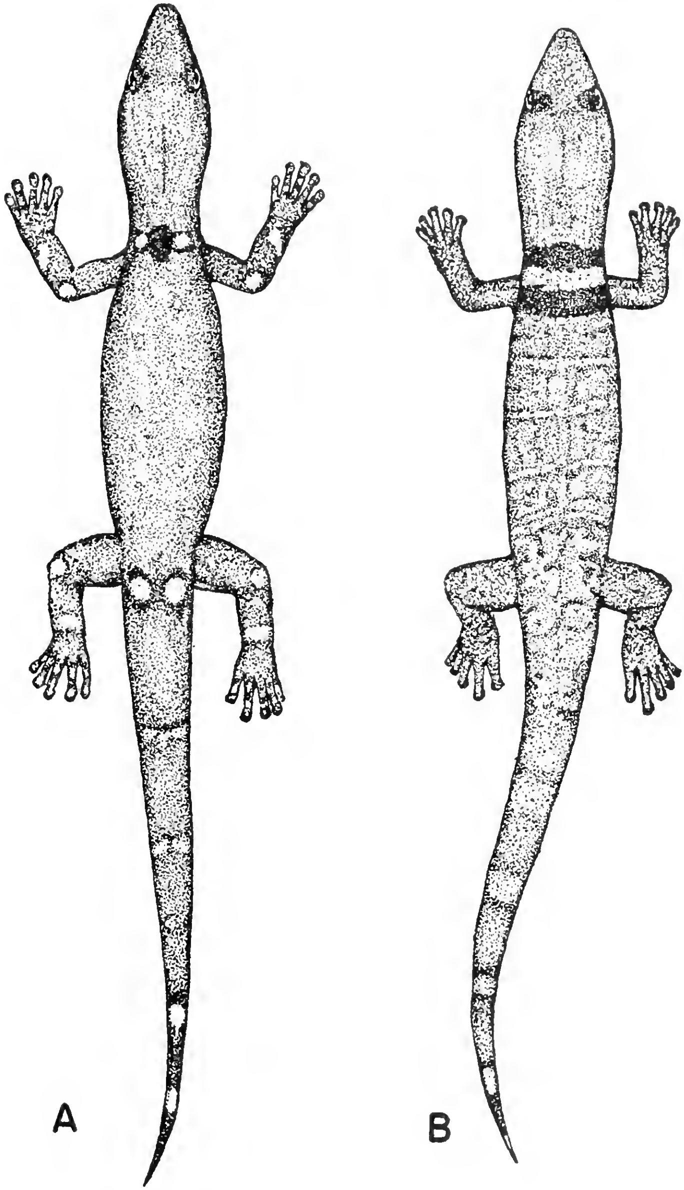


FIG. 2. A, *Sphaerodactylus glaucus* Cope. Somewhat diagrammatic showing the juvenile color pattern. Much enlarged. B, *Sphaerodactylus torquatus* Strauch. Somewhat diagrammatic, showing the juvenile color pattern. Much enlarged.

cream spot on the outer face of the arm; the fingers are annulated with cream at the joints. The leg has a knee spot of cream and a spot almost forming a band about middle of the lower part of leg. There are cream spots or annulations at the toe joints.

At the base of the tail there are two rounded spots of cream, variable in distinctness; toward the tip, when the tail is complete, there are two cream bands bordered by black on each side; occasionally whitish flecks are discernible toward the base. Ventrally on the tail the enlarged scales are cream at the base of the tail and in older specimens the color may extend to the tip; the flanking scales on each side are pigmented and this pigment may encroach slightly on the median series. The side of the head and neck is usually darker than the dorsal part of the head. The line bordering the dorsolateral darker stripe or line, may be lighter than the dorsal parts as a whole, suggesting a dim line running back from eye. There are indications of minute lighter dots scattered on the back.

In most if not all older specimens the spot on the shoulders is narrowed and lengthened somewhat, and the cream spots bordering it may be dim or altogether lost. The banding of the tail will be lost except that there usually remains one or two terminal cream and dark stripes usually less intense than in the young. (Note Fig. 2, showing markings of the young.)

The coloration in life differs somewhat from that of the preserved specimens. The cream spots are usually described as orange, reddish orange or pale red especially on tail. The general dorsal coloration is greenish gray or gray brown.

Mrs. Helen T. Gaige (1936) has described a specimen identified as *Sphaerodactylus glaucus* from Tuxpena Camp, Campeche as follows:

"Color gray with a single large black spot just behind the nape, followed by a spot lighter than the ground-color edged with two smaller black spots posteriorly; two conspicuous black dorsal spots between the hind legs, followed by a light spot; sides of neck with longitudinal stripes of gray. Nape with three converging dark longitudinal stripes; a faint indication of a darker gray stripe between fore and hind leg."

The present known distribution of the form in Mexico includes Yucatán, Campeche, Tabasco, Oaxaca and Veracruz. The most northern record is on the Jalapa-Veracruz highway about 20 miles from the city of Veracruz. I obtained the specimen from the bark of a small tree at the edge of a lagoon.

CONCLUSION

Of the four species of the genus *Sphaerodactylus* described from actual or presumed type localities in Mexico, *Sphaerodactylus glaucus* and *Sphaerodactylus torquatus* must be regarded as valid forms, since each is known from specimens unquestionably originating in southern Mexico. Despite the fact that the types of *Sphaerodactylus anthracinus* were reputed to come from Mexico and a specimen has been reported by Peters from Puebla, its presence in Mexico must be verified before it can have a certain place on Mexican faunal lists. Concerning *Sphaerodactylus inornatus*, Boulenger regarded it a synonym of *S. glaucus* and Barbour, a synonym of *lineolatus* and as coming from some locality not Mexican. Until the type is reëxamined the status of this form must remain in question.

THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN
VOL. XXXI, pt. II.] NOVEMBER 1, 1947 [No. 15

Fossil and Living Pupillidae (*Gastropoda: Pulmonata*) in Kansas

By DOROTHEA S. FRANZEN and A. BYRON LEONARD

TABLE OF CONTENTS

ABSTRACT: The family Pupillidae (Gastropoda: Pulmonata) in Kansas and nearby areas is studied from the earliest known occurrence in the lower Pliocene Laverne Formation to and including the living pupillid faunule. The family is not yet known from the middle Pliocene of this region, but is reported from several strata of the Pliocene and Pleistocene.

The family Pupillidae, as now known, is represented in the area studied by 5 genera, including in all 33 species, as follows: genus *Gastrocopta,* 14 fossil and living species and subspecies; genus *Vertigo,* 10 fossil and living species and subspecies; genus *Pupilla,* 3 fossil species and subspecies, genus *Pupoides,* 3 fossil and living species; and the genus *Columella,* represented by 3 fossil species. Two new species of *Gastrocopta* are described, both from deposits of Blancan age.

The paleoecology of the various horizons studied is discussed; the deductions are based upon a consideration of reported floras and vertebrate faunas, together with the known molluscan faunules.

The verticle distribution of the pupillid faunules is reported and discussed. Faunal successions revealed indicate specific pupillid faunules for various horizons as follows: *Gastrocopta riograndensis* and *G. anterides,* known only from the lower Pliocene Laverne Formation; a close faunal relationship between the Saw Rock Canyon deposits (upper Pliocene?, Hibbard, 1946, personal communication) and the beds assigned to the Blancan age is demonstrated, since 5 of the 6 pupillids known from the aggregate faunule of these beds occur both in the Saw Rock Canyon deposits and the Blancan beds. *Gastrocopta paracristata* and *Vertigo hibbardi* are known from the Saw Rock Canyon as well as from beds of Blancan age, *Gastrocopta rexroadensis* is known only from beds now assigned to the Blancan, while the remaining pupillids of these beds are known through the Pleistocene and Recent faunules. Early Pleistocene faunules are characterized by the occurrence of *Gastrocopta proarmifera, G. falcis, Pupilla muscorum sinistra, Columella tridentata,* and *Vertigo gouldii,* and by the first appearance of *Pupilla muscorum,* which is also found in late Pleistocene faunules. Late Pleistocene pupillid faunules are characterized by the occurrence of *Vertigo hannai, V. elatior, V. gouldii paradoxa, Columella hasta* and *C. alticola, Pupilla blandi,* and by the first appearance of *Gastrocopta armifera, Pupoides hordaceus,* and *Vertigo modesta.* Four species are apparently restricted to the living pupillid faunule of Kansas, these are *Gastrocopta corticaria, G. pellucida hordeacella, Vertigo tridentata,* and *Pupoides inornatus.*

The status of *Gastrocopta armifera abbreviata, G. procera sterkiana, G. p. mcclungi,* and the reported species of *Pupilla* are discussed, and the errors in previously published literature on Kansas mollusca are corrected.

INTRODUCTION

INTENSIVE and critical studies of the molluscan fauna of Kansas and the nearby states of Oklahoma, Missouri, and Nebraska have not been made previously, although the molluscan animals of Kansas have been given some attention by biologists for many years.

An early series of surveys of the flora and fauna of Kansas was sponsored by F. W. Cragin of Washburn College. Cragin was also editor of a scientific journal, the Bulletin of the Washburn Laboratory of Natural History, published 1884-1890 by the Natural History Department of Washburn College. In the second number of the Bulletin, R. Ellsworth Call (1885, pp. 48-49) reported a new species of *Unio* from Kansas. Succeeding studies of fresh-water mollusks were conducted by Call, who in the second number of the Bulletin (1885a, 49-51) published on the fresh-water bivalves and (1885b, 51-54) on the fresh-water univalves of northeastern Kansas. In the third number, the report by Call (1885c, pp. 93-97) treated of mollusks occuring in central and southeastern Kansas. The account by Call in the fourth number (1885d, pp. 115-124) included species not previously reported from Kansas and new locality records for previously reported species of lamellibranchs, as well as a study of aquatic gastropods. A fifth report by Call (1886, pp. 177-184) included a study of the molluscan faunule of Crooked Creek, Ford County, a comparison of the mollusks of the Arkansas River drainage in Kansas with that of the Ohio River, and additions to previous accounts of species occurring in Kansas as well as new localities for previously reported species. In the seventh number of the Bulletin, Call (1886a, pp. 201-206) reported on a study he made of the terrestrial molluscan fauna of the state. The final contribution by Call to the knowledge of the molluscan fauna of Kansas, was a study of pelecypods, aquatic and terrestrial gastropods (1887, pp. 11-25). W. G. Binney and Arthur F. Gray (1885, pp. 55-56) listed land shells of northeastern Kansas. Their report was comprised of a list of species with locality data. Richard E. Scammon studied the Kansas Unios and published "The Unionidae of Kansas" (1906, pp. 279-373) which is an extensive account including reports of 61 species and 5 subspecies. Ferris (1907, pp. 37-38) described a new subspecies of terrestrial snail occurring in Kansas.

G. Dallas Hanna (1909, pp. 81-82, 94-96) published a list of aquatic and terrestrial gastropods he had collected from Douglas

County. In a study of the genus *Sphyradium* [now *Columella*], Hanna (1911, pp. 372-373) described a new species obtained from a Pleistocene deposit in northwestern Kansas. A few years later the first report of a Pleistocene molluscan faunule from northwestern (Phillips County) Kansas was published by Hanna and Johnston (1913, pp. 111-121). This was later supplemented by a report by Hanna (1920, pp. 17-19) of the Pleistocene mollusks of Wallace County, Kansas. This was Hanna's final paper concerning Kansas mollusks.

A period of approximately twenty years elapsed before studies of Kansas mollusks were resumed. Doctor Claude W. Hibbard of the Museum of Natural History, University of Kansas, in studying vertebrate paleontology, found shells of mollusks associated with fossil vertebrates in Pleistocene and Pliocene beds in southwestern Kansas. He was interested in these shells insofar as they were of value in determining the ages of various strata of the several geologic formations he was encountering. He sent some specimens to Doctor Frank C. Baker who identified the shells of known species and described two new species (Baker, 1938, pp. 126-131). This molluscan faunule was listed by Hibbard (1941, p. 265) in a paper treating of the Rexroad fauna of southwestern Kansas. Another collection of shells was sent to Mr. Calvin Goodrich of the University of Michigan who identified the snails and listed them in The Nautilis (1940, pp. 77-79). This list appeared again in a subsequent paper by Hibbard (1940, p. 418) in a study of a Pleistocene fauna known as the Jones Fauna.

Leonard studied and identified the shells occurring in several Pleistocene beds and listed them in conjunction with physiographic and faunal studies of Kansas Pleistocene deposits (Frye, Leonard, and Hibbard, 1943, pp. 40-42). The list of mollusks of the Rezabek faunule which appeared in the previous paper, was repeated by Hibbard (1943, p. 236) and the list of mollusks of the Rexroad faunule, also of the same previous paper, appeared again in a stratigraphic and paleontological study of the Meade Basin (Frye, Hibbard, 1943, p. 408).

The study of Pleistocene deposits, and consequently the molluscan faunules of the deposits, was projected into northwestern Kansas following Doctor Maxim K. Elias' study (1931, pp. 163-180) and redefinition of the Sanborn Formation. Physiographic and vertebrate and molluscan faunal studies were conducted and published by Leonard and Frye (1943, pp. 453-462) and Hibbard, Frye, and Leonard (1944, pp. 1-28).

In the meantime, studies of the Recent molluscan fauna of the state of Kansas were resumed. Franzen and Leonard (1942, pp. 334-343) published a report of the aquatic and terrestrial gastropods occurring in Kingman County. A molluscan faunal study was made of the Wakarusa River Valley and published by Franzen and Leonard (1943, pp. 363-439). Alice E. Leonard collected Recent gastropods and pelecypods from Meade and Clark counties and reported them with a list of the associated flora (1943, pp. 226-240). Additions to the previously reported snails occurring in Kansas was made by Franzen (1944, pp. 261-273). Leonard and Leonard (1946, pp. 115-122) reported the pelecypods and gastropods they collected from watercourses in Greenwood County, Kansas.

Henderson (1924) compiled an annotated and somewhat critical list of the mollusks of Colorado and neighboring mountain states, and Doctor Henry A. Pilsbry, of the Academy of Natural Sciences, of Philadelphia, in his series of excellent and well-known monographs, has been concerned with various groups of snails in the southwestern, southern, and eastern states, but little was added to a knowledge of the Kansas fauna by these studies. It is obvious, since previous studies on the Kansas molluscan fauna have been largely uncritical lists, that much remains to be learned regarding the relationships of the fauna in this area to the fauna of surrounding regions. It is equally obvious, in the light of the nature of most of the previous studies on Kansas mollusca, that critical studies should reveal hitherto undiscovered errors and gaps of information concerning these animals in this region.

The present studies were undertaken in an effort to remedy this deficiency in the knowledge of the molluscan fauna of this plains-border and plains province, at least with respect to the members of the gastropod family Pupillidae. This family is here represented by five genera, comprising a total of 33 species and subspecies.

Pupillid snails are small, terrestrial animals, essentially inhabitants of northern continents, however, they have become widely dispersed over the entire inhabitable earth. They are, generally speaking, endowed with a high degree of tolerance for variations in ecological conditions. Their shells are structurally strong, and may be recovered in excellent condition from geologic deposits. Furthermore, they are animals which produce such highly differentiated shells that the shell characters afford the best means of arranging the animals in the scheme of zoölogical classification, which is certainly not true of snails in general. This view is strongly supported by Baker (in Pilsbry, 1935, Vol. 28, pt. 112, p. 191) an eminent American authority on the anatomy of gastropods, in a review of the anatomy of the Pupillidae and related groups, where he states ". . . deductions based on the animal alone would be weak and this would be especially true of a group in which the shell characters, so far as my slight knowledge goes, appear manifest, while those of the soft parts are difficult to study and still more so to evaluate."

The plains province, of which Kansas is a part, has within it many sedimentary deposits of upper Tertiary and Pleistocene age which frequently contain the well-preserved shells of a varied molluscan fauna, including may examples of Pupillidae. Since much of the pupillid faunule of Kansas is known only from the shells recovered from such deposits, the fortunate fact that the shells of this group of snails are so useful in arriving at deductions concerning the zoölogical relationships of these animals, makes it possible to draw rather safe conclusions concerning the faunal succession, and vertical, as well as horizontal relationships among these snails.

The pupillids in this study include those obtained from gastropod faunules recovered from deposits ranging in age from Lower Pliocene to late Pleistocene, together with collections of the Recent pupillid faunule of Kansas.

The Pleistocene deposits in Kansas from which the pupillids of this study have been taken include three formations: the Sanborn Formation (Elias, 1931, pp. 163-180), the Kingsdown Silt Formation (Smith, 1940, pp. 111-116) and the Meade Formation (Cragin, 1896, p. 53; Hibbard, 1944, p. 709). Pupillids have been taken also from the Rexroad Formation, the Big Springs Ranch deposit and the Fox Canyon deposit. These beds have been assigned to the Blancan age (Elias et al, 1944, pp. 270-271). This is a provisional age term to which are assigned beds of undetermined ages overlying undoubted Pliocene beds and underlying beds of undoubted Pleistocene age. Pupillids of Upper Pliocene (?) age have been collected from the Saw Rock Canyon deposits.

The beds belonging to the Laverne Formation from which pupillids included in the study were collected, lie in Beaver County, Oklahoma, a county adjoining Meade and Clark counties, Kansas. Doctor Bertrand Schultz, Director Nebraska State Museum, generously loaned to the Museum of Natural History, University of Kansas, series of pupillids from Nebraska Pleistocene beds; these also have been included in this study.

In the following outline are listed the deposits, and their localities, from which pupillids have been taken. The deposits are listed according to formations and assigned ages. References are made only to the latest publications which, in all cases, contain citations to earlier literature.

UPPER PLEISTOCENE

Sanborn Formation, Northwestern Kansas (Leonard and Frye, 1943, pp. 453-462, Text figs. 1, 2; figs. 1, 2).

Kingsdown Silt Formation (Hibbard, 1944, pp. 745-749). Upper Kingsdown. Pyle Ranch, Clark County, S 13, T 30 S, R 23 W, 12 mi. E of Minneola (Hibbard, 1944, pp. 749-750).

Jones Sink, Locality number 13, Meade County (Hibbard, 1940, p. 417), S 8, T 33 S, R 27 W, 5 mi. S, 3½ mi. E of Meade.

XI Ranch, Locality number 7 (Hibbard, unpublished), 15 mi. S, 7 mi. W of Meade, S 33, T 34 S, R 29 W.

Rezabek Quarry, Lincoln County, S 20, T 13 S, R 10 W, 8 mi. S, 16 mi. W of Lincoln (Hibbard, 1943, p. 236).

MIDDLE PLEISTOCENE

Meade Formation, below Pearlette Ash (Hibbard, 1944, pp. 718-719). The following are equivalents (Hibbard, 1944, pp. 740-744):

Pyle Ranch, in part, Clark County, S 13, T 30 S, R 23 W, 12 mi. E of Minneola (Hibbard, 1944, pp. 718-719). Tobin deposit, Russell County, S 35, T 14 S, R 11 W, 5¼ mi. S, 18 mi. E of Russell (Hibbard, 1944, p. 734). Wilson Valley deposit, Lincoln County, S 28, T 13 S, R 10 W, 9 mi. S, 15 mi. W of Lincoln (Hibbard, 1944, p. 738). Cudahy Volcanic Ash Pit, Type locality of the fauna, Meade County, S 2, T 31 S, R 28 W, 6 mi. N of Meade (Hibbard, 1944, pp. 718-719).

Sunbrite (included in Cudahy), Meade County, S 26, T 31 S, R 28 W (Hibbard, 1944, p. 719).

BLANCAN (Elias et. al., 1945, pp. 270-271).

Rexroad Formation or Equivalents

Rexroad Ranch, Locality number 3, Meade County (Hibbard, 1941, p. 265), SW¼, S 22, T 33 S, R 29 W, 9 mi. S, 7 mi. W of Meade.

Big Springs Ranch, Locality number 24, Meade County (Hibbard, unpublished), NW¼, NW¼, S 19, T 32 S, R 28 W, 2 mi. S, 4 mi. W of Meade.

Fox Canyon, Locality number 24, Meade County (Hibbard, unpublished), S 35, T 34, R 30 W, 17 mi. S, 12 mi. W of Meade.

UPPER PLIOCENE?

Saw Rock Canyon, Seward County S 35, T 34 S, R 31 W, 14 mi. E of Liberal.

LOWER PLIOCENE

Laverne Formation, Beaver County, Oklahoma (Frye and Hibbard, 1941, pp. 398-403, Fig. 3).

With the exception of a few series of Kansas pupillids which are in the molluscan collection of the United States National Museum, the shells of Kansas and of the Laverne Formation are in the Molluscan Collection of the Museum of Natural History, University of Kansas. This collection was augmented a few years ago by the incorporation of G. Dallas Hanna's private collection of gastropods of Kansas.

In proceeding with this study, the authors have studied the pupillid gastropods included in the collection of the Museum of Natural History of the University of Kansas, totaling about 15,000 shells. Comparative studies were made, including those with holotypes, paratypes, and topotypes where possible, at the Museum of Zoölogy, Ann Arbor, Michigan, the United States National Museum, Washington, D. C., at the Academy of Natural Sciences of Philadelphia, Philadelphia, and at the Carnegie Museum, Pittsburgh.

In this study of pupillids, fossil as well as Recent shells were used. Since only the shells were studied, criteria of taxonomy were established accordingly.

Certain pupillid shell characters are of specific significance. These include features such as the general shape of the shell as determined by the width relative to the height; the number, size and convexity of the whorls; the size of the ultimate whorl relative to the total height; ornamentation of the surface of the shell; the number, size, and location of the denticles; the absence or presence of the crest behind the peristome; and the nature of the umbilical opening. The constancy of occurrence or absence of these characters within a species are indications that they are morphological expressions of genetic significance, and are therefore of taxonomic value.

A species is here considered as being comprised of individuals in which any significant shell character or combination of several characters is constant and distinct within the limits of individual variation. These specific characters do not intergrade with the corresponding characters of another species of the genus, even though two species may have only minute morphological differences.

Characters of shells demonstrating wide ranges of individual variations which form a continuous and intergrading series in shells within a population and in localities distributed over the entire state, and over a region in general, fossil as well as Recent, were considered as individual variants and not as specific or subspecific criteria.

A subspecies is here considered as a geographical group of individuals morphologically recognizable within a species. Two subspecies do not occupy the same geographical area except possibly within a restricted zone in which interbreeding takes place. A subspecies is a recognizable group but not as clearly defineable as a species because two related subspecies are not as completely distinct genetically as are two species of a genus. Characters separating two subspecies intergrade where the ranges of the subspecies meet.

DEFINITION OF SHELL CHARACTERS

Many of these terms are illustrated in fig. 1

Aperture: the open end of the ultimate whorl. In pupillids denticles are frequently situated within the aperture.

Biarcuate aperture: an aperture whose palatal wall and peristome are indented to a greater or lesser degree.

Body whorl: the final whorl of a mature shell; same as the ultimate whorl.

Columella: the longitudinal axis of the shell around which the whorls are coiled.

Conic: shell with a spire tapering to a point producing a cone-shaped shell.

Costae: prominent riblets on the surface of the shell.

Crest: a linear callus situated on the ultimate whorl, behind and paralleling the peristome.

Cylindric: shell in which the whorls increase very slowly in size resulting in a shell more or less cylindrical in shape.

Denticles: calcareous excrescences within the aperture; number, size, and location of denticles is specific.

Everted aperture: aperture widely flaring toward the peristome.

Folds: denticles along the palatal wall of the aperture.

- Upper palatal fold: a primary fold situated at the upper part of the palatal wall.
- Suprapalatal fold: a low, secondary fold situated above the upper palatal fold. Sometimes wanting.
- Lower palatal fold: a primary fold situated toward the base of the outer wall of the aperture.
- Interpalatal fold: A secondary fold situated between the lower and upper palatal folds; frequently wanting.
- Infrapalatal fold: a secondary fold situated below the lower palatal fold.
- Basal fold: A low to rather high fold situated at the angle of the columellar and palatal walls. Position variable.

Height of shell: distance from apex to base of shell.

Immersed denticles: denticles located deeply within the aperture.

Imperforate: a shell whose columella has no opening at the base is said to be imperforate.

Lamellae: denticles located on the parietal wall or on the columellar side of the aperture.

Columellar lamella: the denticle situated as the base of the axis within the ultimate whorl.

Subcolumellar lamella: the denticle situated immediately below the columellar lamella; frequently partially fused with the columellar lamella.

Parietal lamella: one of the primary denticles situated on the parietal wall toward the columella.

Infraparietal lamella: a secondary, small lamella situated on the parietal wall between the parietal lamella and the columella.

Angular lamella: a primary denticle on the parietal wall near the outer wall of the aperture.

Nuclear whorl: the first one or one and one-half whorls of the shell; the embryonic whorl; forms the apex of the shell.

Palatal callus: a linear excrescence within the aperture, connecting the palatal folds and paralleling the peristome.

Palatal wall: that part of the wall of the aperture not bounded by any part of the ultimate whorl; the outer wall.

Perforate shell: a shell with an umbilical opening.

Parietal callus: the callus, thin or heavy, laid upon the parietal wall of the peristome and connecting the terminations of the peristome.

Parietal wall: the upper portion of the apertural wall formed by the base of the ultimate whorl.

Reflected peristome: peristome everted from the aperture.

Rimate shell: a shell whose umbilical opening is reduced to a fissure.

Spire: comprised of the whorls of the shell except the ultimate whorl.

Striations: parallel lines of sculpture on the shell.

Suture: the spiral indenture of the shell where a whorl comes in contact with the preceding whorl.

Umbilicus: the opening of the columella at the base of the shell.

Whorl: a complete volution of the shell.

In order for one studying pupillids to be certain of making an accurate observation, it is necessary that an adequate light source be available and also that shells be dissected. Shell characters such as the size, shape, and position of the columellar lamella and of the longer palatal folds, are frequently not completely visible in an undissected shell.

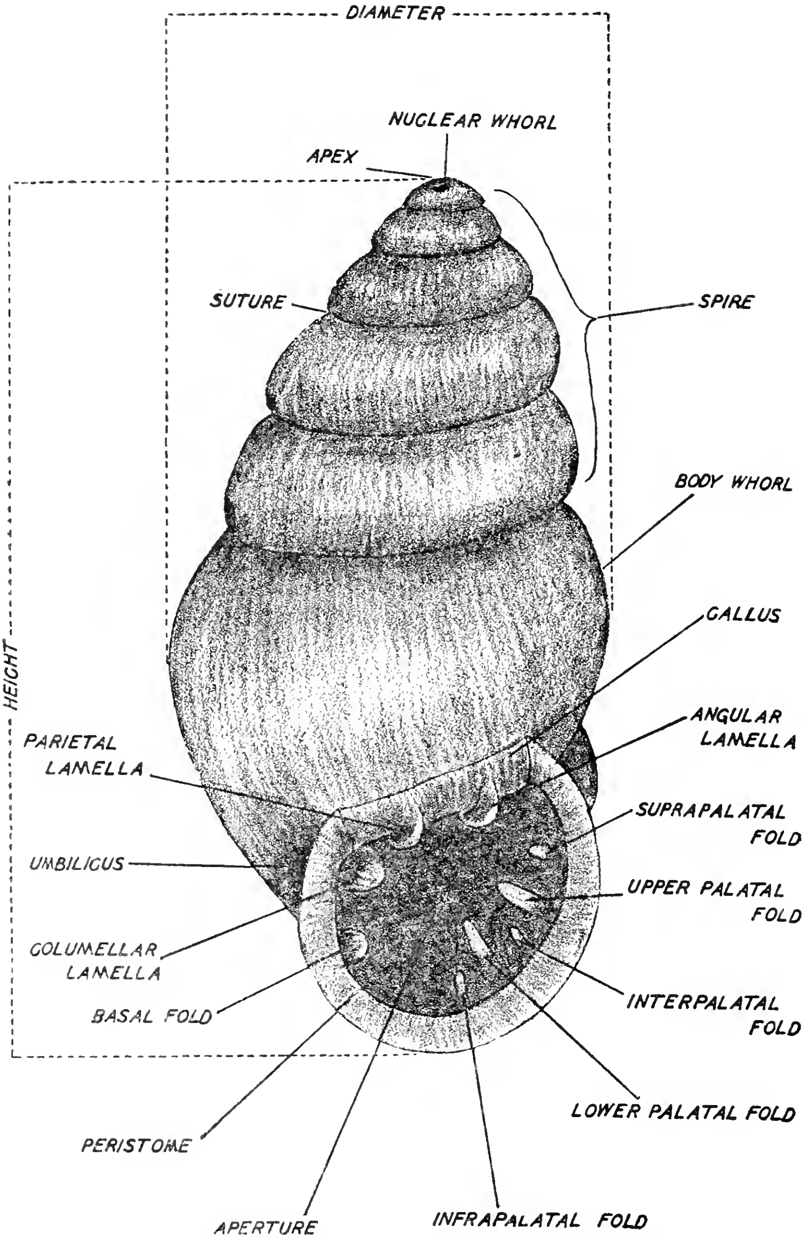


FIG. 1. Diagram of Named Parts of Gastropod Shell.

Family PUPILLIDAE Turton

Pupillidae Turton, Manual of the Land and Fresh-water Shells of the British Islands, 1831, p. 97. Pilsbry, 1916-1918, Vol. 24, pts. 93-96, pp. 1-380; 1918-1920, Vol. 25, pts. 97-100, pp. 1-404; 1920-1921, Vol. 26, pts. 101-104, pp. 1-254; 1922-1926, Vol. 27, pts. 105-108, pp. 1-369; 1927-1935, Vol. 28, pts. 109-112, pp. 1-226. Henderson, 1935, pp. 13, 148-154.

Characteristics of the shell: Shell elongate, whorls coiled in a spire; cylindrical, ovate to conic; color milky-white, auburn to brown, translucent to opaque; height 1.5 mm. to 5.8 mm.; whorls 4½ to 9, compressed to inflated; aperture irregularly rounded to oval, dentate to secondarily edentulous; folds and lamellae 0 to 9; angular and parietal lamellae frequently concrescent; palatal folds varying in distance of immersion and frequently situated on a palatal callus; aperture narrowly to widely expanded; peristome narrowly to widely reflected; rimate to minutely and elongately perforate to roundly perforate.

Distribution:

Recent: Although the family Pupillidae inhabits mainly the Palaearctic Region, it is now represented in all of the continents and many islands. Palaearctic Region: North Atlantic Islands, Central Asia, Transcaucasus and Turkestan to N. China, Maritime Provinces of Siberia, Japan, Korea, China. Ethiopian Region: South Africa, Abyssinia, St. Helena, Mascarene Islands, Madagascar, Comoros. Oriental Region: India, Ceylon, Burma, Indo-China, Malay Peninsula, Indo-Malayan Islands, Phillipines, Java, Borneo. Australian Region: Austro-Malayan Islands, Melanesian Islands, Australia, Tasmania, Polynesia, Micronesia, Hawaiian Islands. Nearctic Region: Temperate North America, Mexico, Central America. Neotropical Region: West Indies, South America (Pilsbry, 1934, pp. 139-169).

Pleistocene: Kansas, Nebraska, Iowa, Illinois, etc.

Pliocene: Europe (Pilsbry, 1934, pp. 147-148). Kansas, Oklahoma.

Miocene: Europe (Pilsbry, 1934, pp. 147-148).

Oligocene: Europe (Pilsbry, 1934, pp. 147-148). Wyoming, Florida (Henderson, 1935, p. 13).

Eocene: Europe (Pilsbry, 1934, pp 147-148). Wyoming, North Dakota (Henderson, 1935, p. 13).

Paleocene: Europe (Pilsbry, 1934, pp. 147-148). Alberta (Henderson, 1935, p. 13).

Permian: Ohio (Henderson, 1935, p. 13).

Upper Carboniferous: New Brunswick, Nova Scotia, Canada, Ohio, Illinois (Henderson, 1935, p. 13).

Center of dispersal: The region in which the family Pupillidae evolved and from which it dispersed is a matter of conjecture. According to Pilsbry (1934, pp. 139-144) several factors indicate Eurasia as the region from which the family radiated. Fifty genera are recognized in the family Pupillidae. Of these, 38, living and fossil, are known from Eurasia. Thirty of these genera, 18 living and 12 fossil, occur in the western part of the Palaearctic Region and 15 genera, all living, occur in the Oriental Region. Three of the widely distributed genera are known from European Tertiary beds. The genus *Gastrocopta* is known from the Oligocene to the Pliocene of Germany; the genus *Pupilla* from the Upper Oligocene and Miocene of Central Europe; the genus *Vertigo* from Eocene and Pliocene in Europe (Pilsbry, 1934, p. 139).

These records do not represent the earliest occurrences of pupillids. The known pupillids of the European Tertiary are too specialized and resemble the modern forms too closely to be the early ancestral stock. Furthermore, since Pilsbry's study, Henderson (1935) has reported shells considered as pupillids from deposits as early as the Upper Carboniferous in North America. More paleontological data are needed before any conclusions can be drawn regarding ancestry and center of dispersal of the family Pupillidae.

KEY TO GENERA

1. Shell rimate to elongate and minutely perforate.............................. 2
   Shell roundly perforate ....*Columella*
2. Aperture not biarcuate 3
   Aperture biarcuate; angular and parietal lamellae never fused...........*Vertigo*
3. Angular and parietal lamellae always present; partially or completely fused, *Gastrocopta*
   Angular or parietal lamella or both frequently wanting, never fused............ 4
4. Ultimate whorl exceeding ½ total height of shell....................*Pupoides*
   Ultimate whorl not exceeding ½ of total height of shell................*Pupilla*

Genus *Gastrocopta* Wollaston

Gastrocopta Wollaston, 1878, p. 515.

"*Leucochilus* Boettger, in von Martens, Conchologishe Mittheilungen, I, 1881, p. 64. Not *Leucochila* von Martens, 1860.

Bifidaria Sterki, in Pilsbry, Proc. Acad. Natural Sciences of Philadelphia, 1891, p. 315, for *P. contracta* and *P. servilis*.—Sterki, Nautilus VI, p. 4, 1892, and p. 99, 1893.—Pilsbry, Proc. A. N. S. Phila. 1900, p. 590.—Dall, Nautilus XVII, p. 116, 1904, type *B. servilis* Gld.

Includes also *Eubifidaria, Albinula, Vertigopsis* and *Privatula*, Sterki, 1893.

Immersidens Pilsbry and Vanatta, 1900" (Pilsbry, 1916, Vol. 24, pt. 93, p. 6).

Gastrocopta, Pilsbry, 1916, Vol. 24, pt. 93, pp. 6-112, Plates 1-8, 10-20, 21—figs. 1-10. 1917, Vol. 24, pt. 94, pp. 112-172, Pl. 21, figs. 11-17, 22-24, 25—figs. 1-9, 12-15, Plates 26-27, 28—figs. 1-6, Pl. 29, figs. 8-10, Pl. 30. 1920, Vol. 25, pt. 100, p. 370. 1934, Vol. 28, pt. 110, pp. 63-73, Pl. 17, figs. 1, 2, 3-9, 10-19; Pl. 18, figs. 1, 2, 3, 5, 6; pt. 111, pp. 117-121, Pl. 22, figs. 1-6; pp. 141-143, text figs. 5, 8; pt. 112, pp. 203-204, Pl. 27, figs. 3-7.

Problems of nomenclature of the genus *Gastrocopta* are discussed by Pilsbry, 1916, pt. 93, p. 8.

Characteristics of the shell: Shell ovate to ovately conic; summit obtuse; total height 2.1 mm. to 5 mm.; whorls 4½-7, convex, irregularly and finely striate; rimate, minutely perforate; lamellae and folds 3-9; parietal lamellae 2-3, angular and parietal lamellae partially fused, bilobed, or angular forming a spur anteriorly, completely fused, sinuous or sharply bent; palatal folds 0-6, frequently situated on a palatal callus; columellar lamella strongly or weakly developed; peristome expanding, usually reflected, adnate upon or continuous across parietal wall by a thin to heavy callus; low to prominent crest on ultimate whorl paralleling the peristome, frequently present.

Distribution:

Recent: One of the most widely distributed of the genera of Pupillidae; circumpolar; inhabiting Africa, India, China, Korea, Japan, islands between Asia and Australia, Australia, Africa, SW Arabia, North America, West Indies, South America (Pilsbry, 1934, pt. 111, pp. 137-160; 1935, pt. 112, pp. 160-169.

Pleistocene: Kansas and Nebraska

Blancan: Kansas

Pliocene: Lower Pliocene, Beaver County, Oklahoma; Pliocene in Kansas. Pliocene of Germany (Pilsbry, 1916, pt. 93, p. 9).

Miocene: Germany (Pilsbry, 1916, pt. 93, p. 9).

Oligocene: U. Oligocene in Germany (Pilsbry, 1916, pt. 93, p. 9).

KEY TO SPECIES

1. Palatal folds prominent, on a callus.................................... 2
 Palatal folds not on a callus.................................... 8
2. Parietal lamellae moderately large to large.................................... 3
 Parietal lamellae small; parietal lamellae completely fused, tubercular, *G. tappaniana*
3. Angulo-parietal lamellae fused 4
 Angulo-parietal lamellae partially fused, divergent anteriorly.................. 7
4. Angulo-parietal lamella fused, buttressed posteriorly; columellar lamella horizontal, turned down inwardly..................................*G. anterides*
 Angulo-parietal lamella fused, not buttressed posteriorly..................... 5
5. Angulo-parietal lamella sinuous, not bifed anteriorly........................ 6
 Angulo-parietal lamella bent sharply at two points; columeller lamella large, subvertical ....*G. contracta*
6. Columellar lamella disk-shaped, large, extending full height of the ultimate whorl, *G. proarmifera*
 Columellar lamella large, recurved, not extending full height of the ultimate whorl ....*G. armifera*
7. Angulo-parietal lamella fused posteriorly, widely divergent anteriorly....*G. falcis*
 Angulo-parietal lamella fused, slightly divergent anteriorly........*G. holzingeri*
8. Parietal lamella small; angulo-parietal lamellae bilobed, straight; columellar lamella small, subvertical ....*G. corticaria*
 Parietal lamellae large 9
9. Angular and parietal lamellae not fused......................*G. rexroadensis*
 Angulo-parietal lamellae fused, partially or completely......................... 10
10. Angulo-parietal lamellae sinuous, angular forming a spur anteriorly.............. 11
 Angulo-parietal lamellae completely fused, angular not forming a spur anteriorly.. 12
11. Lower palatal fold oblique, very deeply immersed...................*G. procera*
 Lower palatal fold not oblique, deeply immersed...............*G. riograndensis*
12. Subcolumellar lamella present; lower palatal fold deeply immersed....*G. cristata*
 Subcolumellar lamella wanting 13
13. Lower palatal fold not deeply immersed......................*G. paracristata*
 Lower palatal fold deeply immersed...................*G. pellucida hordeacella*

STATE OF KANSAS

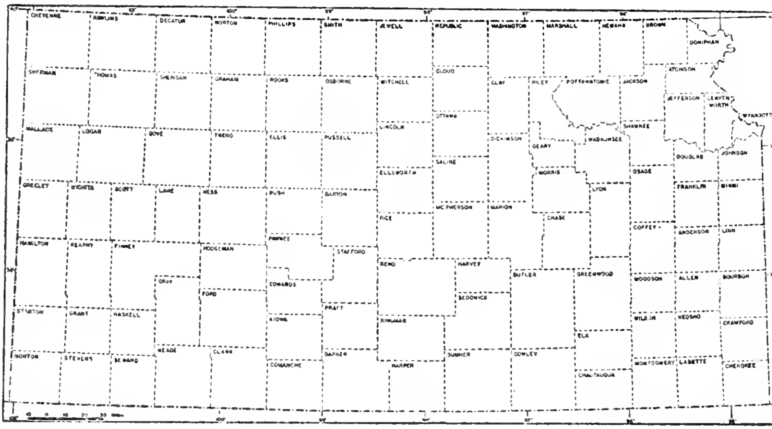


FIG. 2. Key to the counties in Kansas.

Gastrocopta proarmifera Leonard

Plate XVII, figs. 1, 2. Text fig. 3.

Gastrocopta proarmifera Leonard, 1946, pp. 20-22.

Description of the shell: "Shell perforate, rimate, ovate-oblong, summit obtusely conic. Whorls a little more than 6 in number, first 1½ finely granular, remaining whorls finely and diagonally striate; whorls only slightly inflated, last whorl compressed around axis, subangulate below; suture moderately impressed. Aperture irregularly oval; peristome flared; lip thin and simple, reflected, adnate and continuous upon body whorl. A depressed, seamlike scar, behind peristome, indicates position of lower palatal plica. Lamellae 7 in number; a fused angulo-parietal, a columellar, a basal, lower palatal, upper palatal, and suprapalatal. The massiveness of the lamellac restricts the size of the orifice. The angular lamella arises from peristome above sinulus, curves, and is deflected toward periphery, fused with the parietal at its lower termination; parietal heavy with rounded edge, bifurcate below, an elongate limb turns toward the periphery, a shorter, heavier limb curves toward the columella; columellar lamella, when viewed from in front, appears as ½ of a slightly concave disc; it extends obliquely downward, the lower part most deeply immersed. Basal lamella almost obsolete, subcolumellar in position; palatal plicae on a low rounded callous; the lower palatal very deeply placed in cavity (above the termination of the parietal) heavy, bluntly chisel-shaped, transverse in cavity; upper palatal lamella less deeply immersed, less than ½ as large as lower palatal, termination rounded, and directed slightly toward the periphery; suprapalatal lamella small, nodular, located on lower border of sinulus. Lamellae and walls of aperture finely punctuate." (Leonard, 1946.)

Variations: The shells of a large series of paratypes varied only slightly. The only appreciable variant is the difference in height as is shown in the table of measurements below.

MEASUREMENTS

	Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
Holotype:	4.08	2.16	1.6	1.4	6½
Paratype:	3.37	2.0	1.44	1.24	6¼
Paratype:	3.93	2.16	1.5	1.44	6½
Paratype:	3.96	2.16	1.6	1.44	6½

Habitat: This species is known only from Pleistocene deposits, therefore, its habitat is unknown. Since early Pleistocene times it has been replaced by *Gastrocopta armifera.*

Distribution:

Type locality: Russell County, Tobin deposit, S 35, T 14 S, R 11 W; 3 mi. SW of Wilson.

General Distribution: Pleistocene in Nebraska, Kansas.

Distribution in Kansas:

Pleistocene: Meade Formation: Type locality. Meade County: Cudahy Volcanic Ash Pit, S 2, T 31 S, R 28 W, 6 mi. N of Meade. Clark County; Pyle Ranch, S 20, T 13 S, R 10 W, 13 mi. E, ½ mi. S of Minneola.

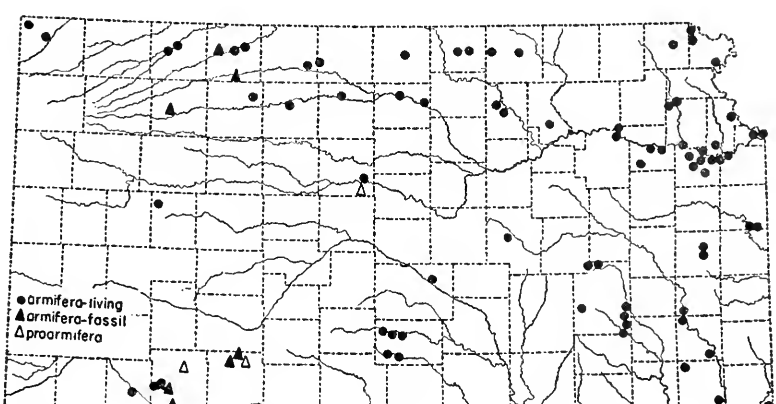


FIG. 3. Records of *Gastrocopta proarmifera* Leonard, and *G. armifera* (Say).

Gastrocopta armifera (Say)

Plate XVII, figs. 3, 4, 5. Text figure 3.

Pupa armifera Say,* 1821, p. 162; Binney and Gray, 1885, p. 56.

Bifidaria armifera, Hanna, 1909, p. 94; Over, 1942, p. 8.

Gastrocopta armifera, Pilsbry, 1916, Vol. 24, pt. 93, pp. 15-17, Pl. 1, figs. 1-4; Hanna, 1920, p. 19; Henderson, 1924, pp. 79, 130-131, fig. 32; Lugn, 1935, Table C, p. 212; Frye, Leonard and Hibbard, 1943, p. 41; Franzen and Leonard, 1943, pp. 415-416, Pl. XXXII, figs. 38, 39, text fig. 6.

Gastrocopta armifera abbreviata, Goodrich, 1940, p. 77; Goodrich in Hibbard, 1940, p. 418; Franzen and Leonard, 1942, p. 339, Pl. I, fig. 4; Leonard and Frye, 1943, p. 457; Franzen and Leonard, 1943, pp. 416-417, Pl. XXXII, figs, 36, 37, text fig. 6; Leonard, 1943, pp. 238-239; Leonard and Leonard, 1946, p 120.

Description of the shell: Shell large, largest of the genus represented in Kansas, fossil or Recent; oval; grayish white; glossy; rimate; whorls 5½ to 7, slowly and regularly increasing in size; the 1½ nuclear whorls finely granular, remaining whorls finely and irregularly striate; body whorl exceeding ½ the total height, somewhat constricted at the base and expanding toward the peristome; aperture large, exceeding half the height of the ultimate whorl, rounded; denticles 6-7: a prominent, bifed, angulo-parietal situated at the center of the parietal wall; 4 folds situated on a low palatal callus, a low, tubercular suprapalatal, a prominent, elongate oblique upper palatal, a prominent elongate, lower palatal, highest point midway of its length, a tubercular basal; columella lamella triangular and projecting outwardly, Pl. III, figs. 4, 5, situated toward the base of the columella. Peristome narrowly reflected; terminations approaching and connected across parietal wall by a wide callus; margin sharp.

Variations: Several characters are subject to considerable variation. The height of the shell varies from 3.6 mm. to 5 mm. The columellar lamella varies in size from one occupying only the lower half of the columella of the apertural portion of the ultimate whorl to one extending the entire length of the apertural portion of the columella. When the columella lamella is of maximum length, it is also wider than in other shells, see Pl. III, figs. 4, 5. The basal fold varies from a prominent tubercular tooth to one perceptible only as a remnant; frequently it is entirely wanting. These several variations occur among shells of a single population, and in the various Kansas localities, among fossil as well as Recent populations. Because all intermediate steps betweeen the two extremes of a character occur at one locality, it is impossible to subdivide a series satis-

* The synonomies listed in this study include only references to type description , to Pilsbry's monographic treatment of the pupillidae in the Manual of Conchology (1916-1935), and to papers dealing with pupillids of Kansas and nearby areas.

factorily into several subspecies. Therefore, the shells from Kansas which previously have been identified as *Gastrocopta armifera* and *G. a. abbreviata* are here designated only as *G. armifera*.

Shells of this species in the Museum of Natural History, University of Kansas, have been compared by the author with those of the same species in the Academy of Natural Sciences of Philadelphia and with Sterki's collection in the Carnegie Museum of Pittsburgh. The variations in the shells in Philadelphia and Pittsburgh correspond closely to those of shells in the collection at the University of Kansas. In a conversation, Doctor H. A. Pilsbry (April 30, 1946) expressed doubt of the validity of the several subspecies into which Sterki has divided *G. armifera*. However, since the present study is restricted to only a small part of North America, no attempt is made to determine the status of the alleged subspecies of *G. armifera* from other parts of North America.

MEASUREMENTS

Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
3.6	2.1	1.4	1.35	5½
3.9	2.2	1.6	1.4	5½
4.4	2.4	1.8	1.4	6
4.7	2.5	1.8	1.5	6½
5.0	2.5	1.8	1.45	7

Habitat: *Gastrocopta armifera* is a gregarious species occurring commonly on wooded slopes, near or removed from a stream. It is to be found under dead wood, limestone rocks, or light cover of leaf mold or other debris. *G. armifera* frequently occurs under boards or rocks in gardens.

Distribution:

Type locality: Pennsylvania.

General distribution: Quebec, eastern United States to northern Florida, west to Alberta, Dakota, Colorado, southeastern New Mexico and to the mouth of the Pecos River in Texas (Pilsbry, 1916, Vol. 24, pt. 93, p. 18).

Distribution in Kansas:

Recent: Ubiquitous in Kansas.

Pleistocene: Clark County: Pyle Ranch faunule, above the Pearlette Ash (Cragin, 1896, p. 54, from Hibbard, 1944, p. 742), S 13, T 30 S, R 23 W, 13 mi. E, ½ mi. S of Minneola; Taylor Ranch, NE¼, S 20, T 30 S, R 23 W, ½ mi. S, 9 mi. E of Minneola, relation to Pearlette Ash not known. Meade County, Jones Sink, Locality number 13 (Hibbard, 1940, p. 417), S 8, T 33 S, R 27 W, 5 mi. S, 3½ mi. E. of Meade; XI Ranch deposit, S 33, T 34 S, R 29 W, 15 mi. S, 7 mi. W of Meade. Sanborn Formation: Norton County; NW¼, NE¼ S 18, T 3 S, R 23 W.

Gastrocopta armifera is distributed in North America in regions of diverse climates. It is the most widely distributed and numerous of the pupillids in the Recent fauna of Kansas. It is represented also in Upper Pleistocene beds of Kansas and Nebraska. Apparently this species has not been receding from Kansas since Pleistocene times.

The widespread distribution in North America, including Kansas in general, indicates that this species is tolerant of and adaptable to various climatic conditions. In the prolonged dry, hot summer months, *G. armifera* is able to aestivate, making possible its survival in Kansas, especially in the western part of the state, where the summer droughts are often severe.

Gastrocopta armifera has not been found in deposits below the Pearlette Ash. In the Tobin, Wilson Valley, and Pyle Ranch beds of the Meade Formation, *Gastrocopta proarmifera* (Leonard, 1946) occurs in large numbers where *G. armifera* is not known to occur.

Gastrocopta contracta (Say)

Plate XVIII, fig. 9. Text figure 4.

Pupa contracta Say, 1822, p. 374.
Pupilla contracta, Call, 1886, p. 206.
Bifidaria contracta, Hanna, 1909, p. 94.
Gastrocopta contracta, Pilsbry, 1916, Vol. 24, pt. 93, pp. 22-23, Pl. 2, figs. 9, 10, 11, 12; Lugn, 1935, p. 212, Table C; Franzen and Leonard, 1942, p. 339, Pl. I, fig. 2; Franzen and Leonard, 1943, p. 417, Pl. XXXII, figs. 34, 35, Text fig. 6; Frye, Leonard, and Hibbard, 1943, pp. 41, 42; Leonard and Leonard, 1946, p. 120.

Description of the shell: Shell ovate-conic, summit convex, moderate in size for the genus, height varying from 2.1 mm. to 3.0 mm.; rimate, minutely perforate; living shells bluish-milky, glossy, semi-translucent; dead shells white, opaque; whorls 4½ to 6, convex, increasing gradually in size; body whorl slightly more than half of total height of shell; 1½ nuclear whorls finely granular; remaining whorls finely and irregularly striate; last half of body whorl sharply turned toward aperture, contracted at the base and rapidly expanding toward the aperture; a crest varying from one well-developed to one scarcely perceptible, paralleling the peristome and removed from it by a wide groove; aperture triangularly rounded, apex of triangle forming the base of the aperture; folds and lamellae large, almost completely filling the aperture; a fused angulo-parietal lamella, large, the angular portion continuous with the outer lip of the peristome, lamelliform and folded toward the outer lip, midway bent at a right angle toward the angular side and terminating by a low appendage directed dorsally at a right angle; upper palatal fold immersed, tubercular, situated on a low palatal callus; lower palatal fold slightly elongate, oblique, deeply immersed, columellar lamella large, lamelliform, descending inwardly; peristome broadly expanded and reflected, thin, continuous, adnate upon the ultimate whorl; a heavy, elongate callus situated along the inner margin of the columellar side of the peristome and paralleling the peristome; margin sharp.

Variations: Only a few of the characters of this species are variable. The variations in heights and widths of the shells are not in the same proportions, resulting in variations in shape. The crest behind the peristome varies from one very prominent to one scarcely perceptible. The number of whorls varies from 4½ to 6. Kansas shells of this species agree with those in the collection of the Academy of Natural Sciences of Philadelphia, including shells from northeastern United States.

MEASUREMENTS

Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
2.1	1.2	0.9	0.8	5
2.3	1.25	0.7	0.7	5½
2.6	1.4	1.0	0.9	5
2.8	1.6	1.1	1.0	5½
3.0	1.5	1.1	0.9	6

Habitat: On shaded slopes along the watercourses, under dead wood, leaf mold and grass.

Distribution:

Type locality: Occoquan, Virignia.

General distribution: Ontario and Manitoba, Canada; Maine south to Florida; Veracruz, Mexico; Jamaica; west to Clay county, South Dakota; Kansas; Lawton, Oklahoma. Pleistocene in Nebraska, Kansas.

Distribution in Kansas:

Recent: Northeastern Kansas, along the courses of the Missouri and Kansas Rivers; southeastern Kansas, along the courses of the Marais des Cygnes, Neosha, and Verdigris rivers; southcentral Kansas, along the course of the Arkansas River.

Pleistocene: Lincoln County: Rezabek faunule, NE¼, S 20, T 13 S, R 10 W, 8 mi. S, 16 mi. W of Lincoln; Wilson Valley faunule, NE¼, S 28, T 13 S, R 10 W, 9 mi. S, 15 mi. W of Lincoln.

Gastrocopta contracta is unknown in Kansas west of northwestern Kingman County where it occurs along the South Fork of the Ninnescah River and in northcentral Reno County along the Arkansas River. These two localities are west of the previously known midwestern occurrences, namely, Clay County, South Dakota, and Payne County, Oklahoma (Pilsbry, 1916, pt. 93, Vol. 24, p. 22).

However, the westernmost range in Texas, the mouth of the Pecos River, lies west of these two Kansas localities.

In the Pleistocene deposits of Kansas, *G. contracta* has been found only in Lincoln County, in the Rezabek and Wilson Valley faunules. It has been found also in the Pleistocene in Nebraska. After more intensive collecting, this species may be found also in the intervening Pleistocene deposits, the Sanborn Formation. *G. contracta* has not been found either in the Pleistocene or the Recent faunules of southwestern Kansas.

Gastrocopta contracta does not appear to have been a predominating representative of the genus in Kansas in Pleistocene times. It was then and is still today, secondary to *G. armifera*.

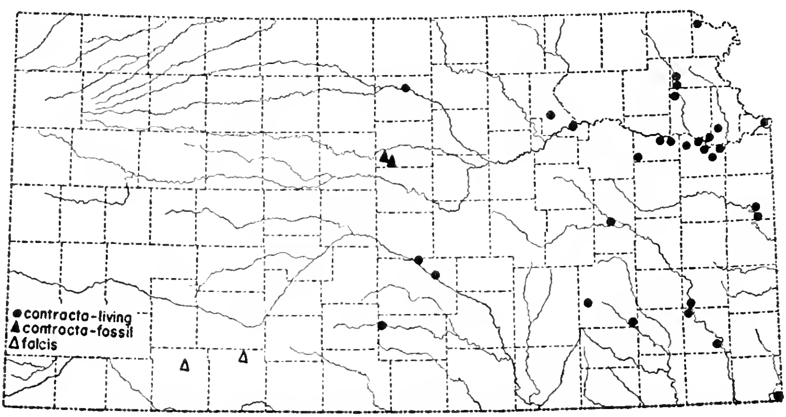


FIG. 4. Records of *Gastrocopta contracta* (Say) and *G. falcis* Leonard.

Gastrocopta falcis Leonard

Plate XVIII, fig. 2. Text figure 4.

Gastrocopta falcis Leonard, 1946, pp. 22-24.

Description of the shell: "Shell small, cylindrical, narrowly perforate; whorls 5 in number, moderately convex; summit obtuse; suture deeply impressed; first whorl microscopically granular, remaining whorls minutely punctate and striate; body whorl compressed around axis, broadly angulate below; aperture rounded below, squarish above; peristome thin, simple and reflected, lips approaching, scarcely connected by a thin callus on body whorl; a constriction behind reflected lip of peristome, followed by a heavy crest on right side only; behind the crest an axially elongate, depressed scar indicates position of lower palatal plica. Lamella 7 in number; angular, thin, high, confluent with angular lip of peristome above, and with parietal lamella below; it curves slightly toward, and is deflected toward, the periphery; parietal lamella heavy, widely divergent from angular above; below the lower end of the angular, where it is strong, high, and rounded, the parietal lamella curves toward the periphery; columellar lamella highly specialized; it arises low in orifice as a high plate extending toward the parietal, turns slightly upward, and extends straight forward on the columellar wall of the peristome to the point where the lip flares, where it ends in a thickened callus; the whole resembling a pruning knife with the thin edge turned toward the columella. No subcolumellar denticle; basal plicae heavy, triangular, deeply placed in the cavity; lower palatal plica arising broadly from the callus on which are set also the basal and upper palatal plicae, deeply entering, to a point above the termination of the angular, free surface plane; upper palatal plica less deeply placed, high toothlike; two minute, conical suprapalatal plicae. Denticles and walls of orifice smooth and glistening." (Leonard, 1946.)

Variations: No significant variation occurs among the 4 shells of the series.

MEASUREMENTS

	Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
Holotype:	1.7	0.87	0.62	0.55	5
Paratype:	1.5	0.87	0.62	0.59	5
	1.75	0.87	0.62	0.55	5

Habitat: This species is known only from deposits of the Meade Formation, Middle Pleistocene.

Distribution:

Type locality: Meade County, Kansas: Cudahy Volcanic Ash Pit, SW¼, S 2, T 31 S, R 28 W, 6 mi. N of Meade.

Distribution in Kansas:

Pleistocene: Meade County: Type locality. Clark County: Pyle Ranch, NE¼, S 13, T 30 S, R 23 W, 13 mi. E, ½ mi. S of Minneola.

Gastrocopta holzingeri Sterki

Plate XVIII, fig. 2. Text figure 5.

Pupa holzingeri Sterki, 1889, Nautilus iii, p. 119.

Bifidaria holzingeri, Hanna, 1909, p. 94; Over, 1942, p. 8; Hanna and Johnston, 1913, p. 119.

Bifidaria holzingeri fordiana, Hanna, 1909, p. 94.

Gastrocopta holzingeri, Pilsbry, 1916, Vol. 24, pt. 93, pp. 25-26, Pl. 2, figs. 4, 5, 6; Henderson, 1924, pp. 79, 131; Hibbard, 1941, p. 265; Frye and Hibbard, 1941, p. 408; Frye, Leonard, and Hibbard, 1943, p. 42.

Gastrocopta procera cf. mcclungi, Frye, Leonard, and Hibbard, 1943, p. 42; Hibbard, 1943, p. 236.

Description of the shell: Shell small; oval; height 1.6 mm. to 1.9 mm.; grayish-white, translucent, glossy; rimate; whorls 5, convex, gradually and regularly increasing in size; 1½ nuclear whorls minutely granular; remaining whorls very finely and irregularly striate; body whorl less than one-half the total height; aperture irregularly rounded, exceeding one-half the height of the body whorl; lamellae and folds 7, the angular and parietal lamellae fused inwardly and distinct outwardly, the parietal lamella long, high, sinuous, the angular lamella short, the two forming a mirror image of the pattern of the letter "Y"; the 4 folds situated on a heavy palatal callus; a low, tubercular suprapalatal, a prominent tubercular, lower palatal, a higher, slightly elongate lower palatal, the three becoming progressively more deeply immersed; a prominent, slightly elongate basal fold, less deeply immersed than the lower palatal fold; columellar lamella situated midway on the ultimate portion of the columella, high, elongate, entering horizontally and posterior third turned downward; peristome narrowly reflected, terminations approaching and connected across the parietal wall by a thin callus; margin sharp; a high, heavy rounded, white callus situated on the body whorl and separated from the peristome by a wide groove.

Variations: Only a few characters are perceptibly variable. The total height varies from 1.6 mm. to 1.9 mm. The number of whorls varies from 4½ to 5.

MEASUREMENTS

Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
1.6	0.8	0.5	0.5	4½
1.7	0.8	0.6	0.5	4¾
1.8	0.9	0.6	0.6	5
1.9	0.9	0.6	0.5	5

Habitat: *Gastrocopta holzingeri* is found on timbered slopes under leaf mold. Although it may occur in large numbers, it is probably overlooked because of its small size.

Fossil records show that *G. holzingeri* has lived in Kansas since at least Blancan times. Hibbard (1941a, pp. 100-101) concludes that, according to geological studies by Frye, in Blancan times a low gradient, mountain fed stream flowed through southwestern Kansas, south to the Gulf. The preserved fauna associated with the gastropod mollusks of this locality indicates that along the valley probably were meadows, marshes, and trees. The summers were probably characterized by temperatures somewhat lower than they are in the region today, accompanied by higher humidity, and absence of extreme droughts.

In order to remain established in northwestern Kansas, as it is doing to some extent, it must be tolerant of the hot, dry climatic conditions which obtain in the summertime. *G. holzingeri* is not one of the predominating species of the fauna of Kansas. According to its general distribution in North America, it prefers decidedly cooler climates.

Distribution:

Type locality: Winona, Minnesota.

General distribution: Ontario and western New York west to Helena, Montana; south to Illinois, Kansas, and eastern New Mexico (Pilsbry, 1916, Vol. 24, pt. 93, p. 25). Pleistocene of Nebraska.

Distribution in Kansas:

Recent: Wyandotte County west to Cheyenne County; central Kansas, Reno County, probably from drift along the Arkansas River; southeastern Kansas, Labette County.

Pleistocene: Lincoln County, Rezabek faunule, S 20, T 13 S, R 10 W, 8 mi. S, 16 mi. W of Lincoln.

Blancan: Meade County, Rexroad faunule, Locality number 3 (Hibbard, 1941, p. 265), 9 mi. S, 7 mi. W of Meade, SW¼, S 22, T 33 S, R 29 W.

According to fossil records, *Gastrocopta holzingeri* has been living in Kansas since Blancan times, although this species is essentially a snail of northern United States.

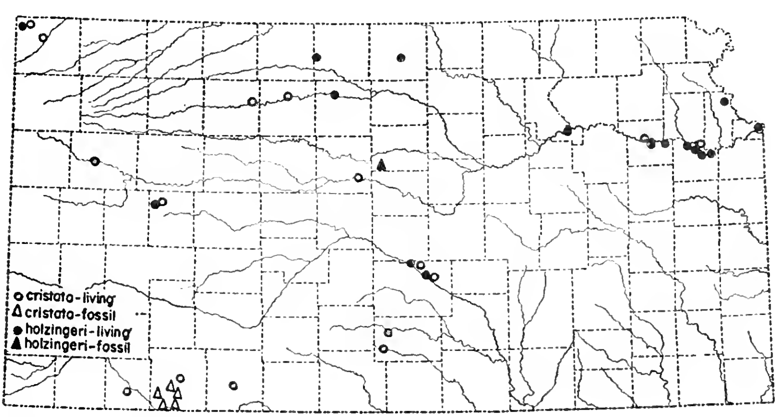


FIG. 5. Records of *Gastrocopta holzingeri* (Sterki) and G. *cristata* (Pilsbry and Vanatta).

Gastrocopta tappaniana (C. B. Adams)

Plate XVIII, fig. 8. Text figure 6.

Pupa tappaniana Ward inedit, C. B. Adams, 1842, p. 158.

Bifidaria pentodon, Hanna, 1909, p. 94.

Bifidaria tappaniana, Hanna, 1909, p. 94.

Gastrocopta pentodon, Franzen and Leonard, 1942, p. 339, Pl. 1, fig. 1; Franzen and Leonard, 1943, p. 417-418. Pl. XXXII, fig. 33, text fig. 6.

Gastrocopta tappaniana, Pilsbry, 1916, Vol. 24, pt. 93, pp. 33-35, Pl. 3, fig. 9, Pl. 5, figs. 42-53; Lugn, 1935, p. 212, Table C; Hibbard, 1941, p. 265; Franzen and Leonard, 1942, p. 339, Pl. 1, fig. 6; Frye, Leonard and Hibbard, 1943, pp. 41, 42; Hibbard, 1943, p. 236.

Gastrocopta tappaniana curta, Leonard, 1943, p. 239, Pl. 1, fig. 15.

Description of the shell: Shell conic, summit obtuse, 1.5 mm. to 2.5 mm. in height; grayish-white; translucent; rimate, minutely perforate; whorls 4½ to 5, regularly and rapidly increasing in height; body whorl exceeding ½ of the total height; the 1½ nuclear whorls finely granular, remaining whorls finely and irregularly striate; aperture ovate, oblique, expanding somewhat toward the peristome; folds and lamellae 6 to 9: a low, tubercular infraparietal rarely present; a completely fused, high, lamelliform angulo-parietal situated at the center of the parietal wall; six elongate, equally immersed folds situated on a strong palatal callus, a suprapalatal, an upper palatal, an interpalatal, a lower palatal, an infrapalatal, and a basalar; a lamelliform, elongate, columellar lamella ascending along the axis; peristome simple, scarcely reflected, terminations approaching and connected across the parietal wall by a thin callus, margin sharp; a heavy, white callus on the body whorl paralleling the peristome and separated from it by a narrow groove.

Variations: The shells of *Gastrocopta tappaniana* vary considerably in shape and in size. Shells from any one population can be arranged in a continuous series, ranging from elongate-conic to ovate-conic forms. The total height varies from 1.5 mm. to 2.5 mm. (see table below). The occurrence of certain of the plicae varies: the infraparietal lamella is rarely present; the suprapalatal is sometimes prominent, sometimes scarcely perceptible and sometimes wanting; the basal fold is sometimes double. The variables are phenotypic and not characteristic of the shells of any certain part of the state nor of any one or several fossil faunules. The shells from the Saw Rock Canyon deposits of Upper Pliocene (?) age, do not differ from those living in Kansas at the present time.

MEASUREMENTS

Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
1.5	0.9	0.4	0.4	4½
1.8	1.1	0.5	0.5	5
2.2	1.35	0.8	0.7	4½
2.5	1.35	0.8	0.7	5

Habitat: Gastrocopta tappaniana is a common snail in Kansas. Its most frequent habitat is on shaded slopes near streams. However, it has been taken from among the grass roots on an unshaded slope near a pasture pond.

Distribution:

Type locality: Vermont.

General distribution: Ontario; Maine to Virginia, west to South Dakota and Kansas, to Arizona (Pilsbry, 1916, Vol. 24, pt. 93, p. 33). Pleistocene of Nebraska and Kansas.

Distribution in Kansas:

Recent: Widespread in distribution: along the courses of the Kansas River and its tributaries; Neosha River, Arkansas River, Meade County State Park, and South Fork of the Republican River.

Pleistocene: Lincoln County: Rezabek Faunule, S 20, T 13 S, R 10 W, 8 mi. S, 16 mi. W of Lincoln; Wilson Valley Faunule, S 23, T 13 S, R 10 W, 9 mi. S, 15 mi. W of Lincoln. Clark County: Pyle Ranch Faunule, S 13, T 23 W, 13 mi. W, ½ mi. S of Minneola. Russsell County: Tobin Faunule, S 35, T 14 S, R 11 W, 5½ mi. S, 18 E of Russell.

Blancan: Meade County: Fox Canyon Faunule, 17 mi. S, 12 mi. W of Meade, S 35, T 34 S, R 30 W; Big Springs Ranch, NW¼, NW¼, S 19, T 32 S, R 28 W, 2 mi. S, 4 mi. W of Meade.

Gastrocopta tappaniana, essentially a northern species, entered Kansas sometime previous to Upper Pliocene times. Since its entrance into this region, it has become widespread, and it is still one

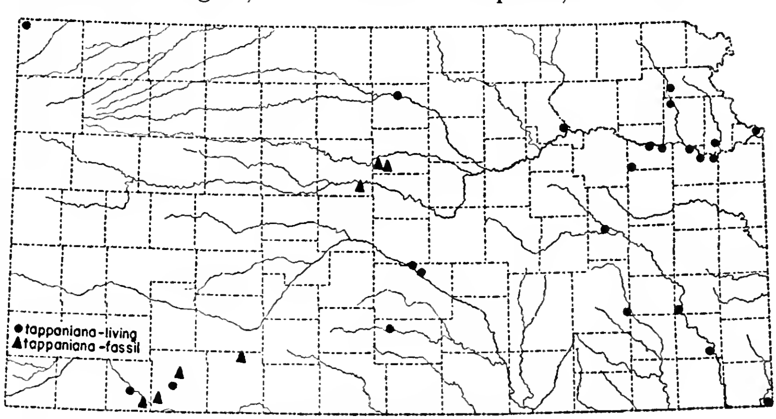


FIG. 6. Records of *Gastrocopta tappaniana* (C. B. Adams).

of the most abundant species of the genus represented in Kansas. Shell characters of this species have remained unchanged since Pliocene times.

Gastrocopta rexroadensis new species

Plate XVIII, figs. 4 & 5. Text figure 7.

Holotype: Catalogue number 3781, University of Kansas Museum of Natural History.

Horizon and type locality: Blancan. Meade County, Kansas, Rexroad Ranch, SW¼, S 22, T 33 S, R 29 W, 9 mi. S, 7 mi. W of Meade.

Diagnosis: Shell small, elongate-conic, rimate; whorls 4¾, slightly convex; lamellae and folds 5, large, nearly filling the aperture: a prominent, arched, deeply immersed parietal lamella; an elongate, prominent angular lamella, approximate to but not fused posteriorly with the parietal lamella; upper palatal fold immersed, appearing as a callus of the peristome; a deeply immersed, oblique lower palatal fold; a prominent columellar lamella, entering horizontally and turned downward posteriorly; peristome continuous across parietal wall by means of a thin callus. Subgenus *Immersidens.*

Description of the Holotype: Shell small, elongate-conic; summit obtuse; rimate; suture sharply incised; whorls 4¾; apical whorls strongly convex, lower whorls slightly convex; whorls slowly and regularly increasing in size; the 1½ nuclear whorls finely granular; remaining whorls irregularly and finely striate; height of body whorl exceeding one-half of the total height, contracted basally and expanding rapidly toward the aperture; a prominent, rounded crest paralleling the peristome from which it is separated by a deep, wide groove; aperture triangularly rounded, scarcely oblique, widely expanding; denticles 5; a prominent, oblique, arched, deeply immersed parietal lamella extending toward the periphery below the angular lamella; an elongate, prominent angular lamella arising from the peristome, approximate to but not fused posteriorly with the parietal lamella; the upper palatal fold immersed, fused with a triangular callus on the outer border of the peristome; a prominent, shortly elongate, deeply immersed, oblique lower palatal fold; a prominent columellar lamella, entering horizontally with the posterior half turned downward; margin of peristome very narrowly reflected; ends of peristome approaching, connected by a thin callus upon the parietal wall.

MEASUREMENTS

	Total height, mm	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
Holotype:	2.4	1.35	0.9	0.9	4¾
Paratype:	2.25	1.25	0.9	0.8	5
Cat. No. 3764	2.35	1.35	0.9	0.8	5
Cat. No. 3764	2.35	1.25	0.8	0.7	5
Cat. No. 3764	2.4	1.25	0.9	0.8	5¼

The paratypes of *G. rexroadensis* vary slightly in size and form, some shells being more conic than others.

G. rexroadensis is closely related to *G. bilamellata* (Sterki and Clapp), a species known from southwestern Arizona. *G. rexroadensis* is more conic than *G. bilamellata;* the upper palatal fold is fused with a broad, pointed callus on the outer wall of the peristome; and the parietal lamella is straight rather than sinuous.

Occurrences: In addition to the type locality, *Gastrocopta rexroadensis* occurs in two other deposits assigned to the Blancan age: Meade County; Fox Canyon deposit, S 35, T 34 S, R 30 W, 17 mi. S, 12 mi. W of Meade, Big Springs Ranch deposit, SW¼, S 22, T 33 S, R 29 W, 9 mi. S, 7 mi. W of Meade.

Gastrocopta corticaria (Say)

Plate XVIII, fig. 8. Text figure 7.

Odostomia corticaria Say, Nicholson's American Encyclopedia, IV, Pl. 4, fig. 5, 1816.
Gastrocopta corticaria, Pilsbry, 1916, Vol. 24, pt. 93, pp. 52-53, Pl. 10, figs. 1 to 4; Franzen, 1944, p. 265, Pl. I, fig. 1.

Description of the shell: Shell small, 2.4 mm. to 2.8 mm. in height; ovate, summit obtuse; rimate, minutely perforate; fragile;

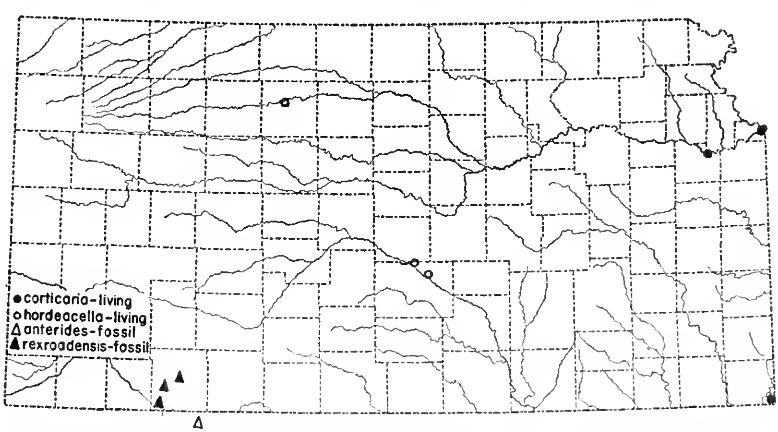


FIG. 7. Records of *Gastrocopta rexroadensis* n. sp., *G. corticaria* (Say), *G. pellucida hordeacella* (Pilsbry) and *G. anterides* Leonard and Franzen.

translucent, grayish-white; suture incised; whorls 5, convex, increasing slowly and regularly in size; body whorl large, somewhat more than ½ total height of shell; nuclear whorl minutely granular; remaining whorls irregularly and finely striate; aperture large, oval, without any callus; lamellae and folds 3; a low, elongate parietal lamella distinct or partially fused with an elongate, low angular lamella; a low tubercular, oblique columellar lamella; a low, tubercular palatal fold rarely present; peristome thin, without a callus, terminations approaching, connected across the parietal wall by a thin callus; peristome reflected, producing a groove on the exterior of the ultimate whorl directly behind the peristome; margin sharp.

Variations: Only 7 specimens from Kansas and 3 from Kansas City, Missouri, were available for study. The total height varied only 0.3 mm. (table of measurements below). The angular lamella, if present, is low, elongate or tubercular; the parietal lamella is low and elongate, or low and tubercular. In one shell from Kansas City, Missouri, a tubercular palatal fold is present.

MEASUREMENTS

Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
2.4	1.2	1.0	0.8	5
2.5	1.25	1.0	0.8	5
2.7	1.25	0.9	0.8	5½
2.8	1.35	1.1	0.8	5

Habitat: *G. corticaria* has been found along timbered slopes near streams, where oak and hickory predominate.

Distribution:

Type locality: Philadelphia, Pennsylvania.

General distribution: Ontario to Minnesota; Maine, south to St. Simon's Island, Georgia; northern Alabama; Louisiana (Pilsbry, 1916, Vol. 24, pt. 93, p. 53). Western Missouri, Kansas.

Distribution in Kansas:

Recent: Wyandotte County: Kansas City. Douglas County: Lawrence. Cherokee County: 6 mi. E of Baxter Springs.

This small shell is not known from the Pleistocene. Its Recent distribution may be more widespread than the number of reported localities would indicate. Because of its small size it can easily be overlooked. However, if it is present, it should be found in drift more frequently than it has been. Since it is a species of humid environment, it is restricted to those localities in Kansas where such a condition obtains.

Gastrocopta procera (Gould)

Plate XVIII, figs. 3 & 6. Text figure 8.

Pupa procera Gould, 1840, p. 401, Pl. 3, fig. 12.

Bifidaria procera, Hanna and Johnston, 1909, pp. 81-82; Over, 1942, p. 8.

Bifidaria mcclungi Hanna and Johnston, 1913, pp. 111-121.

Gastrocopta procera, Pilsbry, 1916, Vol. 24, pt. 93, pp. 62-65; Lugn, 1935, p. 212, Table C; Goodrich, 1940, pp. 78-79; Hibbard, 1940, p. 418; Frye, Leonard, and Hibbard, 1943, pp. 41, 42; Hibbard, 1943, p. 236.

Gastrocopta procera mcclungi, Pilsbry, 1916, Vol. 24, pt. 93, pp. 66-68; Henderson, 1924, pp. 79, 132; Franzen and Leonard, 1942, pp. 339, Pl. 1, fig. 7; Franzen and Leonard, 1943, pp. 419, Text fig. 65, Pl. XXXII, fig. 32; Leonard, 1943, pp. 239, Pl. 1, fig. 14; Leonard and Leonard, 1946, p. 120.

Bifidaria procera mcclungi, Over, 1942, p. 8.

Gastrocopta procera duplicata, Franzen and Leonard, 1942, pp. 339, Pl. 1, fig. 8; Franzen and Leonard, 1943, p. 419, Text fig. 6, Pl. XXXII, fig. 31.

Gastrocopta procera sterkiana, Leonard and Leonard, 1946, p. 120.

Description of the shell: Shell auburn to light brown; glossy; rimate; cylindric; apex obtuse; moderate in size for the genus; suture deeply incised; whorls 5 to 6½, finely and irregularly striate, convex, gradually and regularly increasing in size; body whorl about one-half the height of the shell, somewhat constricted at the base and gradually expanding toward the aperture, linear impressions mark the positions of the upper palatal, the lower palatal, and the basal folds; a crest parallels and is approximate to the peristome; aperture rounded, slightly oblique, a deep sinulus at upper extremity of outer lip; peristome slightly reflected and thin to broadly reflected and thickened by a heavy callus; folds and lamellae 6: a bifed angulo-parietal, the angular portion forming a spur directed toward the outer margin; an immersed, tubercular upper palatal fold; an elongate, deeply immersed, obliquely placed lower palatal fold; a low basal fold immersed equidistant with the upper palatal fold; columellar lamella horizontal, nearly one-half the length of a whorl; a low tubercular subcolumellar lamella.

Variations: The callus of the peristome varies as to position. In some shells it is located within the aperture below the lip, in some along the inner, and in others, along the outer border of the lip. Shells of *G. procera* from the Saw Rock Canyon deposits, Upper Pliocene (?), Seward County, S 35, T 34 S, R 31 W, 14 mi. E of Liberal, have a tubercular labial callus on the outer lip at the level of the upper palatal fold, Plate IV, fig. 6. The distance between the peristome and the crest paralleling it, varies. The crest of some shells is well-developed and rounded, in some it is low and narrow, in others it is scarcely perceptible. The subcolumellar lamella is usually present as a distinct denticle, however, sometimes it is seen only as a thickening of the base of the columellar lamella. The range in size of the shells can be seen in the table below.

MEASUREMENTS

Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
2.1	1.0	0.7	0.7	5
2.3	1.1	0.9	0.7	5½
2.5	1	0.8	0.7	5½
2.8	1.2	0.9	0.9	5½
3.2	1.3	1.1	1	6
3.2	1.2	...	...	6½

Habitat: This pupillid lives on timbered slopes of streams. Its general distribution in Kansas indicates an ability to withstand periods of summer drought. Occurrence with *Gastrocopta cristata* Pilsbry and Vanatta is common.

Distribution:

Type locality: Baltimore, Maryland.

General distribution: Eastern United States, west to Kansas, Oklahoma, Colorado, New Mexico, Arizona; north, South Dakota; south, Alabama and eastern Texas. (Pilsbry, 1916, Vol. 24, pt. 93, p. 63.) Pleistocene, Nebraska.

Distribution in Kansas:

Recent: Along the Kansas River and its tributaries from Kansas City, Wyandotte County, west to Norton and Graham counties; northwest to Cheyenne County; southeastern Kansas: Neosha, Allen, and Greenwood counties; along the Arkansas River and its tributaries. Southwestern Kansas: Meade County; Seward County, along the Cimarron River.

Pleistocene: Lincoln County: Wilson Valley Faunule, NE¼, S 28, T 13 S, 9 mi. S, 15 mi. W of Lincoln; Rezabek Faunule, NE¼, S 20, T 13 S, R 10 W, 8 mi. S, 16 mi. W of Lincoln. Russell County: Tobin Faunule, NW¼, S 27, T 14 S, R 11 W, 4½ mi. S, 17 mi. E of Russell. Meade County: Jones Sink Faunule, S 8, T 33 S, R 27 W, 5 mi. S, 3½ mi. E of Meade. locality number 13 (Hibbard, 1940, p. 417).

Sanborn Formation: Norton County, NE¼, S 21, T 5 S, R 23 W, 15 mi. S, 1¼ mi. W of Norton. Phillips County: Prairie Dog Creek.

Upper Pliocene (?): Seward County, Saw Rock Canyon, S 35, T 34 S, R 31 W, 14 mi. E of Liberal.

Pupillids which have been referred to *Gastrocopta procera* and to the two "subspecies," *G. p. mcclungi* and *G. p. sterkiana,* have been collected from Kansas. According to the type descriptions of these forms, they differ from each other in the location and thickness of the palatal callus. In *G. procera,* the callus is along the inner margin of the peristome; in *G. p. mcclungi,* the callus is said to be heavier and situated along the outer margin of the peristome; *G. p. sterkiana* differs from the above two forms by the callus being lower and farther within the aperture.

Gastrocopta procera and the two "subspecies" under consideration, have been collected in Kansas at various localities which differ in environmental conditions. The authors found that in a majority of the localities in Kansas from which *G. procera* was obtained, either one or both of the above two "subspecies" occurred. Furthermore, the characters of the shell which are used to differentiate these forms intergrade among the Recent as well as among fossil individuals in lots taken from the same locality. Shells from the same locality cannot be successfully separated into the three catagories. This intergradation of the three forms within a population occurs throughout Kansas as well as in the neighboring states of Arkansas, Oklahoma, and Texas. The occurrence of typical *G. procera, G. p. mcclungi,* and *G. p. sterkiana* is not limited geographically, nor can the position of the callus be correlated with any climatic conditions nor with any other variables of the shell.

Since the characters used in separating the three forms intergrade among individuals of the same population and this intergradation is widespread geographically, and since no two subspecies occupy the same geographic locality except in a restricted zone in which they intergrade, *G. p. mcclungi* and the shells from Kansas localities previously identified as *G. p. sterkiana* cannot be considered as subspecies of *G. procera*, but as variations within the species.

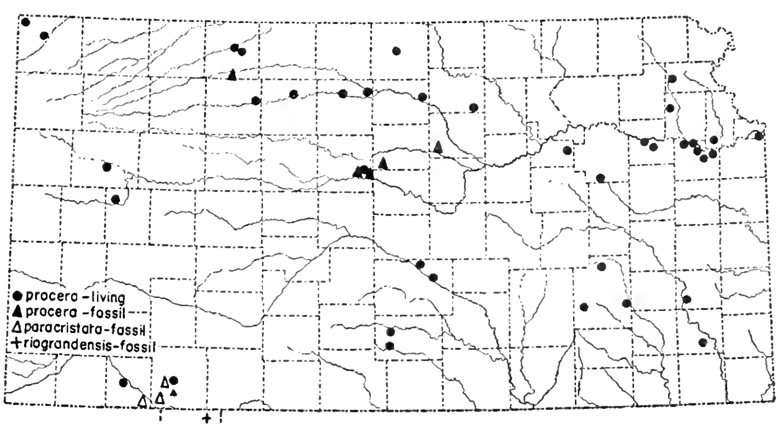


FIG. 8. Records of *Gastrocopta procera* (Gould), *G. paracristata* n. sp., and *G. riograndensis* Sterki.

After studying the shell designated as the holotype of *G. p. mcclungi* in the United States National Museum, and comparing shells identified as *G. p. mcclungi* with *G. procera* at the Philadelphia Academy of Science, and comparing them with shells from Kansas, the authors consider *G. p. mcclungi* as synonomous with *G. procera.* However, not having studied shells of *G. p. sterkiana* from various localities within its range, the author refers the shells from Kansas previously reported as *G. p. sterkiana* to *procera,* without pronouncing judgment on the validity of *sterkiana* as a subspecies.

Gastrocopta cristata (Pilsbry and Vanatta)

Plate XIX, fig. 1, Plate VI, fig. Text figure 5.

Bifidaria procera cristata Pilsbry and Vanatta, 1900, p. 595, Pl. 22, figs. 4, 5; Hanna, 1909, p. 94; Hanna and Johnston, 1913, p. 113.

Gastrocopta cristata, Pilsbry, 1916, Vol. 24, pt. 93, pp. 68-69, Pl. 13, figs. 6, 8 to 12; Baker, 1938, p. 130; Frye and Hibbard, 1941, pp. 390-424; Hibbard, 1941, p. 265; Leonard, 1943, p. 239, Pl. I, figs. 9, 10.

Description of the shell: Auburn to golden brown in color; glossy; surface marked with fine and irregular striations; rimate; cylindrical; apex convex, obtuse; whorls $5\frac{1}{4}$ to $6\frac{1}{2}$, increasing regularly and gradually in size; body whorl more than one-half of the total height. constricted at the base and expanding toward the aperture, linear impressions mark the positions of the upper and lower palatal and basal folds; a prominent, rounded crest parallels the peristome from which it is slightly removed; aperture rounded, slightly oblique, peristome expanding, terminations approaching, connected across the parietal wall by a thin callus; margin slightly reflected, sharp; folds and lamellae six: angulo-parietal fused, sinuous, increasing in height inwardly and terminating abruptly, from without the approach to these lamellae is sometimes "Y"-shaped; upper palatal fold immersed, tubercular; lower palatal fold somewhat more deeply immersed, elongate, and slightly deflected toward the columella; basal fold immersed equidistant with the upper palatal fold; columellar lamella horizontal, elongate, about one-half the length of a whorl; subcolumellar lamella nodose, situated immediately below the columellar lamella.

Variations: The angulo-parietal lamella varies in the degree of sinuosity, sometimes being nearly straight. The crest behind the peristome, usually prominent, is sometimes low; the crest, usually removed from the peristome, is sometimes approximate to it. The lip, typically thin, is infrequently slightly thickened. The aperture varies in size. The size of the shell varies considerably as may be seen in the table below.

Gastrocopta cristata, though closely related to *G. procera,* can, with rare exceptions, be separated from the latter by the completely fused rather than bifid angulo-parietal lamella; the crest behind the lip is usually more prominent and farther removed, and the diameter of the shell is greater. Rarely some shells are very narrow and elongate.

Shells recovered from the several Pleistocene deposits are typical *G. cristata* in their shape and other features. Some of the shells, catalogue number 3771, recovered from a deposit of Blancan age, Rexroad Ranch, Meade County, show a close relationship to *G. procera* by having a semifused angulo-parietal lamella and a prominent, rounded callus on the outer lip. This is considered to be a representation of an isolated population which has retained some of the primitive characteristics. The separation of the ancestral stock into these two species must have occurred at an earlier time since shells from the Fox Canyon fauna, Blancan in age, are typically *G. cristata.*

Although occasional individuals of *G. cristata* closely resemble *G. procera,* these two species do not intergrade. Since these two species are closely related, occasional interbreeding may occur which possibly accounts for an occasional elongate, narrow shell approaching that of *G. procera.*

MEASUREMENTS

	Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
Pleistocene	3.5	1.4	1.2	1.0	6
Pleistocene	3.5	1.35	1.1	1.0	6½
Recent	3.2	1.35	1.1	...	5½
	3.15	1.35	1.0	1.0	6
	2.7	1.25	1.0	0.9	6
	2.35	1	0.8	0.7	5½

Habitat: *Gastrocopta cristata* has, in Kansas, usually been found associated with *G. procera* (Gould) on timbered slopes near streams. In Meade County it was found living in grassy meadowlands of the State Park (Leonard, 1943, p. 239).

Distribution:

Type locality: Camp Verde, Yavapai County, Arizona.

General distribution in North America: Northern Kansas, south to Oklahoma and southern Texas; west to New Mexico and Arizona (Pilsbry, 1916, Vol. 24, pt. 93, p. 68).

Distribution in Kansas:

Recent: Along the Kansas River and its tributaries, Douglas and Shawnee counties west to Rooks, Graham and Logan counties; northwest to Cheyenne County; south to Reno, Kingman, Clark, Meade, and Seward counties.

Pleistocene: Meade County: Jones Sink, Locality number 13 (Hibbard, 1940, p. 417), S 8, T 33 S, R 27 W, 5 mi. S, 3½ mi. E of Meade; XI Ranch, high terrace, S 33, T 34 S, R 29 W, 15 mi. S, 7 mi. W of Meade.

Blancan: Meade County: Rexroad Ranch, SW¼, S 22, T 33 S, R 29 W, 9 mi. S, 7 mi. W of Meade; Big Springs Ranch, NW¼, NW¼, S 19, T 32 S, R 28 W, 2 mi. S, 4 mi. W of Meade; Fox Canyon, S 35, T 34 S, R 30 W, 17 mi. S, 12 mi. W of Meade.

Gastrocopta paracristata new species

Plate XIX, figs. 2 & 3. Text figure 8.

Holotype: Catalogue number 3929, University of Kansas Museum of Natural History.

Horizon and type locality: Blancan, Fox Canyon, Meade County, Kansas, S 35, T 34 S, R 30 W, 17 mi. S, 12 mi. W of Meade.

Diagnosis: Shell moderate in size for the genus; elongate oval; rimate, minutely perforate; whorls 5¾, convex; lamellae and folds 5: a fused, sinuous, angulo-parietal, the angular portion continuous with the parietal callus and the outer lip; 3 equally immersed palatal folds connected anteriorly to the palatal callus; a horizontal columellar fold, the extreme innermost portion ascending the columella. Subgenus *Gastrocopta.*

Description of the Holotype: Shell elongate-oval, summit obtuse; rimate, minutely perforate; suture sharply and deeply incised; whorls 5¾; convex, regularly and slowly increasing in size; the 1½ nuclear whorls finely granular; remaining whorls finely and irregularly striate; height of body whorl less than one-half of the total height of the shell, constricted at the base and expanding rapidly toward the aperture; prominent, rounded crest paralleling the peristome from which it is somewhat removed; aperture rounded, slightly oblique, expanding toward the peristome; denticles 5: a fused, sinuous, angulo-parietal, the angular portion continuous with a parietal callus and outer lip; 3 equally entering palatal folds, connected anteriorly by a low callus, a tubercular upper palatal, a higher, elongate lower palatal, its highest point about midway of its length, and a low, tubercular basal fold; the columella lamella high, elongate, entering horizontally and ascending the spire at its extreme innermost portion; peristome reflected, thickened along its inner border, margin sharp.

MEASUREMENTS

	Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
Holotype:	3.1	1.35	1.1	1.0	5¾
Paratype:	3.4	1.4	1.1	1.1	6½
Paratype:	3.3	1.4	1.1	1	6¼
Paratype:	2.9	1.3	1.1	0.9	5¾
Paratype:	2.7	1.5	1.1	1.0	5¼

The range in height of the shells of *Gastrocopta paracristata* is from 2.7 mm. to 3.4 mm. The width varies independently of the height, therefore, shells vary in shape from elongate-ovate to elongate-conic. The basal fold, usually prominent, is sometimes very low and occasionally wanting. The callus of the peristome varies in prominence. A prominent, rounded crest on the ultimate whorl, paralleling the peristome is usually present, rarely wanting, sometimes low and sharp. The distance between the peristome and the center of the crest varies from 0.5 to 0.25 mm. Two sinistral individuals occur in the Rexroad faunule.

Gastrocopta paracristata differs in several respects from *Gastrocopta cristata* to which it is closely related. *G. paracristata* lacks the subcolumellar lamella which is present in *G. cristata*. The anterior portion of the lower palatal fold of *G. paracristata* is in contact with the palatal callus, whereas, in *G. cristata* the lower palatal fold is removed from the callus. The peristome is usually heavier in *G. paracristata* than it is in *G. cristata*.

Occurrences: *Gastrocopta paracristata* is known from three localities: Blancan: Type locality, Fox Canyon, Meade County, S 35, T 34 S, R 30 W, 17 mi. S, 12 mi. W of Meade; Rexroad Ranch, Meade County, SW¼, S 22, T 33 S, R 29 W, 9 mi. S, 7 mi. W of Meade. Upper Pliocene (?): Saw Rock Canyon, Seward County, S 35, T 34 S, R 31 W, 14 mi. E of Liberal.

Gastrocopta riograndensis (Sterki)

Plate XIX, fig. 7. Text figure 8.

Pupa riograndensis Sterki, 1891, p. 142.
Gastrocopta riograndensis, Pilsbry, 1916, Vol. 24, pt. 93, pp. 69-70; Leonard and Franzen, 1944, p. 30, Pl. V, fig. 14.

Description of the shell: Shell elongate ovate, summit convex; suture deeply incised; whorls 5, convex, gradually and regularly increasing in size; 1½ nuclear whorls finely granular, remaining whorls irregularly and finely striate; body whorl large, exceeding one-half the height of the shell; aperture large, exceeding one-half the height of the body whorl, irregularly rounded; a fused, anteriorly bifid, angulo-parietal lamella situated at the midpoint of the parietal wall, the angular portion forming a spur directed toward the outer lip; the outer portion continuous with the upper lip; three deeply immersed palatal folds, a shortly elongate upper palatal, a high, elongate lower palatal, and a tubercular basalar; columellar lamella horizontal, prominent, elongate, extending about one-half the length of a whorl, thickened at the base; peristome broadly reflected, thin at the margin, thickened by a callus along the inner border; a callus prominence on the inner border of the outer lip results in a sinulus at the upper right-hand portion of the aperture, the inner border of which is continuous with the angular lamella; a prominent, narrow callus on the body whorl parallels the peristome from which it is separated by a groove; body whorl indented behind the crest; a longitudinal impression at the level of the lower palatal fold.

Variations: The shells vary in size and general form. Some are narrow and elongate, some tend to be conically-elongate. In some instances the base of the columella is thickened almost to the extent of forming a subcolumella lamella, in others the base of the columella is only slightly thickened. The width of the peristome and the size of the callus along its inner margin vary. In some shells the crest behind the peristome is sharp and very prominent, whereas in others it is almost wanting. The infraparietal is wanting in all of the 9 shells of the one series in the collection of the University of Kansas.

MEASUREMENTS

Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
2.5	1.2	0.9	0.8	5¼
2.5	1.25	0.9	0.8	5¼
2.6	1.2	0.9	0.8	5¼
2.7	1.2	0.9	0.8	5½

Habitat: Chaney and Elias (1938, pp. 25-34) interpreted, on the basis of the fossil flora, the climatic conditions which characterized Beaver County, Oklahoma, at the time the Laverne deposits were laid down. The flora found in these deposits suggests that a flood plain forest existed in Beaver County in Lower Pliocene times. This forest was similar to the one growing today in eastern and central Oklahoma. The present annual precipitation in eastern Oklahoma is more than 30 inches, which may have been approximately the amount in Beaver County in Lower Pliocene times. The temperature was probably somewhat warmer than present day temperatures of western Oklahoma. It is probable that *Gastrocopta riograndensis,* associated with other pupillids such as *G. anterides* Leonard and Franzen, and *Pupoides marginatus* Say, was a woodland snail.

Distribution:

Type locality: Hidalgo, Texas.

General distribution: Texas; Lower Rio Grande Valley. Mexico, Panuco River Valley, Tampico, Tamaulipas, below Valles and Las Canoas, San Luis Potosi (Pilsbry, 1916, Vol. 24, pt. 93, p. 70). Laverne Formation, Beaver County, Oklahoma, Pliocene (Leonard and Franzen, 1944, pp. 17, 30).

Gastrocopta pellucida hordeacella (Pilsbry)

Plate XIX, fig. 8. Text figure 7.

Pupa hordeacella Pilsbry, 1890, p. 44, Pl. 1, figs. g, h, i, j, k.
Bifidaria hordeacella, Hanna, 1909, p. 94.
Gastrocopta pellucida hordeacella, Pilsbry, 1916, Vol. 24, pt. 93, pp. 78-80, Pl. 17, figs. 1-4, Pl. 16; Henderson, 1924, pp. 79, 132.

Description of the shell: Shell small, elongate and narrow, subcylindrical; height varying from 1.9 mm to 2.5 mm.; light brown in color, pellucid; rimate; suture sharply and deeply incised; whorls 5 to 5½, convex, increasing gradually and regularly in size; 1½ nuclear whorls finely granular; remaining whorls finely and irregularly striate; body whorl slightly more than half total height of shell; aperture oval, slightly oblique, without a callus; lamellae and folds 5: an elongate, prominent, sinuous angulo-parietal lamella frequently with a spur on the columellar side, angular portion continuous with the outer lip, a tubercular upper palatal fold, a prominent, elongate, somewhat more deeply immersed lower palatal fold, a prominent, tubercular basal fold, a prominent, elongate, horizontal columellar lamella, base thickened; peristome simple, reflected, forming a groove on the ultimate whorl immediately behind the peristome; terminations approaching and continuous across the parietal wall by a thin callus; margin sharp.

Variations: The only variants evident in the small series in our collections are the variation in size and in the number of whorls as shown in the table below.

MEASUREMENTS

Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
1.9	0.8	0.6	0.6	5
2.2	0.9	0.8	0.7	5
2.4	1.0	0.8	0.7	5½
2.5	1.0	0.8	0.7	5½

Habitat: The single shell taken from the locality in Rooks County designated below, was found in local debris on the shore of the Rooks County State Lake. The drift was apparently composed of debris washed down from the immediate slope which was covered with short grass and a few dwarfed trees. The other Kansas shells of this species are probably from drift of the Arkansas River, therefore, the geographic origin of those shells is not known.

Distribution:

Type locality: New Braunfels, Texas.

General distribution: Florida and the Keys north to New Jersey; northeastern Oklahoma west to southeastern Colorado, and Arizona; Lower California (Pilsbry, 1916, Vol. 24, pt. 93, p. 79).

Distribution in Kansas:

Recent: Rooks County; SW¼, S 34, T 7 S, R 18 W, 2 mi. S, 2 mi. W of Stockton. Reno County: Hutchinson, Nickerson.

Gastrocopta pellucida hordeacella, essentially a southern snail, has been found only in small numbers in Kansas. This species is not known in Kansas from any fossil beds. Apparently its entrance into territory of the midwest as far north as Kansas has been made possible by the change from a cool, humid, glacial climate to the warmer, drier climate of postglacial times.

Gastrocopta anterides Leonard and Franzen

Plate XIX, fig. 9. Text figure 7.

Gastrocopta anterides Leonard and Franzen, 1944, pp. 29-30.

Description of the shell: "Shell small, perforate, conic-ovate in form; whorls 5, moderately convex, increasing regularly in size, except the last which is compressed around the axis; suture sharply incised, but not deep; aperture obliquely oblong; peristome thin, sharp, margins approaching and connected across parietal wall by thin callus; the one and one-half nuclear whorls nonstriated, granular; remaining whorls marked with fine, closely spaced, oblique striations; denticles 5: the angular projecting as a small spur from the well fused angulo-parietal, the tooth extending from the inner margin of the angular lip of the peristome to a point opposite the columellar lamella, terminating in a strong pyramidal buttress; columellar lamella well developed, horizontally compressed around the axis, its inner termination turned downward; basal fold feebly developed; lower palatal dentiform, somewhat laterally compressed, diminishing as it extends inward; upper palatal fold nodose, weakly developed; palatal folds set on a callus which bears faint suggestions of two interpalatal plicae; the callus appears also as a low external ridge." (Leonard and Franzen, 1944, pp. 29-30).

Variations: "The two paratypes of *Gastrocopta anterides*, except for a few slight variations in the development of the denticles, are identical with the type. The angulo-parietal and the columellar lamellae are invariable, but in the one specimen the basal fold is feebly developed, as in the type, in the other nodose. The interpalatal folds are missing in one example, although the callus between the upper and lower palatals is persistent; in this specimen there is an indentation of the angular portion of the peristome suggestive of the angle so characteristic of *Vertigo*." (ibid, p. 30).

MEASUREMENTS

	Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
Holotype:	2.9	1.9	1.08	0.99	5

Habitat: Probably a woodland pupillid which lived in association with *Pupoides marginatus* and *Gastrocopta riograndensis*.

Distribution:

Type locality: Laverne Formation. Lower Pliocene, 6½ mi. S, ½ mi. W of Gate, Beaver County, Oklahoma.

General distribution: Known only from the type locality.

Genus *Vertigo* Müller

Vertigo O. F. Müller, 1774, p. 124.

"*Isthmia* Gray, London Medical Repository, xv, 1821, p. 239, for ' "*Helix Isthmia cylindrica* Drapernaud t. 3, f. 30, 31" ' = *V. pygmaea* Drapernaud cf. Dall, Tr. Wagner Inst. iii, pt. 2, p. 248; Nautilus xvii, 1904, p. 114, and Newton and Harris, Proc. Malac. Soc. London i, p. 72, footnote 1.—Gray, P Z. S. 1847, p. 176, type *Vert. nitida* = *edentula* Drapernaud.

Alaea Jeffreys, Trans. Linn. Soc. London xvi, 1830, p. 357. Gray, P. Z. S. 1847, p. 176, type *A. palustrus* Jeffreys = *V. antivertigo*.—Pilsbry, Nautilus xviii, 1905, p. 119.

Staurodon Lowe, Proc. Zoöl. Soc. 1854, p. 214, type *P. pygmaea* Drapernaud. Not *Staurodon* Lowe, 1852.

Dexiogyra Stabile, Moll. terr. Viv du Piemont, 1864, p. 104 (in Atti della Soc. di Scienze Nat. Milano, vi), for *V. moulinsiana*, *V. pygmaea*, *V. antivertigo*, *V. antivertigo* here designated as type.

Dexiogira De Betta, Moll. Prov. Veron., 1870, p. 83.

Nearctula Sterki, Nautilus vi, 1892, p. 5, type by orig. des., *V. californica* Rowell.

Haplopupa Pilsbry, Nautilus xi, Feb. 1908, p. 119, monotype *V. dalliana*.

Pupa Drapernaud, 1801, and of many subsequent authors. Not *Pupa* Bolten, . . ." (Pilsbry, 1919, Vol. 25, pt. 98, pp. 69-70.)

Vertigo, Pilsbry, 1919-1920, Vol. 25, pts. 98, 99, pp. 69-221, Plates 6-18. Pilsbry, 1931, and 1934, Vol. 28, pts. 110, 111, pp. 93-105; 1935, Vol. 28, pt. 112, pp. 208-209, Pl. 15, figs. 1, 2, 8, 9; Pl. 18, figs. 11-17; Pl. 22, figs. 7-14, Pl. 24, figs. 1-4, 7-9; Pl. 31, figs, 4, 5.

Characteristics of the shell: Shell moderate to small in size for the family; conically ovate to oval or oblong; summit conic to obtuse; rimate to minutely perforate; total height 1.53 mm. to 2.5 mm.;

whorls 4½ to 5, convex, irregularly and finely to coarsely striate; lamellae and folds 3-9, never concrescent, angular lamella frequently wanting, palatal folds frequently on a palatal callus; frequently a crest on body whorl paralleling the peristome; linear impression frequently present on body whorl at level of upper and lower palatal folds.

Distribution:

Recent: Circumpolar. In North America, abundant in northern latitudes above 60°, in the Canadian and Transition Life zones to about 33° latitude, and south to Arizona at high elevations where cool and humid atmospheric conditions obtain. Five species are known from Mexico and the West Indies. In the Palaearctic the genus has undergone the greatest development in Scandinavia and the eastern Alps. Known also from Asia, northern Africa, Japan, and West Indies (Pilsbry, 1919, Vol. 25, pt. 98, pp. 72, 74).

Pleistocene: North America, northern Europe.

Pliocene: southern France.

Miocene: central Europe.

Middle and Upper Oligocene: central Europe.

Lower Oligocene: Baltic coast.

Eocene: western Europe. (Pilsbry, 1919, Vol. 25, pt. 99, pp. 214-215).

KEY TO SPECIES

1. Columellar lamella ascending inwardly.. 2
   Columellar lamella not ascending inwardly.................................... 7
2. Palatal folds on a callus... 3
   Palatal folds not on a callus... 6
3. Denticles 3-4; a single, short parietal lamella.................... *V. tridentata*
   Denticles 5 or more 4
4. Denticles 5 .... *V. elatior*
   Denticles 7-9; 3 parietal lamellae.. 5
5. Ultimate whorl exceeding ½ of total height.......................... *V. ovata*
   Ultimate whorl less than ½ of total height.......................... *V. morsei*
6. Denticles 4-6; a single, lamelliform parietal lamella; lower palatal fold not oblique, not entering deeply...................................... *V. gouldii*
   Denticles 4-5, lower palatal fold oblique, entering deeply........ *V. g. paradoxa*
7. Columellar lamella horizontal. Palatal folds not on a callus................. 8
   Columellar lamella crescentic, descending inwardly; palatal folds on a callus..... 9
8. Denticles 6; two parietal lamellae.................................. *V. hannai*
   Denticles 3-4; only 1 parietal lamella.............................. *V. modesta*
9. Denticles 5; lower palatal fold recurved toward the columella......... *V. milium*
   Denticles 7; lower palatal fold not recurved........................ *V. hibbardi*

Vertigo morsei Sterki

Plate XIX, fig. 4. Text figure 11.

Vertigo morsei Sterki, 1894, pp. 89-90; Walker, 1894, p. 17; Walker, 1899, p. 18; Blatchley and Daniels, 27th Ann. Rep. Dep. Geol. and Nat. Res. Indiana, 1902, pp. 587, 632; Walker, 1906, p. 516, fig. 149; Pilsbry, 1919, Vol. 25, pt. 98, pp. 81-82, Pl. 6, figs. 8, 9.

Description of the shell: Shell largest of the genus represented in the Kansas fauna; elongate-conic, height 2.5 mm.; rimate; suture sharply and deeply incised; whorls 5 to 5¾, convex and inflated, finely and irregularly striate, slowly and regularly increasing in size; body whorl less than half the total height of the shell, contracted at the base and expanding rapidly toward the aperture; crest paralleling the peristome rounded, low and removed from the peristome; body whorl indented immediately behind the crest, linear impressions at the level of the indentation of the aperture and at the upper and lower palatal folds; aperture small, rounded, strongly biarcuate, slightly oblique, dilating rapidly toward the peristome; denticles essentially as in *Vertigo ovata*: a low tubercular infraparietal lamella, an elongate, lamelliform parietal lamella, a low, tubercular angular lamella, a low tubercular suprapalatal fold situated above the indenture of the aperture, a high, angular, elongate upper palatal fold situated at the level of the indenture of the aperture, a high, elongate lower palatal fold, a low tubercular infrapalatal fold, a prominent basal fold and a prominent columellar lamella ascending inwardly; folds on a palatal callus and immersed subequally; peristome narrowly reflected, thin, margin sharp, terminations approaching, continuous across the parietal wall by a thin callus.

Vertigo morsei differs from *Vertigo ovata* in being of greater height, having 6 whorls and in the whorls increasing slowly in size. The latter results in a smaller body whorl and aperture. The columellar lamella is more prominent than it is in *Vertigo ovata*.

Four of a series of 11 shells from the Cudahy faunule, Lower Pleistocene, Meade Formation, 6 mi. N of Meade, cannot be distinguished from *V. morsei*. Seven of this series are transitional in form between *V. ovata* and *V. morsei*. Transitional shells occur in other Pleistocene faunules, Sunbrite (Cudahy) S 26, T 32 S, R 28 W, 3 mi. S of Meade. Upper Pleistocene; Rezabek, Lincoln County, S 20, T 13 S, R 10 W, 8 mi. S, 16 mi. W of Lincoln. These transitional shells (Plate V. fig. 5), are elongate, about 2.5 mm. in height, have 5½ whorls, a smaller body whorl and aperture than *V. ovata*.

Individuals with characters intergrading between *V. ovata* and *V. morsei* occur also in the Recent fauna, and have been found at the following localities: Kansas City, Wyandotte County; Hutchinson and Nickerson, Reno County; Kingman County; Arkalon, Seward County.

The persistent occurrence of shells transitional between *V. ovata* and *V. morsei* places the validity of *V. morsei* in question. However, since typical *V. morsei* occurs in a single Pleistocene population, sufficient grounds for reducing the taxonomic status of *V. morsei* are lacking.

MEASUREMENTS

	Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
	2.45	1.35	0.8	0.8	5½
	2.45	1.35	0.8	0.8	5½
Transitional Pleistocene ..	2.4	1.4	0.8	0.9	5
Transitional Pleistocene ..	2.5	1.5	0.9	0.8	5½
Recent	2.4	1.5	0.9	0.9	5
Recent	2.3	1.35	0.9	0.8	5
Recent	2.5	1.5	1	0.9	5½

Habitat: "Its habitat appears to be most often near the shore of lakes" (Baker, 1939, p. 104). Since the only shells of *V. morsei* known in Kansas are fossil, its preferred habitat in Pleistocene times here is not known. Though this form is now extinct in Kansas, its general distribution is in areas of a more humid and somewhat cooler climate.

Distribution:

Type locality: Michigan, Kent County.

General distribution: New Jersey, Michigan, Ohio, Indiana, Illinois (Pilsbry, 1919, Vol. 25, pt. 98, p. 81). Pleistocene in Kansas.

Distribution in Kansas:

Pleistocene: Cudahy Volcanic Ash Pit, S 2, T 31 S, R 28 W, 6 mi. N of Meade.

Vertigo ovata Say

Plate XIX, fig. 6. Text figure 9.

Vertigo ovata Say, 1822, p. 375; Hanna, 1909, p. 95; Pilsbry, 1919, Vol. 25, pt. 98, pp. 82-86, 372; Henderson, 1924, pp. 80, 136, fig. 39; Lugn, 1935, p. 212, Table C; Baker, 1938, p. 130; Goodrich, 1940, p. 77; Goodrich in Hibbard, 1940, p. 418; Over, 1942, p. 9; Franzen and Leonard, 1942, p. 339, Pl. I, fig. 3; Franzen and Leonard, 1943, p. 420, text fig. 6, Pl. XXXII, fig. 28; Leonard, 1943, p. 239, Pl. I, fig. 13; Leonard and Franzen, 1944, p. 30, Pl. V, fig. 13.

Vertigo hibbardi, Frye, Leonard and Hibbard, 1943, p. 42; Hibbard, 1943, p. 236.

Description of the shell: Shell moderate to large in size for the genus; roundly ovate to elongate; auburn to brown in color; glossy; translucent; rimate; whorls usually 5 in number, the nuclear whorl finely granular; remaining whorls finely and irregularly striate; convex, rapidly increasing in size; body whorl as much as ⅗ of the total height of the shell, contracted at the base and rapidly expanding toward the aperture; crest paralleling the peristome, prominent, rounded and removed; linear impressions at the level of the upper and lower palatal folds, sometimes incising the crest; shell indented immediately below the crest; aperture large, slightly oblique, strongly biarcuate, expanding toward the peristome; denticles 9: 3 lamellae on the parietal wall, a low, tubercular infraparietal; a high, elongate thin parietal lamella, slightly less deeply immersed; a low tubercular angular, slightly less deeply immersed; 5 folds situated on a palatal callus and equidistantly immersed; a low, tubercular suprapalatal just above the indenture of the outer margin of the aperture; an elongate upper palatial increasing in height rapidly and decreasing inwardly slowly; a similar lower palatal; a low, tubercular, infrapalatal; a low, slightly elongate basal; columellar lamella high, elongate, ascending inwardly along the axis; peristome narrowly reflected, thin, margin sharp, continued across parietal wall by a thin callus.

Variations: The variation in shape is pronounced. Shells of several series, one from the Laverne Formation, Lower Pliocene, Beaver County, Oklahoma (Leonard and Franzen, 1944, p. 30), another from the XI Ranch, Pleistocene, Meade County, and one from the Pyle Ranch, Pleistocene, Clark County, are of a typical ovate form. In other series of Pleistocene age as, for example, the Rezabek faunule, Lincoln County, the Cudahy faunule, and Sunbrite (Cudahy) faunule, Meade County, and of Recent age, the shells vary from an ovate to an elongate oval form approaching *Vertigo morsei* Sterki, in size, height of body whorl relative to total height, and the number of whorls.

The whorls, usually 5 in number, vary from 4½ to 5½. The total height varies from 1.8 mm. to 2.7 mm. Not all of the denticles are constantly present. The infraparietal lamella, variable in size, is frequently wanting. The suprapalatal fold varies in degree of prominence, sometimes scarcely perceptible. The infrapalatal fold is sometimes wanting and sometimes double.

MEASUREMENTS

Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
2.0	1.4	0.8	0.8	5
2.2	1.4	0.9	0.9	5
2.5	1.5	1.0	1.0	5
2.7	1.7	1.0	...	5½

Habitat: *Vertigo ovata,* although found in various parts of the state, lives only in moist environs afforded by shaded slopes near streams and shores of ponds. Its range in Kansas extends westward into the generally dry regions of the High Plains. In these regions are local ponds and streams, many of which are fed by artesian springs, along whose shaded slopes *V. ovata* is found, though not in great numbers. This species is not known from the Ozark Region, extreme southeastern Kansas.

In Kansas, the Recent distribution of this species, which is essentially a northern form, is sporadic. This is true even along tributary streams such as the Wakarusa River, a tributary of the Kansas River. A series of collections along this stream resulted in finding *V. ovata* at only one locality (Franzen and Leonard, 1943, text fig. 6, and p. 420).

V. ovata lived in Lower Pliocene times in Oklahoma, near the Kansas border (Leonard and Franzen, 1944, p. 30) and in Pleistocene times in Kansas when the climate was cooler and more humid than it is in that area at the present time. This species is probably now receding from Kansas because it is intolerant of the high temperatures coupled with the relative low humidity of the summer season.

Distribution:

Type locality: Philadelphia, Pennsylvania.

General distribution: Labrador, Alaska to Alabama, Texas, Arizona, Mexico and West Indies (Pilsbry, 1919, Vol. 25, pt. 98, p. 83). Pliocene, Beaver County, Oklahoma; Pleistocene, Kansas and Nebraska.

Distribution in Kansas:

Recent: Northeastern and northwestern Kansas, along the Kansas River and its tributaries; Southcentral Kansas, along the Arkansas River and its tributaries; Southwestern Kansas, along the Cimarron River and near lakes and ponds.

Pleistocene: Meade County: Jones Sink, S 8, T 33 S, R 27 W, 5 mi. S, 3½ mi. E Meade (Locality number 13, Hibbard, 1940, p. 417); Lincoln County: Rezabek faunule, S 20, T 13 S, R 10 W, 8 mi. S, 16 mi. W of Lincoln; Lower Pleistocene: Meade County, Cudahy, Volcanic Ash Pit, SW¼, S 2, T 31 S, R 28 W, 6 mi. N of Meade; Sunbrite (Cudahy) S 26, T 32 S, R 28 W, 3 mi. S of Meade.

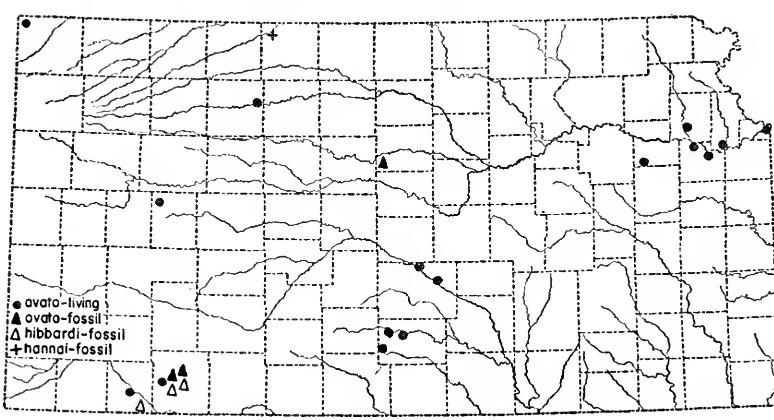


FIG. 9. Records of *Vertigo ovata* Say, *V. hannai* Pilsbry, and *V. hibbardi* F. C. Baker.

Vertigo elatior Sterki

Plate XX, fig. 2. Text figure 11.

Vertigo ventricosa elatior Sterki, 1894a, pp. 5-6; Pilsbry, 1919, Vol. 25, pt. 98, pp. 95-96, Pl. 7, fig. 6; Henderson, 1924, pp. 80, 136.
Vertigo elatior. Pilsbry, 1931, Vol. 28, pt. 110, pp. 93-95.

Description of the shell: Shell conic-ovate; summit obtuse; rimate; nuclear whorl finely granular; whorls 5, convex, rapidly and regularly increasing in size, irregularly striate; body whorl one-half of total height, contracted at the base and expanding toward the aperture; aperture oblique, biarcuate, at least one-half the height of the ultimate whorl; folds and lamellae 5: a high, short angular lamella situated at the center of the parietal wall; two palatal folds situated on a palatal callus, a triangular upper palatal located at the place of the indenture of the outer lip, a somewhat more prominent and more deeply immersed lower palatal; a low, tubercular basal fold situated at the base of the columellar wall, a low, tubercular, columellar lamella, subvertical, ascending inwardly; peristome not everted, margin sharp, terminations approaching, connected across parietal wall by a thin callus; crest behind the lip usually prominent; linear impressions at the level of the upper and the lower palatal folds, the former sometimes incising the crest, the latter causing the body whorl to be constricted at the base.

Variations: Since only 8 specimens, all from the same population, were available for study, very little individual variation could be noted. Some of the shells lacked the definite palatal callus while this feature was well-developed in others. The characteristics of these shells compared favorably with those of the type lot of *Vertigo elatior* studied by the author in the Carnegie Museum, Pittsburgh.

MEASUREMENTS

Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
2.0	1.2	0.6	0.6	5
2.1	1.2	0.6	0.6	5

Habitat: *Vertigo elatior* prefers a cool humid climate characteristic of northern United States or mountainous areas of southern states. Cool and humid climatic conditions probably obtained in Kansas in the time this species lived in northwestern Kansas. Prolonged drought and high temperatures, characteristic of Kansas' summers, are factors excluding *V. elatior* from Kansas today.

Distribution:

Type locality: New Philadelphia, Ohio.

General distribution: Maine, New York, Ohio, Michigan, Montana, British

Columbia and Alberta, Oscuro Mts., Socorro County, N. Mexico. Loess, New Harmony, Indiana; marl deposits, Castalia, Erie County, Ohio (Pilsbry, 1919, Vol. 25, pt. 98, p. 95). Pleistocene in Kansas.

Distribution in Kansas:

Pleistocene: Sanborn Formation: Norton County; SE¼, S 5, T 1 S, R 22 W, 9½ mi. N, 4½ mi. E of Norton.

Vertigo gouldii (Binney)

Plate XX, fig. 3. Text figure 10.

Pupa gouldii Binney, 1844, p. 105.

Vertigo gouldii, Pilsbry, 1919, Vol. 25, pt. 98, p. 98; Henderson, 1924, pp. 80, 137, fig. 40; Frye, Leonard, and Hibbard, 1943, p. 41.

Description of the shell: Shell ovate to elongate-oval; apex obtuse; rimate; whorls convex; nuclear whorl finely granular; remaining whorls weakly and irregularly striate (probably due to wear); whorls increasing rapidly and regularly in size; body whorl more than one-half total height; aperture scarcely oblique, biarcuate, somewhat expanded; denticles 5 to 6: a short lamelliform parietal lamella in the center of the parietal wall; a slightly elongate upper palatal fold; a slightly elongate, somewhat more deeply entering lower palatal fold; a tubercular basal fold; a low, tubercular, subcolumellar lamella appearing tubercular when viewed from without, ascending inwardly; folds not situated on a palatal callus; peristome not reflected, terminations approaching and connected across the parietal wall by a thin callus, margin slightly rounded, edge sharp; crest behind the lip usually prominent and separated from the peristome by a groove; sharp, linear impressions on the body whorl at the level of the upper and the lower palatal folds; body whorl constricted at the base and expanding towards the aperture.

Variations: Some of the shells are elongate while others tend to be more ovate. The basal fold is frequently wanting, though sometimes double. The crest behind the peristome is usually prominent, sometimes inconspicuous. In the shells from Kansas Pleistocene deposits, the sutures are more deeply and sharply incised than they are in Recent shells from southeastern United States with which comparisons were made. The Pleistocene shells are not as conspicuously striate as are the Recent shells, which may be due to wear.

MEASUREMENTS

Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
1.8	1.1	0.6	0.6	5
1.9	1.17	0.6	0.6	5
2.0	1.1	0.6	0.6	5

Habitat: In Kansas *V. gouldii* is known only from the Lower Pleistocene (Meade Formation). This species at the present time is limited in its distribution to regions where cooler and more humid climatic conditions obtain. It is very probable that in Lower Pleistocene times of Kansas, climatic conditions differed from those of the Recent times. Hibbard (1944, p. 741) has studied the vertebrate fauna of the Meade Formation and says, "The abundance of the Sorex and the associated *Neosorex, Microsorex, Synaptomys borealis,* and *Microtus* of the *operarius* group indicate that at the time they lived in southwestern Kansas the climate was considerably cooler and more humid than at present. This conclusion is based upon the habitats in which their nearest living relatives are found."

Distribution:

Type locality: New England

General distribution: Prince Edward and Magdalen Islands, British Columbia and Montana; Potomac River, North Carolina; mountains of Tennessee, Alabama (Pilsbry, 1919, Vol. 25, pt. 98, p. 98). Pleistocene in Kansas.

Distribution in Kansas:

Pleistocene: Meade Formation: Meade County, Cudahy Volcanic Ash Pit, S 2, T 31 S, R 28 W, 6 mi. N of Meade; Lincoln County, Wilson Valley deposit, S 28, T 13 S, R 10 W, 9 mi. S, 15 mi. W of Lincoln.

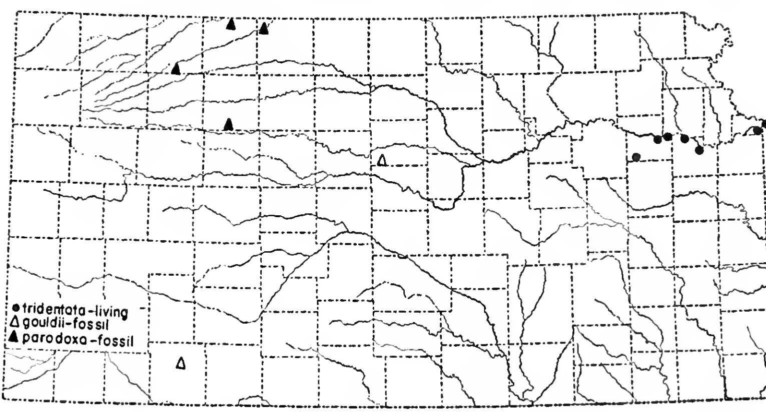


FIG. 10. Records of *Vertigo gouldii* (Binney). *V. g. paradoxa* Sterki, and *V. tridentata* Wolf.

Vertigo gouldii paradoxa Sterki

Plate XX, fig. 4. Text figure 10.

Vertigo gouldii paradoxa Sterki, in Nylander, 1900, p. 103; Pilsbry, 1919, Vol. 25, pt. 98, pp. 99-100, Pl. 12, figs. 6, 8 (a more complete description); Pilsbry, 1931, Vol. 28, pt. 110, p. 95.

Vertigo gouldii, Hanna and Johnston, 1913, pp. 115, 120; Hibbard, Frye and Leonard, 1944, pp. 13, 14.

Vertigo coloradensis, Leonard and Frye, 1943, p. 457, text fig. 3; Hibbard, Frye, and Leonard, 1944, p. 13, fig. 2.

Description of the shell: Shell moderate in size for the genus; oval; summit obtuse; rimate; suture incised; the 1½ nuclear whorls white, finely granular; remaining whorls convex, irregularly and coarsely striate, rapidly and regularly increasing in size; body whorl somewhat more than half the total height, constricted at the base and expanding toward the aperture; aperture rounded, biarcuate; somewhat oblique; denticles 4 to 6; an elongate, lamelliform, parietal lamella situated on the center of the parietal wall, increasing gradually in height and terminating rapidly but not abruptly; an elongate lamelliform upper palatal fold; an elongate, more deeply entering, oblique, lower palatal fold; a low, tubercular basal fold; a columella lamella which appears to be tubercular when viewed from without, ascending inwardly; peristome not everted, margin slightly rounded, terminations approaching and connected across the parietal wall by a callus; crest behind the peristome prominent, broad, and separated from the peristome by a groove; sharp, linear impressions on the body whorl at the level of the upper and lower palatal folds.

Vertigo gouldii paradoxa differs from the typical form of the species in several respects. The lower palatal fold is deeply entering and the basal fold occasionally present in *V. g. paradoxa,* while the lower palatal fold enters subequally with the upper palatal fold, and the basal fold is usually present in *V. gouldii*. *V. g. paradoxa* differs from *V. hannai* Pilsbry in several ways. The columellar lamella ascends inwardly and the angular lamella is usually wanting, though occasionally present in *V. g. paradoxa*. The columellar lamella is horizontal and heavier in *V. hannai* than in *V. g. paradoxa*. The angular lamella is well-developed and consistently present in *V. hannai.*

Variations: Several features are subject to individual variation. The shape of the shell is oval to ovate. The position of the lower palatal fold varies considerably; in some individuals this fold is deeply entering, on the dorsal wall, and almost transverse to the axis while in other individuals it is somewhat shorter and not entering as deeply, approaching the condition in *V. gouldii*. A small lamella is occasionally present. The basal fold is sometimes wanting.

MEASUREMENTS

Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
1.88	1.1	0.6	0.6	5
1.9	1.1	0.6	0.6	5
2.1	1.1	0.6	0.6	5

Habitat: Since this pupillid is known in Kansas only from the Pleistocene, the ecological conditions under which it lived here is a matter of conjecture. Its inhabiting northern regions in North America at the present time signifies that it is a snail which prefers lower temperatures than now obtain in Kansas, especially in the summer season. This probably accounts for the absence of *V. g. paradoxa* from the Recent fauna of Kansas.

Distribution:

Type locality: Woodland, Aroostock County, Maine.

General distribution: Quebec (Pilsbry, 1919, Vol. 25, pt. 98, p. 100). Pleistocene in Kansas and Nebraska.

Distribution in Kansas:

Pleistocene: Long Island, Phillips County. The shells were collected from this locality by Hanna and Johnston (1913, pp. 112, 120, *Vertigo gouldii*). However, data regarding the locality and horizon are inadequate to assign the shells to the fauna of the Sanborn Formation, though the area from which they were obtained lies within its boundaries. Sanborn Formation: Decatur County, 1.4 mi. SW Dresden. Graham County, 15 mi. N of Wakeeny. Sheriden County, NW¼. S 34, T 8 S, R 28 W, 2 mi. S of Hoxie. Norton County, SE¼, S 5, T 1 S, R 22 W, 9½ mi. N, 3½ mi. E of Norton.

Vertigo tridentata Wolf

Plate XX, fig. 5. Text figure 10.

Vertigo tridentata Wolf, 1840, Amer. J. of Conch., May 5, p. 198 (Pilsbry, 1919, Vol. 25, pt. 98, p. 106); Hanna, 1909, p. 95; Pilsbry, 1919, Vol. 25, pt. 98, pp. 106-107, Pl. 12, figs. 1, 2, and 3; Henderson, 1924, pp. 81, 136; Franzen and Leonard 1943, p. 421, text fig. 6, Pl. XXXII, fig. 29.

Description of the shell: Shell oval to oblong; summit conic; rimate; whorls 5, nuclear whorl finely granular; remaining whorls finely and irregularly striate, increasing regularly and rapidly in size; body whorl more than half the total height, constricted at the base and expanding toward the margin; aperture pyriform, oblique, biarcuate, slightly expanding; denticles 4: a single, short, well-developed angular lamella; a low, tubercular lower palatal fold; a low columellar lamella, tubercular from without, entering horizontally and ascending inwardly; the two palatal folds are situated on a low callus which extends to the columellar lamella; terminations of peristome approaching, connected across the parietal wall by a thin callus; margin very narrowly reflected.

Variations: The most pronounced variant is the size which ranges from 2.1 mm. to 2.5 mm. The upper palatal fold is usually present, though sometimes low. The crest behind the peristome is sometimes scarcely perceptible.

MEASUREMENTS

Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
2.1	1.25	0.7	0.7	5
2.25	1.2	0.7	0.7	5
2.3	1.2	0.8	0.7	5

Habitat: Hanna (1909, p. 95) states that *Vertigo tridentata* is "Our commonest *Vertigo;* found on Blue Mound and in river drift at various places." Since that time *V. tridentata* has become less common. The author has found it in only one locality in Kansas, on a timbered bank of the Wakarusa River, a tributary to the Kansas River, 6 mi. W, ½ mi. S of Auburn, Shawnee County. These specimens were recovered from local drift. No living specimens have been found.

Distribution:

Type locality: Canton, Illinois.

General distribution: Ontario, New York, New Jersey, Pennsylvania, Ohio, Indiana, Illinois, Minnesota, Michigan, Kansas, Colorado, Texas (Pilsbry, 1919, Vol. 25, pt. 98, p. 106).

Distribution in Kansas:

Recent: Reported from 7 localities along the Kansas River and tributaries, northeastern Kansas in Wyandotte, Douglas, and Shawnee counties.

Vertigo hannai Pilsbry

Plate XX, fig. 7. Text figure 9.

Vertigo martini Hanna and Johnston, 1913, p. 120, Pl. XVIII, fig. 3.
Vertigo hannai, Pilsbry, 1919, Vol. 25, pt. 98, pp. 114-115, Pl. 12, fig. 12.

Description of the shell: Shell of moderate size; ovate; summit obtuse; rimate; whorls 4½ to 5, convex; the one and one-half nuclear whorls white, finely granulose; remaining whorls conspicuously and irregularly striate, regularly increasing in size; body whorl about one-third the total height; aperture about three-fifths of height of body whorl, ovate, oblique, slightly biarcuate, somewhat expanded; folds and lamellae 6; 2 lamellae on the parietal wall, equally immersed, the parietal lamella the larger, lamelliform; the angular, tubercular; two folds on the palatal side, a lamelliform, elongate, upper palatal fold and an equally entering, elongate, lamelliform, lower palatal fold, both increasing rapidly in height and decreasing gradually inwardly; two denticles on the columellar side; a tubercular basal fold and a shortly elongate, horizontal columellar lamella; peristome slightly reflected on the columellar side, terminations approaching and connected across the parietal wall by a conspicuous callus; margin rounded.

In the description of the holotype (Hanna and Johnston, 1913, p. 120), the columellar lamella is described as being bifid. Upon close examination of the holotype, No. 226396, The United States National Museum, the columella lamella is seen to be single, short and horizontal.

A well-developed angular lamella which is invariably present, a horizontal rather than ascending columellar lamella, a less pronounced indentation of the outer margin of the peristome, heavier palatal folds and a less prominent crest behind the peristome are characteristics which distinguish *V. hannai* from *V. gouldii* (Binney).

Variations: The individual variations of the 70 shells studied were small. The principal variants were a slight difference in the total height and in the size of the basal folds.

MEASUREMENTS

Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
1.8	1.1	0.6	0.6	4½
1.89	1.2	0.6	0.6	5
1.9	1.1	0.6	0.6	5
1.98	1.1	0.6	0.6	5

Habitat: Vertigo hannai lived in Kansas in Pleistocene times associated with several species of pupillids which are today found only in regions of cool and humid climatic conditions. This indicates that cool and humid climatic conditions obtained in Kansas at the time *V. hannai* lived here.

Distribution:

Type locality: Long Island, Phillips County, Kansas, in deposits presumably of Pleistocene age. Exact geological and geographical data are not available.

General distribution: Known only from the type locality.

Vertigo modesta (Say)

Plate XX, fig. 6. Text figure 11.

Pupa modesta Say, 1824, p. 259, Pl. 15, fig. 5.

Vertigo modesta, Hanna and Johnston, 1913, pp. 115, 120; Pilsbry, 1919, Vol. 25, pt. 98, p. 123, Pl. 10, figs. 1, 2; p. 124, figs. 1, 2, 2a; Henderson, 1924, pp. 80, 137.

Vertigo tridentata, Leonard and Frye, 1943, p. 457.

Description of the shell: Shell ovately-conic; summit convex; moderate in size for the genus; rimate; suture deeply incised; whorls 4½ to 5, convex; nuclear whorl white and finely granular; remaining whorls coarsely and irregularly striate, rapidly increasing in size; body whorl more than half the total height; aperture ovate, outer peristome scarcely indented; denticles 3 to 4: a low, slightly elongate parietal lamella; a low, tubercular upper palatal fold usually present; a lower palatal fold somewhat larger and elongate, entering equidistantly with the upper palatal fold; a low short, horizontally placed columellar lamella; palatal folds not on a callus; peristome not everted, terminations approaching and connected across the parietal wall by a thin callus; margin slightly rounded; a low crest behind the peristome sometimes present.

Several characteristics of the shell distinguish *Vertigo modesta* from *V. tridentata* Wolf. The palatal folds of *V. modesta* are not situated on a callus, the columella lamella is nodose, the sinulus of the outer margin of the peristome is scarcely perceptible. The palatal folds of *V. tridentata* are situated on a callus; the indentation of the outer margin of the aperture is more pronounced than it is in *V. modesta;* the columellar lamella ascends inwardly.

Variations: Usually all of the 4 denticles are present, although occasionally the upper palatal fold is wanting. The presence of the crest behind the peristome is variable. The most outstanding variable is the height of the shell which ranges from 1.98 mm. to 2.6 mm.

MEASUREMENTS

Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
2.6	1.35	0.9	0.7	5
2.4	1.4	0.9	0.7	5
2.2	1.2	0.8	0.7	4¾
1.98	1.17	0.7	0.6	5

Habitat: *Vertigo modesta* is a species inhabiting regions of humid, cool climate. It is abundant in Alaska.

Distribution:

Type locality: Northwest Territory, . . . "somewhere in northern Minnesota, southern Manitoba, or near the western end of Lake Superior, on the route of Major Long's second expedition" (Pilsbry and Vanatta, 1909, p. 601).

General distribution: Labrador to Victoria and Nanaimo, Alaska; Maine, Vermont, and Connecticut. Loess of Iowa and Kansas. Pleistocene in Nebraska.

Distribution in Kansas:

Recent: Jefferson County, 2.2 mi. NW of Valley Falls, along Cedar Creek, one dead shell from drift. Geologic age doubtful.

Pleistocene: Northwestern Kansas, Sanborn Formation: Decatur County: 1.4 mi. SW of Dresden; 1½ mi. E of the eastern city limits of Oberlin; NW¼, S 15, T 3 S, R 29 W, 1 mi. S, 2 mi. W of Oberlin. Norton County; SW¼, S 11, T 1 S, R 25 W, 8½ mi. N, 12 mi. W of Norton; SE¼, S 5, T 1 S, R 22 W, 9½ mi. N, 4 mi. E of Norton;

SE¼, S 13, T 1 S, R 24 W, 7½ mi. N, 4 mi. W of Norton; Norton-Phillips County line, US Hgwy. 36, roadcut. Graham County: 2½ mi. W of the eastern border of Graham County, US Hgwy. 24. Phillips County: Long Island.

Because *Vertigo modesta* is a species which prefers cool and humid climates, it has receded from Kansas since Pleistocene times.

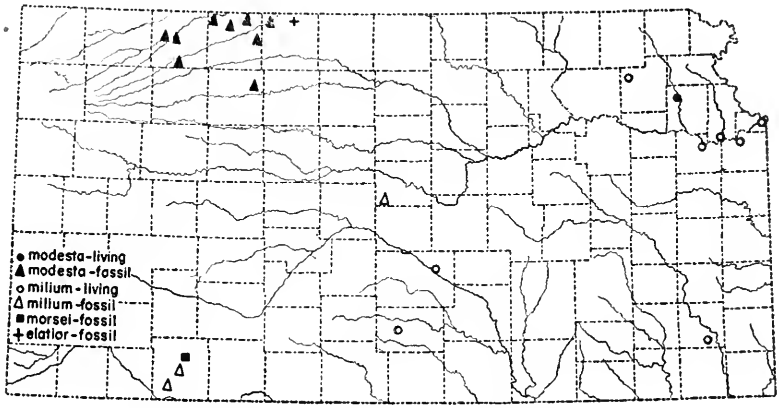


FIG. 11. Records of *Vertigo morsei* Sterki, *V. elatior* Sterki, *V. modesta* (Say), and *V. milium* (Gould).

Vertigo milium (Gould)

Plate XX, fig. 8. Text figure 11.

Pupa milium Gould, 1840, p. 402.
Vertigo milium, Hanna, 1909, p. 95; Pilsbry, 1919, Vol. 25, pt. 99, pp. 146-149; Henderson, 1942, pp. 80, 139; Lugn, 1935, Table C, p. 212; Frye and Hibbard, 1941, p. 408; Hibbard, 1941, p. 265; Over, 1942, p. 9; Frye, Leonard and Hibbard, 1943, p. 41.

Description of the shell: Shell small, the smallest of the genus represented in Kansas; ovate to somewhat cylindric in form; height varying from 1.53 mm. to 1.9 mm.; rimate; whorls 4½ to 5, convex but not inflated, finely and irregularly striate, gradually and regularly increasing in size; body whorl relatively large, more than half of total height of shell, contracted at the base and expanding toward the aperture; aperture slightly more than one-half the height of the body whorl, ovate, somewhat oblique, strongly biarcuate, expanding toward the peristome; peristome slightly everted, margin sharp, terminations approaching and continued across the parietal wall by a thin callus; denticles 5: an elongate lamelliform parietal lamella, increasing in height inwardly and terminating abruptly; a smaller, nearly tubercular, less deeply immersed angular lamella; an elongate lamelliform upper palatal fold, rapidly increasing in height and terminating gradually; a slightly more deeply entering lower palatal fold whose inner third is bent toward the columella usually at an angle greater than 90°, although occasionally at 90°; a low, slightly elongated basalar; a short, crescentic columellar lamella situated on the central portion of the columellar wall; crest behind the peristome prominent, usually rounded though sometimes sharp; linear impressions on the body whorl at the level of the upper and the lower palatal fold, the former incising the crest.

Variations: Two characters subject to individual variation are the general form and size of the shell and the degree of the curvature of the lower palatal fold. The extreme variation in height of Kansas shells, in specimens available, fossil as well as Recent, is 0.3+ mm. (see table of measurements). The degree of the curvature of the lower palatal fold varies approximately from an angle of about 140° to one of 90°. Extremes of this variation occur in specimens of the same population, fossil as well as Recent. The full degree of variation is noted particularly in specimens from two populations, (a) a series from the Cudahy fauna, Meade Formation, Lower Pleistocene, 6 mi. N of Meade, Meade County, in which the degree of curvature in some instances was a 90° angle, and approaching 140° in others; (b) a lot of Recent shells from Kansas City, Wyandotte County, collected by Hanna, perhaps from drift. In this group the lower palatal fold of a single individual curved at a 90° angle whereas in the other specimens of the same lot it curved at an angle greater than 90°. In populations varying in age from Pliocene to Recent, the general tendency is for the curvature to approach an angle greater than 90°. Since the degrees of these variations are not limited to, nor found to be consistent in any locality or geologic age, they are obviously characters of individual variation and not specific characters.

Vertigo milium has not become modified from Upper Pliocene (?) to the present time. The fossil shells, except for the difference in texture and color, cannot be separated from the Recent shells. The individuals from Kansas do not differ from those of localities in Arkansas, Oklahoma, Illinois, Alabama and Texas.

MEASUREMENTS

Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
1.6	1.08	0.6	0.6	4½
1.7	1.1	0.6	0.6	5
1.8	1.08	0.6	0.6	5
1.89	1.1	0.6	0.6	5
1.9	1.1	0.6	0.6	5

Habitat: Moist situations afforded by timbered stream banks, or marshes. It is not found in areas of low relative humidity or low annual precipitation and high summer temperatures, features which are characteristic of the climate of the western half of the state.

Although *Vertigo milium* lived in the western part of Kansas in Pliocene (?) and Pleistocene times, climatic conditions such as prolonged drought in the summer, low annual precipitation and low relative humidity, exclude it from that area today. It is living in isolated localities in the eastern part of the state which indicates that it is receding from this part of the country because conditions are no longer at an optimum.

Distribution:

Type locality: Oak Island, Chelsea, near Boston, Mass.

General distribution: Maine to Florida, South Dakota, Colorado, Arizona, Mexico, and Jamaica (Pilsbry, 1918-1920, pp. 146-149). Recent and Pleistocene in Kansas. Pleistocene in Nebraska.

Distribution in Kansas:

Recent: In northeastern, southeastern and southcentral Kansas.

Pleistocene: Meade Formation: Lincoln County, Wilson Valley deposit, NE¼, S 28, T 13 S, R 10 W, 9 mi. S, 15 mi. W of Lincoln; Meade County, Cudahy Volcanic Ash Pit, SW¼, S 2, T 31 S, R 28 W, 6 mi. N of Meade.

Blancan: Meade County, Rexroad deposit, SW¼, S 22, T 33 S, R 29 W, 9 mi. S, 7 mi. W of Meade.

Upper Pliocene (?): Seward County, Saw Rock Canyon deposit, S 35, T 34 S, R 31 W, 14 mi. E of Liberal.

Vertigo hibbardi F. C. Baker

Plate XX, figs. 9, 10. Text figure 9.

Vertigo hibbardi F. C. Baker, 1938, pp. 126-127; Baker in Hibbard, 1941, p. 95; Frye, Leonard and Hibbard, 1943, p. 42; Hibbard, 1943, p. 236.

Description of the shell: Shell moderate in size for the genus; ovately conic; rimate; whorls typically 5, convex; suture sharply incised; nuclear whorl finely granulose; remaining whorls glossy, and finely striate in well-preserved shells, regularly and rapidly increasing in size; body whorl as much as 3/5 of total height; aperture biarcuate, expanding toward the peristome; peristome narrowly reflected, margins sharp, terminations approaching and connected across parietal wall by a thin callus; denticles 7: 2 elongate lamellae on parietal wall, the parietal lamella the more deepy immersed, the innermost third deflected at a right angle toward the outer lip; the angular about 1/3 as long as the parietal, less deeply immersed; suprapalatal fold, when present, tubercular; upper palatal fold lamelliform, high, long and sinuous; lower palatal fold lamelliform, more deeply immersed than the upper palatal, increasing in height up to its midpoint and then declining, partially forked anteriorly; infrapalatal low, elongate, as deeply immersed, and about half as long as the lower palatal; basal, lamelliform, elongate, increasing in height inwardly and terminating rather abruptly; the folds connected by a low callus; columellar lamella large, heavy, crescentic, ascending slightly toward the columella, then turning downward and recurving slightly forward at the base; crest behind the peristome prominent, rounded, separated from the peristome by a groove; body whorl indented at level of the upper and lower palatals resulting in the contraction of the body whorl at its base.

Variations: A large series of specimens, totaling 320 individuals from 3 populations, which were available for study, indicate that *Vertigo hibbardi* is only slightly variable. The lamellae and folds are constant in occurrence and position. The suprapalatal fold varies in degree of prominence. There is some individual variation in the total height and consequently the general shape of the shell. The largest shells are conic and the smaller shells are ovate. The difference in height between the largest and the smallest individuals is 0.5 mm. Occasionally the crest behind the peristome is low, but usually it is prominent.

Although *Vertigo hibbardi* has been found in only 3 localities, the number of specimens indicates that this species was well represented in Kansas from the Pliocene to Blancan times. Apparently this was one of the dominant species of the genus in this area.

MEASUREMENTS

Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
1.9	1.3	0.9	0.9	4½
2.1	1.4	0.8	0.7	5
2.2	1.5	0.9	0.9	5
2.4	1.5	0.9	0.9	5

Habitat: The terrestrial gastropods associated with *Vertigo hibbardi* (Baker in Hibbard, 1941a, p. 95) in the Rexroad Ranch deposits are for the most part woodland snails. Hibbard (1941a, pp. 94-101) after studying the vertebrate fauna of the Rexroad Ranch deposits, concluded that meadows, marshes and trees existed along the valley of a major stream which flowed through the region. The presence of shrews and voles indicates summers of lower temperatures and of greater humidity than obtain in southwestern Kansas today. At the time these deposits were laid down, there was probably an absence of extreme summer droughts.

Distribution:

Distribution in Kansas:

Type locality: Designated only as Pliocene, Meade County, Kansas, Baker, 1938, pp. 126-127. Hibbard (1941, p. 265), collector of the type and paratypes, assigns the type locality as Meade County, Kansas, locality number 3, Rexroad deposit, SW¼, S 22, T 33 S, R 29 W, 9 mi. S, 7 mi. W of Meade, Blancan age.

Blancan: Type locality. Big Springs, 2 mi. S, 4 mi. W of Meade.

Upper Pliocene:

Seward County: Saw Rock Canyon deposit, S 35, T 34 S, R 31 W, 14 mi. E of Liberal.

Genus *Pupoides* Pfeiffer

Pupoides Pfeiffer, 1854, p. 192; Pilsbry and Vanatta, 1900, p. 585. "Kobelt, Syst. Conchylien-Cabinet, Buliminidae, p. 917.—Iredale, Proc. Malac. Soc. Lond., xi, p. 176.—Gude, Fauna of British India, Moll., ii, 1914, p. 259, *P. nitidulus* selected as type.

Leucochila v. Martens in Albers, Die Heliceen, 1860, p. 296, type by original designation *Pupa fallax* (= *P. marginatus* Say).

Leucochiloides Pfeiffer, Nomencl. Hel. Viv., 1878, p. 292. *B. lardeus* (Pfeiffer), designated as type by Connolly, Ann. S. Afr. Mus., xi, 1912, p. 176." (Pilsbry, 1921, Vol. 26, pt. 102, p. 108).

Pupoides, Pilsbry, 1921, Vol. 26, pt. 102, pp. 108-147, Pl. 11, figs. 10-12, 14-15; Pl. 12; Pl. 13; Pl. 14, figs. 1-7, 8-11; Pl. 15; Pl. 17, figs. 1-6. Pilsbry, 1926, Vol. 27, pt. 108, pp. 248-253, Pl. 31, figs. 10-13, 15. Pilsbry, 1931, Vol. 28, pt. 110, pp. 80-81, Pl. 18, fig. 8. Pilsbry, 1934, Vol. 29, Pt. 111, pp. 137-138. Pilsbry, 1935, Vol. 28, Pt. 112, pp. 200-201.

Characteristics of the shell: Shell elongate-conic to oval; summit sharply obtuse to convex; total height ranging from 3.3 mm. to 5.6 mm.; whorls 4½ to 6½, regularly and rapidly increasing in size; ultimate whorl exceeding one-half total height; peristome expanded, terminations approaching, connected across parietal wall by a thin callus; aperture ovate, usually edentulous; angular lamella, if present, marginal and tubercular, situated at the outer parietal and upper palatal angle; rimate to minutely perforate.

Distribution:

Recent: North America, West Indies, South America, Arabia, Africa, India, Australia (Pilsbry, 1934, Vol. 28, pt. 111, pp. 139-168).

Pleistocene: North America.

Pliocene: North America.

KEY TO SPECIES

1. Peristome widely reflected. Sinulus present at upper lateral angle of aperture, *P. marginatus*

   Peristome not widely reflected 2

2. Surface finely striate .... *P. inornatus*

   Surface costate .... *P. hordaceus*

Pupoides marginatus (Say)

Plate XXI, figs. 3 & 4. Text figure 12.

Cyclostoma marginata Say, 1821, pp. 172-173.

Pupoides marginatus, Hanna, 1909, p. 94; Hanna and Johnston, 1913, p. 113; Hanna, 1920, p. 19; Pilsbry, 1921, Vol. 26, pt. 102, pp. 111-113, Pl. 12, figs. 1-7; Henderson, 1924, p. 79; Hibbard, 1940, p. 418; Hibbard, 1941, p. 313; Frye and Hibbard, 1941, p. 408; Over, 1942, p. 8; Franzen and Leonard, 1942, p. 339, Pl. I, fig. 12; Franzen and Leonard, 1943, pp. 421-422, text fig. 6, Pl. XXXII, fig. 30; Leonard, Alice, 1943, p. 239, Pl. I, fig. 12; Leonard and Franzen, 1944, p. 30, Pl. V, fig. 18; Leonard and Leonard, 1945, p. 120.

Description of the shell: Elongate-conic, summit obtuse; rimate, color brown; shell heavy, somewhat translucent; suture sharply and deeply incised; whorls 4½ to 6½, convex, increasing regularly and rapidly in size; body whorl more than one-half total height of shell; 1½ nuclear whorls finely granular; remaining whorls finely, closely and irregularly striate giving the surface a silky appearance; aperture large ovate with a pronounced angular sinulus at upper corner of outer lip; peristome heavy, widely and flatly reflected, thickened within, terminations approaching and connected across parietal wall by a thin callus; margin sharp.

Variations: Several characters of the shell of *P. marginatus* are variable. The size ranges from 3.7 mm. × 2 mm. to 5.6 mm. × 2.6 mm.; the width does not vary in proportion to the height, thus making for a variation in the general shape of the shell. A prominent variable is the width of the peristome. The peristome varies from one narrowly reflected, about 0.2 mm. wide, to one attaining a width of about 0.4 mm., Plate VII, figs. 3, 4. The sinulus varies in size and shape. It may be shallow or very pronounced, rounded or angular. A tubercular callus at the upper extremity of the sinulus is pronounced, weakly developed, or wanting. In a few shells faint spiral striations are visible on the penultimate whorl.

This species is almost ubiquitous in the known Pliocene, Upper Pleistocene and Recent faunas under consideration. None of the several variations is restricted to any one population, but occurs in specimens of any of the several geologic ages or geographic localities.

MEASUREMENTS

Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
3.7	1.98	1.5	1.4	5
3.9	1.9	1.5	1.4	5¼
4.2	2.1	1.7	1.4	5½
4.8	2.2	1.8	1.5	6
5.5	2.4	1.9	1.6	6¼
5.6	2.4	2.0	1.6	6½

Habitat: This species, tolerant of high summer temperatures and drought, is found in woodlands, in deep grass, or even among the roots of short grass in unshaded areas.

Distribution:

Type locality: Upper Missouri.

General distribution: Maine and Ontario, south to the Gulf of Mexico, west to the Dakotas, western Arizona; northeastern Mexico to Cuba, Haiti, San Domingo, Porto Rico, Bermuda (Pilsbry, 1921, Vol. 26, pt. 102, p. 111). Kansas. Pleistocene in Nebraska. Oklahoma Pliocene, Beaver County, Oklahoma.

Distribution in Kansas:

Recent: Its occurrence in Kansas is general.

Pleistocene: Sanborn Formation: Wallace County, SW¼, S 19, T 12 S, R 41 W, 6 mi. N, 10 mi. W of Sharon Springs. Meade County: Jones Sink, S 8, T 33 S, R 27 W, 5 mi. S, 3½ mi. E of Meade, locality number 13 (Hibbard, 1940, p. 417); XI Ranch, S 33, T 34 S, R 29 W. Clark County: Pyle Ranch, S 11, T 30 S, R 23 W, above the Pearlette Ash.

Blancan: Meade County: Big Springs Ranch, NW¼, NW¼, S 19, T 32 S, R 28 W, 2 mi. S, 4 mi. W of Meade; Rexroad Ranch, SW¼, S 22, T 33 S, R 29 W, 9 mi. S, 7 mi. W of Meade; Fox Canyon, S 35, T 34 S, R 30 W, 17 mi. S, 12 mi. W of Meade.

Pliocene: Seward County, Saw Rock Canyon, S 35, T 34 S, R 31 W. Lower Pliocene, Beaver County, Oklahoma, Laverne Formation (Leonard and Franzen, 1944, p. 17).

Pupoides marginatus is known from the Lower Pliocene, Laverne Formation, Beaver County, Oklahoma; it occurs in Kansas in the one known Upper Pliocene (?) deposit, and in the several known deposits of Blancan age. It occurs in the Upper Pleistocene deposits in northwestern Kansas, the Sanborn Formation, as well as in the Upper Pleistocene in southwestern Kansas, Jones Sink, Pyle Ranch and the XI Ranch. No shells have been found in any of the several localities of the Meade Formation. However, one would expect to find this species in the Lower Pleistocene since it is found in the immediately earlier and later deposits in southwestern Kansas. Since it has a strong shell, it is readily preserved and more intensive collecting will probably result in its appearance in the Meade Formation.

Pupoides marginatus is the only representative of the genus in the Recent fauna of Kansas, with the exception of the few shells of *P. hordaceus* and *P. inornatus* whose geographic origin is doubtful since they are very likely from drift.

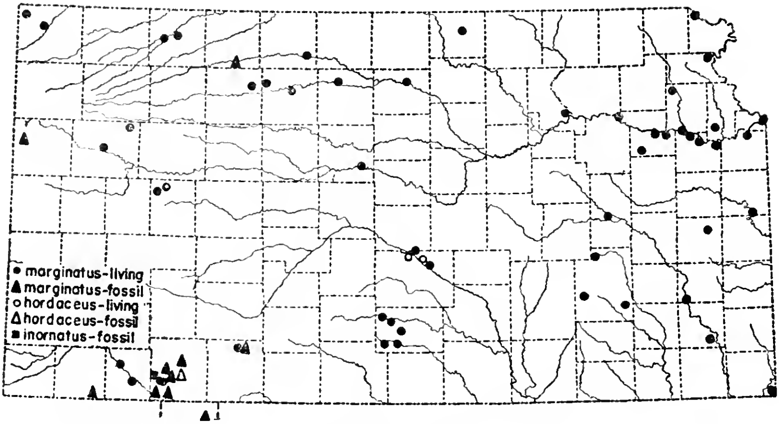


FIG. 12. Records of *Pupoides marginatus* (Say), *P. hordaceus* (Gabb), and *P. inornatus* Vannata.

Pupoides hordaceus (Gabb)

Plate XXI, fig. 2. Text figure 12.

Pupa hordacea Gabb, 1866, p. 331, Pl. 21, fig. 7.
Pupoides hordaceus, Pilsbry, 1921, Vol. 26, pt. 102, pp. 116-118; Henderson, 1924, pp. 79, 132, fig. 35.
Pupoides inornatus, Goodrich, 1940, p. 77; Hibbard, 1940, p. 418.

Description of the shell: Shell elongate, oval; summit obtuse; color auburn; suture sharply and deeply incised; whorls 5½, convex, slightly shouldered above, body whorl slightly flattened; 1½ nuclear whorls, white, finely granular; remaining whorls marked with low but conspicuous, widely-spaced, oblique costae; body whorl more than half the total height of the shell; aperture oblique, oval, without sinulus, edentulous; peristome very slightly reflected at the outer margin and becoming increasingly reflected toward the columellar margin, thickened within; margin rounded; terminations approaching and connected across parietal wall by a thin callus.

Variations: Due to the simplicity of the shell, not many characters are subject to variation. The height of the shells of the small series available ranges from 3.3 mm.-3.9 mm. The umbilicus, usually closed, is very small when open. The costae, distinctive of the species, are prominent. Sometimes, probably due to wear, they are rather faint and irregular in occurrence.

MEASUREMENTS

Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
3.3	1.5	1.2	1.2	4½
3.6	1.5	1.3	1.17	4½
3.8	1.6	1.3	1.17	4½
3.9	1.7	1.4	1.2	5½

Habitat: According to Pilsbry (1921, Vol. 26, pt. 102, p. 117), *P. hordaceus* is a southwestern form. It is a species presumably not found north and east beyond San Miguel County, in southwestern Colorado. "By correspondence with Junius Henderson and the examination of specimens it appears that all published records for *hordaceus* were based on specimens of *inornatus,* with the possible exception of Sampson's Williams canyon record (Nautilus, vi, 102) which has not been reëxamined. The true *P. hordaceus* is known to occur only in the extreme southwestern part of the state, west of the Rocky Mountains." (Pilsbry, Vol. 26, pt. 102, p. 119.) Its habitat is in the arid plateaus and foothills. "It is known by specimens taken in the debris of streams or in Pleistocene or later deposits." (Ibid, p. 117.)

Shells from 4 Kansas localities were available for study. Of these, two series were obtained from localities along the Arkansas River at Hutchinson and Nickerson, Reno County. Some of these shells were bleached while others, though dead, were not bleached. Since the Arkansas River heads in the Rocky Mountains, it is possible these shells were in drift which originated near the headwaters. Nevertheless, the Arkansas River heads east of the Rocky Mountain divide. The occurrence of *P. hordaceus* in the debris of this river would extend its range eastward of previous records.

A small series of dead shells was obtained by Hanna from a locality near Healy, Lane County. The origin of these shells is not known. The town of Healy is not located near a major stream in which the shells could have been found in drift.

A series of 3 shells of *P. hordaceus* was obtained from the Upper Pleistocene of the Jones Sink, Meade County. The gastropod Jones faunule in general (Hibbard, 1940, p. 418), including such species as *Pupilla blandi,* and *Vertigo ovata,* indicates that a cooler temperature prevailed in southwestern Kansas in Upper Pleistocene times than obtains at the present time. Some of the species represented in the Jones fauna are typical of the fauna of a humid climate. However, it is probable that semiarid conditions obtained locally and that *P. hordaceus* was washed from nearby plateaus and deposited in a stream.

Distribution:

Type locality: Ft. Grant, Pinal County, Arizona.

General distribution: Southwestern Colorado, New Mexico and Arizona (Pilsbry, 1921, Vol. 26, pt. 102, p. 116); southwestern Kansas. Pleistocene of Kansas.

Distribution in Kansas:

Recent: Healy, Lane County (dead shells); Hutchinson and Nickerson, Reno County (probably from drift).

Pleistocene: Jones Sink, Upper Pleistocene, Meade County, S 8, T 33 S, R 27 W, 5 mi. S, 3½ mi. E of Meade.

Pupoides inornatus Vanatta

Plate XXI, fig. 1. Text figure 12.

Pupoides inornatus Vanatta, 1915, pp. 95-96; Pilsbry, 1921, Vol. 26, pt. 102, pp. 118-119, Pl. 12, fig. 10; Henderson, 1924, pp. 132-133; Baker in Hibbard, 1941, p. 265; Over, 1942, p. 8.

Description of the shell: Moderate in size for the genus; elongate-oval; tapering toward the convex summit; minutely perforate; light cinnamon brown in color; suture incised; whorls 5½, convex and decreasing in convexity toward the ultimate whorl, increasing regularly and rapidly in height; body whorl more than one-half total height of shell; 1½ nuclear whorls, white, finely granular; remaining whorls finely and irregularly striate; aperture ovate, oblique, edentulous; peristome simple, reflected only on the columellar side; margin blunt; terminations approaching and connected across parietal wall by a thin callus.

Variations: Since only one individual was available from a Kansas locality, no comparison could be made. This shell, however, closely resembles the holotype, No. 110977, The Academy of Natural Sciences of Philadelphia.

MEASUREMENTS

Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
3.4	1.53	1.17	1.1	5½

Habitat: This single individual of *Pupoides inornatus* was taken from the flood plain of the Arickaree River, Cheyenne County. The Arickaree River heads in eastern Colorado near the foothills of the Rocky Mountains. The flood plain of the Arickaree River had been recently flooded when this shell was taken, so it is not unlikely that this shell may have been brought down from eastern Colorado. According to Pilsbry (1921, vol. 26, pt. 102, p. 119), *Pupoides inornatus* ". . . appears to be a species of the Rocky Mountains, spreading eastward . . ."

Distribution:

Type locality: Drift of White River, Washington County, South Dakota.

General Distribution: South Dakota, Colorado, New Mexico (Pilsbry, 1921, Vol. 26, pt. 102, p. 118).

Distribution in Kansas:

Recent: Flood plain of the Arickaree River, Cheyenne County, Kansas.

Blancan: Rexroad, Meade County, Locality number 3 (Hibbard, 1941, p. 265), SW¼, S 22, R 33 S, R 29 W, 9 mi. S, 7 mi. W of Meade. The shells from this locality were studied by F. C. Baker and reported by Hibbard (1941, p. 265). They are not available for study at this time.

Genus *Pupilla* Leach

"*Pupilla* Leach in Turton, Man. Land and Freshwater Shells of the British Islands, 1831, p. 99.—Gray, P. Z. S., 1847, p. 176 (type *P. muscorum*).—Herrmannsen, Ind. Gen. Malac., ii, p. 362 (*typus*: *Pupa muscorum* L.).—Cockerell, Nautilus, xviii, 1905, p. 104.

Torquatella Held, Isis, 1837, p. 919, for *P. muscorum* L. and *P. triplicata* Studer.—Herrmannsen, Ind. Gen. Malac., ii, p. 583, '"type *P. muscorum* L."' *Pupa* of most authors." (Pilsbry, 1921, Vol. 26, pt. 103, p. 152.)

Pupilla, Pilsbry, 1921, Vol. 126, pt. 103, pp. 152-225, Pl. 16; Pl. 17, figs. 8-18; Pl. 18, 19; Pl. 20, figs. 1-10, 12-20, 22-24; Pl. 21, 22; Pl. 23, figs. 1-21. 1931, Vol. 28, pt. 110, pp. 81-86.

Characteristics of the shell: Shell cylindrical, summit broadly convex; moderately large to large for the family, height ranging from 2.5 mm. to 3.9 mm.; rimate to minutely perforate; ultimate whorl less than one-half of total height; aperture irregularly oval; folds and lamellae 0-3: a parietal lamella, a lower palatal fold, a columellar lamella; peristome reflected, terminations approaching and connected across parietal wall by a thin callus; crest on ultimate whorl paralleling the peristome.

Distribution:

Recent: North America, Europe, North Africa, Cape Verde Islands, Reunion Island, Asia, Australia, in temperate and cool regions. (Pilsbry, 1921, Vol. 26, pt. 103, p. 154.)

Pleistocene: Kansas, Nebraska.

Pliocene: North America (Pilsbry, 1921, Vol. 26, pt. 103, p. 154).

Miocene: Central Europe (Ibid)

Upper Oligocene: Central Europe (Ibid)

KEY TO *PUPILLA*

1. Aperture characteristically tridentate. Denticles prominent .... *P. blandi*
   Aperture characteristically edentulous. Denticles, if present, small 2
2. Dextral .... *P. muscorum*
   Sinistral .... *P. muscorum sinistra*

Pupilla muscorum (Linnaeus)

Plate XXII, fig. 2. Text figure 13.

Turbo muscorum Linnaeus, 1758, p. 767.

Pupilla muscorum, Hanna, 1909, p. 94; Hanna and Johnston, 1913, pp. 118-119; Pilsbry, 1921, Vol. 26, pt. 103, pp. 156-159; Hanna, 1920, p. 19; Henderson, 1924, pp. 79, 134; Lugn, 1935, p. 212; Over, 1942, p. 9; Frye, Leonard and Hibbard, 1943, p. 41; Leonard and Frye, 1943, pp. 457, 459; Hibbard, Leonard and Frye, 1944, pp. 13, 14.

Pupilla hebes, Frye, Leonard and Hibbard, 1943, p. 41; Leonard and Frye, 1943, pp. 457, 458; Hibbard, Frye, and Leonard, 1944, pp. 13, 14.

Description of the shell: Shell moderate to large in size ovate to cylindrically-ovate; height 2.9 mm.—3.9 mm.; rimate with an open umbilicus; suture sharply but not deeply incised; whorls 5¾ to 7, convex but not inflated; the 1½ nuclear whorls finely granular; remaining whorls finely and irregularly striate, slowly and regularly increasing in size; body whorl less than half of the total height of the shell, contracted at the base and expanding toward the aperture; a prominent, rounded crest paralleling the peristome and removed from it by a deep groove; aperture truncately oval, slightly oblique, edentulous; peristome sharply everted, margins sharp, terminations approaching and connected across the parietal wall by a thin callus.

Variations: *Pupilla muscorum* is typically edentulous. Folds and lamellae, if present, are small and tubercular (Pilsbry, 1921, Vol. 26, pt. 103, pp. 156, 158). The majority of the shells identified as *P. muscorum* are edentulous, although a few shells have a low, tubercular parietal lamella. In some instances shells were encountered bearing a very low but elongate parietal, making specific identification difficult and problematical. The range of variation in size is within 1 mm. Shells of any one population are not restricted to any certain size, shape, number of whorls, or pattern of dentition.

MEASUREMENTS

Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
2.9	1.6	1.0	0.9	6
3.2	1.8	1.1	1.0	6½
3.6	1.8	1.1	1.1	7
3.9	1.9	1.2	1.3	6½

Habitat: Lives in regions having a cool, humid climate. Is found living on the ground, under wood, stones and leaves.

Distribution:

Type locality: Europe, on mossy ground.

General distribution: Palaearctic Region, generally over Europe, north Africa, northern and central Asia, south to Persia. North America: Eastern North America from Anticosti Island south to New Jersey; westward in Canada, northern tier of the States, north to Alaska, Rocky Mountain Region from Colorado south to New Mexico and northern Arizona. Loess of Iowa. (Pilsbry, 1921, Vol. 26, pt. 103, pp. 157, 174.) Pleistocene of Kansas and Nebraska.

Distribution in Kansas:

Pleistocene: Sanborn Formation: Norton County: 13 mi. S, 10 mi. E of Norton; 2½ mi. E, 10 mi. N of Norton; 3 mi. S, 5½ mi. W of Norton; 8½ mi. N, 4 mi. W of Norton; 3½ mi. E, 10 mi. N of Norton; 6½ mi. W, 9 mi. N of Norton; Norton-Phillips County line, U. S. Hgwy. 36. Thomas County: 16 mi. S, 3½ mi. W of Colby. Sheridan County:

2½ mi. W of Seldon; 4 mi. W of Seldon. Wichita County: 15 mi. N of Leoti. Sherman County: 14 mi. S, 15 mi. E of Goodland. Decatur County: 1.4 mi. E of Dresden; 8.6 mi. E of Oberlin; 13 mi. S, 6 mi. E of Oberlin; 1.4 mi. W, SW of Dresden. Phillips County: Long Island. Graham County: 15 mi. N of Wakeeny. Meade Formation: Wilson Valley Faunule, S 28, T 13 S, R 10 W, 9 mi. S, 15 mi. W of Lincoln, Lincoln County. Hanna collected this species from Topeka in Shawnee County, and from Lawrence in Douglas County; in either case probably from drift in the Kansas River.

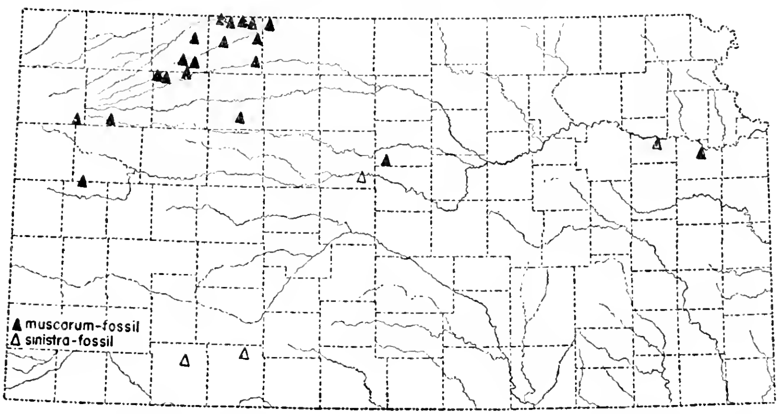


FIG. 13. Records of *Pupilla muscorum* (Linnaeus) and *P. m. sinistra* Franzen.

Pupilla muscorum sinistra Franzen

Plate XXII, fig. 4. Text figure 13.

Pupilla muscorum sinistra Franzen, 1946, pp. 24-25.

Description of the shell: "Shell sinistral, subcylindric, summit obtuse; whorls 7½, increasing regularly and gradually in height, convex; suture incised; greatest diameter at level of fifth whorl of spire from which the shell tapers to a constricted base; nuclear whorl finely granular; remaining whorls finely and irregularly striate; aperture ovate, oblique; lip reflected, thickened within by a low, rounded callus; peristrome sharp, continuous across parietal wall by a thin callus; dentition consisting of a single, low, elongate parietal lamellae; crest behind lip high and round."

Variations: "Size is the only appreciable variable among the paratypes. The parietal lamella is wanting in only a few specimens. A small lower palatal fold occurs rarely. The greatest diameter of the type specimen is at the level of the fifth whorl while in some of the paratypes the greatest diameter is at the level of the fourth whorl." (Franzen, 1946.)

MEASUREMENTS

	Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
Type (3728)	3.9	1.9	1.25	1.08	7½
Paratype (3827)	3.8	1.8	1.25	0.9	7½
Paratype (3827)	3.7	1.8	1.08	0.9	7
Paratype (3827)	3.4	1.8	1.08	0.9	7
Paratype (3827)	3.2	1.7	1.08	0.9	7
Paratype (3828)	4.0	1.7	1.25	...	7½

Habitat: Known only from the Meade formation, Lower Pleistocene.

Distribution:

Type locality: Pyle Ranch, Clark County, Kansas, NE¼, S 11, T 30 S, R 23 W; Lower Pleistocene, Meade Formation.

Distribution in Kansas:

Pleistocene: Meade Formation: The type locality.

Tobin faunule, Russell County, S 35, T 14 S, R 11 W, 5½ mi. S, 18 mi. E of Russell. Cudahy faunule, S 2, T 31 S, R 28 W, 6 mi. N of Meade.

Pupilla blandi Morse

Plate XXII, fig. 1. Text figure 12.

Pupilla blandi Morse, Ann. Lyc. N. H. of N. Y., viii, 1865, p. 5, fig. 8; Hanna, 1909, p. 94; Hanna, 1913, p. 119; Henderson, 1924, p. 134; Over, 1942, p. 9; Hibbard, Frye and Leonard, 1944, pp. 13, 14.

Vertigo modesta, Goodrich, 1940, p. 77; Hibbard, 1940, p. 418.

Pupilla muscorum, Goodrich, 1940, p. 77; Hibbard, 1940, p. 418.

Description of the shell: Moderately large to large in size; ovate to cylindrical-ovate; height ranging from 2.5 mm. to 3.7 mm.; rimate; suture sharply but not deeply incised; whorls 5 to 6½, convex but not inflated; 1½ nuclear whorls, finely granular; remaining whorls finely and irregularly striate, gradually and slowly increasing in size; body whorl less than half of total height of shell, contracted at the base and expanding toward the aperture; crest paralleling the peristome, large, rounded; groove immediately behind the peristome, deep; aperture triangularly oval, slightly oblique; denticles 3: an elongate and high parietal lamella, a prominent, tubercular basal fold, a prominent and inwardly ascending columellar lamella; peristome abruptly reflected, margin sharp, terminations approaching and continuous over the ultimate whorl by a thin callus.

Pupilla blandi is characterized by 3 prominent denticles while *P. muscorum* is edentulous or has low tubercular denticles.

Variations: The folds and lamellae vary in degree of prominence, remaining, however, larger than those occurring in *P. muscorum*. The number of denticles varies, the following combinations occur:

(a) a parietal lamella, a basal fold, a columellar lamella; (b) a low but elongate parietal and a low columellar lamella; (c) an elongate parietal lamella and a palatal fold; (d) a prominent, elongate parietal lamella and a prominent basal fold. Since the denticles of *Pupilla muscorum* are low and tubercular when present, shells with a reduced number of, but prominent, narrow and elongate denticles are referred to *Pupilla blandi*. The variation in height of the shell is about 1.2 mm. Elongate, as well as the shorter individuals vary in shape from ovate to cylindrically-ovate.

Although *Pupilla muscorum* and *P. blandi* differ essentially in the number and prominence of the denticles, not all of the shells of the genus *Pupilla* from the Kansas Pleistocene can be satisfactorily placed into one or the other of the two categories. Shells lacking one of the three denticles, may have two denticles which are larger than the low, tubercular denticles of *P. muscorum*. Because of the reduced number of folds and lamellae, these individuals are not typical *P. blandi*. In some instances the parietal lamella is greatly elongate, but very low. This feature is not characteristic of either species. These variables are not restricted to shells from any one locality or region, but occur among shells from several localities.

Some of the shells of the genus *Pupilla* of the Pyle Ranch, Cudahy, and Tobin faunules are edentulous which is characteristic of *P. muscorum*. Other shells have a low but long parietal lamella while others have an elongate but very low parietal lamella and a basal fold. The absence of denticles or reduced number of denticles would suggest that these shells should be referable to *P. muscorum*, but the elongate parietal lamella is suggestive of *P. blandi*.

Until a more careful study can be made of *P. muscorum* and *P. blandi* from several locations and compared with the Kansas shells, the final classification of some of the Kansas *Pupilla* remains enigmatical.

MEASUREMENTS

Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
2.5	1.1	0.9	0.9	5
2.7	1.7	1.0	1.0	5½
3.1	1.7	1.1	1.0	5½
3.3	1.9	1.1	1.1	6½
3.6	1.8	1.17	1.0	6½

Habitat: A shell of cool, humid situations. It has completely receded from Kansas.

Distribution:

Type locality: Ft. Berthold, North Dakota.

General Distribution: Rocky Mountain Region. From Alberta and Montana south to New Mexico. Mainly as a fossil and in river drift in North Dakota, South Dakota, Kansas and Texas. (Pilsbry, 1921, Vol. 26, pt. 103, pp. 159-160.) Pleistocene in Nebraska.

Distribution in Kansas:

Pleistocene: Sanborn Formation: Sherman County: 15 mi. S. of Goodland. Decatur County: 1.4 mi. E of Dresden; 8.6 mi. E of Oberlin; 14 mi. S of Oberlin. Norton County: 13 mi. S, 10 mi. E of Norton; 3 mi. S, 5½ mi. W of Norton. Logan County: 8.5 mi. S of Oakley. Thomas County: 1½ mi. W of Brewster; 3 mi. S, 3½ mi. W of Mingo; 6 mi. S, 3½ mi. E of Colby. Sheridan County: 2½ mi. W of Seldon; 5½ mi. W, ½ mi. S of Seldon; 3 mi. S, 8 mi. W of Seldon; 4 mi. W of Seldon. Graham County: 15 mi. N of Wakeeny. Phillips County: Long Island. Meade County, Locality number 13, (Hibbard, 1940, p. 417), Jones Sink, S 8, T 33 S, R 27 W, 5 mi. S, 3½ mi. E of Meade; XI Ranch, S 33, T 34 S, R 29 W, 15 mi. S, 7 mi. W of Meade. Drift in stream, 3 mi. W of Deer Park, Meade County State Park; ravine W of Meade County State Park. Clark County, Taylor Ranch, 9 mi. E, 1 mi. S of Minneola.

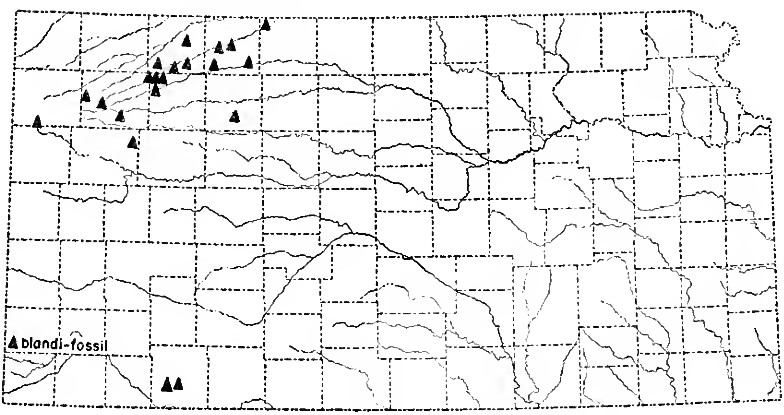


FIG. 14. Records of *Pupilla blandi* Morse.

Genus *Columella* Westerlund

"*Sphyradium* (Agass.) Charpentier, Westerlund, Fauna Palaärctischien Region Binnenconchylien III, 1887, p. 125.—Sterki, Nautilus, X, 1896, p. 75.—Hanna, Proc. U. S. Nat. Mus., vol. 41, p. 371 (monograph, anatomy); and of most recent American and European authors. Not *Sphyradium* as limited by von Martens, 1860.

Paludinella Lowe, P. Z. S. 1854, p. 206, type *P. edentula* Drapernaud. Not *Paludinella* Pfeiffer, 1851.—*Paludellina* Tyron, Struct. and Syst. Conch., III, 1884, p. 72, error for *Paludinella.*

Edentulina Clessin, Deutsche Excursions-Mollusken-Fauna, 1876, p. 208, for *Pupa inornata* = *P. edentula* Drapernaud. Not *Edentulina* Pfeiffer, 1855 (Streptaxidae).

Columella Westerlund, Fauna Europaea Moll. Extramar. Prodromus, fasc. II, p. 193, 1878, type *Pupa* ' "*inornata* Mich." ' = *edentula* Drapernaud, Pilsbry, Nautilus, XXVI, 1912, p. 60.—H. Watson, Proc. Malac. So. Lond., XV, 1923, p. 275 (anatomy)." (Pilsbry, 1926, Vol. 27, Pt. 108, p. 232.) Pilsbry, 1926, Vol. 27, Pt. 108, pp. 232-248, Plates 30, 31, figs. 1-9. Pilsbry, 1934, Vol. 28, Pt. 111, p. 109, Pl. 22, fig. 1.

Characteristics of the shell: Shell large, elongate, cylindrical, summit convex; height ranging from 2.7 mm. to 5.8 mm.; number of whorls, 6½ to 9, finely and irregularly striate, compressed, slowly increasing in size; distinctly and roundly perforate; edentulous to tridentate: angular and parietal lamellae, if present, partially fused; columellar lamella, if present, rounded and deeply immersed; crest behind the peristome wanting.

Distribution:

Recent: Atlantic Islands, Europe, Asia, North America, Hawaii (?). (Pilsbry, 1926, Vol. 27, pt. 108, p. 234.)

Pleistocene: Europe and the United States.

Upper Pliocene: England. (Pilsbry, 1926, Vol. 27, pt. 108, p. 234.)

KEY TO SPECIES

1. Aperture edentulous 2
   Aperture not edentulous. Three denticles within the aperture...... *C. tridentata*
2. Shell exceeding 5 mm. in height.................................... *C. hasta*
   Shell not exceeding 3 mm. in height................................ *C. alticola*

Columella tridentata Leonard

Plate XXII, fig. 6. Text figure 15.

Columella tridentata Leonard, 1946, pp. 20-21.

Description of shell: "Shell large for the genus, subcylindrical, with 7½ compressed whorls; suture well impressed; umbilicus round, small, diameter only ⅛ diameter of body whorl; first 3 whorls enlarging rapidly, producing bluntly conic apex; remaining whorls increasing in size slowly but regularly; first 1½ whorls with finely granular sculpture, remaining whirls embellished with fine, diagonal, closely spaced growth lines; last half of body whorl compressed around axis, subangulate below; aperture small, subtriangular; peristome simple, continuous by thin callus across body whorl; lip relatively heavy (broken?); lamellae 3; angular, bluntly triangular, arising near angular lip of peristome and extending downward, curving slightly toward periphery; fused with parietal lamella except near termination, which is situated midway along peripheral border of parietal; parietal lamella deeply immersed, thick, heavy, broadly spatulate, rounded; columellar lamella compressed, rounded, its long axis vertical; inner surfaces of peristome, including lamella, finely punctate." (Leonard, 1946.)

Variations: Known only from the type.

MEASUREMENTS

	Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
Holotype:	5.2	2.52	1.5	1.44	7½

Habitat: Known only from the Lower Pleistocene in Kansas. Other species of the genus live in cool, humid regions.

Distribution:

Type locality: Pleistocene, Meade Formation: Tobin faunule, Russell County, Kansas, S 35, T 14 S, R 11 W, 5 mi. S, 18 mi. E of Russell.

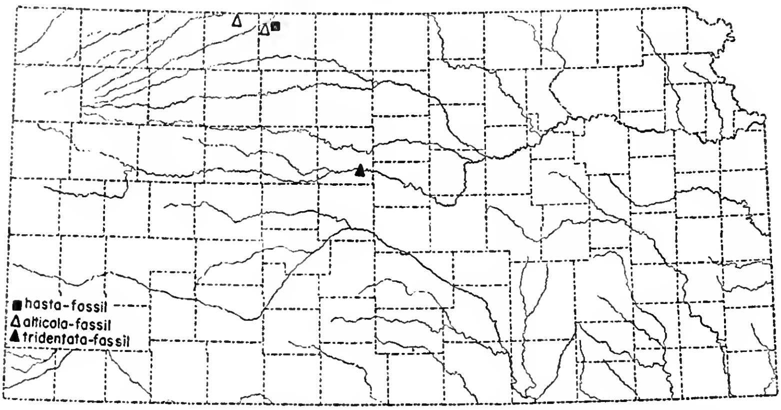


FIG. 15. Records of *Columella tridentata* Leonard, *C. alticola* (Ingersoll), and *C. hasta* (Hanna).

Columella alticola (Ingersoll)

Plate XXII, fig. 3. Text figure 15.

Pupilla alticola Ingersoll, 1875, p. 128.

Sphyradium alticolum, Hanna, 1911, pp. 373-374, fig. 2; Hanna and Johnston, 1913, pp. 115, 118, fig. 6.

Columella alticola, Henderson, 1924, p. 140, fig. 43; Pilsbry, 1926, Vol. 27, pt. 108, pp. 243-245, Pl. 31, figs. 6, 7, 8.

Description of the shell: Moderate in size for the genus; perforate, cylindrical; summit convex; height varying from 2.7 mm. to 3.0 mm. 1½ nuclear whorls, white, finely granular; remaining whorls finely and irregularly striate; whorls 6½—7, convex, very slowly and regularly increasing in size to the large and inflated ultimate whorl which is without crest or callus; aperture oval, oblique, edentulous, without a callus; peristome simple, reflected on columellar side; margin sharp.

Variations: Since the shells occurring in Kansas are fossils, their coloration is white or pale auburn with a white nucleus. The only other variant is the total height of the shell which ranges from 2.7 mm. to 3.0 mm.

MEASUREMENTS

Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
3.0	1.35	0.7	0.6	6¾
2.9	1.3	0.7	0.6	6¾
2.8	1.35	0.8	0.7	6½
2.7	1.2	0.7	0.6	6½

Habitat: Columella alticola is known from Kansas only from the Sanborn formation, Upper Pleistocene in age. Its present day distribution includes northern areas or areas of high altitudes of New Mexico, Colorado, Utah, and Wyoming which indicates that in the time of its existence in Kansas, the temperature was lower and the humidity higher than obtains in northwestern Kansas at the present time.

Distribution:

Type locality: Cunningham Gulch, Colorado.

General distribution: Alberta and British Columbia; mountainous regions of New Mexico, Arizona, Colorado and Wyoming. (Pilsbry, 1926, Vol. 27, pt. 108, p. 244.) Pleistocene in Kansas and Nebraska.

Distribution in Kansas: Sanborn Formation: Phillips County, Long Island; Norton County, SE¼, S 5, T 1 S, R 22 W, 10½ mi. N, 4 mi. E of Norton.

Columella alticola is extinct from Kansas probably because it is intolerant of high temperatures and low precipitation which characterize the prolonged summer season. Its occurrence in the Pleistocene beds indicates that in the time the Sanborn deposits were laid down, climatic conditions differed from those of the present time. The temperature must have been lower and the amount of annual precipitation higher than at the present time, or the precipitation more equitably distributed.

Columella hasta (Hanna)

Plate XXII, fig. 5. Text figure 15.

Sphyradium hasta Hanna, 1911, pp. 372-373; Hanna and Johnston, 1913, pp. 115, 118.
Columella hasta, Pilsbry, 1926, Vol. 27, pt. 108, pp. 245-246, Pl. 30, fig. 18.

Description of the shell: "Shell more than 5 mm. in height, long and cylindrical. Light brown in color and glossy. Spire greatly elevated but obtusely pointed on the apex. Whorls 8½-9, rather flattened on the face and the last subangulated around the periphery. The last six whorls are of about equal diameter; the first three increase rapidly. Lines of growth faint and oblique; apex smooth and white. Aperture somewhat angulated at the base of the columella. Peristome thin and acute, forming a regular curve without an indentation in the upper palatal region, such as is present in most of the *Vertigos*. The aperture is very slightly thickened by a callus on the inside of the peristome in the basal region. Peristome not reflected and with no callus back of the aperture. Teeth and lamellae entirely absent from the aperture. Umbilicus with a very small perforation. Length 5.81 mm.; diameter, 2.03 mm. This species differs from all others of *Sphyradium* [*Columella*] by its much greater size and the relatively smaller aperture." Hanna, 1911, pp. 372-373.

Variations: Hanna (1911, p. 373) speaks of a series of specimens of *Columella hasta* collected by Edward C. Johnston and G. Dallas Hanna. However, only the holotype was available for this study and no record of the paratypes could be found. Therefore, no comparisons with paratypes nor with other individuals could be made.

MEASUREMENTS

	Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
Holotype:	5.81	2.03	1.35	1.2	8½

Habitat: Columella hasta is known only from the type locality. Since *Columella alticola* and many other pupillids represented in the fauna of the Pleistocene, northwestern Kansas, are restricted in their recent distribution to regions where cooler climatic conditions obtain, a reasonable conjecture is that *C. hasta* likewise preferred a cool, moist habitat.

Distribution:

Type locality: Pleistocene of Long Island, Phillips County, Kansas.
Distribution in Kansas: Known only from the type locality.

DISCUSSION

The family Pupillidae is represented in Kansas and in the Lower Pliocene of northern Oklahoma by 33 species and subspecies, fossil and Recent, belonging to 5 genera. The predominating genus, *Gastrocopta,* is known by 14 fossil and living species and subspecies, *G. proarmifera, armifera, contracta, falcis, holzingeri, tappaniana, rexroadensis, corticaria, procera, cristata, paracristata, riograndensis, pellucida hordeacella* and *anterides.* The genus *Vertigo,* second in prominence, is represented by 10 species and subspecies, fossil and Recent, in the fauna of the region studied: *Vertigo ovata, V. ovata morsei, elatior, gouldi, gouldii paradoxa, tridentata, hannai, modesta, milium,* and *hibbardi.* Of the genus *Pupoides,* three species, fossil and Recent are known: *P. marginatus, hordaceus,* and *inornatus.* Three fossil species and subspecies belong to the genus *Pupilla: P. muscorum, muscorum sinistra,* and *blandi.* Three fossil species of the genus Columella are known from this region: *C. alticola, hasta,* and *tridentata.*

Of the 33 species and subspecies of Pupillidae in the region studied, 4 are known from the Recent only. Eleven species and subspecies are known from the fossil as well as from the living fauna including *Vertigo ovata* and *Pupoides marginatus* which occur in the earliest known fauna of the region studied. Eighteen species and subspecies are known only as fossils of which 10 are extinct and 8 are extant but have receded from this region to cooler climates before or since the close of the Pleistocene.

Ecological Considerations:

The pupillid faunule of the Laverne Formation, Lower Pliocene, includes 4 species, *Gastrocopta anterides, G. riograndensis, Vertigo ovata,* and *Pupoides marginatus.* The small number of species as well as a small number of individuals of pupillids known from this formation presents only an incomplete indication of the climatic conditions and ecological situations. *Vertigo ovata* and *Pupoides marginatus* are living today, are widespread in their distribution in North America and live in timbered areas as well as in grasslands. They are, therefore, not good indicators of any specific ecological situations. *Gastrocopta anterides* is known only from the Laverne Formation. Perhaps the most significant pupillid is *Gastrocopta riograndensis* which is a southern species living today in valleys and canyons of Texas and northern central Mexico where the mean temperature is higher than in northern Oklahoma.

The total known molluscan faunule of the Laverne Formation includes 4 species of pelecypods and 21 species of gastropods. The gastropods include 16 aquatic and 5 terrestrial species (Leonard and Franzen, 1944, pp. 15-39, Plates IV, V). The occurrence of the large number of aquatic species, as well as individuals, and the occurrence of fish scales and vertebrae, and amphibian bones signifies that bodies of water were present. The bodies of water, whether large lakes, a series of small lakes, or flowing streams must have been permanent rather than ephemeral. This is indicated by the occurrence of 4 species of *Helisoma,* 2 species of *Ferrissia,* 1 species of Viviparidae, and 4 species of Amnicolidae.

Fossil plants have been recovered from the Laverne deposits. These have been studied by Chaney and Elias (1938, pp. 16-34), who have recognized 11 species of trees of which one species, *Cercidiphyllum crenatum,* a magnolia now restricted to eastern Asia, may have belonged to the humid redwood forest, whereas the other trees are mesic species. Only one of the trees, *Sapindus drummondi* (of the Soapberry family) related to the Laverne flora remains in western Oklahoma.

The present day amount of rainfall, scarcely 20 inches, is insufficient to support a mesic floodplain forest which Chaney and Elias assume to have existed in Laverne times. Areas in eastern and central Oklahoma which support a floodplain forest consisting of species closely related to the Laverne flora, receive approximately 30 inches of rainfall annually. Chaney and Elias recognize the occurrence of buckthorn and a coffee tree in the Laverene deposits as indicative of a higher mean temperature than that of western Oklahoma today.

The occurrence of a large aquatic, molluscan fauna, including Viviparidae and Amnicolidae, associated with fish and amphibians, the presence of a southern pupillid, and the records of a floodplain forest including trees almost entirely restricted to regions of large amount of rainfall and warm temperatures, are indicative of warm and humid climatic conditions obtaining in western Oklahoma in Lower Pliocene times when the Laverne deposits were laid down.

The Saw Rock Canyon (Upper Pliocene in age, Hibbard, verbal communication, June, 1946) pupillid faunule resembles closely that of the Fox Canyon, Big Springs and Rexroad deposits which have been assigned to the Blancan age. *Gastrocopta paracristata* and *Vertigo hibbardi* occur in beds of both ages and are restricted in distribution to the Saw Rock Canyon and Blancan beds. The earliest known occurrence of *Gastrocopta tappaniana* and *Vertigo milium* living in Kansas today, is in the Saw Rock Canyon deposits but these species occur also in the Blancan beds. Associated gastropod mollusks other than pupillids also tend to show a continuity rather than a contrast of fauna. Three species of pupillids, *Gastrocopta cristata, rexroadensis* and *holzingeri* occur in the Blancan but apparently not in the Saw Rock Canyon deposits. This apparent absence may be due to incomplete recovery of the Saw Rock Canyon faunule rather than absence from these deposits.

Aquatic mollusks are also included in the molluscan faunule of the Saw Rock Canyon as well as in the Blancan deposits and approximate in number of species, the terrestrial species. The abundance of aquatic mollusks indicates the presence of bodies of water. The pupillids, *Gastrocopta tappaniana, procera, holzingeri, Vertigo* *milium* and, as reported from the Rexroad Ranch deposits by Baker (in Hibbard, 1941a, p. 265), the associated terrestrial woodland species, *Retinella electrina* (Gould), *rhoadsi* Pilsbry, *wheatlyi* Bland, *Strobilops sparsicostata* F. C. Baker, are indicative of the presence of moist, wooded floodplains.

The amphibian faunule, including salamanders, frogs and toads, as known from the Rexroad Ranch deposits, is larger than that of Meade County of the present time (Taylor, 1942, p. 220). Spines of catfish and other fish remains indicate the presence of streams with permanent pools or oxbow lakes.

The known mammals include horses from grassy uplands, beaver and raccoon from lowlands near water, a shrew, a vole, a lemming, a meadow mouse, and a cotton rat from meadows and marshes, browsers such as mastodonts and deer and the woodrat from forests.

The occurrences in the Rexroad Ranch deposits of aquatic gastropods, of mammals which rely upon water for food supply, and of fish are evidence of streams flowing through southwestern Kansas in Blancan times. The abundance and varied nature of the amphibian faunule is indicative of humid conditions. Woodland gastropods and browsing mammals are evidence of the existence of timber (Hibbard, 1941a, pp. 94-102), although such ecological features as streams, meadows, and timber may well have been of local occurrence.

Temperatures were probably not much lower in winter nor higher in the summer than they are in southwestern Kansas today, a conclusion which may be reached by comparing the Rexroad Ranch fauna with that of present day Kansas. The cotton rat, *Sigmodon*, is included in the Rexroad fauna. It is a present day inhabitant of Meade County, but its known range extends only about 150 miles farther north. The present day molluscan fauna includes *Pupoides marginatus, Gastrocopta cristata, holzingeri, tappaniana, Stenotrema* sp., *Succinea grosvernori* and *Physa anatina*, all species which have been recovered from the Rexroad Ranch deposits.

The pupillids, *Pupilla muscorum, Vertigo gouldii*, and *V. modesta* are included in the fauna of the Meade Formation, Lower Pleistocene, of southwestern Kansas. These species are extant in North America where their range is in cool regions of Canada, northern United States and in mountainous areas. Their occurrence in the deposits of the Meade Formation indicates that somewhat lower mean temperatures obtained in Kansas in early Pleistocene times. Other terrestrial gastropods recovered from beds of the Meade Formation include *Cochlicopa lubrica,* essentially a northern snail, *Strobilops affinis,* a woodland snail of humid regions, and *Euconulus chersinus,* also a woodland snail. The last three snails named are included in the present-day Kansas fauna but are known to be living only in the timber of the eastern part of the state. Woodland snails widely distributed over the United States and found in deposits of the Meade Formation, include *Stenotrema monodon, Discus cronkhitei anthonyi* Pilsbry, and *Zonitoides arboreus* (Say). *Carychium exiguum,* a snail preferring damp places and being able to withstand very moist conditions, has also been recovered from the Meade Formation. It is found living in Kansas but only in moist and usually in wooded areas.

Aquatic species are well represented in the Lower Pleistocene of southwestern Kansas. *Menetus kansasensis* Baker, *Helisoma trivolvis* (Say), *Gyraulus parvus* (Say), *Valvata tricarinata* and species of *Lymnea* and *Physa* are included in the fauna.

The occurrence of mammals such as *Sorex, Microtus, Neosorex,* and *Microsorex* in the fauna of the Meade Formation also indicates that the climate in southwestern Kansas may have been cooler in early Pleistocene times than it is today. This is based upon the distribution of the living relatives of the above forms. They live mainly in the Boreal region although they do range into the Transition Life-zone of the Austral region. Their habitat is in humid and shaded areas (Hibbard, 1944, p. 741).

The occurrence in the deposits of the Meade Formation of terrestrial gastropod species now living in areas of cool and humid climate, an abundant aquatic gastropod faunule including northern forms, a large faunule of mammals many of whose living relatives inhabit cool and humid regions, abundance of plant remains in some localities and iron concretions indicative of local swampy conditions, are evidence of a comparatively cool and relatively more humid climate in southwestern Kansas in early Pleistocene times.

The pupillid species dominant in the Upper Pleistocene deposits in Kansas are now living or represented by closely related species in Canada, northern United States or in cool, humid mountainous regions. Those species which entered Kansas in Upper Pleistocene times are no longer represented in the Kansas fauna. One exception to this may be *Vertigo modesta.* However, the one record of *Vertigo modesta* is a dead, bleached shell which is of doubtful age.

Approximately 20,000 skeletal elements of salamanders, and also bones of frogs and toads have been recovered from Jones Ranch beds. Fish vertebrae, spines and pharyngeal bones with teeth are also included in this fauna.

The general occurrence in the Upper Pleistocene deposits of pupillids which live today under cool and humid climatic conditions, an abundant molluscan faunule, a large number of amphibians, especially salamanders, the occurrence of mammals occupying meadows and timber and living in humid environments are indications of a cool and humid climate in the Upper Pleistocene of Kansas.

The climate of Kansas today is characterized by periodic rains, prolonged dry, hot summers and mild to cold winters. The weather is subject to sudden changes. The species of pupillids living here are those one would expect to find under prevailing climatic conditions. The species represented in the Pleistocene which are restricted in range to cool and humid climates have receded to cooler regions. The species which have remained are either tolerant of the present day conditions or are limited in distribution to isolated areas where humid conditions obtain. Southern species, *Gastrocopta corticaria* and *Gastrocopta pellucida hordeacella* have invaded Kansas apparently since Pleistocene times.

Certain pupillids such as *Gastrocopta cristata* and *G. procera* live in timbered areas in various parts of the state. Some of the woodland snails other than pupillid species which are found in timber, such as *Cochlicopa lubrica* and the genera *Strobilops* and *Euconulus* are also known from the deposits of the Meade Formation in southwestern Kansas. Today these snails are restricted in Kansas to the timbered areas of the eastern part of the state.

Faunal Succession:

Several significant faunal discontinuities are evident in the vertical distribution of pupillids, Lower Pliocene to Recent, in Kansas and Beaver County, Oklahoma. Although there is a continuity in the fauna of certain pupillids which, according to wide extent of their present range, are tolerant of varied climatic situations, there are certain very evident faunal changes indicating climatic changes between the several deposits under consideration. (See Table I.)

The known pupillid faunule of the Laverne Formation, Beaver County, Oklahoma, is meager. Of the four pupillid species known, two species, belonging to two genera, *Vertigo ovata* and *Pupoides marginatus* are extant in Kansas, one species, *Gastrocopta anterides,* is extinct, and one species, *Gastrocopta riograndensis* is living only in southern states and is not known to occur either in the Pleistocene or in the Recent fauna of Kansas.

Pupillids are not known from deposits of the Middle Pliocene in Oklahoma and Kansas; thus there is a gap in the faunal sequence. The molluscan faunule of the Laverne Formation contrasts markedly with that of the Saw Rock Canyon deposits, presumably of Upper Pliocene age, and the beds assigned to the Blancan age as may be seen by noting the absence of *G. anterides* and *G. riograndensis* from the succeeding horizons and the consequent introduction of other species.

The continuity of the pupillid faunule from the Saw Rock Canyon deposits through those of Blancan age is certainly more conspicuous than any trend toward discontinuity. Five of the 6 pupillids known from the Saw Rock Canyon faunule occur in the Blancan beds. *Gastrocopta procera* occurs in the Saw Rock Canyon deposits, is not known from the Blancan deposits, but is continuous in occurrence from Lower Pleistocene to Recent times. This species will probably be recovered from the Blancan beds when more intensive studies are made. Of the eight pupillids recovered from the beds of Blancan age, 5 occur also in the Saw Rock Canyon deposits. Among the 5 species common to the Saw Rock Canyon deposits and the Blancan beds are *Vertigo hibbardi* F. C. Baker and *Gastrocopta paracristata.* This is significant because these two species are abundant but limited in vertical distribution to these deposits. *Gastrocopta tappaniana* occurs uninterruptedly from Saw Rock Canyon deposits to the Recent time. *Vertigo milium,* a pupillid of the Saw Rock Canyon deposits and of a Blancan deposit, is known to occur in the Lower Pleistocene and Recent fauna of Kansas. *Pupoides marginatus,* common to the Saw Rock Canyon and the Blancan deposits is not known from the Lower Pleistocene beds, possibly because of insufficient collecting, but is abundant in the Upper Pleistocene and Recent faunas.

Although there is not a complete break in the molluscan faunule between the beds of Blancan age and the beds of Lower Pleistocene age, represented here by the Meade Formation, some very significant faunal changes take place. *Gastrocopta paracristata,* an abundant fossil species, *Vertigo hibbardi,* the dominant species of the genus of its time and *G. rexroadensis* are not known to occur above the deposits assigned to the Blancan. Another pronounced change in the molluscan faunule is that of the appearance for the first time in Kansas of the genera *Pupilla* and *Columella* and of the species *Vertigo gouldii, Gastrocopta contracta* and the *Gastrocopta armifera* series as introduced by *Gastrocopta proarmifera. Gastrocopta falcis* is a species known from only two localities of the Meade Formation. (See Table I.)

The species which persist through the Middle Pleistocene times are those whose vertical range extends from the Laverne and the Blancan to the present time. Those species include *V. ovata, Pupoides marginatus, G. tappaniana* and *G. procera.*

A significant pupillid faunal discontinuity occurs between the Lower and Upper Pleistocene horizons. However, the break is not as profound as it is between the Blancan and the Lower Pleistocene. This break is characterized mainly by the introduction of species and an increase in prominence of certain species rather than by a termination of many species. Three species of the Lower Pleistocene, *Vertigo gouldii, Gastrocopta falcis* and *G. proarmifera* are not found in the beds of the Upper Pleistocene. *G. proarmifera* is succeeded by a closely related species, *G. armifera. V. gouldii* is replaced by the subspecies *Vertigo gouldii paradoxa. V. elatior, V. modesta, C. hasta, C. alticola* and *Pupilla blandi* are known for the first time in Kansas in the Upper Pleistocene.

There is a marked contrast between the Pleistocene and the Recent pupillid faunule. The species *V. tridentata, V. modesta, V. g. paradoxa, Pupilla muscorum, Pupilla blandi,* and *C. alticola,* whose Recent range is restricted to cool and humid climates, have receded, while *V. hannai* and *C. hasta* have become extinct. A few southern snails, *G. pellucida hordeacella* and *G. corticaria,* have come in from the south. If the shell of *Pupoides inornatus,* which was probably taken from drift, indicates that this species is a Kansas resident, then a western form has entered Kansas. The validity of the Recent record of the eastern form, *Vertigo modesta,* is doubtful.

The predominant living pupillids are those which have been residents of Kansas since Blancan, Lower Pliocene or Upper Pleistocene times. These species include *V. ovata, V. milium,* which are distributed sporadically and are probably remnant forms, *Pupoides marginatus* and *Gastrocopta armifera* which are tolerant of varied climatic conditions and are ubiquitous in Kansas today, and *G. cristata, G. procera* and *G. tappaniana* which also are tolerant of varied climatic conditions. The predominant pupillids of the present day molluscan faunule are *Gastrocopta armifera* and *Pupoides marginatus.*

CONCLUSIONS

The purposes of this study have been to make a taxonomic study and a vertical as well as horizontal distributional study of the pupillids as found in the Lower Pliocene of northwestern Oklahoma, Lower Pleistocene to Recent in Kansas, and Pleistocene of Nebraska.

In proceeding with the taxonomic study, the authors studied carefully the shells of pupillids in the collection of the Museum of Natural History, University of Kansas, and a series of unidentified Pleistocene shells loaned by the State Museum, University of Nebraska. The classifications of shells previously identified as well as those identified by the authors were carefully compared with the shells of the collections of the Museum of Zoölogy, University of Michigan, Ann Arbor; The United States National Museum, Washington; The Academy of Natural Sciences of Philadelphia; and the Carnegie Museum, Pittsburgh, Pennsylvania.

At various times, *Gastrocouta procera* and the subspecies, *G. p. sterkiana* and *G. p. mcclungi* have been reported as occurring in Kansas. The authors made a study of shells assigned to these named kinds and studied also their geographical distribution within Kansas. As a result it was found that the shells assigned to these three forms occurred within the same populations over all of the region considered and that the characters of the shells formed a continuous intergrading series within a population. Therefore, the pupillids of Kansas previously assigned to the subspecies *G. p. sterkiana* and the previously known subspecies described from Kansas, *G. p. mcclungi,* are here considered as synonymous with *G. procera.*

A similar study was made of the shells collected in Kansas, which have been assigned to the species *Gastrocopta armifera* and its several subspecies. The shells assigned to the several subspecies are not limited geographically in their distribution and the characters of the several "subspecies" intergrade within a population. Therefore, the shells occurring in Kansas and previously assigned to the several subspecies of *G. armifera* are here referred only to *G. armifera.*

Vertigo hannai Pilsbry was originally described as *Vertigo martini* Hanna and Johnston. This species is distinct and valid. However, in the description of the holotype an error was made in describing the columellar lamella. The senior author recently examined the holotype at The United States National Museum, Catalogue number

226396, and consequently made corrections in the definition of the species.

Two new fossil species belonging to the genus *Gastrocopta* are described. *Gastrocopta paracristata* occurs in the Saw Rock Canyon deposit, Upper Pliocene (?), and in beds assigned to the Blancan age. *Gastrocopta rexroadensis* is known from deposits assigned to the Blancan age.

Previously certain shells from Kansas have been referred to the species *Pupilla hebes*. This identification is an error. The species *Pupilla hebes* does not occur in Kansas either in the fossil or in the living faunas.

Certain shells have previously been identified as *Vertigo coloradensis*. This is also an error. *V. coloradensis* is not known from collections of fossil or living shells from the area studied.

A study of the vertical distribution reveals a faunal break between the pupillid faunules of the Laverne Formation, Lower Pliocene, and of the Saw Rock Canyon, supposedly Upper Pliocene in age. The pupillid faunule of the Saw Rock Canyon closely resembles the faunule occurring in the beds referred to the Blancan age. The differences between the two faunules are much less pronounced than are the similarities. A very pronounced faunal break is evident between the pupillids of the Blancan deposits and those of the Meade Formation. A significant, though not profound, faunal break occurs between the Lower Pleistocene and the Upper Pleistocene pupillid faunules. The contrast between the Upper Pleistocene and the Recent pupillids is mainly the result of a recession of several forms and the invasion of a few species since Pleistocene times.

Faunal discontinuities are one indication of climatic change. The pupillid faunules of the several ages are indicative of the prevalence of certain climates. The four pupillid species known from the Laverne Formation indicate a warm, humid climate. The pupillids of the Saw Rock Canyon and of the Blancan faunas are associated with a cool, humid climate. The pupillids of the Lower and the Upper Pleistocene faunaus also prefer cool and humid conditions. The species formerly resident in the state, but now known to be living only in cool and humid regions are not included in the present day Kansas fauna. A few pupillids from warmer regions have entered Kansas. The predominating species are those which are tolerant of a cool to warm, and humid to dry climate.

Two pupillids which lived in this region in Lower Pliocene times, three species which are first known from the Saw Rock Canyon deposits, two species first occurring in the Blancan deposits, one species first appearing in the Lower Pleistocene still remain in the Recent fauna of this region.

The pupillids of Kansas and of the adjoining areas included in this study, do not present a study of evolutionary progression. The characters of the shells of *Vertigo ovata* and of *Pupoides marginatus* as known from the Laverne Formation do not differ from those of the Pleistocene deposits or from those of the Recent fauna. *Vertigo milium* is also an example of this conservatism. The shells of this species occurring in the Saw Rock Canyon deposits do not differ from those of *Vertigo milium* living in Kansas at the present time. *Gastrocopta tappaniana* and *G. holzingeri* also have not undergone any changes since Lower Pleistocene time.

The study of the pupillids represented in the fossil and the living faunas is of value in determining probable climatic and ecological conditions in various geological ages. The faunal assemblages and faunal breaks are significant. The pupillids tolerant only of a warm climate do not occur with those species limited in range to areas of cool climates. The faunal breaks between the two geologic horizons having similar climates, such as the Lower and the Upper Pleistocene, indicates a long interval in which adverse conditions prevailed.

ACKNOWLEDGMENTS

We are grateful to Doctor Henry A. Pilsbry, Curator of Mollusks, The Academy of Natural Sciences of Philadelphia; to Doctor Paul Bartsch, formerly Curator, and Doctor Harald A. Rehder, Acting Curator, Division of Mollusks and Cenozoic Invertebrates, The United States National Museum; to Doctor Gordon K. MacMillan, Assistant Curator, Section of Recent Invertebrates, Carnegie Museum, Pittsburgh; to Mr. Calvin Goodrich, formerly Curator, and Doctor Henry van der Schalie, Curator, Division of Mollusca, Museum of Zoölogy, The University of Michigan, all of whom have generously assisted us in every possible manner.

Doctor Bertrand Schultz, Director of the Nebraska State Museum, generously loaned us all the molluscan specimens available from Nebraska Pleistocene deposits.

Several Grants-in-Aid to the senior author from the Kansas Academy of Science have greatly facilitated the progress of this study.

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SPECIES \ VERTICAL DISTRIBUTION	LAVERNE FORMATION	SAW ROCK CANYON	FOX CANYON	BIG SPRINGS RANCH	REXROAD RANCH	SUNBRITE	CUDAHY	WILSON VALLEY	TOBIN	PYLE RANCH-BELOW ASH	SANBORN FORMATION	REZABEK	XI-RANCH	JONES QUARRY	TAYLOR RANCH	UPPER KINGSDOWN	RECENT
GASTROCOPTA PROARMIFERA							O		T	O							
GASTROCOPTA ARMIFERA											O		O	O	O	O	O
GASTROCOPTA CONTRACTA								O				O					O
GASTROCOPTA FALCIS							T			O							
GASTROCOPTA HOLSINGERI					O							O					O
GASTROCOPTA TAPPANIANA		O	O	O				O	O	O		O					O
GASTROCOPTA REXROADENSIS			O	O	T												
GASTROCOPTA CORTICARIA																	O
GASTROCOPTA PROCERA		O						O	O		O	O		O			O
GASTROCOPTA CRISTATA			O	O	O								O	O			O
GASTROCOPTA PARACRISTATA		O	T		O												
GASTROCOPTA RIOGRANDENSIS	O																
GASTROCOPTA P. HORDEACELLA																	O
GASTROCOPTA ANTERIDES	T																
VERTIGO O. MORSEI							O										
VERTIGO OVATA	O					O	O					O		O			O
VERTIGO ELATIOR											O						
VERTIGO GOULDII							O	O									
VERTIGO G. PARADOXA											O						
VERTIGO TRIDENTATA																	O
VERTIGO HANNAI											T						
VERTIGO MODESTA											O						O
VERTIGO MILIUM		O			O		O	O									O
VERTIGO HIBBARDI		O		O	T												
PUPOIDES MARGINATUS	O	O	O	O	O						O		O	O		O	O
PUPOIDES HORDACEUS														O			O
PUPOIDES INORNATUS					O												O
PUPILLA MUSCORUM								O			O						
PUPILLA M. SINISTRA							O		O	T							
PUPILLA BLANDI											O		O	O	O		
COLUMELLA TRIDENTATA									T								
COLUMELLA ALTICOLA											O						
COLUMELLA HASTA											T						

T - type locality O - records of occurrence

TABLE 1. Vertical distribution of *Pupillidae* in Kansas.

PLATE XVII

EXPLANATION OF FIGURES

FIG. 1—*Gastrocopta proarmifera* Leonard.
Catalogue number 3710, p. 23.

FIG. 2—*Gastrocopta proarmifera* Leonard.
Catalogue number 3710, p. 23.
Dissected view to show the columellar lamella.

FIG. 3—*Gastrocopta armifera* (Say).
Catalogue number 3489, p. 25.

FIG. 4—*Gastrocopta armifera* (Say).
Catalogue number 3489, p. 25.
Dissected view to show the columellar lamella.

FIG. 5—*Gastrocopta armifera* (Say).
Catalogue number 3489, p. 25.
Dissected view to show the columellar lamella.

All figures × 18

All catalogue numbers are those in the molluscan collection in the Kansas University Museum of Natural History.

PLATE XVII

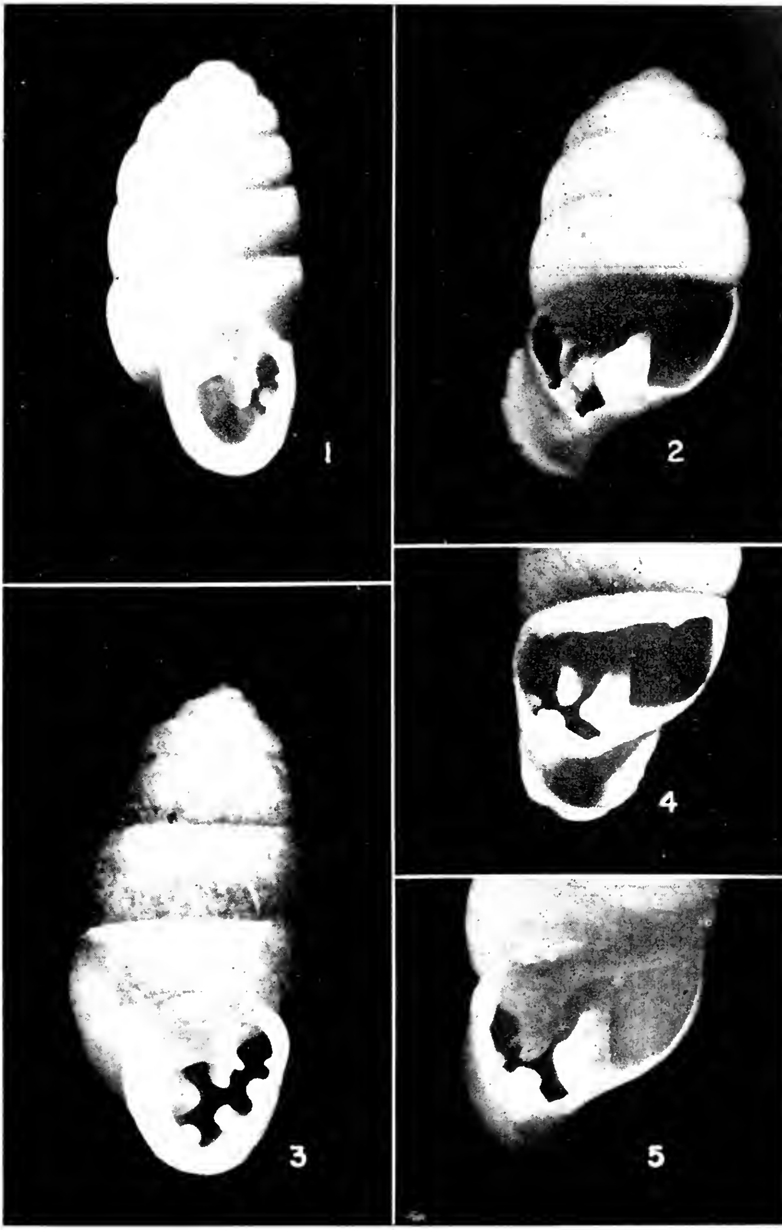


PLATE XVIII

EXPLANATION OF FIGURES

FIG. 1—*Gastrocopta falcis* Leonard.
Catalogue number 3729, p. 35.

FIG. 2—*Gastrocopta holzingeri* Sterki.
Catalogue number 2281, p. 41.

FIG. 3—*Gastrocopta procera* (Gould).
Catalogue number 59, p. 52.

FIG. 4—*Gastrocopta rexroadensis* Franzen.
Catalogue number 3764, Paratype. p. 46.

FIG. 5—*Gastrocopta rexroadensis* Franzen.
Catalogue number 3764, p. 46.
Dissected view showing angular, parietal, and columellar lamellae.

FIG. 6—*Gastrocopta procera* (Gould).
Catalogue number 3797, p. 52.
Showing labial callus.

FIG. 7—*Gastrocopta corticaria* (Say).
Catalogue number 2062, p. 49.

FIG. 8—*Gastrocopta tappaniana* (C. B. Adams).
Catalogue number 398, p. 42.

FIG. 9—*Gastrocopta contracta* (Say).
Catalogue number 1029, p. 30.

All figures × 18

All catalogue numbers are those in the molluscan collection in the Kansas University Museum of Natural History.

PLATE XVIII

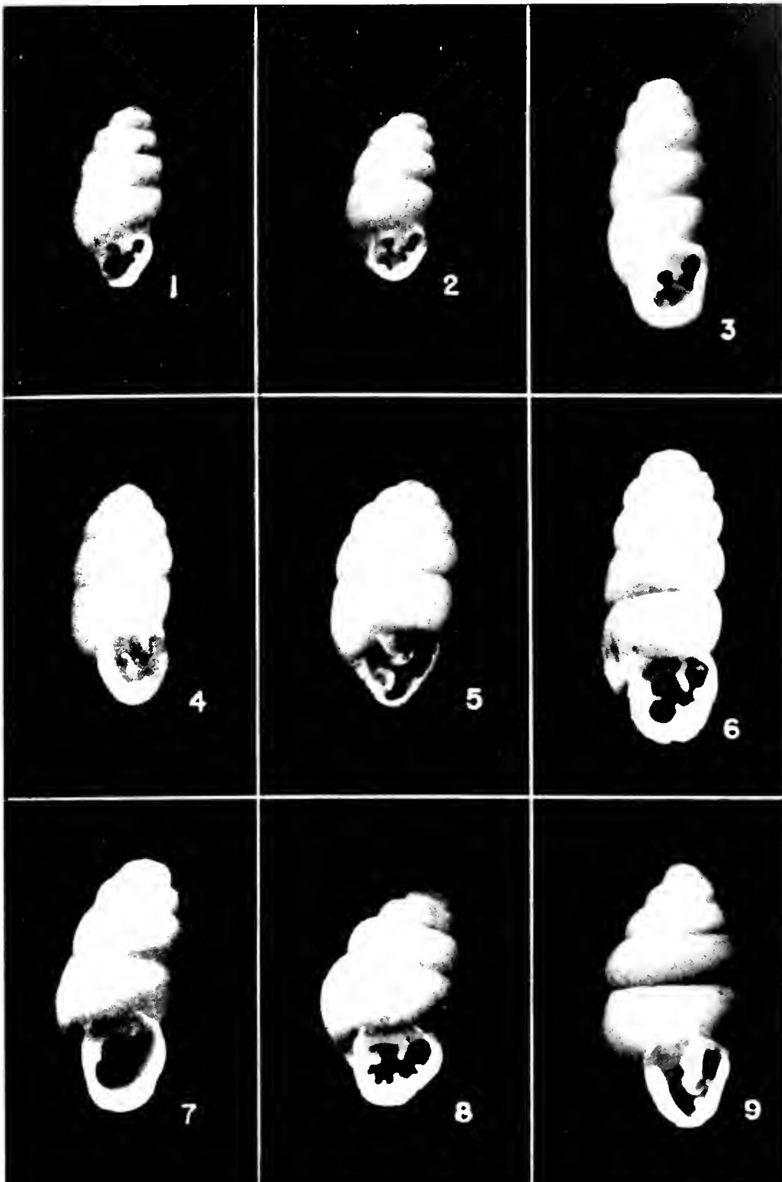


PLATE XIX

EXPLANATION OF FIGURES

FIG. 1—*Gastrocopta cristata* (Pilsbry and Vanatta)
Catalogue number 3794, p. 59.
Showing labial callus.

FIG. 2—*Gastrocopta paracristata* Franzen.
Catalogue number 3929, Holotype, p. 63.

FIG. 3—*Gastrocopta paracristata* Franzen.
Dissected view showing columellar lamella.

FIG. 4—*Vertigo morsei* Sterki.
Catalogue number 3704, p. 78.

FIG. 5—*Vertigo morsei* Sterki.
Catalogue number 3704, Transitional, p. 78.

FIG. 6—*Vertigo ovata* Say.
Catalogue number 56, p. 83.

FIG. 7—*Gastrocopta riograndensis* (Sterki).
Catalogue number 1003, p. 67.

FIG. 8—*Gastrocopta pellucida hordeacella* (Pilsbry).
Catalogue number 2085, p. 70.

FIG. 9—*Gastrocopta anteridea* Leonard and Franzen.
Catalogue number 1002, Holotype, p. 73.

All figures × 18

All catalogue numbers are those in the molluscan collection in the Kansas University Museum of Natural History.

PLATE XIX

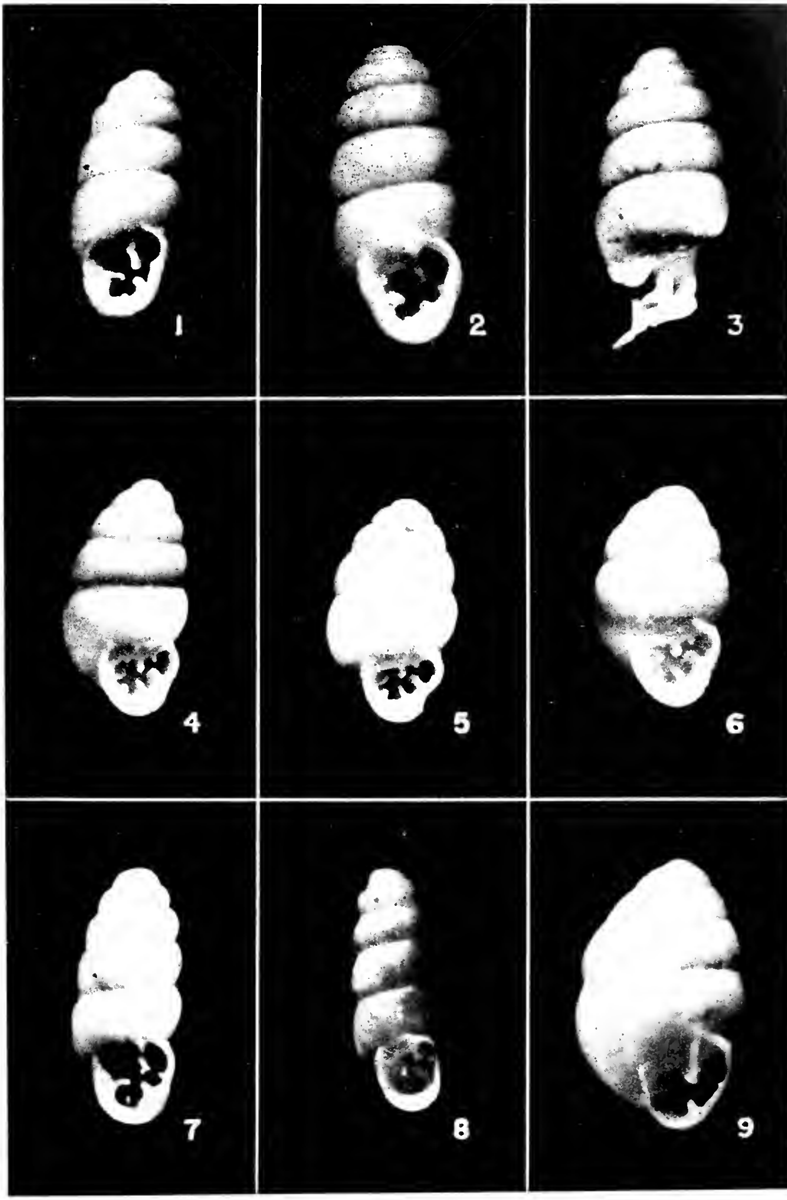


PLATE XX

Explanation of Figures

FIG. 1—*Gastrocopta cristata* (Pilsbry and Vanatta).
Catalogue number 82, p. 59.
FIG. 2—*Vertigo elatior* Sterki.
Catalogue number 3608, p. 88.
FIG. 3—*Vertigo gouldii* (Binney).
Catalogue number 404, p. 91.
FIG. 4—*Vertigo gouldii paradoxa* Sterki.
Catalogue number 3822, p. 94.
FIG. 5—*Vertigo tridentata* Wolf.
Catalogue number 2668, p. 98.
FIG. 6—*Vertigo modesta* (Say).
Catalogue number 3615, p. 104.
FIG. 7—*Vertigo hannai* Pilsbry.
Catalogue number 2647, p. 101.
FIG. 8—*Vertigo milium*.
Catalogue number 2648, p. 108.
FIG. 9—*Vertigo hibbardi* F. C. Baker.
Catalogue number 3754, p. 112.
FIG. 10—*Vertigo hibbardi* F. C. Baker.
Dissected view showing angular, parietal and columellar lamellae.

All figures × 18

All catalogue numbers are those in the molluscan collection in the Kansas University Museum of Natural History.

PLATE XX

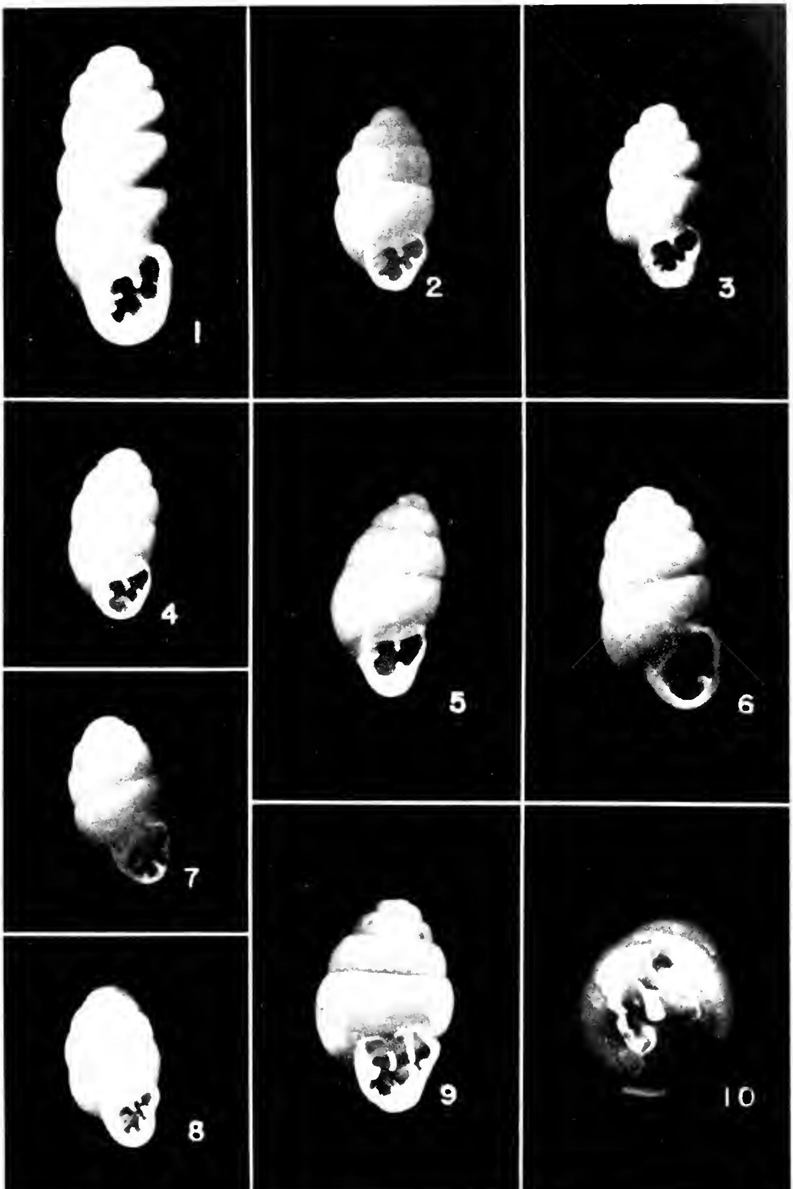


PLATE XXI

EXPLANATION OF FIGURES

FIG. 1—*Pupoides inornatus* Vanatta.
Catalogue number 2374, p. 126.

FIG. 2—*Pupoides hordaceus* (Gabb).
Catalogue number 2083, p. 122.

FIG. 3—*Pupoides marginatus* (Say).
Catalogue number 1037, p. 118.
Showing a very widely reflected lip.

FIG. 4—*Pupoides marginatus* (Say).
Catalogue number 157, p. 118.

All figures × 18

All catalogue numbers are those in the molluscan collection in the Kansas University Museum of Natural History.

PLATE XXI

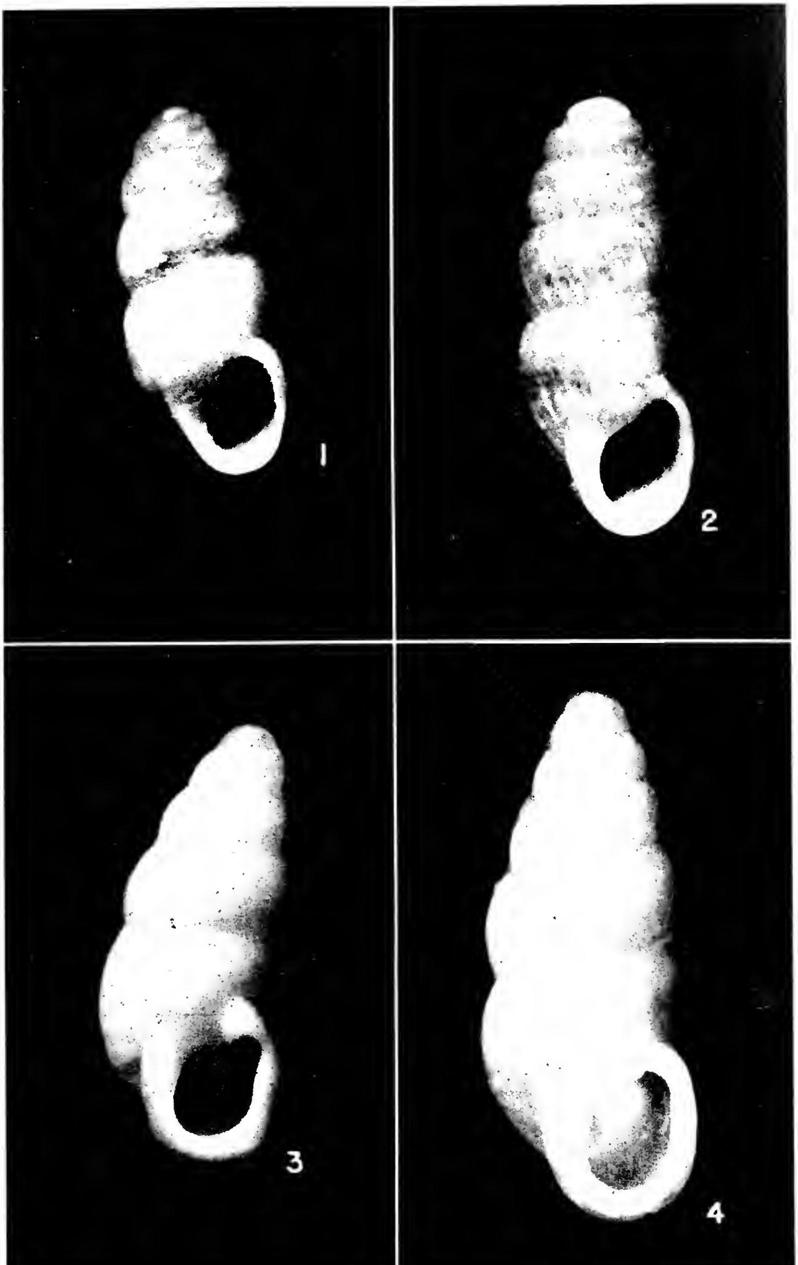


PLATE XXII

EXPLANATION OF FIGURES

FIG. 1—*Pupilla blandi* Morse.
Catalogue number 75, p. 137.

FIG. 2—*Pupilla muscorum* (Linneaus).
Catalogue number 2373, p. 131.

FIG. 3—*Columella alticola* (Ingersoll).
Catalogue number 3549, p. 147.

FIG. 4—*Pupilla muscorum sinistra* Franzen.
Catalogue number 3827, p. 135, Paratype.

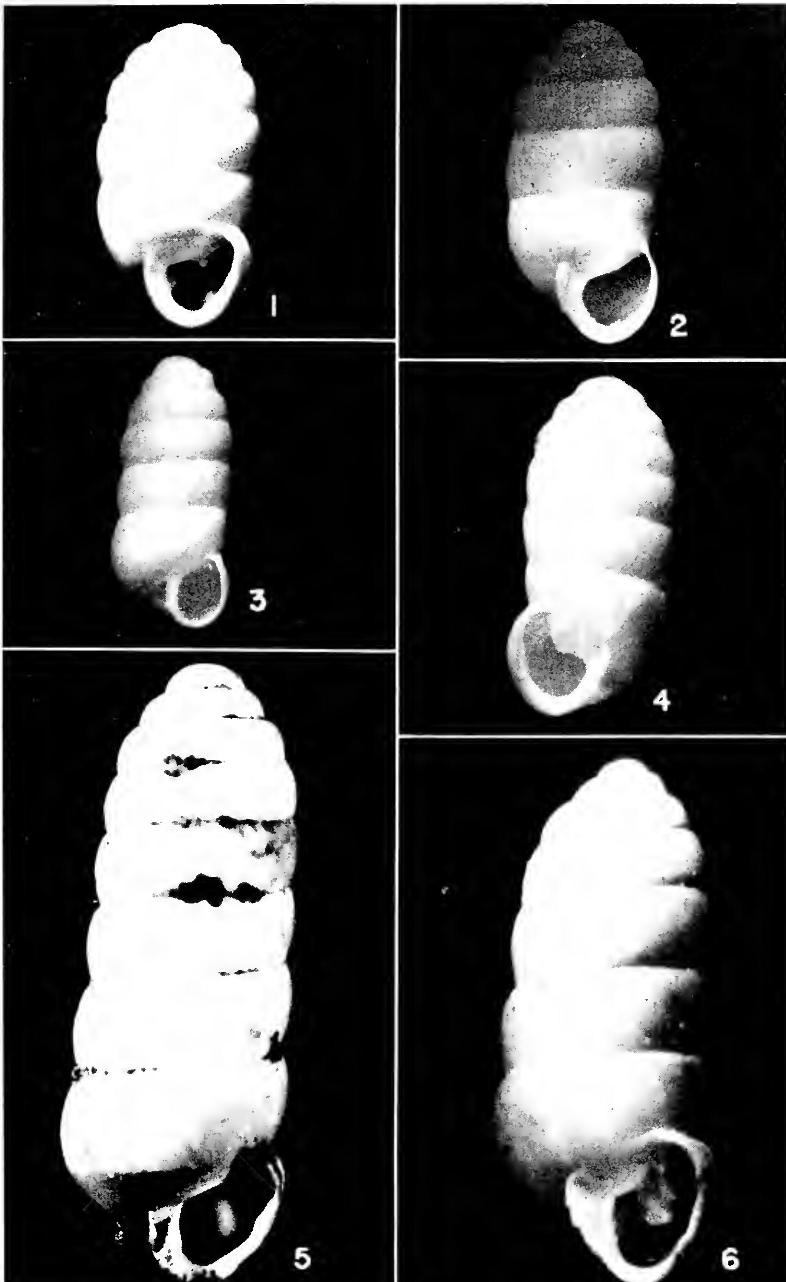
FIG. 5—*Columella hasta* (Hanna).
Catalogue number 214302, United States National Museum, p. 150.

FIG. 6—*Columella tridentata* Leonard.
Catalogue number 3734, Holotype, p. 144.

All figures × 18

Catalogue numbers, unless otherwise designated, are those in the molluscan collection in the Kansas University Museum of Natural History.

PLATE XXII



THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN
VOL. XXXI, pt. II.] NOVEMBER 1, 1947 [No. 16

A Revision of the Tribe Scaphytopini (*Homoptera, Cicadellidae*) in America North of Mexico

By LEON W. HEPNER

ABSTRACT: The following genera and subgenera of *Cicadellidae* in America north of México are revised: *Platymetopius, Japananus, Scaphytopius, Cloanthanus, Tumeus* and *Vertanus*. Keys to genera, subgenera, species and subspecies are included, as well as prints of male genitalia and last ventral segment of the females. Discusses 73 species and subspecies. Synonyms considered are as follows: *Cloanthanus* Ball = (*Deltopinus* Ball = *Convelinus* Ball = *Nasutoideus* Ball = *Platymoideus* Ball); *Japananus hyalinus* (Osborn) = (*Platymetopius cinctus* Matsumura); *Scaphytopius (Scaphytopius) elegans* (Van Duzee) = (*Scaphytopius elegans* var. *glennanus* Ball = *Scaphytopius floridanus* Ball = *Scaphytopius floridanus* var. *glennanus* Ball); *Scaphytopius (Cloanthanus) fuscifrons* (Van Duzee) = (*Platymetopius abruptus* Ball); *Scaphytopius (Cloanthanus) dorsalis* (Ball) = (*Platymetopius bicolor* DeLong); *Scaphytopius (Cloanthanus) magdalensis* (Provancher) = (*Platymetopius obscurus* Osborn = *Platymetopius carolinus* Lathrop = *Cloanthanus atratus* DeLong = *Cloanthanus vaccinium* DeLong); *Scaphytopius (Cloanthanus) scriptus* (Ball) = (*Cloanthanus varius* DeLong); *Scaphytopius (Cloanthanus) cinereus* (Osborn and Ball) = (*Platymetopius parvus* Lathrop = *Platymoideus oviedus* Ball); *Scaphytopius (Cloanthanus) acutus* (Say) = (*Jassus modestus* Stal = *Platymetopius acutus* var. *dubius* Van Duzee = *Cloanthanus filamentus* DeLong = *Cloanthanus tenuis* DeLong); *Scaphytopius (Cloanthanus) latus* (Baker) = (*Platymetopius cuprescens* Osborn); *Scaphytopius (Cloanthanus) argutus* DeLong = (*Scaphytopius hastus* DeLong = *Scaphytopius lanceus* DeLong); *Scaphytopius (Cloanthanus) trilineatus* (Ball) = *Platymetopius pexatus* (Van Duzee); *Scaphytopius (Cloanthanus) abbreviatus* (DeLong) = (*Cloanthanus parvus* var. *niger* DeLong). *Cloanthanus* and *Tumeus* are reduced to subgenera of *Scaphytopius*. *Hebenarus huachucus* Delong is placed in the subgenus *Scaphytopius*. Both lectotype and lectoallotype are designated for the following species: *Japananus hyalinus* (Osborn), *Scaphytopius (Cloanthanus) nigricollis* (Ball), *Scaphytopius (Cloanthanus) fulvus* (Osborn), *Scaphytopius (Cloanthanus) fulvus collaris* (Sanders and DeLong), *Scaphytopius (Cloanthanus) cinnamoneus* (Osborn), *Scaphytopius (Cloanthanus) angustatus* (Osborn), *Scaphytopius (Cloanthanus) nigriviridis* (Ball) and *Scaphytopius (Cloanthanus) rubellus* (Sanders and DeLong). Lectoallotype only is designated for each of the following species: *Scaphytopius*

(Cloanthanus) fuscifrons (Van Duzee), *Scaphytopius (Cloanthanus) frontalis* (Van Duzee) and *Scaphytopius (Cloanthanus) cinereus* (Osborn and Ball). Lectotype, allotype and parallotypes are designated for each of the following species: *Platymetopius palliolatus* (Ball), *Scaphytopius (Tumeus) majestus* (Ball), *Scaphytopius (Cloanthanus) torridus* (Ball), *Scaphytopius (Cloanthanus) compactus* (Ball), *Scaphytopius (Cloanthanus) dorsalis* (Ball), *Scaphytopius (Cloanthanus) scriptus* (Ball), *Scaphytopius (Cloanthanus) nigriviridis dixianus* (Ball), *Scaphytopius (Cloanthanus) oregonensis* (Baker), *Scaphytopius (Cloanthanus) latus* (Baker), *Scaphytopius (Cloanthanus) trilineatus* (Ball) and *Scaphytopius (Cloanthanus) abbreviatus* (DeLong). Lectotype only is designated for *Scaphytopius (Cloanthanus) verecundus* (Van Duzee). Allotype and parallotypes are designated for *Scaphytopius (Scaphytopius) elegans* (Van Duzee), *Scaphytopius (Scaphytopius) catalinus* (Ball) and *Scaphytopius (Cloanthanus) loricatus* (Van Duzee). *Scaphytopius (Cloanthanus) torridus* (Ball), *Scaphytopius (Cloanthanus) cinnamomeus* (Osborn) and *Scaphytopius (Cloanthanus) dorsalis* (Ball) are considered full species rather than varieties of other species. *Scaphytopius (Cloanthanus) xanthanus* (Ball), *Scaphytopius (Cloanthanus) compactus* (Ball) and *Scaphytopius (Cloanthanus) collaris* (Sanders and DeLong) have been reduced from full species to subspecies. *Scaphytopius (Cloanthanus) nogalinus* (Ball) and *Scaphytopius (Cloanthanus) dixianus* (Ball) are considered subspecies rather than varieties.

TABLE OF CONTENTS

INTRODUCTION

THIS paper is a revision of the tribe *Scaphytopini* in America north of México and includes the following genera: *Platymetopius* Burmeister, *Japananus* Ball and *Scaphytopius* Ball. The genus *Scaphytopius* is divided into four subgenera—*Scaphytopius* Ball, *Cloanthanus* Ball, *Tumeus* DeLong and *Vertanus* Hepner.

More than twenty-five thousand specimens have been examined, including types, paratypes or compared with type specimens of all but the following species: *Japananus hyalinus* (Osborn), *Scaphytopius (Cloanthanus) osborni* (Van Duzee), *Scaphytopius (Cloanthanus) magdalensis* (Provancher), *Scaphytopius (Cloanthanus) modestus* (Stal), *Scaphytopius (Cloanthanus) analis* var. *castranis* (Ball), *Scaphytopius (Cloanthanus) rubellus* (Sanders and DeLong), *Scaphytopius (Cloanthanus) acutus* (Say) and *Scaphytopius (Cloanthanus) abbreviatus* (DeLong).

Platymetopius Burmeister was named in 1838 as a subgenus with *rostratus* (Herrich-Schaeffer) listed first and no gentoype designated. *Japananus* Ball in 1931 with *hyalinus* (Osborn) as genotype and *Scaphytopius* Ball in 1931 with *elegans* (Van Duzee) as genotype. Among the subgenera of *Scaphytopius*, *Cloanthanus* Ball was named in 1931 with *angustatus* (Osborn) as genotype, *Tumeus* DeLong in 1943 with *serrellus* DeLong as genotype and *Vertanus* Hepner in 1946 with *ulcus* as genotype.

In 1910, E. P. Van Duzee published a revision of the genus *Platymetopius* in America. He included twenty-eight species, subspecies and varieties found north of México.

In 1931, E. D. Ball described seven new genera—*Japananus*, *Scaphytopius*, *Deltopinus*, *Convelinus*, *Nasutoideus*, *Platymoideus* and *Cloanthanus*, in which he placed the species formerly considered in *Platymetopius*. However, my studies of the internal male genitalia showed definitely that these genera, as limited, did not satisfactorily show the proper relation of, or group the species. For example: *castranus*, placed in *Convelinus*, was more closely related to those species in *Nasutoideus; heldoranus*, named in *Nasutoideus*, proved more like *Platymoideus; dorsalis* fitted into no genus as limited. *Japananus* and *Scaphytopius* are the two genera retained of those erected by Ball in 1931, with *Cloanthanus* retained as a subgenus. *Scaphytopius (Scaphytopius)* is retained to include *elegans*, *vitanus* and *catalinus* just as Ball did, plus *huachucus*, named later by DeLong (1944). All the other species have been placed in *Scaphytopius* (*Cloanthanus*) with the exception of *majestus*, placed in *Scaphytopius* (*Tumeus*) Delong.

Host plants are known for a great many of the species and this information is given for each individual species in the description.

ACKNOWLEDGMENTS

The author is deeply indebted to Dr. R. H. Beamer of the University of Kansas, under whose supervision the work was done, for assistance in taxonomic problems and collection of most of the material examined; to Dr. Paul W. Oman of the National Museum, Washington, D. C., for the loan of much material and assistance on taxonomic problems; Dr. Herbert Osborn, Dr. Dwight M. DeLong, and Dr. and Mrs. Joseph N. Knull of Ohio State University for the loan of material and types; Mr. D. A. Wilbur, Kansas State College, for the loan of material and to Mr. R. E. Snodgrass for assistance in morophological problems of the male genitalia.

TECHNIQUE OF STUDY

Equipment Used: Dissecting microscope, for dissection and study of specimens; art gum erasers with a hole, one-sixteenth inch in diameter and one-half inch deep; at least two dissecting needles, one with the tip bent at a one-hundred degree angle; metal loop for transferring genitalia; a casserole for heating caustic potash or soda; a small glass container for distilled water; well slide for dissection in glycerine; slides and cover slips for mounting; slide labels; specimen dissection labels; wax pencil for temporary labels on slide; small vials and corks for staining and placing unmounted genitalia on the same pin with the specimen; a bottle of diaphane for permanent slides; a silk or linen cloth for cleaning slides; tweezers for placing the coverslip on the slide; photographic equipment for making negative prints; photographic paper; eight by five inch cards; photographic mounting paper.

Dissection of Male Genitalia: The head of the insect pin is inserted into the hole in the art gum eraser so that the insect is upside down with the dorsal part of the insect against the eraser. By using a dissecting needle, the entire abdomen is separated from the rest of the insect. The abdomen is transferred to the casserole of caustic potash or soda by a moistened metal loop, where it is boiled slowly for two to ten minutes. As the solution evaporates, distilled water and caustic solution are alternately added to retain about the same amount in the casserole.

Upon removal from the caustic solution, the abdomen is rinsed in distilled water and placed in a drop of glycerine on a slide, ready for dissection. The genital capsule is removed by holding the abdomen with the bent needle in the left hand and using the other needle to pull the capsule loose at its point of attachment. The capsule is then placed so that the tip of the plates and pygofers are directed away from the dissector.

In order to see the parts more easily, the pygofers are separated from the rest of the capsule. To do this the bent needle is placed along the anterior margin where the pygofer and plate join, holding this part against the slide while the straight needle is used to tear gently the connection between the two parts. The anal tube is held by the bent needle and torn out, care being taken that the aedeagus is not pulled off with it. In many species of *Scaphytopius,* the aedeagus is more strongly attached to the base of the anal tube and pygofer lining than to the other genital parts. It has been found necessary to tear loose the inner lining of the pygofer with the aedeagus in order that the aedeagus remain with the other genital parts. This is done by holding the pygofer with the bent needle and gently tearing loose this lining, along with the connectives of the base of the aedeagus. This lining in then teased or cut away so as not to interfere with the genital parts. If possible, the other connective between the plate and pygofer is best left intact until the permanent slide is made. If no slide is desired, the opened capsule is put in a small vial with a drop of glycerine and the pin of the dissected specimen stuck through the cork so that the genitalia are on the same pin as the specimen from which it was taken.

Staining: If slides are to be made, it is best to stain the parts. For this purpose a one and one-half percent aqueous mercurochrome solution is used. The genitalia are rinsed in distilled water to remove the glycerine and put in a small jug containing the stain. The jug is then put on the same pin as the dissected specimen as described above, so there will be no danger of confusion where several genitalia are being stained at the same time. The genitalia are left in the stain from one to twenty-four hours, depending on the darkness of the specimen and intensity of stain desired.

Temporary Slides: Whenever possible, permanent slides should be made, but in some cases it is necessary to make temporary slides so that the genitalia may be placed on the same pin as the dissected insect after the genitalia have been studied or photographed.

In this case the genitalia are rinsed in water to remove all surplus stain and then mounted in glycerine. In most cases negative prints are made of the parts and the prints studied. The cover slip should not be left on the slide any longer than necessary, as this tends to flatten the parts.

Permanent Slides: The genitalia are rinsed in distilled water to remove surplus stain and then placed in a drop of glycerine on a slide (a well slide is best) and any surplus tissue is removed and the plates are separated so that the aedeagus may be seen between them. The genitalia are then put in clean water so that the glycerine is completely removed. A slide and cover slip are then cleaned so that no dirt or lint is present, especially if prints are to be made. A silk or linen cloth is best for this purpose.

The genital parts are then placed in 95% alcohol for thirty seconds to one minute for dehydration. If left longer than this, the paraphyses, especially if coiled, tend to break near the base when the cover slip is put on, and the genitalia are flattened. A drop of diaphane is placed in the middle of the slide and the genital parts put in it with the metal loop. The dissecting needles are then used to separate the pygofer from the rest of the capsule and the parts are arranged as desired. The cover slip is then placed slowly on the diaphane so that no bubbles will be formed. This is best done with tweezers, one side of the cover slip being placed on the slide and the other side slowly lowered until the cover slip touches the diaphane. The cover slip is pressed down slowly and evenly until the parts are flattened. Not over forty-five seconds should be allowed from the time the diaphane is put on the slide until the cover slip is placed in position. The slide should remain in a horizontal position for several days—until the diaphane has completely dried.

The slide is numbered and the insect given a corresponding number. If the last ventral segment of the female is mounted, the same procedure is used and mounted on the same slide with a male of the same species.

Photographing and *Studying Genitalia*: In studying the male genitalia, negative prints are made and studied. This consists of directing a strong light through the slide, an objective and an ocular, onto sensitive paper, using a magnification of ninety times for the male genitalia and sixty times for the last ventral segment of the female. The prints, four by five inches for the males, half this size for the females, are then mounted, by using photographic mounting paper, on five by eight inch cards. These cards are given the same number as the slide and filed for study. In determining variation in a species, or differences in the genitalia of different species, these cards are of inestimable value. Any additional information regarding a specimen or species is written on the back side of the card. When specimens are determined, the species name is written on each card.

Prints similar to those used for study were made for this publication, but a dark amber filter was used to allow for a longer exposure, resulting in a clearer image.

CHARACTERS USED IN CLASSIFICATION

The characters used most in separating species were differences in the male genitalia—the paraphyses, aedeagus, and to a lesser degree, the valve, plates and pygofers.

External structural features used were the length and shape of crown; length of pronotum at middle and behind eye in relation to width; length and shape of clypeus, shape of face in lateral view and arrangement of veins in forewing. The variation in color and color pattern was helpful, if accompanied by some structural difference.

TERMINOLOGY

The terminology used by P. W. Oman (1936) was followed in this paper. The *crown* is that part often termed "vertex" and is the dorsal part of the head between the eyes; the *median suture* is the line down the center of the crown, terminating anteriorly in the *"wedge."* By *length of crown* is meant the length on median line and *width between eyes* is the shortest width between the eyes. *Width of pronotum* refers to the distance from one lateral margin to the other; *length behind eyes* refers to the distance from the most posterior portion of the eye to the margin of the pronotum directly posterior to it. The *clypeus* is that part sometimes termed the "frons," length refers to the greatest length and *width at ocelli* refers to the shortest distance between the margins of the clypeus at ocelli. The *"sharksmouth"* is the inverted V-shaped marking found near the base of clypeus in almost all species of *Scaphytopius*. The *clypellus* is the sclerite extending from the apex of clypeus to the external mouthparts. *Lorae* are the small, circular sclerites on each side of clypellus. The *genae* refers to all the rest of the face. The *forewing* refers to the outer wing, often called the tegmina. The *brachial cell* is that cell in the corium bordering the claval vein.

In regard to the genitalia, Mr. R. E. Snodgrass was consulted as to the names of the various parts. The copulatory organ is termed *aedeagus;* processes of the aedeagus, the genital paraphyses; the parameres, the *styles;* the ventral plate of the male, the *valve;* the ventral apical processes, the *plates;* and the apical dorsal processes, the *pygofers.*

SYNOPSIS OF TRIBE SCAPHYTOPINI

Crown relatively flat with anterior margin distinct; pronotum convex anteriorly and concave posteriorly; forewing with distinct appendix and either one or two cross-veins; clypeus broadest along posterior margin, sinuate or straight at antennae; clypellus usually broadest near apex; genae expanded and extending behind eyes, visible from above; ocelli on margin of crown, near eyes.

KEY TO GENERA OF TRIBE SCAPHYTOPINI

1. Crown with shortest width between eyes greater than length at middle; lateral margin of genae with small concavity beneath eye.....*Platymetopius Burmeister,* page 420
   Crown as long as or longer at middle than shortest width between eyes.......... 2
2. (1) Only one cross-vein in costal cell; claval veins united at middle,
   Japananus Ball, page 423
   More than one cross-vein in costal cell or claval veins not united at middle,
   Scaphytopius Ball, page 426

SYNOPSIS OF GENUS PLATYMETOPIUS BURMEISTER

Jassus subgenus *Platymetopius* Burmeister, Genera insectorum iconibus illustravit et descripsit. 1: pl. 14, subgenus 4, 1838.

The original reference to the genus *Platymetopius* is as follows:

"Subgenus 4, *Platymetopius*

"37. J. rostratus *Herr. Schaeff.* Fn 122. 2.

"38. J. vittatus *Fabr. Germ.* C. undata *Pz. Fn. Germ.* C. flammigera de *Vill. Ent.* (tab. rostra fig. 4 caput cum pronoto et scutello, fig. 5 caput infra.)

Spec. complures, huic subgeneri adscriptae, in Mus. Germari Halae asservantur, quarum nomina haec:

J. impluviatus *Germ.,* e Pennsylvania

J. meta *Germ.,* e Pennsylvania

J. costalis *Germ.,* Brasilia."

The generic name attained nomenclatorial status in the above indicated publication by virtue of the inclusion of the previously described species. The first designation of a type species apears to have been by Van Duzee (Ent. Soc. Amer. Ann. 3: 214, 1910), who designated *Jassus rostratus* Herrich-Schaffer, 1834, as type.

Additional data relative to American species are as follows: Crown much wider than length at middle, anterior margin rounded to a bluntly pointed apex; pronotum almost parallel margined on median half; forewing with numerous veins to costa; clypeus almost as broad between ocelli as median length and over three times as wide at base as at apex, sinuate at antennal sockets; clypellus more than one-third as long as clypeus, only slightly broadest at apex and barely reaching genae; lateral margin with small concavity beneath eye; relatively deep pit from antennal socket to ventral margin of eye; face convex in lateral view.

KEY TO SPECIES OF PLATYMETOPIUS BURMEISTER

1. Forewing fulvous to brown with milky spots..............1. *vitellinus* (Fitch), page 421
   Forewing green with thin brown area along mesal margin...2. *palliolatus* (Ball), page 422

1. *Platymetopius vitellinus* (Fitch)

Acocephalus vitellinus, Fitch, Asa, Catalogue with references and descriptions of the insects collected and arranged for the State Cabinet on Natural History—Ann. Report State Cabinet Nat. Hist. of N. Y., IV: p. 57, 1851.

Resembling *palliolatus* but with shorter, yellow crown and brownish forewings. Length: female 6 mm., male 5 mm.

Color: Crown and face ivory to yellow and without darker markings. Pronotum brown, yellowish along anterior margin, indications of three pale vittae, one on median line and another on each side. Scutellum about same color as crown, with a large orange to brown spot near each basal corner. Forewing pale hyaline amber with darker clouded areas in clavus and an irregular, oblique, clouded vitta from apex of clavus to costal margin; veins light.

Structural Characteristics: Crown about half as long at middle as width between eyes, only slightly longer at middle than next eyes; shallow transverse furrow near rounded anterior margin. Pronotum almost twice length of crown, slightly more than twice as wide as length at middle. Clypeus only slightly longer than width at ocelli, distinctly sinuate at antennae. Clypellus relatively broad and only slightly enlarged near apex. Lateral margins of genae concave near eye, convex on apical two-thirds. Face in lateral view distinctly convex, except for slight arcuate concavity joining antennal sockets. Forewing with four or five recurved veins to costa.

Genitalia: Valve triangular, about one and one-half times as wide as length at middle, posterior margin slightly convex on each side of a rounded apex. Aedeagus in ventral view broadest at base, narrowest on apical third; two pairs of lateral processes, one pair from near base extending beyond apex of shaft, and another pair at apex about two-fifths length of shaft. Styles less than one and one-half times as long as basal width, apical half slender and almost parallel margined. Pygofer roughly triangular, with hook somewhat falcate and sharply pointed.

Last ventral segment of female about twice as wide as length at middle, lateral margins convex, posterior margin with a large, rounded lobe on each side of a small median lobe which may or may not be notched at middle.

Types: Holotype ♂, No. 762, allotype ♀, No. 763, in the New York State Museum, Albany, N. Y.

Material Examined: (British Columbia) Hope, Merritt, Vernon. (Manitoba) Russell, Birch River, Keld, Mafeking, Hartney. (Ontario) Toronto. (Montana) Missoula, Bozeman. (Utah) Barclay. (Colorado) Pagosa Springs, North Peak, Dutch Gap, Ft. Collins. (North Dakota) Tarkio, Hamar. (Minnesota) Two Harbors. (Wisconsin) Rib Mt. State Park. (Michigan) Cheboygan Co., Douglas Lake, Clare Co. (New Hampshire) Bretton Woods, Center Harbor, Notchland. (Tennessee) Clarksville.

Host Plants: Ball (1932) writes "The writer has reported this species as curling and reddening the leaves of roses. Later at Woods Hole it was found curling and coloring the leaves of blackberry and dewberry." Lowry (1933) gives grasses, sedges and shrubs in collection data regarding this species.

Comparative Notes: This species has a wide range but shows little variation except that the specimens from Tennessee were slightly larger.

2. *Platymetopius palliolatus* (Ball)

Eutettix palliolatus, Ball, E. D., Can. Ent., XXXIV: p. 13, 1902.

Resembling *vitellinus* but green with brown pronotum, scutellum and area along clavus. Length: female 5.5 mm., male 5 mm.

Color: Crown green and without markings. Pronotum dark reddish-brown, a pair of irregular broad orange vittae on disc and extreme lateral margin white. Scutellum about same color as pronotum, indication of two oblique light vittae near disc. Face greenish-yellow without definite markings. Forewing hyaline green except for white-margined, narrow brown area from near base of wing, along scutellar and sutural margin to apex of wing; two or three white aeroles in clavus and a like number in apical cells.

Structural Characteristics: Crown about two-thirds as long as width between eyes, slightly more pointed than in *vitellinus*, with transverse furrow indistinct or absent. Pronotum slightly longer than crown, about twice as wide as length at middle. Clypeus only slightly longer than width at ocelli, sinuate at antennae. Clypellus relatively stout and somewhat enlarged near apex. Face distinctly convex in lateral view. Forewing with three or four recurved veins to costa, especially near apex.

Genitalia: Valve almost twice as wide as length at middle, posterior margin almost straight on each side of a bluntly pointed apex. Plates long and slender. Aedeagus in lateral view short, broadest at base, almost parallel-margined on apical two-thirds with a pair of short, slender apical processes. Styles short, less than twice as long as basal width, slightly sinuate on basal third, with short, rounded apical process.

Last ventral segment of female somewhat converging on lateral margins; posterior margin almost straight except for median lobe notched at middle.

Types: Lectotype ♀, "Tex. Collection C. V. Riley" collected by Belfrage, in the National Museum, Washington, D. C., allotype ♂ and 45 ♂ parallotypes, Seymore, Texas, June 30, 1936, R. H. Beamer, in the Snow Entomological Collections, here designated. Additional ♂ parallotypes from Texas as follows: 1, Palo Pinto Co., July 14, 1928, R. H. Beamer; 1, San Saba Camp, July 1, 1936, R. H. Beamer; 1, Loyal Valley, July 2, 1936, R. H. Beamer; 2, Castroville, July 5, 1936, R. H. Beamer; 1, San Antonio, July 4, 1936, R. H. Beamer; 1, Seguin, June 26, 1938, R. H. Beamer; 3, Concan, July 6, 1936, R. H. Beamer.

Host Plants: Fletcher (1930) writes regarding this species, "on wild sunflower at Dallas."

Comparative Notes: This species is easily recognized by its distinctive color markings and is evidently restricted to Texas.

SYNOPSIS OF GENUS JAPANANUS BALL

Japananus, Ball, E. D., Can. Ent., LXIII: p. 218, 1931.

The original description of *Japananus* is as follows:

"Resembling *Platymetopius* (sens. strict.) in the narrow head the single cross nervure and the lack of vermiculations but also lacking the supernumerary costal veinlets of that genus.

"A narrow headed form with a long acute vertex in the female, a short and but slightly acute one in the male, a broad pronotum strongly constricted and advanced between the eyes, a large scutellum, broad elytra with simple venation and no reticulations, a single cross nervure between the sectors. Three large cells occupy the apical portion of the elytra, the first apical forming a long narrow cell against the costa bounded by two short veinlets at right angles to costa. The posterior veinlet is in line with the apex of the outer anteapical, the second apical therefore triangular as in the fifth. Face in profile acutely angled with vertex, front narrow, in the female, produced in a triangle with the vertex. A hairlike dark line just beneath the margin.

"Type of the genus, *Platymetopius hyalinus* Osb.

"This introduced species has no close relationships with any other North American form and while lacking the second sector it does not belong in *Platymetopius* proper nor even close to that group as indicated by the widely different head characters and genital patterns.

"The remainder of the American groups agree in possessing the narrow head with the pronotum narrowed between the eyes, the second cross nervure, a large number of reflexed veinlets to costa, the white triangle or "Sharksmouth" marking on the front and more or less of reticulations and vermiculations. None of these groups are represented in the European fauna as far as known."

Additional data regarding *Japananus* is as follows: Crown flat, sharply pointed, longer than shortest width between eyes, median suture and wedge distinct; pronotum very convex on anterior margin, much wider at middle than behind eyes; forewing with claval veins joined near middle, only two veins to costa and one cross-vein in discal cell; clypeus long and slender, lateral margins hardly sinuate at antennae; clypellus over one-third length of clypeus, enlarged near apex, reaching slightly beyond genae. Shallow concavity on genae from antennae to ventral part of eye.

3. *Japananus hyalinus* (Osborn)

Platymetopius hyalinus, Osborn, Ent. News, XI, p. 501, 1900.
Platymetopius cinctus, Matsumura, Jour. Tohoku Imperial Univ. College of Agri., V: p. 215, 1914.

Yellow to greenish, sharply pointed crown, resembling no other species in the group. Length: female 5.5 mm., male 4.5 mm.

Color: Crown pale green to grennish-brown along margin, becoming darker on disc; apical wedge light. Pronotum mottled dark gray in male, dark green in female, darkest on disc. Scutellum slightly lighter than pronotum with dark markings, if present, irregular in shape. Face pale fulvous fading to gray on lateral margin of genae in male, greenish-yellow in female; irregular dark line just below base, connecting ocelli. Forewings pale greenish hyaline (almost colorless in male), with following dark markings: four or five lines or dots near middle and a mark in apex of clavus; cross vein on anterior margin of discal cell; area where apical and anteapical cells join; and a dot on costa opposite apex of clavus.

Structural Characteristics: Crown about one and one-third times as long as width between eyes in male, twice as long as width between eyes in female, almost straight on each side of a sharply pointed apex; concavity on disc; distinct wedge. Pronotum about as long as crown in male; two-thirds length of crown in female, two and one-third times as wide as length at middle and five times length behind eyes, extending beyond eye on each side, posterior margin with shallow notch at middle. Clypeus about twice as long as width at ocelli, not sinuate at antennae. Clypellus large, enlarged near apex. Face in lateral view slightly convex in male, concave between anterior margin of eyes in female. Forewing with the two claval veins united except at ends and only one cross vein to costa.

Genitalia: Genital parts long and slender. Valve triangular, about twice as wide as length at middle. Shaft of aedeagus short, base long and with a pair of slender processes, each bifid on outer fifth, one part straight the other acutely recurved at base and recurved again on apical two-thirds. Plates with a parallel-margined apical process longer than remainder of plate. Styles long, broadest near basal third, slightly lobed on outer margin before blunt outward-projecting apical process.

Last ventral segment of female slightly longer than greatest width, latero-posterior margin convex on basal third, broadly concave on each side of a long median lobe on apical two-thirds.

Types: Lectotype ♂, lectoallotype ♀, Washington, D. C., 1897, J. S. Hine, here designated, in the Osborn Collection, Ohio State University, Columbus, Ohio.

Material Studied: (Connecticut) New Haven. (New Jersey) South Orange, Springfield. (D. C.) Washington. (Virginia) Falls Church, Dismal Swamp, Arlington. (Tennessee) Clarksville. (Ohio) Barberton. (Oregon) Portland.

Host Plants: Ball (1932) writes "—feeds both as nymphs and adults, on the Japanese maple." DeLong (1923) writes "apparently an imported species occurring on Japanese and sugar maples, and perhaps other species of the same group."

Comparative Notes: Evidently this easily recognized, introduced species is fairly well distributed in many parts of the United States.

SYNOPSIS OF GENUS SCAPHYTOPIUS BALL

Scaphytopius, Ball, E. D., Can. Ent., LXIII: p. 218, 1931.

The original description of *Scaphytopius* is as follows:

"Resembling *Platymetopius* as formerly recognized but lacking most of the vermiculations. Allied to *Scaphoideus* Van Duzee, relatively short and stout species with two cross nervures, numerous oblique veinlets to costa and about three or four lines on face paralleling the vertex margins.

"Vertex rather broad and flat, slightly acutely angled and nearly the same length in both sexes—eyes large oblique and enclosing one-half of the pronotum. Face convex, the profile straight and acutely angled with vertex. Front narrow and almost parallel margined below antennae. The 'shark's mouth' markings and the vertex margin both narrowly edged with black, often a line between these. Pronotum much broader than head, the anterior half constricted by the oblique eyes. Elytra as in *Scaphoideus* except for two cross nervures, the venation regular and strongly emphasized on posterior half.

"Type of the genus, *Platymetopius elegans* Van Duzee."

Additional characteristics of the genus are as follows: Crown pointed, longer at middle than shortest width between eyes; pronotum much longer at middle than behind eyes, shortest on lateral margins; forewing with several veins to costa and either one or two veins in discal cell; clypeus narrow, usually slightly sinuate at antennae, broadest at ocelli; clypellus broadest near apex, extending to or beyond margin of genae.

KEY TO SUBGENERA OF SCAPHYTOPIUS BALL

1. Broad, irregular, whitish, sunken band near apex of crown; sharp carina on basal half of clypeus.......... *Vertanus* Hepner, page 427
   No band nor carina as described above.......... 2
2. (1) Crown fulvous without distinct dark markings, with light markings on disc consisting of a long light vitta on each side of median suture posterior to light wedge; distinctly convex on each side of an acutely angled apex. Clypeus uniform brown to black with distinct white line along posterior margin between ocelli and thin sharksmouth reaching to or almost to margin of clypeus, *Tumeus* DeLong, page 428
   Crown and clypeus not as above.......... 3
3. (2) Clypellus with apical fourth reaching beyond normal curve of genae, *Scaphytopius* Ball, page 432
   Clypellus with less than apical fourth reaching beyond normal curve of genae, *Cloanthanus* Ball, page 439

SYNOPSIS OF SUBGENUS VERTANUS HEPNER

Vertanus, Hepner, L. W., J. Kans. Ent. Soc., p. 87, 1946.

Crown broadly convex on each side of a sharp apex, irregular, sunken, unmarked band before eyes; forewings broad with wide costal cell and several strongly recurved veins to costa; clypeus long, much wider on basal third with a thin median carina on basal half, strongly sinuate at antennae; clypellus slender, slightly enlarged near apex and extending beyond normal curve of genae; lorae oval; lateral margins of genae convex, small pit at base of antennae.

Type of subgenus—*Scaphytopius* (*Vertanus*) *ulcus* Hepner.

4. *Scaphytopius* (*Vertanus*) *ulcus* Hepner

Scaphytopius (*Vertanus*) *ulcus*, Hepner, Jour. Kans. Ent. Soc., XIX, p. 87, 1946.

A striking species unlike any other north of México, with broad colorless band on crown and sharply carinate clypeus. Length: female 5.2 mm., male 5 mm.

Color: Crown with apical fifth mottled brown to fuscous, excepting wedge; broad irregular, colorless band across crown on apical third, remainder with vittae as follows: ivory along outer margin, broad brown, fuscous-margined vitta just inside this, with narrow ivory, fuscous and white lines in that order before thin fuscous line on each side of median suture; slightly lighter in female. Pronotum with broad light and dark alternating vittae, the light ones lined with fuscous. Scutellum about same color as pronotum. Clypeus mottled brown and yellow on apical half, basal half brown on lateral margins, remainder black except white sharksmouth and irregular oblique broad white vittae from near sharksmouth to basal margin. Remainder of face mottled brown and yellow except for white vitta behind eye and dot near ocellus and antenna. Forewing semihyaline yellow, at least on disc of clavus, in apical cells, and along some of veins; remainder semihyaline white or colorless, excepting black clouded areas in clavus and especially in discal and anteapical cells, one conspicuous mark through outer anteapical to costal margin; distinct hyaline spot in posterior end on middle and outer anteapicals.

Structural Characteristics: Crown slightly over twice as long as width between eyes, anterior margin strongly convex on each side of a sharply pointed apex; concave on disc. Pronotum slightly over half as long as crown, two and one-fourth times as wide as length at middle, and three and one-half times length behind eyes, broadly concave on posterior margin. Clypeus about two and one-fourth times as long as width at antennae, sharp median carina on apical half and rather strong concavity on each side, lateral margins sinuate at antennae. Clypellus relatively stout, enlarged at apex. Face in lateral view strongly concave. Forewing with several vein-like marks in brachial cell, sometimes extra veins on clavus and six or seven strongly reflexed veins to costa.

Genitalia: Valve triangular, about two-thirds as long as greatest width, posterior margin slightly concave on each side of a sharply pointed apex. Aedeagus large, basal portion roughly cone shaped with a large "U"-shaped apical portion about as long as base but about twice as wide. Plates short and truncate. Styles projecting mesally, about twice as long as basal width, large lobe on outer margin just before short, blunt, outward-projecting apical process.

Last ventral segment of female convex and converging on lateral margins; posterior margin with a distinct, blunt lobe on each side of a small median notch.

Types: Holotype ♂, allotype ♀ and 2 pairs of paratypes, Hidalgo, Texas, Dec. 28, 1945, R. H. Beamer, in the Snow Entomological Collections. Additional paratypes as follows: 5 ♀ ♀, 2 ♂ ♂, Brownsville, Texas, June 29, 1938, 1 pair, July 3, 1938, R. H. Beamer; 1 ♀, Brownsville, Texas, May 25, 1939, D. J. and J. N. Knull; 1 pair, Progresso, Texas, July 1, 1938, R. H. Beamer; 1 ♂, Taxco, Mexico, Aug. 22, 1936, W. E. Stone; 1 ♂, Mexico, April 10, 1939.

Host Plants: The specimen labelled "Mexico" was collected from cantaloupe.

Comparative Notes: The white band on crown and carina on clypeus easily separates this species from any other. There is evidently much variation in the length of the crown as one of the specimens from Mexico had a longer crown and the other a shorter one than the type, but the internal genitalia proved to be the same.

SYNOPSIS OF SUBGENUS TUMEUS DELONG

Tumeus, DeLong, D. M., Bull. Brook. Ent. Soc., p. 168, 1943.

The original description of the subgenus is as follows:

"Related to *Cloanthanus* but with a flat, more broadened and bluntly angled vertex with the sides convexly rounded to form a narrow, rounded tip. The face is broader than in *Cloanthanus,* but the angled line just beneath the apex of vertex resembles the markings of that genus. The venation is similar in type to *Cloanthanus,* the coastal veinlets are of the same type and the first anteapical cell is usually decidedly shorter than the second anteapical cell. Genotype *Tumeus serrellus* n. sp."

Additional characteristics regarding the subgenus are as follows: Crown broad, anterior margin convex on each side of a sharply pointed apex, markings consisting of a light vitta on each side of median suture from base to wedge; light vitta on pronotum very faint or absent; forewings relatively long and slender, outer anteapical short, central anteapical narrowed near apex; clypeus dark, without dots, a light line along basal margin joining ocelli and a long slender sharksmouth; slightly sinuate at antennae; clypellus slightly enlarged near apex, barely reaching to normal curve of genae.

KEY TO SPECIES OF SCAPHYTOPIUS (TUMEUS) DELONG

1. Frons mostly black: California..........................5. *majestus* (Ball), page 429
   Frons brown: Texas..................................6. *texanus* DeLong, page 431

5. *Scaphytopius* (*Tumeus*) *majestus* (Ball)

Platymetopius majestus, Ball, E. D., Ent. News, XX: p. 164, 1909.

Resembling *Scaphytopius elegans* somewhat but without the broad dorsal yellow stripe, with crown much broader and with anterior margin distinctly convex on each side of pointed apex. Length: female 5 mm., male 4.5 mm.

Color: Crown yellow and orange with a broad, light vitta on each side of median suture on basal four-fifths, light wedge on apical fifth. Pronotum usually darker than crown, lightest along anterior margin. Scutellum about same color as crown. Clypeus with narrow light band along base between eyes and a long, light sharksmouth; remainder dark chocolate brown, except for lighter brown area between sharksmouth and basal margin. Genae lighter than clypeus. Clypellus and lorae either color of clypeus or genae, or varying between the two colors; light vitta behind eye and dots before eye usually present. Forewing semihyaline brown to fuscous, lightest on clavus and costa, darkest on outer anteapical cell and apex of corium and clavus.

Structural Characteristics: Crown about twice as long as width between eyes, anterior margin definitely and broadly convex on each side of a pointed apex. Pronotum half as long as crown in female, proportionately longer in male, about two and one-half times as wide as length at middle and three and one-half times length behind eye; posterior margin convex behind outer margin of eye, concave at middle with a small median notch. Clypeus about twice as long as width at ocelli, lateral margin sinuate at antennae. Clypellus much larger near apex. Face in lateral view definitely concave. Forewing with six or seven recurved veins to costa.

Genitalia: Valve almost as long as greatest width, posterior margin rounded, anterior margin with relatively long lobe on median two-fifths. Single paraphysis, "hinged" on basal third, bifid on outer third, each branch of which is bifid, with the outer branch longer than the inner. Aedeagus very short and broad, resembling a ring. Styles slightly more than twice as long as basal width, slightly sinuate near middle, small lobe on outer margin before curved, outward-projecting apical process.

Last ventral segment of female about twice as wide as length at middle, lateral margin straight near base, convergant on apical three-fifths; posterior margin straight except for median lobe with a notch at middle.

Types: Holotype ♂, Pasadena, California, June 17, 1908, in the National Museum, Washington, D. C. Allotype ♀ and 7 ♀ parallotypes, Miramar, Calif., July 28, 1938, R. H. Beamer, in the Snow Entomological Collections. Additional ♀ parallotypes from California as follows: 6, Irvine Park, Aug. 4, 1939, R. H. Beamer; 1, Boulevard, July 26, 1938, R. H. Beamer; 1, San Antonio Canyon, Aug. 4, 1938, R. H. Beamer; 1, San Antonio Canyon, Aug. 4, 1938, R. I. Sailer; 2, Mt. Tamalpais, Aug. 15, 1938, R. H. Beamer; 5, La Jolla, July 13, 1941, R. H. Beamer; 1, Arroyo Seco River, Aug. 8, 1938, R. H. Beamer; 3, Mint Canyon, July 6, 1933, R. H. Beamer; 2, San Diego, Aug. 7, 1935, 1, Dec. 24, 1941, R. H. Beamer; 1, Nipomo, July 24, 1935, R. H. Beamer.

Host Plants: Ball (1932) writes "—taken in June by the writer on a tall *Rhus* growing in isolated clumps at Pasadena." Specimens collected on *Photinia arbutifolia* at Mt. Tamalpais, California, and on *Rhus integrifolia* at Miramar, California, were examined.

Comparative Notes: This dark, slender species can hardly be confused with any other species in California, and the male genitalia is distinctly different from any other, with the single, twice bifid paraphysis.

Scaphytopius (Tumeus) texanus DeLong

Tumeus texanus, DeLong, D. M., Bull. Brook. Ent. Soc., XXXVIII: p. 170, 1943.

Resembles *majestus* somewhat, but with shorter crown and light brown dorsum. Length: female 5 mm., male 4.5 mm.

Color: Crown pale greenish-fulvous, thin dark line along anterior margin, pale vitta on each side of median suture on basal three-fourths, median vitta on apical fourth; pale areas bordered by dark. Pronotum darker than crown, lightest on anterior and lateral margins, usually some vermiculations on disc; vittae sometimes evident on lateral margins. Scutellum about same color as crown, light in each basal corner and an irregular, slightly oblique line from lateral margin to anterior margin, usually fuscous lined. Face chocolate brown excepting light markings as follows: thin line along anterior margin, long sharksmouth, three or four pairs of short, oblique lines on disc of clypeus, line behind eye and a dot before eye. Forewing semihyaline greenish-fulvous, large milky aeroles in clavus, anteapical and apical cells, most cells in corium, except middle apical cell, with large hyaline area, dark vermiculations throughout; veins light except on apex and costal margin.

Structural Characteristics: Crown one and two-thirds times as long as width between eyes in male, slightly longer in female, anterior margin slightly convex on each side of bluntly pointed apex in male, more strongly convex in female. Pronotum about three-fifths length of crown in male, relatively shorter in female, two and one-half times as wide as length at middle and four times length behind eyes, posterior margin only slightly concave. Clypeus about twice as long as width at ocelli, lateral margins constricted at antennae, shallow concavity along sharksmouth. Clypellus stout and enlarged near apex. Face in lateral view concave between anterior margin of eyes, especially in female. Forewing with numerous vein-like marks in brachial cell and about seven recurved veins to costa.

Genitalia: Valve about four-fifths as long as greatest width, posterior margin convex on each side of a bluntly pointed apex; anterior margin with short, broad median lobe. Plates short but sharply pointed. Paraphysis single, bulblike at base with a slender hairlike apical part. Aedeagus attached to base of paraphysis; shaft in lateral view, straight, narrowing to apex with a pair of short, slender apical processes. Styles slightly more than twice as long as basal width, outer margin with pointed lobe before long, slender, curved process on apical half.

Last ventral segment of female almost twice as wide as length at middle, lateral margins straight, posterior margin convergant to a median lobe with a small notch at middle.

Types: Holotype ♂, allotype ♀, Brownsville, Texas, May 8, 1935, J. N. Knull, in the DeLong Collection, Ohio State University, Columbus, Ohio.

Material Studied: (Texas) Concan, Progresso, Brownsville.

Host Plants: The host plant is not known.

Comparative Notes: This species is easily recognized in southern Texas by the clouded dark face and distinctive crown.

SYNOPSIS OF SUBGENUS SCAPHYTOPIUS BALL

Scaphytopius, Ball, E. D., Can. Ent., LXIII: p. 218, 1931.

For original description of subgenus, see description of genus *Scaphytopius*.

Additional characteristics of the subgenus are as follows: Crown straight to slightly convex on each side of apex, markings light, but sometimes lined with dark; pronotum with vittae absent or indistinct on disc; forewing with several recurved veins to costa; clypeus sinuate at antennae, light sharksmouth near posterior margin between eyes typically present; clypellus relatively long with apical fourth extending beyond normal curve of genae; loral margins oval; genae with shallow pits for antennae.

KEY TO SPECIES OF SCAPHYTOPIUS (SCAPHYTOPIUS) BALL

1. Color hyaline brown except for wide yellowish area covering crown, middle half of pronotum, all of scutellum and mesal margin of clavus,
   7. *elegans* (Van Duzee), page 432

   Markings different than above 2
2. (1) Face unicolor; last ventral segment of female not split on posterior margin; male paraphysis roughly "T"-shaped..........................8. *ritanus* Ball, page 434

   Frons usually darker than rest of face; last ventral segment of female split on posterior margin; male paraphysis not "T"-shaped.......................... 3
3. (2) Paraphysis of male and last ventral segment of female split to near base,
   9. *catalinus* (Ball), page 436

   Paraphysis of male and last ventral segment of female split only partly to base,
   10. *huachucus* (DeLong), page 437

7. *Scaphytopius* (*Scaphytopius*) *elegans* (Van Duzee)

Platymetopius elegans, Van Duzee, E. P., Ent. Amer., VI: p. 94, 1890.
Scaphytopius floridanus, Ball, E. D., Can. Ent., LXIII: p. 220, 1931.
Scaphytopius elegans var. *glennanus*, Ball, E. D., Can. Ent., LXIII: p. 220, 1931.
Scaphytopius floridans var. *roseus*, Ball, E. D., Can. Ent., LXIII: p. 221, 1931.

Resembling *ritanus* but more slender, with longer crown, and forewings unclouded on corium except for apical cells. Length: female 5 mm., male 4.7 mm.

Color: Crown white to yellow with brown markings as follows: broad "Y"-shaped mark before each eye and a thin line on each side of median suture on apical two thirds. Pronotum yellow on disc, brown on each side, excepting one or two light vittae near lateral margin. Scutellum yellow. Face yellow, excepting fuscous-bordered broad sharksmouth, a line along basal margin between ocelli, and in darkly marked specimens a vitta behind eye and shorter one near ocellus. Forewing hyaline except for opaque yellow area in clavus and smaller, lighter area in apical cells; veins concolorous in clavus, dark brown to fuscous in corium.

Structural Characteristics: Crown one and one-half times as long as width between eyes in male, slightly longer in female, anterior margin straight to slightly convex on each side of a sharp apex; wedge about two-fifths length of crown. Pronotum almost as long as crown, slightly more than twice as wide as length at middle, and four times length behind eye; posterior margin slightly concave. Clypeus slightly more than twice as long as width at ocelli, somewhat sinuate at antennae. Clypellus long and slender and about one and one-half times as wide near apex as narrowest point. Face in lateral view straight to slightly concave between anterior margin of eyes. Forewing with about eight recurved veins to costa and claval veins sometimes joined near middle.

Genitalia: Valve about two-thirds as long as greatest width, posterior margin bell-shaped, anterior margin with broad, short median lobe. Paraphysis "T"-shaped, broadest near base, apical, laterally-projecting processes sharp at apex, and with tiny teeth along the edges. Aedeagus small, about as wide as greatest width, notched at middle of flattened apical margin. Plates short and bluntly pointed. Styles about three times as long as basal width, sinuate on basal third, large lobe on outer margin on median third and bluntly pointed process on apical third.

Last ventral segment of female about twice as wide as length at middle, lateral margins straight and converging, posterior margin slightly convex.

Types: Holotype ♀, "California, Coquillet," in the Iowa State College collection, Ames, Iowa. Allotype ♂ and one parallotype ♂, Idyllwild, California, Aug. 3, 1935, R. H. Beamer, here designated, in Snow Entomological Collections. Additional ♂ parallotypes from California as follows: 1, San Margareta, Aug. 6, 1912, E. D. Ball; 1, Dulzura, Aug. 9, 1935, R. H. Beamer; 1, Lompoc, Aug.

7, 1938, R. I. Sailer; 2, Santa Rosa, Aug. 16, 1938, R. H. Beamer; 1, Campo, Aug. 10, 1935, R. H. Beamer; 1, Pine Valley, July 27, 1938, R. H. Beamer; 11, La Jolla, July 13, 1941, R. H. Beamer; 2, Escondido, July 15, 1941, R. H. Beamer.

Additional Material Studied: (Arizona) Arivaca, Oak Creek Canyon, Chiricahua Mts., Yarnell, Jerome and Ruby. (Utah) Pintura and Zion National Park. (New Mexico) Silver City. (Texas) Sutton Co. (Florida) Sanford, La Belle, Old Town, Ocala and Yankeetown.

In addition to the types listed above, the following paratypes were on hand for study: 1 ♀ *floridanus*, Sanford, Florida, July 22, 1926, E. D. Ball, and a pair of *glennanus*, Yarnell Hts., Aug. 20, 1929, and Oct. 8, 1929, E. D. Ball.

Host Plants: Ball (1932) writes "*Scaphytopius elegans* Van Duzee is a Pacific coast form which the writer has found feeding exclusively on the live oaks of that region. Var. *glennanus* Ball was found by the writer throughout southern Arizona feeding, both nymphs and adults, on the different live oaks, especially *Q. turbinella* and *oblongifolia.*

"*S. floridanus* Ball with its var. *roseus* Ball are strictly confined to the under side of the live oak (*Q. virginiana*) in the Florida region. The margins of the leaves are revolute and furnish a fine hiding place for the young nymphs."

Comparative Notes: S. elegans was named from California, darker specimens from Arizona were named the variety *glennanus* and lighter specimens from Florida named *floridanus.* There are intermediate forms both in color and distribution, specimens having been studied from New Mexico, Texas and Mexico. Specimens collected in Florida in the winter are often as dark as the typical California specimens. The variety *roseus* is a reddish form, evidently specimens in which the yellow color is replaced by red, a rather common occurrance in other species of the group.

The broad, yellow vitta on dorsum readily separates this species from any other in the genus.

8. *Scaphytopius* (*Scaphytopius*) *ritanus* Ball

Scaphytopius ritanus, Ball, E. D., Can. Ent., LXIII: p. 221, 1931.

Resembling *elegans* but broader, with shorter crown, and with more clouded area on corium. Length: female 5 mm., male 5 mm.

Color: Crown yellow to orange, a thin, wavy brown line along anterior margin; wedge, long vitta on each side of median suture and small irregular area inside each eye, lighter. Pronotum about same color as crown, often gray on disc and broad, irregular vitta formed by absence of pigment. Scutellum about same color as crown, usually somewhat darker just inside each basal angle. Clypeus reddish-fulvous, thin black line along base between ocelli; sharksmouth and three or four pairs of short, oblique lines beneath, light. Remainder of face about same color as clypeus, sometimes darkest on lateral margins, white spot near each ocellus and antenna and sometimes vitta behind eye. Forewing hyaline to semi-hyaline brown, light band before apex of clavus extending across anterior ends of anteapical cells to costa and another light band just before apex. These light bands may be white or devoid of color. Veins light brown anteriorly, becoming dark on costa and at apex.

Structural Characteristics: Crown one and one-third times as long as width between eyes, straight on each side of a pointed apex; wedge about one-third length of crown. Pronotum about as long as crown, two and one-fourth times as wide as length at middle and about four and one-half times length behind eyes, posterior margin almost straight. Clypeus about twice as long as width at ocelli, lateral margins slightly sinuate at antennae. Clypellus long and enlarged near apex. Face convex in lateral view. Forewing with five or six recurved veins to costa.

Genitalia: Valve about as long as greatest width, posterior margin rounded, anterior margin with rather narrow, median lobe. Plates short and sharply pointed. Paraphysis "T"-shaped, broadest at base, with apical, laterally projecting processes margined with tiny teeth. Aedeagus slender, about half as long as style, and with a pair of short apical processes. Style about three times as long as basal width, sinuate near middle, a large lobe on outer margin just before slender, pointed, outwardly curved, apical process.

Last ventral segment of female about twice as wide as length at middle, lateral margin almost straight and convergant, posterior margin with a wide, short median lobe.

Types: Holotype ♀, Tucson, Ariz.. June 19, 1929, allotype ♂, Santa Rita Mts., May 12, 1929, E. D. Ball, in the National Museum, Washington, D. C.

Material Studied: (Arizona) Ruby, Santa Rita Mts., Huachucua Mts., Benson, Santa Catalina Mts. and Patagonia.

Host Plants: Ball (1932) writes "—taken as nymphs and adults from the live oaks of southern Arizona, especially *Q. oblongifolia* and *emoryi*."

Comparative notes: The female of this species is easily separated from *catalinus* and *huachucus* by the last ventral segment being unnotched, the male has the distinctive "T"-shaped paraphysis. This species was placed in *Hebenarus* DeLong but the great similarity of the genitalia of *ritanus* and *elegans* shows these two species very closely related and undoubtedly in the same genus.

9. *Scaphytopius* (*Scaphytopius*) *catalinus* (Ball)

Scaphoideus catalinus, Ball, E. D., Can. Ent., XLI: p. 82, 1909.

Resembling *ritanus* but smaller, clypeus somewhat darker than adjoining area of face and more distinct band on forewing. Length: female 5 mm., male 4 mm.

Color: Crown light fulvous with wedge and broad vitta on each side of median suture usually faintly indicated; faint black line along anterior margin. Pronotum slightly darker than crown, lightest along anterior margin; vittae usually indicated on margin. Scutellum orange with white spot at apex and another on each side near middle. Clypeus slightly darker than remainder of face, white line along basal margin between eyes; sharksmouth and two or three pairs of oblique lines beneath, light. Lorae, gena next clypeus below antennae and apical half of clypellus, ivory to light fulvous. Lateral margins of genae about same color as clypeus; light vittae behind eye and much shorter ones near ocellus and antennae usually at least indicated. Forewing hyaline or semihyaline brown on basal half, across middle of anteapical cells and apex, white to colorless in a band across base and apex of anteapicals, giving a two-banded appearance.

Structural Characteristics: Crown about as long as width between eyes, anterior margin straight to slightly convex on each side of bluntly pointed apex; wedge about one-fourth length of crown. Pronotum about as long as crown, two and one-half times as wide as length at middle and five times length behind eye; posterior margin concave with a small median notch. Clypeus slightly over one and one-half times as long as width at ocelli, lateral margin definitely sinuate at antennae. Clypeus long and enlarged near apex. Face in lateral view convex. Forewing with a few vein-like markings in brachial cell and eight or nine recurved veins to costa.

Genitalia: Valve almost one and one-half times as wide as length at middle, rounded on posterior margin, anterior margin with broad median lobe. Plates short but sharply pointed. Paraphysis bifid almost to base, each fork curved, long, and sharply pointed. Aedeagus almost as long as basal width, a sharp median process at apex, and a pair of lateral, apical processes, truncate and slightly produced anteriorly. Styles about three times as long as basal width, sinuate on basal third, large lobe on outer margin before a blunt, outward-projecting process on apical third.

Last ventral segment of female about twice as wide as greatest length, median notch on posterior margin reaching almost to base, forming two oval lobes.

Types: Holotype ♀, "Santa Rita Mts., Ariz. 5 to 8000 ft. June, F. H. Snow" in the National Museum, Washington, D. C. Allotype ♂ and four ♂ parallotypes, Santa Rita Mts., Arizona, July 17, 1932, R. H. Beamer, here designated, in the Snow Entomological Collections. One other ♂ parallotype—Santa Rita Mts., July 6, 1933, E. D. Ball.

Host Plants: Ball (1932) writes "—taken as nymphs and adults from the live oaks of southern Arizona, especially *Q. oblongifolia* and *emoryi*."

Comparative Notes: The deeply emarginate last ventral segment of the female is the best external criterion for separating this species from any other. This species has been listed in *Hebenarus* but the similarity of the genitalia of this species to *elegans* and *ritanus* would cause it to be retained in this genus.

10. *Scaphytopius* (*Scaphytopius*) *huachucus* (DeLong)

Hebenarus huachucus, DeLong, Pan-Pac. Ent., XXII: p. 41, 1944.

Resembling *catalinus* but larger, with darker clypeus and paraphysis bent near middle. Length: female 5.5 mm., male 5 mm.

Color: Crown yellow to orange with light markings, if present, as follows: thin line along anterior margin, wedge, long vitta on each side of median suture and an irregular area inside each eye. In many specimens collected in the summer, these marking are absent, while in fall or winter collected specimens, the markings are fuscous-lined and distinct. Pronotum usually slightly darker than crown, lightest along anterior margin; vittae usually absent, but sometimes indicated along lateral margins. Scutellum yellow to dark orange with white dot at apex and another on each lateral margin. Clypeus much darker than remainder of face, orange, excepting fuscous bordered white line along basal margin between eyes, and white sharksmouth; sometimes oblique lines on disc faintly indicated. Remainder of face yellow to fulvous with vitta behind eye and spot near ocellus and antennae usually evident. In fall and winter specimens, the orange is replaced by dark brown and the remainder by light brown. Forewing hyaline brown on basal half, across middle of anteapical cells and in middle apical cell, remainder semihyaline white or colorless, giving a faintly two-banded appearance across apex of and base of anteapical cells.

Structural Characteristics: Crown only slightly longer than width between eyes, slightly convex on each side of a bluntly pointed apex; wedge about one-third length of crown. Pronotum almost as long as crown, about two and one-half times as wide as the length at middle and four and one-half times length behind eyes; posterior margin convex and with a small, broad median notch. Clypeus about one and two-thirds times as long as width at ocelli, lateral margin only slightly, if any, sinuate at antennae. Clypellus long and enlarged at apex. Forewings with numerous veins in brachial cell and numerous recurved veins on costa and usually extra veins on clavus.

Genitalia: Valve about as long as greatest width, posterior margin rounded; anterior margin with long median lobe. Paraphysis long, curved and almost parallel margined on basal two-thirds, split on apical two-thirds, with two pairs of short apical processes, one pair straight and the other recurved; another pair of short, straight processes on ventral margin on apical third where the paraphysis curves. Aedeagus small, ring-like, almost separated dorsally. Style less than three times as long as basal width, sinuate near middle, conspicuous lobe on outer margin before short, bluntly pointed, finger-like, apical process.

Last ventral segment of female straight on lateral margins; posterior margin with a deep median notch reaching almost to middle, forming two distinct lobes.

Types: Holotype ♂, allotype ♀, Huachucua Mts., Ariz., July 20, 1936, and June 9, 1935, J. N. Knull, in the DeLong collection, Ohio State University, Columbus, Ohio.

Material examined: (Arizona) Huachucua Mts., Chiricahua Mts., and Santa Rita Mts.

Host Plants: Unknown, but probably live oaks.

Comparative Notes: This species is placed in *Scaphytopius* because of its similarity to other members of this genus, most nearly related to *catalinus*, but larger and with darker frons.

SYNOPSIS OF SUBGENUS CLOANTHANUS BALL

Cloanthanus, Ball, E. D., Can. Ent., LXIII, p. 219, 1931.

The original description of this subgenus is as follows:

"Resembling *Platymetopius* (sens. strict.) but with a narrower vertex, a shark's mouth marking on frons, and two cross nervures. Closely related to *Platymoideus* but without the vermiculations on the anterior portion of elytra.

"Vertex flat, acutely angular, longer than wide, narrowing from the front of the eye to the base where it is very narrow. Face long, convex, acutely angled with vertex as seen from side. Front long and narrow especially below the antennae. Pronotum much broader than head. Venation regular, two cross nervures between sectors and numerous short reflexed veinlets to costa. The claval nervures are united by a cross nervure and usually tied to the suture by another one. The vertex, pronotum and anterior portion of elytra are usually unicolorous in sharp contrast to the dark venation on the posterior portion of elytra.

"Type of the genus *Platymetopius angustatus* Osb."

Additional characters of the subgenus are as follows: crown flat or depressed, usually pointed; forewing with anteapical cells almost the same length; numerous recurved veins to costa, darkest on outer anteapical and adjacent area of costa; lateral margins of clypeus straight to sinuate at antennae, sharksmouth usually present; clypellus parallel-margined or enlarged near apex, extending to, or slightly beyond, normal curve of genae; antennae in shallow pits near ventral margin of eyes.

Typical Color Pattern if Present: Crown with light markings as follows: Wedge; line along anterior margin; two pairs of spots on posterior margin, one pair near median suture and one spot next each eye; either three pairs of spots in a band across crown before eyes, or long straight or arcuate mark on each side of median suture (the band before eyes is usually present in short-crowned species, the long or arcuate markings usually in long-crowned species). Pronotum with seven vittae, one on median line and three on each side, usually more pronounced nearest lateral margins. Scutellum with light mark at apex, in each basal corner and on lateral margin half-way between apex and base; dark area inside each basal corner and line across middle. Forewing variable, darkest on apical cells, outer anteapical cell and adjacent area of coastal cell. Clypeus with light, fuscous-margined sharksmouth near base. Genae darkest on lateral margins, fuscous-margined white vitta behind eye, two short vittae before eye, one near ocellus and another near base of antennae.

KEY TO SPECIES OF SCAPHYTOPIUS (CLOANTHANUS) BALL

1. Crown pattern absent, indistinct or consisting of two to three distinct light spots on disc of crown, sometimes coalesced or reduced, or forming a transverse band before the eyes, more or less complete, the median pair of spots often elongate; usually relatively short crown................ 2

Markings on crown taking the form of lineations, often arcuate, usually one long mark on each side of median suture; usually long crown.......... 43

2. (1) Dorsum opaque yellow or fulvous to reddish, crown often darkest; scutellum without large dark area; crown parallel-margined or at most slightly angled; aedeagus long and with short, anteriorly projecting apical processes 3

Color and shape of crown not as above, or if so, aedeagus much different... 4

3. (2) Color yellow ....11. *nigricollis* (Ball), p. 443

Color fulvous to reddish ....12. *torridus* (Ball), p. 445

4. (2) Dorsum opaque white with fuscous markings; crown with irrorate dark area at apex and broken band between anterior half of eyes, 13. *desertanus* (Ball), p. 446

Dorsum and crown not as above.................................... 5

5. (4) Four mm. or less in length; light markings on crown usually thin, the median pair often extending to base; last ventral segment of female much lighter than rest of venter; aedeagus with two short, erect apical processes on dorsal margin..................14. *irroratus* (Van Duzee), p. 447

More than four mm. in length; or if not, light markings on crown larger and shorter or aedeagus variable, but not as above.................. 6

6. (5) Light fulvous, face with darker markings, especially in male: Arizona, 15. *irroratus* subsp. *xanthanus* (Ball), p. 449

Not light fulvous; or if so, face without darker markings or not from Arizona 7

7. (6) Crown fulvous and short; face irrorate with brown throughout; Arizona, 16. *irroratus* subsp. *nogalinus* (Ball), p. 450

Crown not as above; or if so, face not irrorate with brown throughout..... 8

8. (7) Entire face white or yellow in sharp contrast to much darker venter; no genital paraphysis in male 9

Face not as above; or if so, with genital paraphysis, although often small, 12

9. (8) Processes at apex of aedeagus at least half as long as shaft, 17. *albifrons* Hepner, p. 452

Processes at apex of aedeagus less than half as long as shaft.............. 10

10. (9) Light markings on crown slender; general color fuscous to black; aedeagus with short, erect apical processes at apex; Texas to California, 18. *loricatus* (Van Duzee), p. 453

Light markings on crown broader; general color lighter; aedeagus not as above; Texas 11

11. (10) Aedeagus with wing-like apical processes..............19. *pennatus* Hepner, p. 455

Aedeagus with more slender, laterally-projecting apical processes, 20. *flavifrons* Hepner, p. 457

12. (8) Light band on crown before eyes complete except for two or three fine dark lines; many tiny fine dots and vermiculations more or less evenly distributed throughout forewing; aedeagus long and abruptly curved on apical third ....21. *anisacanus* (Ball), p. 458

Crown and forewing not as above; or if so, aedeagus much different...... 13

13. (12) Forewings translucent greenish-fulvous, crown mostly light except for irregular brown band between anterior margin of eyes; southern Texas, 22. *contractus* Hepner, p. 459
Forewings and crown not as above; or if so, not from southern Texas..... 14
14. (13) Dorsum brown with ivory markings; face infuscated on lateral margins; aedeagus broad and enlarged at apex, small paraphyses, 23. *brunneus* Hepner, p. 460
Dorsum and face not as above, or if so, with different genitalia........... 15
15. (14) Male plates truncate at apex; female last ventral segment broadly concave with a slender median notch; face dark............................ 16
External genitalia not as above, or if so, face not dark.................. 18
16. (15) Crown evenly irrorate with light, no band before eyes, 24. *fuscifrons* (Van Duzee), p. 461
Crown with a band before the eyes.................................. 17
17. (16) Area of crown next pronotum with some dark markings, especially next eye, four and one-half mm. or more in length, 25. *fuscifrons* subsp. *compactus* (Ball), p. 463
Area of crown next pronotum without dark markings, less than four and one-half mm. in length...........26. *fuscifrons* subsp. *minutus* Hepner, p. 464
18. (15) Face bright yellow throughout, dorsum light fulvous...27. *dodonanus* (Ball), p. 466
Face not bright yellow throughout; or if so, dorsum not light fulvous..... 19
19. (18) Crown with light band before eyes and at base, giving a more or less distinct four-banded appearance—two ivory and two fuscous; forewings not distinctly darkened at apex.....................28. *celtidus* (Ball), p. 467
Crown not as above; or if so, forewings darkened at apex................ 20
20. (19) Forewings semihyaline white with many dark dots throughout; scutellum with large area next each basal corner; erect genital paraphyses extending slightly beyond simple aedeagus............29. *californiensis* Hepner, p. 468
Forewings and scutellum not as above; or if so, genitalia different......... 21
21. (20) Light band before eyes broad, distinct and almost complete; remainder of crown black except for apical wedge and irrorations next pronotum...... 22
Crown not as above 23
22. (21) Scutellum primarily black......................30. *diabolus* (Van Duzee), p. 470
Scutellum with few, if any, black markings........31. *pallidiscutus* Hepner, p. 472
23. (21) Clavus of forewing semihyaline fulvous without darker markings; genital paraphyses of male bifid on outer third............................ 24
Clavus not as above, or if so, paraphyses different...................... 25
24. (23) Pronotum fulvous ....32. *fulvus* (Osborn), p. 473
Pronotum fuscous............33. *fulvus* subsp. *collaris* (Sand. and Delong), p. 475
25. (23) Clypeus bright yellow and without markings on apical two-thirds; outer margin of lorae infuscated; forewings blackish, 34. *frontalis* (Van Duzee), p. 476
Face and forewings not as above.................................... 26
26. (25) Crown heavily irrorate, but without definite pattern...................... 27
Crown not heavily irrorate; or if so, with pattern...................... 28
27. (26) Scutellum fulvous and with few or no fuscous or black markings, 35. *cinnamoneus* (Osborn), p. 477
Scutellum dark, with fuscous or black markings throughout, 36. *deltensis* Hepner, p. 479
28. (26) Crown and face ivory and without markings.............37. *dorsalis* (Ball), p. 480
Crown or face with darker markings.................................. 29
29. (28) Entirely dark fuscous to blackish, except for small light marks on crown, 38. *nigrifrons* (DeLong), p. 481
Not entirely fuscous to blackish...................................... 30
30. (29) Forewings fulvous with large milky spots throughout, 39. *amplinotus* Hepner, p. 482
Forewings not as above 31
31. (30) Crown only slightly longer at middle than next eye and only slightly longer than width between eyes....................40. *osborni* (Van Duzee), p. 483
Crown distinctly longer at middle than next eye....................... 32

32. (31) Crown fulvous and without dark markings and with a distinct spot on each side of median suture on disc; entire dorsum about same color; Florida, 41. *andromus* (Ball), p. 485
Crown and dorsum not as above, or if so, not from Florida.............. 33
33. (32) Crown more than twice as long as width between eyes, 42. *verecundus* (Van Duzee), p. 486
Crown shorter than above.. 34
34. (33) Dorsum reddish-brown, markings on crown small, but distinct, 43. *insolitus* Hepner, p. 487
Dorsum and crown not as above.................................... 35
35. (34) Aedeagus notched along dorsal margin; eastern.......................... 36
Aedeagus tube-like; western (except *angustatus*)....................... 38
36. (35) Genital paraphysis with small pointed, lateral lobe near middle, 44. *magdalensis* (Provancher), p. 488
Genital paraphysis without lobe; or if present, nearer apex.............. 37
37. (36) Light band before eyes only about half complete; not Florida, 45. *scriptus* (Ball), p. 490
Light band before eyes on crown almost complete; Florida, *scriptus* subsp. *meridianus* Hepner, p. 492
38. (35) Color greenish-yellow; eastern..................47. *angustatus* (Osborn), p. 493
Color not greenish-yellow; western 39
39. (38) Scutellum primarily ivory to orange, with black markings; remainder of dorsum black ....48. *calliandrus* (Ball), p. 494
Scutellum not marked as above; dorsum lighter........................ 40
40. (39) Dorsum white with dark dots; face with only scattered dark dots, 49. *analis* var. *castranis* (Ball), p. 496
Dorsum and face not as above.. 41
41. (40) Crown dark brown with marks before the eyes thin and directed toward apex; aedeagus relatively long...................50. *radiatus* Hepner, p. 497
Crown and aedeagus not as above..................................... 42
42. (41) Aedeagus very short; styles more than twice as long as greatest width; crown almost same color throughout...............51. *modicus* Hepner, p. 498
Aedeagus longer; styles less than twice as long as greatest width, 52. *pallidicapitatus* Hepner, p. 499
43. (1) Forewing with only green or brown clouded area on anterior half; usually four or less dark reflexed veins to costa........................... 44
Forewings with vermiculations or dots on anterior half; usually more than four reflexed veins to costa......... 45
44. (43) Color greenish ....53. *nigriviridis* (Ball), p. 500
Color brownish ....54. *nigriviridis* subsp. *dixianus* (Ball), p. 502
45. (43) Crown white, with a large black mark around and behind wedge; forewings opaque white with sparse fuscous vermiculations...55. *heldoranus* (Ball), p. 503
Crown and forewings not as above.................................. 46
46. (45) General color pale gray; crown short; Southwest, 49. *analis* var. *castranus* (Ball), p. 496
Color and crown not as above, or if so, not Southwest.................. 47
47. (46) Fuscous-margined, light vitta on clypeus from near sharksmouth to near apex ....56. *vittifrons* Hepner, p. 504
Without such a line on clypeus.. 48
48. (47) Color pale fulvous, except for dark area over most of pronotum and basal half of scutellum.........33. *fulvus* subsp. *collaris* (Sanders & DeLong), p. 475
Color various, but not as above...................................... 49
49. (48) Arcuate markings very indistinct or absent............................ 50
Arcuate or long discal markings more distinct......................... 51
50. (49) Forewings greenish-fulvous with dark veins restricted to apical half, 47. *angustatus* (Osborn), p. 493
Forewings brownish ....35. *cinnamoneus* (Osborn), p. 477
51. (49) Crown light fulvous with few or no fuscous markings; crown of female at least two and one-half times as long as width between eyes; that of male almost as long.......................57. *slossonae* (Van Duzee), p. 505
Crown not as above.. 52

52. (51) Color dark reddish brown; face dark and in lateral view distinctly concave ....58. *rubellus* (Sanders and DeLong), p. 507
Color not as above 53
53. (52) Pronotum yellowish, forewing semihyaline light with veins and markings consisting primarily of dots; crown with many vermiculations,
59. *cinereus* (Osborn and Ball), p. 508
Pronotum, forewing and crown not as above.......................... 54
54. (53) Face unmarked yellow, at least on disc of clypeus...................... 55
Face dark, even on disc of clypeus.................................... 64
55. (54) Dorsum white with veins and markings consisting primarily of dots; crown with many vermiculations......................60. *guterranus* (Ball), p. 510
Dorsum and crown not as above....................................... 56
56. (55) Pygofer of male broadly concave on basal half of outer margin; face yellow on disc ....61. *acutus* (Say), p. 511
Pygofer of male not as above, or if so, face not yellow on disc............ 57
57. (56) Entire dorsum fulvous; crown less than one and one-half times width between eyes ....62. *oregonensis* (Baker), p. 513
Dorsum and crown not as above...................................... 58
58. (57) Crown long, darkest on disc with arcuate markings pale or indistinct,
63. *latus* (Baker), p. 515
Crown not as above 59
59. (58) Aedeagus in ventral view much smaller at apex than at base; eastern,
64. *argutus* DeLong, p. 516
Aedeagus not as above, or if so, not eastern.......................... 60
60. (59) Crown primarily dark brown to fuscous...........65. *fuscicephalus* Hepner, p. 517
Crown lighter colored 61
61. (60) Crown greenish or light fulvous; southern........66. *viridicephalus* Hepner, p. 519
Crown not as above, or if so, not southern............................ 62
62. (61) Aedeagus broad; genital paraphyses enlarged on apical two-fifths,
67. *utahensis* Hepner, p. 520
Aedeagus slender; genital paraphyses, if enlarged, only on outer fourth.... 63
63. (62) Less than five and one-half mm. in length............68. *graneticus* (Ball), p. 521
More than five and one-half mm. in length.............69. *canus* Hepner, p. 523
64. (54) Crown at least two and one-half times as long as width in female; twice as long as width in male, very slender; crown mottled, with three to five distinct lines 65
Crown not as above 66
65. (64) Plates truncate, aedeagus long.....................70. *trilineatus* (Ball), p. 524
Plates pointed, aedeagus short........72. *trilineatus* subsp. *spicatus* Hepner, p. 525
66. (64) Less than four mm. in length; face lighter on disc of clypeus than on genae ....72. *abbreviatus* (DeLong), p. 527
More than four mm. in length; face about same color throughout,
73. *triangularis* DeLong, p. 529

11. *Scaphytopius* (*Cloanthanus*) *nigricollis* (Ball)

Platymetopius nigricollis, Ball, E. D., Ent. News, XXVII, p. 205, 1916.

Resembles *torridus* but yellow with a dark crown and mottled face. Length: female 4 mm., male 3.5 mm.

Color: Crown yellow and brown mottled, area next pronotum, apical wedge and a spot on each side, light. Sometimes the dark is somewhat reduced. Pronotum and scutellum bright yellow with sometimes a few scattered dark spots. Face yellow and brown mottled, sharksmouth small, vitta behind eye distinct. Forewings semihyaline white to yellow, usually with small dark dots throughout; veins yellow, usually darker at apex and along costal margin.

Structural Characteristics: Crown only slightly longer than width between eyes, almost parallel-margined in male, more produced in female. Pronotum about as long as crown, two and one-half times as wide as length at middle and five times as wide as length behind eyes. Clypeus about twice as long as width at ocelli, only slightly broader at base than at antennae. Face distinctly convex in lateral view. Forewing with venation typical; about nine recurved veins to costa.

Genitalia: Valve about as long as greatest width, posterior margin somewhat convex on each side of a rounded apex; anterior margin with a broad, rather flat, median lobe. Plates slender. Aedeagus "J"-shaped, with dorsal portion quite broad and about two-thirds as long as shaft, which is slender and with a pair of short, anterio-dorsally projecting, sharply pointed processes; base short. Styles about four times as long as basal width, sinuate at middle, only slightly lobed on outer margin before short, curved, finger-like apical process.

Last ventral segment of female about one and two-thirds as wide as length at middle, lateral margins straight and slightly converging, posterior margin straight to slightly concave on each side of prominent median lobe, notched at middle.

Types: Lectotypes ♀, Mojave, California, July 30, 1912, lectoallotype ♂, St. George, Utah, E. D. Ball, here designated, in the National Museum, Washington, D. C.

Material Studied: (Utah) St. George. (Arizona) Vail, Tucson, Congress Junction, Alamo, Yarnell, Black Mts., Santa Rita Mts., Chiricahua Mts., Empire Mts. and Mt. Graham. (New Mexico) Alamogordo, Rodeo and Socorro Co. (Texas) Presidio Co., Ft. Stockton and 65 miles south of Marathon.

Host Plants: Ball (1932) writes "—found as nymphs and adults on the creosote bush (*Larrea tridentata*) in southern Utah and Arizona."

Comparative Notes: In some specimens the dark dots are absent, only the crown being colored. This species might possibly be confused with a male *nigriviridis*, but is much broader, with a shorter crown and more dark on the crown.

Nigricollis was made genotype for the genus *Convelinus*, but there is no good structural difference to separate it from other *Cloanthanus*. In fact, *castranus*, mentioned by Dr. Ball as belonging to *Convelinus*, has genital structures like typical *Cloanthanus*, with paraphyses. Although *nigricollis* and *torridus* have similar genital structures and feed on the same host plant, no evidence of hybridization has been noted.

12. *Scaphytopius* (*Cloanthanus*) *torridus* (Ball)

Platymetopius brevis var. *torridus*, Ball, E. D., Ent. News, XXVII, p. 205, 1916.

Resembles *nigricollis* but dark fulvous to reddish-brown with different pattern on crown. Length: female 3.5 mm., male 3.2 mm.

Color: Crown usually tan and white mottled; spot on posterior margin next each eye, line on each side median suture broadest at base, irregular band before eye, and small apical wedge, light. Pronotum about same color as crown, sometimes a series of white marks along anterior margin. Scutellum same color as crown, with typical light markings at least indicated. Face mottled brown and fulvous, lightest on lorae; small sharksmouth and light vitta behind eye, distinct. Some specimens are mottled brown and red.

Structural Characteristics: Crown about as long as width between eyes in male, slightly longer in female; wedge very short. Pronotum only slightly shorter than crown, about two and one-half times as broad as length at middle, five times as broad as length behind eyes. Clypeus about twice as long as width at ocelli; only slightly sinuate at antennae. Clypellus stout, only slightly enlarged at apex. Forewing with typical venation, seven or eight indistinct, recurved veins to costa.

Genitalia: Valve about as long as greatest width, posterior margin somewhat convex on each side of a bluntly pointed apex; anterior margin with a broad, short median lobe. Plates slender. Aedeagus "J"-shaped with dorsal portion broad and about two-thirds as long as shaft, which is slender, and a pair of dorso-anteriorly projecting, short, apical processes; base short. Styles about four times as long as greatest width, almost parallel-margined to finger-like apical process.

Last ventral segment of female almost twice as wide as length at middle, lateral margins slightly convex, posterior margin distinctly convex.

Types: Lectotype ♀, Calexico, Calif., June 18, 1909, E. D. Ball, here designated, in the National Museum, Washington, D. C. Allotype ♂, Big Bear Lake, Calif., July 26, 1932, R. H. Beamer, here designated, in the Snow Entomological Collections. Parallotype ♂♂ as follows: (California) 2, Barstow, June 1, 1935, P. W. Oman; 3, Jacumba, Aug. 12, 1935, R. H. Beamer; 1, Jacumba, May

18, 1941, D. J. and J. N. Knull; 1, Ontario, June 12, 1908; 6, Kelso, June 9, 1908, E. D. Ball; 1, Palm Spgs., Sept. 2, Hubbard; 2, Indio, June 4, 1935, P. W. Oman; 1, Holtville, June 1, 1935, P. W. Oman; 1, El Centro, June 1, 1935, P. W. Oman; and 1, San Diego Co., Coquillet. (Nevada) 2, Las Vegas, March 7, 1934, 1, April 28, 1934, E. W. Davis. (Utah) 2, St. George, Sept. 8, 1930, E. W. Davis and 1, "Dixie," Aug. 8, 1915, E. D. Ball. (Arizona) 1, Littlefield, Sept. 10, 1930, 1, June 7, 1931, E. W. Davis; 2, Black Mts., July 13, 1932, R. H. Beamer; 1, Congress Jct., Aug. 27, 1935, E. D. Ball; 2, Cong. Jct., June 14, 1937, D. J. and J. N. Knull; 1, Wickenburg, May 31, 1935, P. W. Oman; 2, Empire Mts., Aug. 18, 1935, E. D. Ball; 1, Gila Bend, June 8, 1931; 1, Yuma, Aug. 25, 1929, 1, Oct. 30, 1931, 2, Nov. 1, 1931, E. D. Ball; 2, Mohawk, Oct. 29, 1931; 1, Ajo Mts., Apr. 20, 1935, 4, July 22, 1937, E. D. Ball; 4, Tucson, May 31, 1929, 1, July 24, 1930, E. D. Ball; 1, Pima Co., July 27, 1927, R. H. Beamer; 1, Cochise, Aug. 24, 1935, R. H. Beamer and 1, Santa Rita Mts., June 8, 1937, D. J. and J. N. Knull.

Host Plants: Ball (1932) writes "—confined to the creosote bush." The author has examined specimens collected from *Larrea tridentata, Larrea mexicana* and *Covillea tridentata,* probably different names for the same plant.

Comparative Notes: Unlike *nigricollis,* this species is about the same color throughout. It varies considerably both in size and color. It was originally described as a variety of *brevis,* a Jamaica species, but apparently differs considerably from that species.

13. *Scaphytopius (Cloanthanus) desertanus* (Ball)

Nasutoideus desertanus, Ball, E. D., Can. Ent., LXIII, p. 225, Oct., 1931.

Resembles *heldoranus,* but with irregular black markings between anterior part of eyes, forming a dark, incomplete band; without genital paraphyses. Length: female 3.5 mm., male 3.3 mm.

Color: Crown white except for irregular black markings around wedge, irregular black markings inside anterior margin of each eye and usually two to four lines connecting these two dark areas. Pronotum milky semihyaline, sparsely marked with dark dots, vittae usually faintly indicated. Scutellum white to fulvous with usually a few dark vermiculations on basal half. Face ivory with a few dark dots or vermiculations in area of small sharksmouth and along lateral margin; apex of clypellus dark. Forewing milky translucent with sparsely spaced fuscous dots, especially along veins; apical cells clouded; veins in costa dark.

Structural Characteristics: Crown almost twice as long as width between eyes in female, shorter in male, anterior margin somewhat convex on each side of bluntly pointed apex. Pronotum two-thirds as long as crown in female, three-fourths as long in male; about two and one-half times as wide as length at middle, slightly over four times as wide as length behind eyes. Clypeus about twice as long as width at ocelli in male, slightly longer in female, only slightly sinuate near antennae. Face convex in lateral view. Forewing with venation typical and about nine or ten recurved veins to costa.

Genitalia: Valve about two-thirds as long as greatest width, posterior margin rounded; anterior margin with broad, short, median lobe. Aedeagus "J"-shaped, dorsal part broadest, shaft narrowed and slightly curved to a pair of small, apical processes. Style only slightly over twice as long as basal width, outer margin with distinct lobe before laterally projecting, finger-like apical process.

Last ventral segment of female about twice as wide as length at middle, latero-posterior margin rounded, without median lobe or notch.

Types: Holotype ♀, allotype ♂, Tucson, Arizona, May 5, 1929, E. D. Ball, in the National Museum, Washington, D. C. One pair of paratypes, Tucson, Arizona, Aug. 31, 1929, E. D. Ball, were on hand for study.

Additional Material Studied: (Arizona) Wickenburg, Sentinel, Coolidge Dam, Granite Dell, Glenn Oaks, Apache Jct., Phoenix and Littlefield. One specimen collected by Dr. Ball at Brownsville, Texas, on the same pin with a *castranus* specimen may be mislabelled, as no other specimen has been seen from east of Arizona.

Host Plants: Dr. Ball (1932) writes "—found breeding abundantly on the gray bur sage (*Franseria deltoides*) in Arizona."

Comparative Notes: This small gray species is easily recognized by its small size and color. It can be easily separated from *heldoranus* by the dark irrorate area at apex of crown, whereby *heldoranus* has a solid black area at apex of crown.

14. *Scaphytopius* (*Cloanthanus*) *irroratus* (Van Duzee)

Platymetopius irroratus, Van Duzee, E. P., Ann., Ent. Soc. Amer., III, p. 227, 1910.

Resembles *loricatus*, but with dark face and with aedeagus produced on dorsal margin. Length: Female 4 mm., male 3.6 mm.

Color: Crown mottled brown and light with light markings as follows: Wedge, thin line along anterior margin; three pairs of elongate spots forming an incomplete band before eyes, and two pairs of spots on posterior margin, one pair next median suture (often joined to median spots of band before eyes) and one next each eye. Pronotum about same color as crown, light vittae usually at least faintly indicated. Scutellum fulvous to brown with typical light markings. Face of male fulvous with brown to fuscous markings throughout, darkest on lateral margins of genae, lightest in area next lorae and broad line behind eye; sharksmouth small but usually distinct. Face of female usually lighter. Forewing brown to fuscous, veins and irrorations darker at apex and costal area opposite apex of clavus. Often the fulvous coloration is lacking and forewing is merely white with dark markings.

Structural Characteristics: Crown about as long as width between eyes in male, longer in female, margins slightly convex to a dull point in male, margins more convex in female; wedge one-third to one-fourth as long as crown. Pronotum about three-fourths as long as crown, about two and one-half times as broad as length at middle. Clypeus over twice as long as width at ocelli, only slightly sinuate at antennae. Forewing with eleven or twelve recurved veins to costa.

Genitalia: Valve about three-fourths as long as greatest width, posterior margin somewhat convex on each side to a bluntly pointed apex; anterior margin concave on each side of a relatively narrow median lobe. Plates broadest near base, apices relatively short and slender. Aedeagus roughly "U"-shaped with a broad process and smaller shaft, slightly narrowed to apex with a pair of dorsal apical processes; base shorter than shaft. Styles distinctly less than twice as long as greatest width, narrowest near middle, large lobe on outer margin before finger-like apical process.

Last ventral segment of female somewhat over half as long as greatest width, latero-posterior margin rounded.

Types: Lectotype ♂, Tía Juana, México, June 15, 1908; lecto-allotype ♀, San Diego, Calif., June 16, 1908, E. D. Ball, here designated, in the National Museum, Washington, D. C. These were on hand for study.

Additional Material Studied: (California) Irvine Hills, Orange Co., San Diego Co., Anaheim, Sunset Beach, Bonsail, La Jolla, Monrovia, Alpine, Laguna Beach, Otay, Lemon Cove, Escondido, Quatay, Lakeside, Los Angles, Riverside, Pasadena, Santa Barbara, Osnard, Ontario, Redding and Santa Monica. (Arizona) Tucson, Phoenix, Patagonia, Chiricahua Mts., Granite Dell, Yuma and

Bangs. (New Mexico) Blue Spgs. and Carlsbad. (Texas) San Juan, Presidio, Del Rio, Brownsville, Pecos, Sutton Co., Bee Co., Premont Co., Ft. Stockton, Ozona, Kendall Co., Karnes Co., El Paso Co., Valentine, Hidalgo, Sarita, McAllen, Corpus Christi, Laredo, Jim Wells Co., Concan, Carrizo Spgs., George West, Sheffield, Sanderson, San Ygnacia, Comstock, Bexar Co., Ft. Davis, Catarina, Marfa and Marathon.

Host Plants: A large series were collected at Bonsail, California, by R. H. Beamer on *Ambrosia* sp. Other collection data give *Eysenhardia texana* at Sanderson, Tex., peach foliage at El Paso and Bexar Co., Texas, *Amaranthus* sp. in Bexar Co., Texas, and adults and nymphs on *Heterotheca subaxillaris* in Bexar County. The large series from *Ambrosia* in California and the presence of nymphs on *H. subaxillaris* in Texas would suggest one of these two plants as the normal host.

Comparative Notes: As might be expected from its wide distribution, this species varies considerably both in color and size. Color varies from fulvous to dark gray, with the entire dorsum about the same color; the face varies from total infuscation to markings only along the lateral margins. The small size and usually dark face will separate it from most species found along the southern part of the United States from California to Texas, where it is one of the most common species in the genus.

15. *Scaphytopius* (*Cloanthanus*) *irroratus xanthanus* (Ball)

Nasutoideus xanthanus, Ball, E. D., Can. Ent., LXIII, Oct., p. 225, 1931.

Resembles *irroratus* but lighter in color, larger and with a blunter crown. Length: female 4.2 mm., male 4 mm.

Color: Crown fulvous with light markings as follows: wedge, narrow line along anterior margin, two pairs of large, rather elongate spots on each side before eye; a long, broad line from near wedge to base on each side of median suture and a small spot on posterior margin next each eye. Pronotum lighter than crown, vittae usually faintly visible. Scutellum ivory to fulvous with typical light markings usually evident, especially in male. Face of male pale fulvous with brown irrorations, especially behind eyes and on basal half of clypeus, lighter in female; sharksmouth and line behind eye usually distinct. Forewing semihyaline pale fulvous with large milky aeroles throughout, usually a few brown dots scattered throughout; veins darkest on posterior and costal margins.

Structural Characteristics: Crown about one and two-thirds times as long as width between eyes, anterior margin convex on each side of a blunt apex, less convex and more pointed in the female; wedge short. Pronotum somewhat shorter than crown; about two and one-half times as wide as length at middle and about four and one-half times as wide as length behind eyes. Clypeus somewhat over twice as long as width at ocelli, only slightly sinuate near antennae. Clypellus relatively slender and broadest near apex. Face in lateral view slightly convex. Forewing with venation typical and nine or ten recurved veins to costa.

Genitalia: Valve about two-thirds as long as greatest width, posterior margin broadly rounded, very broad at middle; anterior margin distinctly concave on each side of a rounded median lobe. Plates relatively narrow. Aedeagus "J"-shaped with dorsal portion slightly largest, shaft slender, almost parallel-margined to apex, which bears a pair of slender dorsal processes and smaller, spine-like dorsal processes; base short. Styles less than twice as long as greatest width, narrowest on basal third, broadly lobed on median third before an apical, finger-like process.

Last ventral segment of female almost twice as wide as length at middle, latero-posterior margin almost evenly rounded.

Types: Holotype ♀, allotype ♂, Tucson, Arizona, May 10, 1929, E. D. Ball, in the National Museum, Washington, D. C.

Material Studied: (Arizona) Sabino Canyon, Ajo, Tucson and Apache Jct.

Host Plants: Ball (1932) writes "—exclusively on the bur sage (*Franseria ambrosioides*) in Arizona."

Comparative Notes: This species resembles *nogalinus* rather closely, but may be separated by its lighter color, slightly larger size and longer crown.

16. *Scaphytopius* (*Cloanthanus*) *irroratus nogalinus* (Ball)

Nasutoideus irroratus var. *nogalinus*, Ball, E. D., Can. Ent., LXIII, p. 226, Oct., 1931.

Resembles *irroratus* but larger, lighter in color and with a shorter crown. Length: female 4 mm., male 3.8 mm.

Color: Crown fulvous irrorate with light, with white markings as follows: narrow line along anterior margin, wedge, two or three pairs of elongate dots in an area around wedge, two pairs of dots on posterior margin, a small pair next eyes and a longer pair near median suture. Pronotum fulvous with dark dots, milky vittae usually distinct. Scutellum yellow to fulvous with typical ivory markings. Face ivory to fulvous with brown irrorations, usually lightest in area of clypellus and lorae; sharksmouth and vitta behind eye distinct. Forewing semihyaline pale fulvous with large milky aeroles throughout, veins dark, especially in costal area.

Structural Characteristics: Crown over two-thirds as wide as length at middle, almost parallel-margined in male, longer in female; wedge short. Pronotum almost as long as crown, about two and one-half times as wide as length at middle and four times as wide as length behind eyes. Clypeus slightly over twice as long as width at ocelli, only slightly sinuate at antennae. Clypellus relatively slender and only slightly enlarged at apex. Forewing with several vein-like marks in brachial cell and about ten recurved veins to costa.

Genitalia: Valve slightly less than two-thirds as long as greatest width, posterior margin rounded; anterior margin with long median lobe. Plates broadest near base, narrow on outer half. Aedeagus "U"-shaped, base slender, dorsal part broadest, shaft curved, with a pair of erect apical processes from dorsal margin. Styles slightly less than twice as long as greatest width, sinuate near middle, lobed on outer margin just before outward projecting, finger-like apical process.

Last ventral segment of female about half as long as greatest width, latero-posterior margin rounded.

Types: Holotype ♀, allotype ♂, Santa Rita Mts., Arizona, June 22, 1930, E. D. Ball, in the National Museum, Washington, D. C. A pair of paratypes, Tucson, Arizona, June 9, 1929, E. D. Ball, were on hand for study.

Additional Material Studied: (Arizona) Rincon Mts., Patagonia, Santa Rita Mts., Ajo Mts., Sabino Canyon, Santa Catalina Mts., Baboquivara Mts., Mustang Mts., Ruby, Huachucua Mts., Tubac and Chiricahua Mts.

Host Plants: Ball (1932) writes "—beaten in small numbers from oaks on the lower slopes of the mountains in southern Arizona. The small numbers and lack of nymphs would suggest that the adults may have flown up from some plant growing beneath the trees."

Comparative Notes: This species is easily recognized by its short, light crown and dark face.

17. *Scaphytopius (Cloanthanus) albifrons* Hepner

Scaphytopius (Cloanthanus) albifrons, Hepner, L. W., Jour. of Kan. Ent. Soc., XIX, p. 89, 1946.

Resembling *loricatus* but smaller, lighter in color, and with long processes at apex of aedeagus. Length: female 4.1 mm., male 3.9 mm.

Color: Crown mottled brown with light markings as follows: wedge, narrow line along anterior margin, three pairs of spots before eyes, the outer largest and the inner long and slender; two pairs of spots along posterior margin, a large pair next median suture and another pair behind eyes. Pronotum semihyaline fulvous with fuscous dots throughout except for distinct vittae. Scutellum yellow to dark fulvous with typical markings light. Face ivory to yellow with sometimes a few brown marks in area of sharksmouth and dots along lateral margins of genae, especially behind eyes; apex of clypellus black. Strangely enough, the dark specimens from Florida lack all facial color except black tip of clypellus. Specimens collected in Texas in the winter usually have the facial markings. Forewing semihyaline fulvous with brown veins and large milky aeroles throughout. In most specimens from Florida, the fulvous is replaced by brown to black.

Structural Characteristics: Crown one and two-thirds as long as width between eyes in female, somewhat shorter in male, slightly convex on outer margins, rather sharp pointed at apex, especially in female. Pronotum about three-fifths as long as crown in female, slightly longer in male, almost three times as wide as length at middle and four times length behind eye. Clypeus over twice as long as width at ocelli, lateral margin broadly concave near middle. Clypellus broadest near apex. Face in lateral view slightly concave between anterior margin of eyes. Forewing with outer claval vein approaching second claval vein at crossvein, usually numerous vein-like markings in brachial cell; about ten recurved veins to costa.

Genitalia: Valve almost as long as greatest width, posterior margin rounded, anterior margin narrowed to a broadly rounded lobe at middle. Plates wide near base, apical portion relatively short and slender. Aedeagus "J"-shaped, shaft longer than base, broadly curved, almost parallel-margined with a pair of long slender, apical processes almost two-thirds as long as shaft. Styles about twice as long as greatest width, outer margin concave on basal third, small lobe before finger-like process on apical third.

Last ventral segment of female slightly less than twice as wide as length at middle, lateral margins slightly convex, posterior margin evenly produced, but only slightly longer at middle than at sides.

Types: Holotype ♂, allotype ♀, 24 ♀ and 9 ♂ paratypes, Brownsville, Texas, Dec. 27, 1945, R. H. Beamer, in the Snow Entomological Collections. Additional paratypes as follows: (Texas) 1 ♀, 3 ♂ ♂, Brownsville, Jan. 2, 1932, 1 ♂, Jan. 3, 1932, E. D. Ball; 7 ♀ ♀, 8 ♂ ♂, Brownsville, May 31, 1933, P. W. Oman; 10 ♀ ♀, 1 ♂, Brownsville, Dec. 29, 1945 (in palm forest), R. H. Beamer; 1 ♂, Brownsville, Aug. 8, 1937, D. J. and J. N. Knull; 1 ♂, Hidalgo, July 30, 1938, 19 ♀ ♀, 1 ♂, Dec. 28, 1945, R. H. Beamer; 1 ♀, Hidalgo, July 28, 1928, A. M. James; 2 ♀ ♀ and 1 ♂, Cameron Co., Aug. 3, 1928, R. H. Beamer. (Florida) 2 ♂ ♂, 1 ♀, Wakulla, July 10, 1939, R. H. Beamer; 1 ♂, Fruitland, Aug. 11, 1930, R. H. Beamer; 2 ♂ ♂, Sanford, Nov. 18, 1926, 1 ♂, June 22, 1926, E. D. Ball; 4 ♀ ♀, 1 ♂, Tampa, Oct. 17, 1925, E. D. Ball; 1 ♀, Cocoa, May 5, 1926, E. D. Ball; 2 ♀ ♀, La Belle, July 16, 1939, R. H. Beamer; 1 ♀, La Belle, July 16, 1939, P. B. Lawson; 2 ♀ ♀, La Belle, July 16, 1939, P. W. Oman; 1 ♂, La Belle, April 21, 1921, D. M. DeLong; 1 ♂, Likely, July 24, 1934, R. H. Beamer; 1 ♂, Naples, May 14, 1928, E. D. Ball; 2 ♂ ♂, Miami, April 1, 1921, D. M. DeLong; 1 ♂, Homestead, May 16, 1926, E. D. Ball; 1 ♀, Paradise Key, April 8, 1921, D. M. DeLong and 1 ♂, Key West, July 20, 1939, R. H. Beamer.

Host Plants: No host plant is known.

Comparative Notes: This is apparently the only species in Florida in which the face is entirely light. In Texas, however, this species is easily confused with *loricatus* and *pennatus* but the male genitalia easily separate them. *Albifrons* was described by DeLong (1943) as *loricatus* but that species, described from California, extends only into Texas, and this species, distinctly different, is also found in Florida.

18. *Scaphytopius* (*Cloanthanus*) *loricatus* (Van Duzee)

Platymetopius loricatus, Van Duzee, E. P., Bull. of Buffalo Soc. Nat. Hist., V, p. 205, 1894.

Resembling *frontalis,* but more slender, with a sharper crown, face with few or no dark markings and without genital paraphyses in the male. Length: female 4.5 mm., male 4 mm.

Color: Crown brown with light markings as follows: wedge, a thin line along anterior margin, two pairs of slender marks before eyes and a line on each side of median suture joining or almost joining a pair of spots at base next median suture; a spot on posterior margin next each eye. Pronotum irrorate with brown, slightly darker than crown, with pale vittae distinct. Scutellum yellow to brown with typical light markings. Face yellow to light fulvous, much lighter than adjoining area of venter, sometimes a few indistinct darker markings in area of sharksmouth and at apex; line behind eye sometimes faintly indicated; apex of clypellus dark. Forewing brown to fuscous with milky aeroles throughout, especially in costal cell.

Structural Characteristics: Crown in male about one and two-thirds as long as width between eyes, slightly longer in female, almost straight on each side of a rather blunt apex. Pronotum about three-fourths as long as crown, about two and one-half times as wide as length at middle and about three and one-half times length behind eyes. Clypeus slightly over twice as long as width at ocelli, narrowing evenly to clypellus on apical three-fourths; clypellus broadest near apex. Face in lateral view almost straight, sometimes slightly concave between anterior margin of eyes of female. Forewing with venation typical, a few marks in brachial cell and about ten recurved veins to costa.

Genitalia: Valve over two-thirds as long as greatest width, posterior margin broadly rounded; anterior margin concave on each side of a truncate median process. Aedeagus "J"-shaped, shaft almost as long as plates, parallel margined to abruptly curved portion on apical two-fifths, then narrowed to a pair of erect processes on ventral side and a much shorter process on dorsal side; base short. Styles less than twice as long as greatest width, evenly narrowed from base to middle, distinct lobe on outer margin before outwardly projecting, bluntly pointed, apical process.

Last ventral segment of female about one and one-half times as wide as length at middle, posterior margin broadly convex without lobes or notches.

Types: Lectotype ♂, California, Coquillet, in the Iowa State College collection, Ames, Iowa. Allotype ♀, Brea, California, July 29, 1935, R. H. Beamer, here designated, in the Snow Entomological Collections. Parallotype ♀♀ as follows: (California) 1, Alpine, July 9, 1929, R. H. Beamer; 1, Lompoc, Aug. 7, 1938, R. I. Sailer; 4, Laguna Beach, Orange Co., Aug. 10, 1931, Billie Moore; 2, Pasadena, June 17, 1908, E. D. Ball; 1, Santa Barbara, April 25, 1908, E. D. Ball; 1, Los Angeles, P. R. Uhler; 1, Los Angles Co., Coquillet and 1, San Diego Co., July 4, 1929, R. H. Beamer. (Arizona) 1, Patagonia, June 24, 1933, 3, Aug. 22, 1935, 1, Aug. 21, 1935, R. H. Beamer; 7, Patagonia, Sept. 7, 1929, 3, Aug. 8, 1930, 1, Oct. 5, 1935, 4, Sept. 10, 1933, E. D. Ball; 10, Patagonia, Oct. 23, 1937, P. W. Oman; 4, Tucson, June 23, 1929, 1, May 23, 1929, 1, Sept. 20, 1929, 1, June 28, 1930, 1, July 16, 1935, E. D. Ball; 4, Mesa, Sept. 10, 1938, 1, Dec. 16, 1939, Christensen; 11, Santa Cruz River, near Tubac, Oct. 23, 1937, P. W. Oman; 6, Santa Cruz Valley, Sept. 6, 1937, E. D. Ball; 2, Santa Cruz River, July 30, 1937, E. D. Ball; 1, Patagonia Mts., Aug. 20, 1940, D. J. and J. N. Knull; 1, Phoenix, Sept. 14, 1937, 1, Nov. 10, 1938, Christensen; 2, Chiricahua Mts., Sept. 14, 1938, D. J. and J. N. Knull and 2, Roosevelt Dam, Oct. 26, 1930. (Texas) 11, Concan, July 6, 1936, D. R. Lindsay; 19, Concan, July 6, 1936, R. H. Beamer; 2, Val Verde Co., June 28, 1940, D. J. and J. N. Knull; 1, Uvalde Co., June 26, 1940, D. J. and J. N. Knull; 1, Ft. Stockton, May 31, 1937, D. J. and J. N. Knull; 1, Davis Mts., June 2, 1937, D. J. and J. N. Knull and 2, Medina Co., June 24, 1940, D. J. and J. N. Knull.

Host Plants: Ball writes (1932) "—a few nymphs and many adults were taken on the Water-Wally (*Baccharis glutinosa*) which grows so abundantly in the washes in Arizona." Other records on specimens examined were white clover and willow at Tucson, Arizona, and peach foliage and *Amaranthus* sp. in Bexar Co., Texas.

Comparative Notes: This species varies considerably in color—from almost black in southern California to light brown in southern Texas. In some few cases the face becomes reddish and it resembles *irroratus* somewhat, but the darkness of *irroratus* is due to dark dots—that of *loricatus* is a cloudiness. In Texas this species resembles *albifrons* but can be easily separated by the male genitalia.

One male cotype of *irroratus,* with a reddish face, collected at Tijuana, Mex., June 15, 1908, proved to be this species. Dr. Ball had already realized this and had so placed it in his collection. Osborn (1921) in listing *loricatus* from Florida was evidently referring to *albifrons.*

19. *Scaphytopius (Cloanthanus) pennatus* Hepner

Scaphytopius (Cloanthanus) pennatus, Hepner, L. W., Jour. Kan. Ent. Soc., XIX, p. 90, 1946.

Resembles *loricatus* but slightly smaller, larger markings on crown and with wing-like processes at apex of aedeagus. Length: female 4 mm., male 3.8 mm.

Color: Crown dark brown to fuscous, except for light markings as follows: narrow line along anterior margin, wedge, two pairs of large spots forming an incomplete band before eyes, a pair of large spots at base next median suture and a smaller pair next eyes. Pronotum same color as crown with vittae usually distinct. Scutellum yellow to brown with typical light markings usually distinct. Face yellow with a few dark spots along lateral margins of genae and in area of sharksmouth; vitta behind eye sometimes faintly indicated. Forewing semihyaline fulvous with brown veins and irrorations throughout, except for light aeroles.

Structural Characteristics: Crown about one and two-thirds as long as width between eyes, slightly convex on each side of a bluntly pointed apex. Pronotum less than three-fourths as long as crown, about three times as wide as length at middle. Clypeus about twice as long as width at ocelli, margins slightly concave near base of antennae. Face broadly convex in lateral view, except for slight concavity between anterior margin of eyes. Forewing with typical venation in clavus, several vein-like marks in brachial cell and about ten recurved veins to costa.

Genitalia: Valve almost as long as greatest width, posterior margin rounded to a blunt point; anterior margin concave on each side of a broad, rounded median lobe. Plates relatively broad near base, apical portion short and slender. Aedeagus roughly "L"-shaped, shaft almost parallel margined to a pair of wing-like processes at apex; base almost as long as shaft. Styles about twice as long as greatest width, almost parallel margined to lobe on outer margin before finger-like process on apical third.

Last ventral segment of female slightly less than twice as wide as length at middle, lateral margins slightly convex; posterior margin slightly produced to a broad, oval median lobe.

Types: Holotype ♂, allotype ♀, Brownsville, Texas, July 3, 1938, R. H. Beamer, in the Snow Entomological Collections. Paratypes as follows: (Texas) 1 ♂, Hidalgo Co., July 28, 1928, A. M. James; 1 pr., Cameron Co., Aug. 3, 1928, L. D. Beamer; 1 ♀, Cameron Co., Aug. 3, 1928, R. H. Beamer; 1 ♂, Brownsville, July 4, 1938, Jean Russell; 1 ♂, Brownsville, June 29, 1938, R. H. Beamer; 1 ♂, Brownsville, June 29, 1938, R. I. Sailer.

Host Plants: No host plant is known.

Comparative Notes: This species is apparently restricted to southern Texas. It is nearest *loricatus,* but has more distinct spots on crown and wing-like processes at apex of aedeagus.

20. *Scaphytopius (Cloanthanus) flavifrons* Hepner

Scaphytopius (Cloanthanus) flavifrons, Hepner, L. W., Jour. Kan. Ent. Soc., XIX, p. 91, 1946.

Resembling *pennatus* but broader and with longer apical processes at apex of aedeagus. Length: female 4 mm., male 3.8 mm.

Color: Crown dark brown with light marks as follows: wedge, two spots on each side of wedge along anterior margin, the one nearest eye smallest; a spot on each side of median suture on disc; a large spot on each side of median suture and a smaller one next each eye on posterior margin. Pronotum light brown with many fuscous dots throughout; typical light vittae indicated. Scutellum ivory to yellow with dark color restricted primarily to basal half. Face bright yellow, sometimes flecked on clypeus and outer margins of genae; much lighter than venter. Forewings translucent brown and white, the white primarily restricted to aeroles in the male; darkest on outer anteapical cell and adjacent area of costa.

Structural Characteristics: Crown about one and one-half times as long as width between eyes, margins convex on each side of rounded apex. Pronotum about three-fourths length of crown, about two and one-half times as wide as length at middle and four and one-half times length behind eyes. Clypeus about twice as long as width at ocelli, slightly sinuate at antennae. Clypellus broadest near apex. Face distinctly convex in lateral view. Forewing with ten to twelve recurved veins to costa and often extra crossveins in clavus.

Genitalia: Valve about as long as greatest width, posterior margin distinctly convex on each side of bluntly-pointed apex; anterior margin with long, slender, median lobe. Aedeagus roughly "L"-shaped, dorsal part broader but slightly shorter, shaft slightly curved near base, a pair of pointed apical processes, each about two-fifths length of shaft. Styles about two and one-half times basal width, distinct lobe on outer margin before outwardly projecting, finger-like, apical process.

Last ventral segment of female about twice as wide as length at middle, lateral margins convex; posterior margin convex, slightly lobed at middle.

Types: Holotype ♂, Brownsville, Texas, May 25, 1939, D. J. and J. N. Knull, in the Knull collection, Ohio State University, Columbus, Ohio. Allotype ♀, Brownsville, Texas, Dec. 29, 1945, R. H. Beamer, in the Snow Entomological Collections. 1 ♀ paratype, Cameron Co., Texas, Aug. 3, 1938, R. H. Beamer.

Host Plants: No host plant is known.

Comparative Notes: This species is apparently restricted to the extreme southern part of Texas and is relatively rare. Its broadness and distinct genitalia separate it from any other species in the area.

21. *Scaphytopius* (*Cloanthanus*) *anisacanus* (Ball)

Nasutoideus anisacanus, Ball, E. D., Can. Ent., LXIII, p. 222, 1931.

Resembles *loricatus* but larger, with a different pattern on crown and with long aedeagus and small paraphyses. Length: female 4.5 mm., male 4.5 mm.

Color: Crown with area between eyes ivory with brown irrorations, irregular brown markings around wedge and usually dark lines connecting these two dark areas; this leaves a more or less complete light band before the eyes and the remainder of crown consisting primarily of alternating thin light and dark irregular lines. Pronotum milky with fuscous irrorations excepting typical light lines. Scutellum brown with typical light markings. Face creamy yellow with apex of clypellus black and sometimes light markings on clypeus and a few marks behind eye.

Structural Characteristics: Crown about one and two-thirds as long as width between eyes, slightly concave on disc, margins slightly convex to a bluntly-pointed apex. Pronotum almost three-fourths as long as crown, two and one-half times as wide as length at middle and about four and one-half times length behind eye. Clypeus over twice as long as width at ocelli, slightly sinuate near base of antennae. Clypellus broadest near apex. Face almost straight in lateral view. Forewing with vein-like markings in brachial cell and about eleven recurved veins to costa.

Genitalia: Valve almost as long as greatest width, posterior margin oval, with a small apical lobe; anterior margin somewhat concave on each side of median lobe. Paraphyses small and short, much shorter than shaft of aedeagus. Aedeagus about as long as plates, evenly narrowed to sharp curve near outer third; apical third almost parallel margined to a pair of small, slender apical processes. Styles over twice as long as greatest width, narrowest near middle, broadly rounded on outer margin to a short, outwardly projecting, apical process.

Last ventral segment of female slightly less than twice as wide as length at middle, lateral margins slightly convex; posterior margin lobed on each side and small lobes on each side of a small median notch.

Types: Holotype ♀, allotype ♂, Sabino Canyon, Ariz., June 28, 1930, E. D. Ball, in the National Museum, Washington, D. C, 1 pair of paratypes on hand—Santa Catalina Mts., Ariz., July 17, 1930, E. D. Ball.

Additional Material Studied: Babaquivari Mts., Ariz.

Host Plants: Ball (1932) writes "—types together with the nymphs were taken on the mint-like plant (*Anisacanthus thurberi*) near Tucson, Arizona."

Comparative Notes: This is a relatively large species, almost covered with vermiculations. The long, curved aedeagus with tiny paraphyses is distinct and unlike any other species.

22. *Scaphytopius (Cloanthanus) contractus* Hepner

Scaphytopius (Cloanthanus) contractus, Hepner, L. W., Jour. Kan. Ent. Soc., XIX, p. 92, 1946.

Resembles *loricatus,* but lighter in color, shorter crown and small paraphyses. Length: female 4.1 mm., male 3.8 mm.

Color: Crown white with an irregular, broad band across middle and a few thin lines on each side of wedge, yellow to brown. Pronotum a dark greenish-fulvous with light vittae distinct and sometimes irregularly bordered with dark dots. Scutellum same color as pronotum, or slightly lighter, with light markings distinct. Face yellow, narrow white line along margin between ocelli; slightly tawny behind eye, except for short, faint vitta; apex of clypellus black.

Structural Characteristics: Crown about one and two-thirds as long as width between eyes, lateral margins convex on each side of bluntly pointed apex. Pronotum only slightly shorter than crown, two and one-half times as wide as length at middle and five times as wide as length behind eyes. Clypeus about twice as long as width between ocelli and, except for slight sinuation at antennae, evenly narrowed to clypellus. Face convex in lateral view. Forewings with vein-like marks in brachial cell and about ten recurved veins to costa.

Genitalia: Valve almost as long as greatest width, posterior margin oval; anterior margin concave on each side of a blunt, narrow, median lobe. Plates relatively slender, broadest on basal third. Small, short paraphyses, barely extending to apex of valve. Aedeagus almost parallel-margined throughout, consisting of a basal, stem-like part, a short, simple, slightly curved shaft and an apical part about as long as basal part but curved at a right angle on middle. Styles somewhat over twice as long as basal width, "dog-legged" and almost parallel margined on middle, slightly lobed on outer margin at apical fourth before finger-like apical process.

Last ventral segment of female slightly less than twice as wide as length at middle, lateral margins slightly concave, posterior margin produced at middle with a very shallow median notch.

Types: Holotype ♂, allotype ♀, and 1 ♀ paratype, Brownsville, Texas, June 29, 1938, R. H. Beamer, in the Snow Entomological Collections. 1 ♂ paratype, Brownsville, Texas, June 29, 1938, L. W. Hepner.

Host Plants: The host plant is not known.

Comparative Notes: This species, evidently restricted to southern Texas, is quite distinctive with its yellow face and short aedeagus with short, small genital paraphyses.

23. *Scaphytopius* (*Cloanthanus*) *brunneus* Hepner

Scaphytopius (*Cloanthanus*) *brunneus*, Hepner, L. W., Jour. Kan. Ent. Soc., XIX, p. 93, 1946.

Resembles *loricatus* but lighter, darker on lateral margins of face and with small genital paraphyses. Length: female 4 mm., male 3.7 mm.

Color: Crown brown with light markings as follows: narrow line along anterior margin; wedge and a pair of oblique lines on each side; three pairs of markings on a band before eyes, the median pair longest; two pairs of spots on posterior margin, one next each eye and one on each side of median suture, the median pair often split anteriorly. Pronotum about same color as crown with typical vittae evident. Scutellum brown with typical light markings. Clypeus, lorae and clypellus yellow to fulvous with white sharksmouth; irregular area along margin between eyes and irregular light markings in area of sharksmouth, brown; apex of clypellus dark. Genae with numerous dark irrorations, vitta behind eye irregular but distinct. Forewing semihyaline fulvous with milky aeroles and brown irrorations; veins brown, becoming fuscous on apex and costa.

Structural Characteristics: Crown about one and one-third times as long as width between eyes, longer in female, anterior margin almost straight on each side of a blunt apex; wedge about one-fourth length of crown. Pronotum about three-fourths as long as crown, shorter in female, about two and one-half times as wide as length at middle and about four times as wide as length behind eyes. Clypeus over twice as long as width at ocelli, practically no constriction at antennae. Clypeus relatively slender and somewhat enlarged near apex. Face in lateral view almost straight in male, definitely concave between anterior margin of eyes in female. Forewing with several vein-like marks in brachial cell and eight or nine recurved veins to costa.

Genitalia: Valve somewhat shorter than greatest width; posterior margin convex on each side of a bluntly pointed apex; anterior margin with relatively long median lobe. Plates short and very broad near base. Aedeagus in lateral view, broad, roughly "U"-shaped, dorsal part shortest, shaft broad and short, enlarged at apex. Paraphyses very small and short, hardly reaching to apex of shaft of aedeagus. Styles about three times as long as basal width, relatively large lobe on outer margin just before slender, finger-like apical process.

Last ventral segment of female about twice as wide as length at middle, lateral margin convex, posterior margin with small lobe at each side and broad median lobe.

Types: Holotype ♂, allotype ♀ and a pair of paratypes, Paradise Key, Fla., April 9, 1921, D. M. DeLong, in the DeLong collection, Ohio State University, Columbus, Ohio. Additional paratypes as follows: 2 ♀♀, Key Largo, Fla., July 19, 1939, R. H. Beamer.

Host Plants: No host plant is known.

Comparative Notes: The only species with which this might be confused in southern Florida is *albifrons*, from which it may be separated by its marginal infuscation on face, and small paraphyses.

24. *Scaphytopius* (*Cloanthanus*) *fuscifrons* (Van Duzee)

Platymetopius fuscifrons, Van Duzee, Bull. Buffalo Soc. Nat. Hist., V, p. 206, 1894.
Platymetopius abruptus, Ball, E. D., Ent. News, XX, p. 165, 1909.

Resembling *frontalis*, but with shorter crown, face and crown entirely dark and with plates of male very short. Length: female 4.5 mm., male 4 mm.

Color: Crown fuscous and white mottled in male, lighter in female, usually darkest on each side of median suture. Pronotum same color as crown with irregular vittae usually evident. Scutellum dark, orange spot near each basal corner, typical light markings distinct. Face in male fuscous with small white spots throughout, darkest on outer margin of genae, female usually lighter; sharksmouth small in both; white vitta behind eye and two shorter vittae before eye, distinct. Forewing of male fuscous with semi-hyaline milky spots throughout, larger in costal area; female lighter, usually semihyaline milky with brown veins, darkest in apical cells. Occasionally females are found which are the same color as the males but usually they are much lighter.

Structural Characteristics: Crown about one and one-third as long as distance between eyes, anterior margin slightly convex on each side of a blunt apex; wedge about one-third length of crown. Pronotum about four-fifths as long as crown, over twice as wide as length at middle and four times length behind eyes. Clypeus less than twice as long as width between ocelli, only slightly narrowed, if at all, at antennae. Clypellus enlarged at both ends. Face convex in lateral view, more so in the male. Forewing with venation typical, about six vein-like marks in brachial cell and about ten recurved veins to costa.

Genitalia: Valve over three-fourths as long as greatest width, broadly oval on posterior margin; anterior margin broadly produced on median third. Plates truncate, extending only slightly beyond styles. Paraphyses broad, extending well beyond plates, apices spear-like. Aedeagus about as long as width at base, evenly narrowed to a flange-like, broadly pointed apex. Styles over twice as long as basal width, slightly constricted on basal third, outer margin rounded to finger-like process on apical third.

Last ventral segment of female almost three times as wide as length at middle, lateral margins convex, posterior margin lobed on outer third, median third concave with relatively long, parallel-sided notch at middle.

Types: Lectotype ♂, "Arizona," in Iowa State College collection, Ames, Iowa, lectoallotype ♀, same data, here designated. Both of these were on hand for study.

Additional Material Studied: (California) San Jacinto Mts., Topango Canyon, Arroyo Seco River, Alpine, Eureka, Beaumont, Gibson and Pine Valley. (Arizona) Huachucua Mts., Oak Creek Canyon, Chiricahua Mts., Santa Rita Mts., Flagstaff, Glenn Oaks, Santa Catalina Mts. and Pinal Mts. (Utah) Alton and Logan Canyon. (Colorado) Rabbit Ears Pass. (Wyoming) Grand Teton National Park and Yellowstone Park.

Host Plants: Ball (1932) writes "—apparently strictly confined to the buckbrush. The writer has taken it commonly in Utah and

Arizona on *Ceanothus fedleri*." One specimen was taken in 1938 by R. H. Beamer on *Amorpha frutiosa* in Huachucua Mts., Arizona, but this may have been merely resting there.

Comparative Notes: This species, with its two subspecies, are distinctly different from other species in the shape of the external genitalia. References to this species from east of the Rockies probably refer to *nigrifrons* or *magdalensis*.

25. *Scaphytopius* (*Cloanthanus*) *fuscifrons compactus* (Ball)

Platymetopius compactus, Ball, E. D., Ent. News, XXVII, p. 176, 1916.

Resembles *fuscifrons* but with definite light band on crown before eyes. Length: female 4.7 mm., male 4.5 mm.

Color: Crown black with yellow irrorations except for irregular light band before eyes, wedge, and a spot on posterior margin next each eye; often a pair of oblique light marks on base about half way between median suture and eyes. Pronotum semihyaline milky with heavy black irrorations, heaviest near posterior margin, lightest on anterior and lateral margins, often yellow area behind each eye; vittae obscure or faintly indicated near lateral margins. Scutellum with basal half brown with ivory or yellow spots in each corner and irregular spots throughout; apical half usually ivory to yellow with few dark markings, if any. The scutellum varies considerably, but is usually much lighter than in *fuscifrons*. Forewing semihyaline white, with heavy black markings, especially on disc of outer anteapical and adjoining area of costa and in apical cells. The amount of black may vary from almost none in specimens from Colorado and Wyoming to almost entire in specimens from the mountains of California. Face chocolate brown to black, lightest on lorae, with small, light dots throughout; short light vitta behind eye, one below ocellus and another at base of antennae; sharksmouth short but distinct; basal margin of clypeus narrowly lined with light.

Structural Characteristics: Crown only slightly longer at middle than width between eyes; wedge about one-third length of crown. Pronotum about three-fourths as long as crown, almost three times as wide as length at middle and four and one-half times length behind eyes. Clypeus about twice as long as width at ocelli, slightly sinuate near base of antennae. Clypellus widest near apex. Face convex in lateral view. Forewing venation often obscured by dark markings.

Genitalia: Valve about four-fifths as long as greatest width, posterior margin broadly rounded; anterior margin slightly concave on each side of a slender median process. Plates short, evenly rounded on outer margins. Paraphyses more or less parallel-margined to spearlike apices. Aedeagus about as long as basal width, apex flange-like and bluntly pointed. Styles reaching almost to apex of plates, about two and one-half times as long as greatest width, sinuate near basal third, broadly lobed on outer margin to a finger-like process on apical third, somewhat more slender than in *fuscifrons*.

Last ventral segment of female almost three times as wide as greatest length, lateral margins convex, posterior margin with deep, "V"-shaped, median suture and a small concavity on each side.

Types: Lectotype ♀, Dunsmuir, Calif., Aug. 13, 1912, E. D. Ball, here designated, in the National Museum, Washington, D. C. Allotype ♂, Dunsmuir, Calif., June 29, 1935, R. H. Beamer, here designated, in the Snow Entomological Collections. Parallotype ♂ ♂ as follows: (California) 2, Towie, Aug. 20, 1938, R. I. Sailer; 6, Towie, Aug. 20, 1938, R. H. Beamer; 1, Echo, Aug. 10, 1940, R. H. Beamer and 1, Yosemite National Park, Aug. 1, 1940, R. H. Beamer. (Wyoming) 1, Grand Teton National Park, Aug. 18, 1931, John Nottingham. (Montana) 2, Haugan, Aug. 9, 1931, R. H. Beamer and 2, Haugan, Aug. 9, 1931, John Nottingham.

Host Plants: Ball says (1932) "—taken by the writer on a tall species of Buckthorn (*Ceanothus* sp.) in northern California and has since been taken in small numbers in the higher mountains of Arizona." However, Ball may have confused this subspecies with the following subspecies, which it resembles.

Comparative Notes: This subspecies evidently replaces *fuscifrons* at high altitudes.

26. *Scaphytopius* (*Cloanthanus*) *fuscifrons minutus* Hepner

Scaphytopius (*Cloanthanus*) *fuscifrons* subsp. *minutus*, Hepner, L. W., Jour. Kan. Ent. Soc., XIX, p. 94, 1946.

Resembles *compactus*, but smaller, with basal area of crown light and with distinct light band across forewing. Length: female 4 mm., male 4 mm.

Color: Crown brown except for ivory to yellow markings as follows: wedge, narrow area next pronotum, more or less distinct band before eyes, and narrow line along anterior margin. Pronotum brown irrorate with fulvous, more or less broad milky area along posterior margin; vittae indistinct or absent, except near lateral margins. Scutellum ivory to yellow, large brown spot near each basal corner and sometimes indistinct irrorations between these.

Face reddish-brown, approaching black on lateral margins of genea and near sharksmouth; small, light irrorations throughout, larger light spot along margin of genae next lower part of lorae, on disc of loral sclerites and on disc of clypeus near apex; a light vitta behind eye, a shorter one near ocellus and another near base of antennae; sharksmouth small but distinct; basal margin light. Forewing semihyaline milky with black markings on basal half and in anteapical and apical cells, leaving a distinct light band across second cross-vein and across apices of anteapical cells, giving a distinct two-banded appearance, more distinct in males, which are usually slightly darker; veins dark throughout.

Structural Characteristics: Crown about one and one-third as long as width between eyes, margins slightly convex; wedge about one-fourth length of crown. Pronotum about three-fourths as long as crown, about three times as wide as length at middle and four and one-half times length behind eyes. Clypeus almost twice as long as distance between ocelli, only slightly sinuate, if any, at antennae. Clypellus widest near apex. Face convex in lateral view, although slightly concave between anterior margin of eyes. Forewing with claval veins joining or almost joining; eight or ten more or less distinct cross-veinlike marks in brachial cell and about twelve recurved veins to costa.

Genitalia: Valve about four-fifths as long as greatest width, oval on median half of anterior margin, broadly truncate on median half of anterior margin. Plates short, bluntly pointed. Paraphyses only slightly broadened toward sharp apices. Aedeagus short, smallest at base, broadest just before blunt apex. Styles about two and one-half times as long as basal width, sinuate on basal fourth, slightly lobed on outer third to a parallel margined apical process.

Last ventral segment of female about three times as wide as greatest length; irregularly lobed on each side of a relatively long, parallel-margined median notch.

Types: Holotype ♂, allotype ♀, and 6 ♀ and 7 ♂ paratypes, Miami, Arizona, Aug. 6, 1941, R. H. Beamer, in the Snow Entomological Collections. Additional paratypes as follows: (Arizona) 1 ♂, Yarnell Hts., Oct. 8, 1929, 1 ♀, July 21, 1929, E. D. Ball; 4 ♀ ♀, 2 ♂ ♂, Pinal Mts., July 7, 1936, E. D. Ball; 1 ♀, Santa Catalina Mts., July 30, 1930, E. D. Ball; 1 ♂, Santa Rita Mts., June 16, 1933, P. W. Oman and 1 pr., Douglas, June 10, 1936, E. D.

Ball. (Texas) 1 ♀, Concan, July 6, 1936, R. H. Beamer and 1 ♂, Chisos Mts., Sept. 19, 1938, D. J. and J. N. Knull.

Host Plants: Ball's reference (1932) to *compactus* in Arizona probably referred to this subspecies, as some of his specimens were labelled "*Ceonothus*."

Comparative Notes: The specimens from Texas are somewhat smaller than those from Arizona, but appear to be the same thing. It is easily separated from *compactus* by its smaller size and more light color on crown and face.

27. *Scaphytopius* (*Cloanthanus*) *dodonanus* (Ball)

Nasutoideus dodonanus, Ball, E. D., Can. Ent., LXIII, p. 225, 1931.

Resembling *fulvus* but with longer crown, with genital paraphyses united basally and western in distribution. Length: female 4.2 mm., male 4 mm.

Color: Crown fulvous to brown with ivory markings as follows: wedge, three pairs of spots across crown in front of eyes, a pair of spots near median suture at base and a pair of small spots on posterior margin next eyes. Pronotum yellow-fulvous, vittae usually at least faintly indicated. Scutellum yellow to orange with typical markings ivory. Face creamy-yellow throughout. Forewings semihyaline-fulvous with a few scattered aeroles; veins concolorous except in apical cells and costa, where they are brown.

Structural Characteristics: Crown about one and one-half times as long as width between eyes, bluntly pointed, wedge only about one-fifth length of crown. Pronotum about three-fourths as long as crown, about two and one-half times as wide as length at middle and about five times length behind eyes. Clypeus about twice as long as width at ocelli, more or less evenly narrowed to apex. Clypellus widest near apex. Face convex in lateral view except near apex, where it is slightly concave. Forewing with several vein-like marks in brachial cell and about ten recurved veins to costa.

Genitalia: Valve about as long as greatest width, rounded on posterior margin, concave on each side of median lobe on anterior margin. Plates slender, over twice as long as greatest width, broadest on basal fourth. Paraphyses loosely joined on basal third, broadest on apical third, constricted on apical fifth and enlarged again before sharp apex. Aedeagus inserted where paraphyses separate, roughly an inverted "T"-shaped, with ventral process short and stout, dorsal process longer and more slender and shaft slightly narrowing to a pair of erect processes at apex. Styles about three times as long as basal width, almost parallel-margined on basal three-fourths, except for slight constriction near middle, slightly lobed on outer margin before outwardly-projecting, finger-like, apical process.

Last ventral segment of female about twice as wide as length at middle, posterior margin straight and slightly narrower than at widest point.

Types: Holotype ♀, allotype ♂, Tucson, Arizona, June 28, 1930, E. D. Ball, in the National Museum, Washington, D. C. One pair of paratypes, Tucson, Arizona, Sept. 22, 1929, E. D. Ball, on hand for study.

Additional Material Studied: (Arizona) Sabino Canyon, Santa Catalina Mts., Santa Cruz River, Baboquavari Mts. and La Osa River.

Host Plants: Ball (1932) writes "Yellow nymphs and brownish yellow adults were taken exclusively on the shrub *Dodonaea viscosa* var. *angustifolia* in Arizona."

Comparative Notes: Some specimens are gray with darker veins and markings, especially in specimens collected in October and November. The male genitalia is unlike any other species examined.

28. *Scaphytopius* (*Cloanthanus*) *celtidus* (Ball)

Nasutoideus celtidus, Ball, E. D., Can. Ent. LXIII, p. 224, 1931.

Somewhat resembling *anisacanus* but smaller, lighter in color, with area of crown next pronotum with few or no markings and with distinctly different genitalia. Length: female 4.5, male 4 mm.

Color: Crown white except for indistinct fuscous band between anterior part of eyes, area around wedge, a few lines on disc and usually a few small spots on posterior margin next eye. Pronotum semihyaline milky with scattered brown to fuscous dots, darkest along anterior and near posterior margin. Scutellum white to yellow, except for indistinct darker markings near apex and sometimes near each basal corner. Face ivory with brown vermiculations throughout; sharksmouth and vitta behind eye, distinct. Forewing semihyaline milky with numerous scattered fuscous vermiculations, usually dark area on costa and adjoining anteapical cell opposite apex of clavus. In some dark specimens, the vermiculations are fused to form large dark blotches throughout wing.

Structural Characteristics: Crown about one and one-half times as long as width between eyes, margins slightly convex on each side of blunt apex; wedge about one-fourth length of crown. Pronotum about three-fourths as long as crown, about two and one-half times as wide as length at middle and about four and one-half times length behind eyes. Clypeus about twice as long as width at ocelli in female, slightly shorter in male, slightly sinuate near antennae. Clypellus largest near base. Face in lateral view almost straight in male, slightly concave between anterior margin of eyes in female. Forewing with venation typical with numerous markings in brachial cell and about ten recurved veins to costa.

Genitalia: Valve roughly triangular, posterior margin somewhat convex on each side of a bluntly pointed apex; anterior margin with broad median lobe. Plates short, broad near base. Paraphyses joined on basal three-fourths, apical fourth slightly bulbous before sharp apices. Aedeagus in lateral view with broad dorsal portion, shaft "J"-shaped, almost parallel-margined, and with a pair of slender apical processes about as long as shaft; in ventral view the apical processes extend laterally. Styles about two and one-half times as long as basal width, lobed on outer margin just before curved, outwardly projecting, finger-like apical processes.

Last ventral segment of female slightly more than half as long as greatest width, lateral margins slightly convex; posterior margin with small lobe near outer margin and a broad median lobe notched at middle.

Types: Holotype ♀, allotype ♂, Tucson, Arizona, July 24, 1920, E. D. Ball, in the National Museum, Washington, D. C. One pair of paratypes, Tucson, Arizona, June 28, 1930, E. D. Ball, were on hand for study.

Additional Material Studied: (Arizona) Lewis Spgs., Santa Rita Mts., Sabino Canyon.

Host Plants: Ball (1932) writes "—strictly confined, both nymphs and adults, to the evergreen desert hackberry (*Celtis pallida*)."

Comparative Notes: The distinctively marked crown and distinct male genitalia easily separate this species from any other.

29. *Scaphytopius* (*Cloanthanus*) *californiensis* Hepner

Scaphytopius (Cloanthanus) californiensis, Hepner, L. W., Jour. Kan. Ent. Soc., XIX, p. 95, 1946.

Resembles *irroratus* but lighter, larger, with larger spots on crown, and with short genital paraphyses. Length: female 4.2 mm., male 3.8 mm.

Color: Crown with fuscous areas around wedge and between anterior parts of eyes, remainder fulvous except for following light markings: wedge, thin line along anterior margin, three pairs of spots before eyes, the median pair greatly elongated and joining a pair of spots on posterior margin next median suture. Pronotum milky semihyaline to fulvous with irrorations throughout, vittae usually indicated. Scutellum orange with typical light markings usually lined with fuscous. Face fulvous with brown irrorations throughout, usually slightly darker along lateral margins and lightest on lorae; sharksmouth and vitta behind eye usually fairly distinct. Forewing semihyaline milky to pale fulvous with veins and numerous dots, forming aeroles throughout; dark area on costa and adjoining anteapical cell.

Structural Characteristics: Crown of male about one and one-half times as long as width between eyes, slightly longer in female; margins slightly convex in male, almost straight in female. Pronotum about three-fourths as long as crown, almost two and one-half times as wide as length at middle. Clypeus slightly more than twice as long as width at ocelli, slightly sinuate near antennae. Clypellus relatively slender, widest near apex. Face in lateral view convex, slightly concave between anterior margin of eyes in female. Forewing with venation typical, about ten recurved veins to costa.

Genitalia: Valve almost as long as greatest width, posterior margin convex on each side of a bluntly pointed apex; anterior margin with a relatively long median lobe. Paraphyses joined on basal two-thirds, apices free and sharply pointed. Shaft of aedeagus short, curved, only slightly narrower at apex than at base. Styles only about twice as long as basal width, distinct lobe on outer margin just before outward-projecting, finger-like, apical process.

Last ventral segment of female slightly over half as long as greatest width, lateral margins slightly converging; posterior margin straight with exception of small, broad, median lobe.

Types: Holotype ♂, allotype ♀, and 21 ♀ and 10 ♂ paratypes, Ventura, California, July 20, 1933, R. H. Beamer, in the Snow Entomological Collections. Additional paratypes as follows: (California) 2 ♂ ♂, Anza, July 29, 1938, R. H. Beamer; 1 pair San Gabriel Canyon, July 2, 1935, R. H. Beamer; 1 ♀, Mint Canyon, July 6, 1933, R. H. Beamer; 1 ♂, Mint Canyon, June 7, 1935, P. W. Oman; 2 ♀ ♀, 1 ♂, Alpine, July 5, 1931, E. D. Ball; 1 ♀, Three Rivers, June 9, 1935, P. W. Oman; 1 ♀, Fresno, May 20, 1898; 3 ♀ ♀, Monterey, July 22, 1935, R. H. Beamer; 2 ♀ ♀, Nipomo, July 24, 1935, R. H. Beamer; 1 pair Lompoc, Aug. 9, 1938, R. H.

Beamer; 1 ♀, Lompoc, Aug. 9, 1938, R. I. Sailer; 3 ♀ ♀, 1 ♂, Beaumont, June 12, 1931, E. D. Ball; 1 ♀, 2 ♂ ♂, Ontario, Oct. 21, 1938, Christensen; 2 pairs, Hemet, Oct. 26, 1938, Christensen; 1 ♀, Topango Canyon, Aug. 5, 1938, L. W. Hepner; 3 ♀ ♀, 7 ♂ ♂, Topango Canyon, Aug. 5, 1938, R. H. Beamer; 1 ♀, Santa Ana Canyon, July 30, 1932, R. H. Beamer; 1 ♂, Los Angeles, Uhler; 8 ♀ ♀, 2 ♂ ♂, Claremont, July 29, 1935, R. H. Beamer; 1 ♂, Claremont, July 29, 1935, Jack Beamer; 1 ♀, Palm City, Aug. 7, 1935, R. H. Beamer; 1 ♂, Escondido, July 15, 1941, R. H. Beamer; 1 ♀, 2 ♂ ♂, La Jolla, July 13, 1941, R. H. Beamer; 4 ♀ ♀, 2 ♂ ♂, San Diego, Aug. 7, 1935, 2 ♀ ♀, July 24, 1941, R. H. Beamer; 9 ♀ ♀, 3 ♂ ♂, San Diego, July 5, 1931, E. D. Ball; 1 ♀, July 17, 1915, 1 ♀, Aug. 29, 1915, L. A. Titus; 1 ♂, Arroyo Seco River, Aug. 8, 1938, R. H. Beamer; 1 ♀, Strawberry, Aug. 8, 1929, R. H. Beamer; 2 pairs, Long Beach, July 4, 1931, E. D. Ball and 1 ♀, Lindsay Hts., Dec. 19, 1938, E. A. McGregor.

Host Plants: Specimens were examined which had been collected on *Arctostaphaleae glauca* and *A. zacaensis*, but these plants may have been only a resting place for them.

Comparative Notes: This species is restricted to southern California, somewhat resembles *nogalinus*, but has a longer, sharper, darker crown and quite different genitalia.

30. *Scaphytopius* (*Cloanthanus*) *diabolus* (Van Duzee)

Platymetopius diabolus, Van Duzee, E. P., Proc. Calif. Acad. Sci., XIV, p. 413, 1925.

Resembles *frontalis*, but lighter colored, with longer crown, more distinct band before eyes and western in distribution. Length: female 4.5 mm., male 4 mm.

Color: Crown black with ivory or white markings as follows: thin line along anterior margin; wedge and oblique mark on each side; irregular, almost complete band before eyes; and irregular markings in an area along basal margin, largest in female. Pronotum gray with irregular black irrorations, much lighter on lateral and anterior margins. Scutellum black with typical light markings. Clypeus light brown on apical two-thirds, darker on base in area of small sharksmouth. Lorae and clypellus light brown except for black tip of clypellus. Genae mottled brown to fuscous with white vitta behind eye and shorter one near ocellus, distinct. Forewing semi-hyaline white with irregular black markings throughout, heaviest on costa and in anteapical cell opposite apex of clavus.

Structural Characteristics: Crown about one and one-third times as long as width between eyes, anterior margin slightly convex on each side of a bluntly pointed apex; wedge very short. Pronotum slightly over two and one-half times as wide as length at middle and four times length behind eye. Clypeus about twice as long as width at ocelli, only slightly sinuate, if at all, at antennae; depression on each side at end of sharksmouth. Clypellus rather slender and slightly enlarged near apex. Face in lateral view straight in male, slightly concave between anterior margin of eyes in female. Forewing with outer claval vein approaching or touching second claval vein at cross-vein, often extra cross-veins in clavus; brachial cell with many vein-like marks and costal area with ten or eleven recurved veins.

Genitalia: Valve about one and one-third as wide as length at middle, posterior margin somewhat convex on each side of pointed apex; anterior margin with short, broad median lobe. Paraphyses broad, extending well beyond plates, almost parallel-margined to sharp apex. Aedeagus in ventral view short, apices sagittate. Styles long, about three times as long as basal width, constricted on basal fourth, outer margin rounded just beyond middle to a long, bluntly pointed, apical process.

Last ventral segment of female slightly less than twice as wide as length at middle, evenly rounded on latero-posterior margin to a distinct median notch on posterior margin.

Types: Holotype ♂, No. 1788, allotype ♀, No. 1789, Mt. Diablo, Calif., July 14, 1916, E. P. Van Duzee, in the Museum of the California Academy of Science, San Francisco, Calif.

Material Studied: (California) Mt. Shasta, Yosemite Valley, Weed, La Jolla, Lone Pine, Mariposa, Colfax, Doyle, Beaumont, Chilcoot and Ontario. (Oregon) Grants Pass, Spray, Medford and Ashland. (Washington) Satus Pass and Toppinish. (Arizona) Grand Canyon, Jerome, Prescott and Granite Dell. (Nevada) "Nev." March, 1936. (Utah) Provo, Logan Canyon and Heber City. (Idaho) Ruhl. (Colorado) Macedonia and Poudre River Canyon.

Host Plants: Ball (1932) writes of *nasutus,* evidently referring to *diabolus,* "—taken in abundance, nymphs and adults, on the cliff rose (*Cowania stansburiana*) in Utah and Arizona."

Comparative Notes: The male of *nasutus* was probably this species, but since it was described in a paper on Jamaica insects, the female from that island is designated holotype for that species, leaving *diabolus,* described from California, to include the specimens originally placed in *nasutus.* The color of forewing varies from white with scattered black vermiculations, to almost entirely black.

31. *Scaphytopius* (*Cloanthanus*) *pallidiscutus* Hepner

Scaphytopius (*Cloanthanus*) *pallidiscutus,* Hepner, L. W., Jour. Kan. Ent. Soc., XIX, p. 96, 1936.

Resembles *diabolus* but larger, with a longer crown, scutellum lighter colored, and with longer aedegus. Length: female 4.5 mm., male 4.5 mm.

Color: Crown black with white marks as follows: a thin line along anterior margin; wedge and a line on each side parallel to margin; an almost complete, broad irregular band before eyes; and two pairs of spots along posterior margin, one pair next eyes and another next median suture, basal fifth with black replaced by fulvous or brown except for a few lines. Pronotum gray with scattered dark spots; irregular light vittae usually faintly indicated. Scutellum light fulvous to brown with typical light markings; sometimes almost entirely ivory. Face evenly reddish-brown, mottled throughout, much more unicolorous than *diabolus*, except for fuscous tip of clypellus, irregular black markings below small sharksmouth, light vitta behind eye and shorter one near ocellus.

Structural Characteristics: Crown about one and two-thirds as long as width between eyes, almost straight margined on each side of a bluntly pointed apex; wedge about one-fifth length of crown. Pronotum about two-thirds as long as crown, about two and one-half times as wide as length at middle, and four and one-half times length behind eye. Clypeus over twice as long as width at ocelli, slightly sinuate at antennae; a depression, almost parallel to basal margin, on each side before eye. Clypellus broadest just before apex. Face in lateral view concave between anterior margin of eyes. Forewing with two or three cross-veins connecting claval veins; usually ten or more marks or cross-veins in brachial cell and about ten recurved veins to costa.

Genitalia: Valve about four-fifths as long as greatest width, posterior margin convex on each side of a bluntly pointed apex; anterior margin evenly rounded. Paraphysis almost twice as long as style, largest near base, almost parallel-margined to sharp apex, except for constriction near outer third. Shaft of aedeagus slender, about one-half as long as styles, evenly narrowed to a pair of short, dorsal, apical processes. Styles almost four and one-half times as long as greatest width, slightly constricted on basal third, distinct lobe on outer margin before long, slender process on apical half.

Last ventral segment of female somewhat less than twice as wide as length at middle, slightly concave on lateral margins, then rounded to a small median notch at middle on posterior margin; more truncate than *diabolus*.

Types: Holotype ♂, allotype ♀, and 12 ♀ and 8 ♂ paratypes, Boulevard, California, July 26, 1938, R. H. Beamer, in the Snow Entomological Collections. Additional paratypes from California as follows: 1 ♂, Santa Rosa, Aug. 16, 1938, R. H. Beamer; 3 ♀ ♀, Santa Cruz Mts., Aug. 13, 1938, R. I. Sailer; 1 ♀, Jamesburg, Aug. 11, 1938, R. H. Beamer; 1 ♀, Lockwood, July 24, 1935, R. H. Beamer; 1 ♀, Lompoc, Aug. 9, 1938, R. I. Sailer; 1 ♀, 2 ♂ ♂, Beaumont, June 12, 1931, E. D. Ball; 1 ♂, Big Bear Lake, July 26, 1932, R. H. Beamer; 2 ♀ ♀, 1 ♂, Topango Canyon, Aug. 5, 1938, R. I. Sailer; 1 ♀, Topango Canyon, Aug. 5, 1938, L. W. Hepner; 1 ♀, Claremont, July 29, 1935, R. H. Beamer; 12 ♀ ♀, 13 ♂ ♂, Pine Flats Camp, Indio, July 12, 1941, R. H. Beamer; 1 ♀, Jacumba, July 17, 1940, R. H. Beamer; 7 ♀ ♀, 3 ♂ ♂, Campo, Aug. 10, 1935, R. H. Beamer and 3 ♀ ♀, Pine Valley, July 27, 1938, 1 ♀, July 18, 1941, R. H. Beamer.

Host Plants: Specimens have been collected in southern California from *Ceanothus greggii purplexans* and *C. cuneatus* and *Arctostaphylae pungens* and *A. glauca,* so it is possible that *Ceanothus* or *Arctostaphylae* is the host of this species.

Comparative Notes: This species is similar to *diabolus,* but can be separated easily by the lighter scutellum, lighter and more evenly colored face and the longer aedeagus of the male. The female last ventral segment of this species is more truncate than that of *diabolus.* This species is evidently restricted to California.

32. *Scaphytopius* (*Cloanthanus*) *fulvus* (Osborn)

Platymetopius fulvus, Osborn, Herbert, Rep't. of New York St. Entomologist (20th Report) p. 519, 1905.

Resembles *magdalensis,* but fulvous throughout and with paraphyses bifid. Length: female 5 mm., male 4.5 mm.

Color: Crown fulvous with lighter markings as follows: wedge; one or two pairs of dots between wedge and eye, a long mark on each side of median suture from near wedge to posterior margin and another pair on posterior margin next eyes. Pronotum fulvous with light vittae sometimes faintly indicated. Scutellum fulvous with typical light markings. Face fulvous, usually lightest on clypeus, with relatively long sharksmouth faintly indicated. Forewing fulvous, veins only slightly darkened except near apex and on costa.

Structural Characteristics: Crown about one and one-half times as long as width between eyes, anterior margin only slightly convex on each side of pointed apex; wedge about one-fourth length of crown. Pronotum somewhat shorter than crown, a little less than two and one-half times as wide as length at middle and about four times as wide as length behind eyes. Clypeus about twice as long as width at ocelli, almost evenly narrowed to apex. Clypellus relatively narrow and enlarged near apex. Face in lateral view almost straight in male, slightly concave between anterior margin of eyes in female. Forewing with typical venation, seven or eight recurved veins to costa.

Genitalia: Valve almost as long as greatest width; posterior margin only slightly convex on each side of a sharp apex, anterior margin with broad, short median lobe. Paraphyses narrow, about twice as long as styles, with slender lateral process on outer third. Aedeagus roughly "U"-shaped, dorsal part lighter and less heavily sclerotized, shaft almost parallel-margined to a very small dorsal process at apex. Styles about four times as long as greatest width, almost parallel-margined on basal three-fourths, only slightly lobed on outer margin to finger-like apical process.

Last ventral segment of female about one and one-half times as wide as length at middle, latero-posterior margin rounded to a small median lobe.

Types: Lectotype ♂, lectoallotype ♀, Cold Spr. Harbor, New York, August 18, 1904, H. Osborn, here designated, in Osborn Collection, Ohio State University, Columbus, Ohio. The original description gives Oyster Bay as the type locality, but Cold Spring Harbor is within Oyster Bay and in this case, these two localities are identical. One cotype was on hand for study.

Additional Material Studied: (Wisconsin) Grand Rapids. (Connecticut) New Haven. (Maryland) Ashton. (Virginia) Cape Henry (North Carolina) Walnut and Franklin.

Host Plants: Osborn (1904) writes "—beaten from pine and huckleberry—As all are adults it is impossible to determine the food plant with certainty though it seems likely that it is the huckleberry and that individuals taken from pines were resting accidentally on the trees." Ball (1932) writes "—found yellow nymphs swarming on Bayberry (*Myrica carolinensis*) at Woods Hole, Massachusetts, July 7, 1925, a few days later an immature adult that was determined as *fulvus* was taken from this spot."

Comparative Notes: This species, with its subspecies *collaris*, has genitalia which differ considerably from any other—the long, slender bifid paraphyses and the long, slender shaft of the aedeagus easily separate it from any other species. It has a relatively wide distribution, but from the small number of specimens, it seems to be relatively uncommon.

33. *Scaphytopius (Cloanthanus) fulvus collaris* (Sand. and DeLong)

Platymetopius collaris, Ann. Ent. Soc. Amer., XII, p. 232, 1919.

Resembles *fulvus*, but with most of pronotum and basal half of scutellum dark brown and remainder of dorsum ivory to light fulvous. Length: female 5.3 mm., male 4.8 mm.

Color: Crown ivory to light fulvous; wedge and arcuate markings on disc often indicated. Pronotum brown, except for yellow to fulvous area on each lateral margin, slender median vitta, and dots throughout. Scutellum with basal half dark brown and apical half yellow to fulvous. Face completely yellow to fulvous and without irrorations. Forewings translucent pale fulvous, veins brown on apex and costal area.

Structural Characteristics: Crown about one and one-third as long as width between eyes, anterior margin straight to slightly convex on each side of bluntly pointed apex. Pronotum about as long as crown, two and one-half times as wide as length at middle and four times length behind eyes. Clypeus about twice as long as width at ocelli, slightly sinuate at antennae. Clypellus long and somewhat enlarged near apex. Face in lateral view almost straight in male, slightly concave between anterior margin of eyes in female. Forewing with typical venation; ten recurved veins to costa.

Genitalia: Male and female genitalia about the same as for *fulvus*.

Types: Holotype ♂, allotype ♀, Penfield, Clearfield Co., Pennsylvania, Aug. 24, 1918, Sanders, here designated, in the DeLong Collection, Ohio State University, Columbus, Ohio. The holotype was on hand for study.

Host Plants: The original description gives *Vaccinium* sp. as the plant from which the type material was taken.

Comparative Notes: This is apparently a rather rare species, as only the type specimen named above has been seen by the author. Except for color, it agrees with *fulvus* in almost every respect.

34. *Scaphytopius* (*Cloanthanus*) *frontalis* (Van Duzee)

Platymetopius frontalis, Van Duzee, E. P., Can. Ent., XXII, p. 112, 1890.

Resembles *loricatus*, but with lateral margins of face dark and with paraphyses. Length: female 4.1 mm., male 3.8 mm.

Color: Crown fuscous to black with light markings as follows: narrow line along anterior margin; wedge; a large irregular spot on margin before each eye and a smaller pair between these; two pairs of dots on posterior margin, one pair next eyes and another near median suture. The light spots are usually smaller on the male. Pronotum and scutellum about same color as crown with typical light markings. Clypeus yellow with brown markings near base, forming large sharksmouth and other irregular markings along basal margin. Clypellus and lorae yellow. Genae yellow mesially, infuscated behind eyes and along lateral margins, except for distinct white vitta behind eye; less distinct, short vitta near ocellus. Forewing semihyaline black, pale fulvous along veins; milky aeroles throughout.

Structural Characteristics: Crown about one and one-half times as long as width between ocelli, anterior margin slightly convex on each side of blunt apex; wedge about one-fourth length of crown. Pronotum about three-fourths as long as crown, about two and one-half times as wide as length at middle and four times length behind eye. Clypeus about twice as long as width at ocelli, margins almost straight. Clypellus relatively slender, slightly broadened near base. Face in lateral view almost straight. Forewing with typical venation, several vein-like marks in brachial cell and nine or ten recurved veins to costa.

Genitalia: Valve roughly triangular, almost as long as greatest width, posterior margin convex on each side of a pointed apex; anterior margin with a wide, short, median lobe. Paraphysis long, slender, almost parallel-margined to a sharp apex. Shaft of aedeagus "L"-shaped, curved on basal two-fifths, almost parallel-margined to blunt apex. Styles about four times as long as basal width, large lobe on outer margin just before relatively long, slender, finger-like, apical process.

Last ventral segment of female about three-fifths as long as greatest width, latero-posterior margin roughly circular with a small median notch.

Types: Lectotype ♂, Buffalo, N. Y., June, 1887, E. P. Van Duzee. Lectoallotype, same data, here designated. Both types on hand for study and located in Iowa State College Museum, Ames, Iowa.

Additional Material Studied: This species is one of the most common of the genus and occurs throughout the United States from Utah eastward and possibly into Mexico, as specimens are on hand from Brownsville, Texas. Hundreds of specimens are on hand from all parts of this area.

Host Plants: Many host plants are recorded for this species. Specimens were examined collected from hemp in Missouri and *Heterotheca subaxillaris* in Texas. Ball (1932) writes "—was taken in numbers on pure stands of wild blackberry, (*Rubus* sp.) in New Jersey, the District of Columbia and again at Gainsville, Florida." Osborn (1915) writes "ordinarily occurs in grass-land and is very frequently taken in adult form from oak trees." Fletcher (1930) gives native grassland as the host plant in Texas. Gibson and Cogan (1915) give clover, alfalfa, grasses and woody shrubs as the hosts in Missouri. Van Duzee (1894) gives oak bushes as the host plant at Buffalo, N. Y.

Comparative Notes: This species is the only blackish species with a short crown and yellow clypeus. Specimens from southern Texas and Florida are smaller than those collected farther north, but are identical in other respects.

35. *Scaphytopius* (*Cloanthanus*) *cinnamoneus* (Osborn)

Platymetopius magdalensis var. *cinnamoneus*, Osborn, Herbert, Bull. Maine Agri. Exp. Sta., No. 238, p. 114, 1915.

Resembles *magdalensis* but with indistinct markings on crown, lighter face and with more slender paraphyses. Length: female 5 mm., male 4.5 mm.

Color: Crown fulvous mottled with light, with white markings as follows: thin line along anterior margin; wedge; and two spots along posterior margin, one next each eye and one on each side of median suture. Pronotum fulvous, irregularly marked with brown, pale vittae usually faintly evident. Scutellum fulvous to light brown with typical light markings. Face bright fulvous, slightly clouded along lateral margins, sharksmouth and vitta behind eye faintly indicated. Forewing semihyaline light fulvous, with numerous brown irrorations, becoming fuscous on apex and outer anteapical cell; veins brown, darker on costa.

Structural Characteristics: Crown almost one and one-half times as long as width between eyes, anterior margin only slightly convex on each side of bluntly pointed apex; wedge over one-third length of crown. Pronotum about three-fourths as long as crown, two and one-fourth times as wide as length at middle and three and one-half times as wide as length behind eyes. Clypeus about twice as long as width at ocelli, somewhat constricted at antennae, slight concavity along sharksmouth. Clypellus relatively stout and enlarged near apex. Face in lateral view almost straight. Forewing with vein-like marks in brachial cell and about nine recurved veins to costa.

Genitalia: Valve about one and one-third as wide as length at middle, posterior margin bell-shaped to small, teat-like, rounded process at apex. Paraphysis with large basal, bulb-like process, almost parallel-margined to sharp apex. Aedeagus "L"-shaped, narrowest near slightly enlarged apex. Styles about four times as long as basal width, slightly sinuate near basal third, lobe on outer margin before stout, finger-like process on apical two-fifths.

Last ventral segment of female slightly less than twice as wide as length at middle, lateral margins slightly convex; posterior margin almost straight with small median notch.

Types: Lectotype ♂, Aug. 30, 1913, lectoallotype ♀, Aug. 5, 1913, Orono, Maine, Herbert Osborn, here designated, in the Snow Entomological Collections, were on hand for study.

Additional Material Studied: (Manitoba) Red Deer River, Mafeking, Birch River and Swan River. (Michigan) Thompson, Cheboygan Co., Bryants Bog and Mud Lake. (Minnesota) Eveleth and Itasca Park. (Wisconsin) Brule.

Host Plants: A long series was collected on *Chamaedaphne* at Itasca Park, Minnesota, by R. H. Beamer, and a pair was taken from the same host at Bryants Bog, Michigan, by H. B. Hungerford. "Bear berry" was given as the host of a long series collected at Mafeking, Manitoba, by R. H. Beamer. Both of these plants are in the heath family, so it is possible that the species is restricted to the family or certain plants in the family.

Comparative Notes: Although described as a variety of *magdalensis*, the gentalia show this species to be more closely allied to *frontalis* than to any other. Several male specimens collected at

Toronto, Canada, in September are much darker and may represent the fall brood of this species.

36. *Scaphytopius (Cloanthanus) deltensis* Hepner

Scaphytopius (Cloanthanus) deltensis, Hepner, L. W., Jour. Kan. Ent. Soc., XIX, p. 97, 1936.

Resembling *fuscifrons*, but with pointed plates in male and last ventral segment of female produced at middle. Length: female 4.8 mm., male 4.4 mm.

Color: Crown irregularly mottled fuscous and ivory, lightest along anterior margin. Pronotum about same color as crown, vittae evident only on lateral margins. Scutellum dark brown, with typical white markings and usually a large orange area near each basal corner. Face fuscous and light mottled; vitta behind eye, shorter ones near ocelli and antennae and long sharksmouth, light. Forewings semihyaline white, fuscous vermiculations throughout, darkest on apical cells, darkest in males; veins fuscous, becoming black on costa.

Structural Characteristics: Crown only slightly longer at middle than next eyes; about as long as width between eyes, anterior margin convex on each side of a very bluntly pointed apex; wedge about one-third length of crown. Pronotum somewhat longer than crown, about two and one-fourth times as wide as length at middle and three and one-half times length behind eyes. Clypeus somewhat less than twice as long as width at ocelli, only slightly constricted at antennae. Clypellus relatively stout, slightly enlarged near apex. Face in lateral view strongly convex. Forewing with several vein-like marks in brachial cell, about twelve recurved veins to costa and sometimes extra cross-veins in clavus.

Genitalia: Valve somewhat shorter than greatest width, posterior margin almost straight on each side of a rounded apex; anterior margin with broad, short median lobe. Paraphysis bulbed at base, slender and completely spiraled on middle, enlarged before sharp apex. Aedeagus curved near base, gradually narrowing to blunt apex, with small teeth on dorsal margin. Styles about three times as long as width at base, somewhat sinuate near middle, distinct lobe on outer margin just before finger-like, apical process.

Last ventral segment of female about as long as greatest width, lateral margins straight and converging; posterior margin convex except for small median notch.

Types: Holotype ♂, allotype ♀, 7 ♀ and 1 ♂ paratypes, Delta, California, June 28, 1935, P. W. Oman, in the National Museum, Washington, D. C. Additional paratypes as follows: 1 ♀, Mt. Shasta, June 29, 1935, P. W. Oman; 8 ♀ ♀, Delta, June 28, 1935, R. H. Beamer.

Host Plants: The host plant is not known.

Comparative Notes: This species superficially resembles *fusci-frons,* but can be separated easily by the external genitalia.

37. *Scaphytopius (Cloanthanus) dorsalis* (Ball)

Platymetopius frontalis var. *dorsalis,* Ball, E. D., Ent. News, XX: p. 164, 1909.
Platymetopius bicolor, DeLong, D. M., Ohio Jour. Sci., XVII: p. 38, 1916.

Resembling *frontalis* but with crown light and without markings and without white aeroles in forewing. Length: female 4.8 mm., male 4.5 mm.

Color: Crown ivory to yellow without markings. Pronotum dark brown, fading to yellowish along anterior and lateral margins; vittae very faintly indicated in male, mottled ivory with large, dark brown spot near each basal corner in female. Face fulvous, slightly darker behind eyes. Forewing opaque dark chocolate brown with yellow apex in male, veins light brown; apex of clavus and apex of corium semihyaline, darkest on outer anteapical cell in female.

Structural Characteristics: Crown about one and one-third as long as width between eyes, anterior margin slightly convex on each side of pointed apex. Pronotum almost as long as crown, about two and one-half times as wide as length at middle and about four times length behind eyes. Clypeus about twice as long as width at ocelli, slight concavity inside each eye, only slightly constricted, if at all, at antennae. Clypellus relatively long, evenly and slightly enlarged from near base to near apex. Face in lateral view almost straight. Forewing with typical venation, several vein-like marks in brachial cell and six or seven recurved veins to costa.

Genitalia: Valve almost as long as basal width, posterior margin concave on each side of a bluntly pointed apex; anterior margin with median lobe. Paraphysis with basal bulb, slender to outer third, with distinct lateral process before enlarged, sharply pointed apex. Aedeagus curved near middle, broadest on basal half. Styles slightly over three times as long as basal width, sinuate near middle, small lobe on outer margin before long finger-like apical process.

Last ventral segment of female about five-eighths as long as greatest width, latero-posterior margin broadly angled near middle on each side of a small median notch at apex.

Types: This species was described from two female types from Onaga, Kansas. Lectotype female, Onaga, Kansas, June 27, here designated, in the National Museum, Washington, D. C. Allotype male, Saratoga, Union Co., July 17, 1877, Uhler, here designated, in the Snow Entomological Collections. The holotype of *bicolor* was on hand for study, as well as the designated allotype of *dorsalis*.

Additional Material Studied: 1 ♀ with no collection data.

Host Plants: The host plant is not known.

Comparative Notes: This species is probably more closely related to *scriptus* than to any other species, but appears to be distinct. It evidently is quite rare, as the two female types, the pair studied, and the male type of *bicolor* are the only ones recorded.

38. *Scaphytopius* (*Cloanthanus*) *nigrifrons* (DeLong)

Platymetopius nigrifrons, DeLong, D. M., Conn. State Geological and Nat'l. Hist. Surv. Bull. 34, p. 103, 1923.

Resembling *frontalis*, but darker, with dark clypeus and with genital paraphyses enlarged near apex. Length: female 4.6 mm., male 4 mm.

Color: Crown black in male, fuscous in female, with light markings as follows: thin line along anterior margin; wedge and long, irregular, oblique mark on each side (in female these oblique marks may be broken into two more or less circular areas); two pairs of dots on posterior margin, one next each eye and one on each side of median suture (in the female, there is usually two dots on each side of median suture). Pronotum black with fulvous irrorations, male darkest; vittae evident. Scutellum fuscous to black with light markings at least indicated, female lighter. Face fuscous to black with light dots, and light markings as follows: vitta along posterior margin between eyes, long sharksmouth, faint vitta behind eye and shorter ones in front of eye near ocelli and antennae; face darkest on margins of genae and apex of clypellus. Forewings opaque black and fulvous, darkest in male, a few white aeroles on apical third.

Structural Characteristics: Crown about one and one-third as long as width between eyes, anterior margin convex on each side of bluntly pointed apex; wedge about one-third length of crown. Pronotum about as long as crown, two and one-half times as wide as length at middle and about four times as wide as length behind eyes. Clypeus about twice as long as width at ocelli, definitely constricted at antennae. Clypellus stout, enlarged near apex. Face in lateral view convex. Forewing with irregular marks in brachial cell, seven or eight recurved veins to costa and often extra veins in clavus.

Genitalia: Valve about three-fourths as long as wide; posterior margin bell-shaped with a teat-like apical process; anterior margin with broad median lobe. Paraphyses enlarged on apical two-fifths with a sharp, lateral lobe near beginning of enlargement. Aedeagus in lateral view curved, narrowest near apex, and with small spines along dorsal margin. Styles about four times as long as basal width, sinuate near middle, lobe on outer margin before finger-like process on apical fourth.

Last ventral segment of female about one and one-half times as wide as length at middle, latero-posterior margin rounded.

Types: Holotype ♂, North Branford, Conn., July 12, 1921, B. H. Walden, in the DeLong Collection, Ohio State University, Columbus, Ohio.

Additional Material Studied: (Connecticut) New Haven. (Maryland) Plummers Island. (Ohio) Hocking Co.

Comparative Notes: This black species, without light aeroles in wing, is quite distinctive, darker than *frontalis,* and with a black face; somewhat like *scriptus,* but darker.

39. *Scaphytopius* (*Cloanthanus*) *amplinotus* Hepner

Scaphytopius (Cloanthanus) amplinotus, Hepner, L. W., Jour. Kan. Ent. Soc., XIX: p. 98, 1946.

Resembles *verecundus,* but larger, with large white spots throughout, and with lateral projection near apex of genital paraphysis. Length: female 4.6 mm., male 4 mm.

Color: Crown orange-fulvous with white markings as follows: thin line on anterior margin; wedge and oblique line on each side; three pairs of spots across crown before eyes, the median pair about size of wedge; on posterior margin a large spot at middle and a smaller spot next each eye. Pronotum same color as crown with irregular white vittae distinct and sometimes quite broad. Scutellum same color as crown, with typical markings and irregular markings, especially on disc, white. Genae and clypeus fulvous to yellow; area next lorae, vitta behind eye and shorter ones near antennae and ocelli, white. Forewing semihyaline orange-fulvous with large white areas throughout; veins dark on apical half and on costa.

Structural Characteristics: Crown about twice as long as width between eyes, anterior margin almost straight to pointed apex. Pronotum about three-fourths as long as crown, about two and one-half times as wide as length at middle and three and one-half times length behind eye. Clypeus over twice as long as width at ocelli, slender, only slightly constricted, if at all, at antennae. Clypellus slender and slightly enlarged near apex. Forewing usually with claval veins nearest each other at cross vein, several vein-like marks in brachial cell and about ten recurved veins to costa.

Genitalia: Valve about as long as greatest width, posterior margin convex on each side of pointed apex; anterior margin broadly rounded. Paraphyses slender on basal four-fifths, enlarged, with a short lateral process just before sharply pointed apices. Shaft of aedeagus in ventral view almost parallel-margined, in lateral view, long, slender, slightly curved and without processes. Styles slightly over three times as long as basal width, sinuate just beyond basal third, slightly enlarged on outer margin just before finger-like, apical process.

Last ventral segment of female with latero-posterior margin broadly rounded and with a short, broad median lobe.

Types: Holotype ♂, allotype ♀, and 3 ♀ and 26 ♂ paratypes, Hudson, Florida, July 13, 1939, R. H. Beamer, in the Snow Entomological Collections. Additional paratypes as follows: (Florida) 2 ♀ ♀, 1 ♂, Hudson, July 13, 1939, P. B. Lawson; 13 ♀ ♀, 19 ♂ ♂, Hudson, July 13, 1939, P. W. Oman; 2 ♀ ♀, Likely, July 24, 1934, R. H. Beamer; 1 ♀, 2 ♂ ♂, Lacoochee, Aug. 18, 1930, R. H. Beamer; 1 ♂, Eustis, Oct. 12, 1932, J. O. Pepper; 1 ♂, Old Town, July 11, 1939, P. B. Lawson and 1 ♂, Sanford, July 12, 1928, E. D. Ball. (Georgia) 1 pair, Okefenokee Swamp, July 25, 1939, 7 ♀ ♀, 1 ♂, July 27, 1939, and 2 ♀ ♀, 6 ♂ ♂, Aug. 3, 1934, R. H. Beamer.

Host Plants: The host plant is not known.

Comparative Notes: This species is the only one in this country with large white, unmargined spots covering the entire dorsum.

40. *Scaphytopius* (*Cloanthanus*) *osborni* (Van Duzee)

Platymetopius osborni, Van Duzee, E. P., Ann. Ent. Soc. Amer., VII: p. 229, 1910.

Resembles *fuscifrons* but without blunt plates of male and with a different pattern on crown. Length: female 4.5 mm., male 4.3 mm.

Color: Crown brown with light markings as follows: short wedge; two large dots on each side between wedge and eye, sometimes united, a pair of short dashes behind wedge and two pairs of dots along posterior margin, one next each eye and one on each side of median suture. Pronotum gray and fulvous with brown to fuscous irrorations; vittae evident. Scutellum fulvous with typical light markings. Face ivory with brown to fuscous coarse irrorations, large irregular white blotches in lorae and clypellus and on adjoining area of genae; vitta behind eye and shorter ones near ocelli and antenna, distinct. Forewings semihyaline fulvous with dark irrorations and large milky aeroles throughout.

Structural Characteristics: Crown only slightly longer than width between eyes, only slightly longer at center than next eyes; apex rounded; wedge about one-fourth length of crown. Pronotum slightly longer than crown, about two and one-half times as wide as length at middle and four and one-half times length behind eyes. Clypeus about twice as long as width at ocelli, relatively broad, constricted at antennae. Clypellus considerably enlarged near apex. Face in lateral view definitely convex. Forewing with venation typical, several vein-like markings in brachial cell and about ten recurved veins to costa.

Genitalia: Valve almost as long as greatest width, posterior margin roughly bell-shaped with a small, rounded tip; anterior margin with short, broad median lobe. Paraphyses slender on basal half, gradually broadened to a sharp point on outer third before sharply pointed apices. Aedeagus small, parallel-margined and semicircular. Styles more than three times as long as basal width, slightly sinuate near middle, small lobe on outer margin before finger-like process on apical fourth.

Last ventral segment of female about twice as wide as length at middle, latero-posterior margin with small lobe on each side of median lobe with small median notch.

Types: Holotype ♂, allotype ♀, Los Amates, Guatamala, Jan. 17, 1905, and Feb. 28, 1905, J. S. Hine, here designated, in the Osborn Collection, Ohio State University, Columbus, Ohio.

Material Studied: (Texas) 1 ♂, Marfa, Aug. 7, 1936, E. D. Ball. (Mexico) Tamazunchale and Jacala.

Host Plants: The host plant is not known.

Comparative Notes: The one male from Marfa, Texas, is the only record of this species collected in the United States. Since it was collected during the same month that Dr. Ball collected in Mexico, it is possible that the specimen was mislabeled, in which case it does not occur in this country.

41. *Scaphytopius* (*Cloanthanus*) *andromus* (Ball)

Nasutoideus andomus, Ball, E. D., Can. Ent., LXIII, p. 221, 1931.

Resembling *magdalensis*, but smaller, and with process on paraphysis near apex. Length: female 4 mm., male 3.6 mm.

Color: Crown fulvous with white marks as follows: line along anterior margin; wedge and indistinct oblique line on each side; a pair of relatively large spots on disc before eyes and a pair of longer marks between these; on posterior margin, a spot at center and next each eye. Pronotum about same color as crown, dark irrorations, especially in male, light vittae usually evident, although often indistinct. Scutellum fulvous with typical light markings, usually some fuscous markings in male. Face fulvous, mottled with light, white markings as follows: long sharksmouth, vitta behind eye and shorter ones near ocellus and antennae. Apex of clypellus only slightly darkened, if at all. Face in lateral view slightly concave between anterior margin of eyes. Forewing semihyaline fulvous with small milky aeroles throughout.

Structural Characteristics: Crown a little more than one and one-half times as long as width between eyes, anterior margin slightly convex on each side of bluntly pointed apex; wedge over one-fourth length of crown. Pronotum about three-fourths as long as crown, about two and one-half times as wide as length at middle and four times length behind eyes. Clypeus about twice as long as width at ocelli, very slightly sinuate near antennae. Clypellus relatively slender, enlarged near apex. Forewing often with extra cross-veins in clavus, several vein-like marks in brachial cell and about nine recurved veins to costa.

Genitalia: Valve a little wider than length at middle, posterior margin convex on each side of very bluntly pointed apex; anterior margin with broad, rounded lobe on median half. Paraphyses longer than plates, coiled near base, small lateral process on outer third before enlargement near sharply pointed apices. Aedeagus in lateral view almost straight, small teeth on dorsal margin on apical half. Styles about three times as long as basal width, slightly sinuate near middle, lobe on outer margin before finger-like apical process.

Last ventral segment of female slightly less than twice as wide as length at middle, latero-posterior margin unevenly rounded.

Types: Holotype ♂, April 18, 1927, allotype ♀, July 7, 1926, Sanford, Florida, E. D. Ball, in the National Museum, Washington, D. C. One ♂ paratype, Sanford, Florida, July 7, 1926, E. D. Ball, on hand for study.

Additional Material Studied: (Florida) Ft. Mead, Branford, La Belle, Childs, Elfers, Sanford, Gainesville.

Host Plants: Ball (1932) writes, "Nymphs and adults were taken commonly in Florida on the fetter bushes (*Pieris* sp.)."

Comparative Notes: The male of this species somewhat resembles *scriptus,* but the female is very light and quite distinctively colored.

42. *Scaphytopius (Cloanthanus) verecundus* (Van Duzee)

Platymetopius verecundus, Van Duzee, Ann. Ent. Soc. Amer., III, p. 227, 1910.

Resembling *magdalensis,* but smaller, with a longer crown and without lateral process on paraphysis. Length: female 4.2 mm., male 4 mm.

Color: Crown mottled brown with sometimes a reddish tinge and white markings as follows: incomplete narrow line along anterior margin, wedge and oblique line on each side; two large irregular marks sometimes fused between each eye and wedge, and a slender line about size of wedge on each size of median suture; on posterior margin, a large spot at middle and a smaller one next each eye. Pronotum usually somewhat lighter than crown, fuscous markings thickest near posterior margin, light vittae usually evident, especially on sides. Scutellum orange with typical light markings. Clypeus mottled brown and fulvous with irregular light line along posterior margin; relatively long sharksmouth. Lorae and clypellus mottled brown, with apex of clypellus black. Genae mottled, darkest along lateral margins; irregular area next lorae, vitta behind eye and shorter ones near ocellus and antenna, white. Forewing semihyaline fulvous with irregular milky aeroles throughout; veins darkest at apex and on costa; outer anteapical cell usually darkest.

Structural Characteristics: Crown over twice as long as width between eyes, anterior margin almost straight on each side of relatively sharp crown, especially in female; wedge slightly less than one-fourth length of crown. Pronotum less than two-thirds as long as crown, about two and one-half times as wide as length at middle and three and one-half times length behind eyes. Clypeus almost two and one-half times as long as width at ocelli; only slightly sinuate near antennae, slight depression at end of sharksmouth.

Clypellus broadest near apex. Face in lateral view concave between anterior margin of eyes. Forewing with claval veins approaching each other at cross-vein, several vein-like marks in brachial cell and about ten recurved veins to costa.

Genitalia: Valve almost as long as greatest width, posterior margin oval; anterior margin with lobe on median half. Paraphyses about two and one-half times as long as styles, slender, enlarged on outer fourth before sharp apices. Aedeagus in lateral view almost straight and parallel-margined, small teeth on dorsal margin. Styles about three times as long as greatest width, sinuate just before middle, lobed on outer margin before a finger-like process on apical third.

Last ventral segment of female slightly less than twice as wide as length at middle, latero-posterior margin rounded to a broad, short, median lobe.

Types: Lecotype ♀, Fort Myers, Florida, May 3-5, 1908, Van Duzee, in the National Museum, Washington, D. C., here designated. This was the only cotype located.

Material Studied: (Florida) Sanford, Hobe Sound, New Port Richey, Hilliard, Wakulla, Branford, Yankeetown, Hibernaria, Alachua Co., Lacoochee and Old Town. (Georgia) Adel, Folkston and Okefenokee Swamp. (Mississippi) Ireland. (South Carolina) Plantersville, Conway and New Bern. (North Carolina) Shallotte, Wilmington and Rocky Point.

Host Plants: Ball (1932) writes "—taken abundantly at Sanford, Florida, on mixed stands of low shrubs of the families *Ericaceae* and *Vacciniaceae* growing in flat woods."

Comparative Notes: The sharp crown and reddish color readily separate this species from any other.

43. *Scaphytopius (Cloanthanus) insolitus* Hepner

Scaphytopius (Cloanthanus) insolitus, Hepner, L. W., Jour. Kan. Ent. Soc., XIX: p. 99, 1946.

Resembling *verecundus* somewhat, but smaller, with shorter crown and lobed genital paraphyses. Length: female 3.4 mm., male 3 mm.

Color: Crown mottled reddish, with light markings as follows: thin wedge, three pairs of long marks in band before eye, the median pair often united with a pair of spots near median suture on posterior margin. Pronotum, scutellum and face more or less mottled reddish-fulvous, sharksmouth indicated. Forewing translucent dark fulvous, becoming fuscous on coastal and apical margins.

Structural Characteristics: Crown about one and one-half times as long as width between eyes, anterior margin almost straight on each side of pointed apex. Pronotum about four-fifths as long as crown, two and one-third times as wide as length at middle and four and one-half times length behind eyes. Clypeus twice as long as width at ocelli, somewhat sinuate at antennae. Clypellus broad and only slightly enlarged at apex. Face somewhat convex in lateral view. Forewing with typical venation, vein-like marks in brachial cell and about ten recurved veins to costa.

Genitalia: Valve somewhat wider than length at middle, posterior margin bell-shaped, anterior margin with large lobe on median half. Aedeagus in lateral view straight, converging toward blunt apex, toothed along dorsal margin. Paraphyses slender on basal two-thirds, somewhat enlarged toward apices with small, pointed lateral lobes. Styles about two and one-half times as long as basal width, somewhat sinuate on basal fourth, slightly lobed on outer margin before finger-like process on apical third.

Last ventral segment of female about three-fifths as long as greatest width, latero-posterior margin rounded.

Types: Holotype ♂, allotype ♀, Sanford, Fla., June 17, 1927, E. D. Ball, in the National Museum, Washington, D. C.

Host Plants: The host plant is not known.

Comparative Notes: This small species, reddish and distinctively marked, is undoubtedly rare, as only the one pair is known.

44. *Scaphytopius* (*Cloanthanus*) *magdalensis* (Provancher)

Platymetopius magdalensis, Provancher, L., Petite Faune Entomologique du Canada (VIII, Hemiptera) III, p. 275, 1889.

Platymetopius obscurus, Osborn, Ohio Nat., V: p. 274, 1905.

Platymetopius carolinus, Lathrop, Ohio Jour. Sci., XVII: p. 123, 1917.

Cloanthanus atratus, DeLong, D. M., Ohio Jour. Sci., VL: p. 27, 1945.

Cloanthanus vaccinium, DeLong, D. M., Ohio Jour. Sci., VL: p. 27, 1945.

Resembling *acutus*, but with shorter crown, with different color pattern, a uniformly colored face and with a sharp process on genital paraphysis near middle. Length: female 4.8 mm., male 4.5 mm.

Color: Crown mottled fulvous-brown with light markings as follows: wedge, irregular markings from eye along anterior margin; two or three pairs of spots, sometimes fused, forming a very irregular band across crown before eyes; two pairs of spots on posterior margin, one pair next median suture, the other next eyes. Pronotum fulvous-brown, more or less irrorate with dark, light vittae usually very faintly indicated. Scutellum fulvous with typical white markings. Clypeus brown and light mottled, darkest in area of long sharksmouth. Lorae and clypellus as in clypeus, but with a large light spot on each loral sclerite and apex of clypellus infuscated. Genae same color as clypeus, darkest on disc, white vitta behind eye and shorter ones near ocellus and antenna, distinct. Forewing semihyaline yellow with numerous milky aeroles; veins brown, becoming fuscous at apex and on costa, darker in males.

Structural Characteristics: Crown about one and one-half times as long as width between eyes, anterior margin slightly convex on each side of bluntly pointed apex; wedge about one-fourth length of crown. Pronotum almost as long as crown in male, shorter in female, about two and one-half times as wide as length at middle and a little less than four times length behind eyes. Clypeus twice as long as width at ocelli, slightly sinuate at antennae. Clypellus slightly enlarged at apex. Forewing with typical venation, numerous vein-like marks in brachial cell and nine or ten recurved veins to costa.

Genitalia: Valve about three-fourths as long as greatest width, roughly triangular, posterior margin somewhat convex on each side of bluntly pointed apex; anterior margin with broad, short lobe. Paraphyses long, slender on basal half, small, sharp process near middle, enlarged beyond to sharp apices. Aedeagus in lateral view rounded near base, almost parallel-margined on basal half, slightly narrowed to blunt apex; small tooth-like processes on dorsal margin near apex. Styles about twice as long as basal width, greatly sinuate near middle, large lobe on outer margin before finger-like apical process.

Last ventral segment of female slightly over twice as long as greatest width, latero-posterior margin roughly circular.

Types: The type of *magdalensis* should be in the Provincial Museum, Quebec, Canada. The type of *obscurus* is in the Osborn Collection, Ohio State University, Columbus, Ohio. The type of *carolinus* was destroyed in the Clemson College fire some years ago. Types of *atratus* and *vaccinium* in Illinois Natural History Survey collection, Urbana, Ill. Paratypes of *obscurus, atratus* and *vaccinium* were on hand for study.

Additional Material Studied: Specimens are on hand from many points from Florida to Maine west of the Rocky Mountains, as well as from eastern Canada.

Host Plants: Ball (1932) writes "Dr. Osborn credits this to blueberries. Dr. Irene Debroscky tells me that she has carried this species through from egg to adult on the cranberry. The writer has taken this dark-faced species while sweeping shrubs in low damp places in northern Wisconsin and again at Woods Hole, Massachusetts, both situations where cranberries are abundant." Horsfall (1916) writes of the species in Missouri "From blackjack brush in July." Lowry (1933) regarding this species in New Hampshire writes "rare on Vaccinium pennsylvanicum."

Comparative Notes: As might be expected from its wide range, this species varies considerably. Specimens from Florida are much smaller, but the small process near middle of paraphysis readily separates this species from any other, with the exception of *nigrifrons,* which is much darker.

45. *Scaphytopius* (*Cloanthanus*) *scriptus* (Ball)

Platymetopius scriptus, Ball, E. D., Ent. News, XX: p. 165, 1909.
Cloanthanus varius, DeLong, D. M., Ohio Jour. Sci., VL: p. 26, 1945.

Color: Crown brown to fuscous in male, fulvous in female, with light markings as follows: narrow line along anterior margin; wedge and short oblique line on each side; two irregular marks on each side, often coalesced, half-way between eye and wedge, and a smaller, longer mark, often indistinct, extending on each side of median suture from near wedge to base of crown; two pairs of spots on posterior margin, one pair near median suture and another next eyes. Pronotum same color as crown, light vittae irregular, but present. Scutellum same color as crown with typical light markings. Face about same color as crown with light markings as follows: relatively long sharksmouth, vitta behind eye and shorter ones at ocelli and antennae. Forewing semihyaline fulvous with cells in corium of male almost entirely fuscous except next veins, fuscous area in female restricted to outer anteapical cell and adjoining area of costa; light aeroles throughout, but especially near apex.

Structural Characteristics: Crown about one and one-third as long as width at ocelli, anterior margin slightly convex on each side of bluntly pointed apex; wedge about one-fourth length of crown. Pronotum slightly shorter than crown, about two and one-half times as wide as length at middle and four and one-half times length behind eyes. Clypeus over twice as long as width at ocelli, evenly narrowed beyond antennae in male, slightly sinuate in female; slight concavity at end of sharksmouth. Clypellus relatively stout, broadened near apex. Face in lateral view somewhat concave between anterior margin of eyes. Forewing with typical venation, several vein-like marks in brachial cell and about ten recurved veins to costa.

Genitalia: Valve almost as long as greatest width, posterior margin slightly convex on each side of bluntly pointed apex; anterior margin with broad, rounded lobe on median half. Paraphyses extending beyond plates, almost parallel-margined to small lateral process on outer fourth before sharp apices. Aedeagus in lateral view almost as long as style, tooth-like marks on dorsal surface, apex flattened. Styles about three times as long as basal width, inner margin abruptly enlarged near middle, outer margin with distinct lobe on middle before finger-like apical process.

Last ventral segment of female one and two-thirds as wide as length at middle, latero-posterior margin evenly rounded to small median lobe.

Types: Lectotype ♂, Onaga, Kansas, May 27, 1902, here designated, in the National Museum, Washington, D. C. It is presumed that the collector was Crevecoeur. Allotype ♀ and one ♀ parallotype, Douglas Co., Kansas, Aug., 1923, W. Robinson, here designated, in the Snow Entomological Collections. Additional parallotype ♀ ♀ as follows: (Kansas) 1, Leavenworth Co., July 1, 1924, R. H. Beamer; 3, Douglas Co., June 6, 1918, C. P. Alexander and 1, Douglas Co., Aug. 28, 1928, P. B. Lawson. (Indiana) 1, Gary, June 24, 1934, M. W. Sanderson. (Tennessee) 1, Clarksville, July 4, 1917, D. M. DeLong and 2, Clarksville, June 26, 1914. (Maryland) 1, Annapolis, Sept. 27, 1931, 1, June 2, 1932, P. W. Oman; 1, Plummers Island, Sept. 2, 1913, R. C. Shannon and 1, Aug. 4, 1907, W. L. McAtee. (Virginia) 1, Dismal Swamp, Aug. 13, 1934, R. H. Beamer; 1, Chincoteague Island, Sept. 22, 1938, J. C. Bridwell; 1, Nelson Co., June 19, 1925, W. Robinson and 1, L. Drummond, Sept. 10, 1933, P. W. Oman. (Mississippi) 1, Shuqulak, July 16, 1930, R. H. Beamer.

Host Plants: The host plant is not known.

Comparative Notes: This species is found over most of the eastern half of the United States, except the extreme south, and is distinguished by its short crown with small markings and heavily marked forewings.

46. *Scaphytopius (Cloanthanus) scriptus meridianus* Hepner

Scaphytopius (Cloanthanus) scriptus subsp. *meridianus*, Hepner, L. W., Jour. Kan. Ent. Soc., XIX: p. 100, 1946.

Resembles *scriptus,* but lighter color, longer crown and more southern in distribution. Length: female 4.7 mm., male 3.8 mm.

Color: Crown mottled brownish, with light markings as follows: wedge; circular area on apical half, broken by three lines behind wedge; irregular area along posterior margin. Pronotum pale fulvous, irregularly marked with brown, vittae only lightly indicated. Scutellum fulvous with typical markings indicated. Face fulvous, mottled with brown, light sharksmouth and vitta behind eye, evident. Forewing semihyaline fulvous, veins and irrorations fuscous in male, fulvous in female.

Structural Characteristics: Crown slightly less than twice as long as width between eyes, anterior margin straight to slightly convex on each side of pointed apex. Pronotum about three-fourths as long as crown, about two and one-third times as wide as length at middle and three and one-half times length behind eyes. Clypeus slightly over twice as long as width at ocelli, slightly, if any, sinuate at antennae. Clypellus broad, enlarged and rounded at apex. Face in lateral view straight in male, slightly concave between anterior margin of eyes in female. Typical venation, vein-like marks in brachial cell and about ten recurved veins to costa.

Genitalia: Valve almost as long as greatest width, posterior margin bell-shaped; anterior margin with broad, short lobe on median third. Shaft of aedeagus in lateral view slightly curved, almost parallel-margined to blunt apex, rugulose area on dorsal margin near apex. Paraphysis slender on basal two-thirds, coiled near middle, slender lateral process before enlarged, sharply pointed, apical portion. Styles about three times as long as basal width, slightly sinuate near middle, distinct lobe on outer margin before bluntly pointed, finger-like apical process.

Last ventral segment of female slightly more than half as long as greatest width, latero-posterior margin rounded.

Types: Holotype ♂, allotype ♀, 2 ♂♂, and 1 ♀ paratypes, Branford, Florida, July 31, 1930, R. H. Beamer, in the Snow Entomological Collections. Additional paratypes as follows: (Florida) 1 ♂, Branford, Aug. 4, 1939, R. H. Beamer; 1 ♀, Branford, July 16, 1934, R. H. Beamer; 1 ♀, Ft. Mead, Aug. 13, 1930, L. D. Tuthill; 4 ♀♀, 1 ♂, Ft. Mead, Aug. 13, 1930, R. H. Beamer;

2 ♀ ♀, Ft. Mead, Aug. 13, 1930, P. W. Oman; 3 ♀ ♀, 2 ♂ ♂, Hilliard, July 28, 1934, M. E. Griffith; 1 pair, Hilliard, Aug. 31, 1930, L. D. Tuthill; 1 pair Hilliard, Aug. 9, 1930, John Nottingham; 1 ♂, Hilliard, July 28, 1934, 1 ♀, Aug. 31, 1930, R. H. Beamer; 2 ♂ ♂, Hilliard, Aug. 19, 1930, P. W. Oman; 1 ♂, Waldo, Aug. 18, 1930, R. H. Beamer; 1 ♀, Wildwood, Aug. 2, 1930, John Nottingham; 5 ♀ ♀, 3 ♂ ♂, Suwanee Spgs., Aug. 2-3, 1939, R. H. Beamer and 1 ♂, Pensacola, July 12, 1934, R. H. Beamer. (Georgia) 2 ♀ ♀, Okefenokee Swamp, July 27, 1939, and 1 ♀, Aug. 3, 1934, R. H. Beamer. (Louisana) 1 ♂, "La. Carl F. Baker."

Additional specimens, somewhat larger, are on hand from Mississippi and Arkansas.

Host Plants: The host plant is not known.

Comparative Notes: This species might be confused with *verecundus* in Florida but lacks the red color, has a shorter crown and is easily separated by the male genitalia.

47. *Scaphytopius* (*Cloanthanus*) *angustatus* (Osborn)

Platymetopius angustatus, Osborn, Rept. of New York State Entomologist (20th Report), p. 518, 1905.

Resembles *acutus*, but pale greenish-fulvous in color, different color pattern on crown and face not greatly darkened on lateral margin. Length: female 5 mm., male 4 mm.

Color: Crown pale greenish-fulvous with indistinct darker markings, especially next eyes and near wedge. Pronotum gray to fulvous with brown irrorations, often lightest on anterior and lateral margins. Scutellum same color or slightly darker than pronotum, typical light markings usually at least indicated. Face about same color as crown, sharksmouth indicated and a few dark irrorations near basal margin. Forewing semihyaline fulvous, often with a faint greenish tinge, light aeroles in anteapical and apical cells and along costa; veins concolorous except at apex and along costa.

Structural Characteristics: Crown about one and one-half times as long as width between eyes, almost straight margined on each side of blunt apex; wedge about one-third length of crown. Pronotum slightly over twice as wide as length at middle and about four times length behind eyes. Clypeus almost straight margined. Clypellus relatively slender, widest near apex. Face in lateral view almost straight. Forewings with venation usually obscured, five or six recurved veins to costa.

Genitalia: Valve about as long as greatest width, posterior margin with sides only slightly convex to a sharp apex; anterior margin only slightly concave to a short, broad median process. Paraphyses slender, about twice as long as styles, somewhat coiled on basal half, narrowest on outer third, only slightly enlarged before sharp apices. Aedeagus simple, curved near middle, slightly produced on dorsal margin. Styles almost three times as long as basal width, constricted on basal third, outer margin lobed on apical third to finger-like apical process.

Last ventral segment of female about one and one-half times as wide as length at middle, latero-posterior margin rounded to a small lobe on each side of median notch.

Types: Lectotype ♀, lectoallotype ♂, Cold Spr. Harbor, New York, Aug. 18, 1904, H. Osborn, here designated, in the Osborn Collection, Ohio State University, Columbus, Ohio. The original description gives Oyster Bay as the collection locality, but Prof. Osborn has said that these two localities are the same, as Cold Spring Harbor is within Oyster Bay. One specimen on hand from the type series.

Additional Material Examined: (Minnesota) Itasca Park and Bena. (Wisconsin) Florence and Brule. (Maine) Fryeburg.

Host Plants: Ball (1932) writes "—has taken this species from Jack pine in several places in northern Wisconsin and has examined specimens from New Hampshire, (Lowry) taken from pitch pine." Lowry (1933) writes regarding the species in New Hampshire "common on pitch and red pine."

Comparative Notes: This greenish species has the crown pattern faint and variable. The color is quite distinctive and so far as known, is the only species in the genus found on pine.

48. *Scaphytopius* (*Cloanthanus*) *calliandrus* (Ball)

Nasutoideus calliandrus, Ball E. D., Can. Ent., LXIII: p. 222, 1931.

Resembling *loricatus*, but with lighter scutellum, much shorter crown and with genital paraphyses. Length: female 4 mm., male 3.8 mm.

Color: Crown mottled fuscous with light markings as follows: wedge; two pairs of marks along anterior margin, a small pair just in front of eyes and a larger oblique pair about half way from eye to wedge; a small dot on each side of posterior end of wedge; on posterior margin, a dot next each eye and one or two pairs of dots between these. Pronotum same color as crown with light vittae indicated, especially on lateral margins. Scutellum ivory to orange, with a few black marks, especially along base and at apex. Face ivory to pale fulvous with irregular brown irrorations, often reduced; sharksmouth small; white vitta behind eye and shorter ones near ocelli and antennae. Forewing semihyaline white with heavy irrorations and areas throughout; veins dark.

Structural Characteristics: Crown about one and two-fifths times as long as width between eyes, anterior margin slightly convex on each side of blunt apex; wedge short. Pronotum about as long as crown, slightly less than two and one-half times as wide as length at middle, and four and one-half times length behind eyes. Clypeus relatively slender, about two and one-half times as long as width at ocelli, slightly sinuate near antennae. Clypellus relatively slender and enlarged near apex. Face in lateral view distinctly convex. Forewing with typical venation, several vein-like markings in brachial cell and about ten recurved veins to costa.

Genitalia: Valve about as long as greatest width, posterior margin straight on each side of truncate apex; anterior margin concave on each side of a slender, rounded lobe at middle. Paraphyses extending well beyond apex of plates, almost parallel-margined to sharp apices. Aedeagus in lateral view "V"-shaped, shaft more slender but about same length as basal part. Styles about three times as long as width at base, "dog-legged" near base, almost parallel-margined to small lobe on outer margin before small finger-like apical process.

Last ventral segment of female about twice as wide as length at middle, posterior margin with a lobe on outer margin and a smaller lobe at middle, with a slight median notch.

Types: Holotype ♀, Tucson, Ariz., June 22, 1930, allotype ♂, Tucson, Ariz., June 21, 1930, E. D. Ball, in the National Museum, Washington, D. C. Two paratypes on hand, ♂, Coolidge Dam, Ariz., May 18, 1930, E. D. Ball and ♀, Tucson, Ariz., Oct. 20, 1929, E. D. Ball.

Additional Material Studied: (California) Mountain Spgs., and Indio. (Arizona) Baboquivari Mts., Miami, Sabino Canyon, Gila Co., Mescal, Patagonia, Tubac, Hope, Nogales, Huachucua Mts., Castle Hot Spgs., Mustang Mts., Alamo, Ruby, Safford, Arivaca, Vail, Congress Jct., Santa Catalina Mts., Tombstone, Atascosa Mts., Quinlan Mts., La Osa River, Empire Mts., Naco and Hereford.

(Texas) San Ygnacio, Three Rivers, Catarina, Alpine, Marathon, Valentine, George West, Corrizo Spgs., Starr Co. and Presidio Co.

Host Plants: Ball (1932) writes "—has been found only on the low clumps of the fairy duster (*Calliandra eriophylla*) in Arizona."

Comparative Notes: This small, dark species is easily recognized by the yellowish to orange scutellum in sharp contrast to the much darker forewings.

49. *Scaphytopius* (*Cloanthanus*) *analis* var. *castranus* (Ball)

Convelinus analis var. *castranus*, Ball, E. D., Can. Ent., LXIII: p. 228, 1931.

Somewhat resembling *nigricollis*, but gray with dark dots, crown more pointed and with genital paraphyses. Length: female 4.1 mm., male 3.8 mm.

Color: Crown ivory with pale brown dots and irrorations; wedge and irregular area on each side without irrorations. Some specimens have only a few dots. Pronotum white with sparsely-spaced dark dots throughout. Scutellum ivory with an orange spot near each basal corner and a few dark dots, especially near apex. Face ivory with scattered dark dots, thickest behind eyes. Forewing semihyaline white with scattered dots, especially along veins; apex and costa darkest.

Structural Characteristics: Crown about one and one-third as long as width between eyes, anterior margin slightly convex on each side of bluntly pointed apex; wedge about one-third length of crown, sometimes indistinct. Pronotum almost as long as crown, two and one-half times as wide as length at middle, and four and one-half times length behind eyes. Clypeus about twice as long as width at ocelli, slightly constricted at antennae. Face in lateral view distinctly convex. Forewing with typical venation, several vein-like marks in brachial cell and about twelve recurved veins to costa.

Genitalia: Valve about as long as greatest width, posterior margin distinctly convex on each side of blunt apex; anterior margin slightly concave on each side of rounded median lobe. Paraphyses slender, almost parallel-margined to sharp apices. Aedeagus in lateral view "U"-shaped, shaft about as long, but more slender than base. Styles about three times as long as basal width, only slightly narrowed at middle, small lobe on outer margin before finger-like apical process.

Types: Holotype ♀, June 21, 1930, allotype ♂, May 10, 1930, both Tucson, Arizona, E. D. Ball, in the National Museum, Washington, D. C.

Material Studied: (Arizona) Tucson, Tempe and Hope.

Host Plants: Ball (1932) writes that this species is confined strictly to the desert iron wood (*Olneya testota*).

Comparative Notes: This species was originally placed in the genus *Convelinus*, but the genitalia are much different from *nigricollis*, showing more resemblance to *calliandrus*. This might be a synonym of *analis*, as that species was not examined by the author.

50. *Scaphytopius* (*Cloanthanus*) *radiatus* Hepner

Scaphytopius (*Cloanthanus*) *radiatus*, Hepner, L. W., Jour. Kan. Ent. Soc., XIX: p. 101, 1946.

Resembling *loricatus*, but lighter, with a dark face, different markings on crown and with genital paraphysis. Length: female 4 mm., male 4 mm.

Color: Crown brown and white mottled, with the white markings giving the appearance of lines radiating toward the apex. Pronotum gray with fuscous markings; vittae evident, especially on sides. Scutellum dark orange to brown with typical light markings. Clypeus fulvous with brown irrorations excepting small sharksmouth. Clypellus and lorae same as clypeus. Genae same as clypeus, darkest behind eye, light vitta behind eye and shorter ones near ocellus and antenna, evident. Forewing semihyaline fulvous with white aeroles or areas; many brown vermiculations throughout especially in male, darkest at apex and on costa.

Structural Characteristics: Crown slightly less than one and one-half times as long as width between eyes; anterior margin slightly convex on each side of bluntly pointed apex; wedge about one-fifth length of crown. Pronotum somewhat shorter than crown, two and one-fourth times as wide as length at middle and about four times length behind eyes. Clypeus slightly more than twice as long as width at ocelli, only slightly sinuate, if at all, at antennae. Face in lateral view convex in male, concave between anterior margin of eyes in female. Forewing with typical venation; several vein-like marks in brachial cell and about nine recurved veins to costa.

Genitalia: Valve about as long as greatest width, posterior margin broadly convex on each side of small teat-like process at apex; anterior margin with small lobe on median half. Paraphyses long, slender and almost parallel-margined to sharp apices. Aedeagus in lateral view roughly "L"-shaped, shaft longer but narrower than basal portion. Styles about four times as long as basal width, slender, with narrow, long lobe on outer margin before outwardly directed apical process.

Last ventral segment of female almost twice as wide as length at middle, lateral margins slightly convergent, posterior margin with small lobe at each side and a broader lobe on each side of small median notch.

Types: Holotype ♂, allotype ♀, and 2 ♂ and 6 ♀ paratypes, Three Rivers, Texas, June 27, 1938, R. H. Beamer, in the Snow Entomological Collections. One ♂ paratype, Sinton, Texas, Dec. 25, 1945, R. H. Beamer.

Host Plants: The host plant is not known.

Comparative Notes: The brown crown, with light lines radiating toward apex, easily separates this species from any other in southern Texas. The male collected in December is darker, with shorter lineations on crown, but the genitalia are almost identical to the type series. From the description of *flavens* DeLong, this species differs in the markings on the crown and with many more markings on the forewing.

51. *Scaphytopius* (*Cloanthanus*) *modicus* Hepner

Scaphytopius (Cloanthanus) modicus, Hepner, Jour. Kan. Ent. Soc., XIX: p. 102, 1946.

Resembling *magdalensis,* but smaller, lighter in color, a different pattern on crown and greatly produced last ventral segment of female. Length: female 3.6 mm., male 3.2 mm.

Color: Crown fulvous except for light markings as follows: short wedge; most of area before eyes; two pairs of spots along posterior margin, one next each eye and one on each side of median suture. Pronotum fulvous with anterior margin lightest; many brown irrorations in male, almost none in female; vittae evident. Scutellum fulvous to orange with typical light markings. Clypeus ivory to fulvous with dark dots, excepting small sharksmouth. Clypellus and lorae same as clypeus, but with fewer markings. Genae darker than clypeus, with vitta behind eye and shorter ones near ocelli and antennae, distinct. Forewing fulvous with few irrorations.

Structural Characteristics: Crown almost one and one-half times as long as width between eyes, slightly convex on each side of bluntly pointed apex; wedge very short. Pronotum almost as long as crown, about two and one-half times as wide as length at middle and four and one-half times length behind eyes. Clypeus slightly over twice as long as width at ocelli, very slightly sinuate at antennae. Clypellus slightly enlarged near apex. Face in lateral view distinctly convex in male, almost straight in female. Forewing with typical venation, several vein-like marks in brachial cell and about nine recurved veins to costa.

Genitalia: Valve about as long as greatest width, posterior margin convex on each side of small median lobe; anterior margin with long, bluntly pointed lobe. Plates very slender, concave on inner margin. Paraphyses relatively stout, slightly longer than plates, broadest on outer fifth before sharply pointed apices. Aedeagus in lateral view short, curved and parallel-margined. Styles about twice as long as basal width, constricted near middle, lobed on outer margin before sharply pointed, outwardly projecting apical process.

Last ventral segment of female about two-thirds as long as greatest width, latero-posterior margin with very long, notched median lobe.

Types: Holotype ♂, allotype ♀, Cameron Co., Texas, Aug. 3, 1928, R. H. Beamer, in Snow Entomological Collections.

Host Plants: The host plant is not known.

Comparative Notes: This is one of the smallest species in southern Texas and the genitalia are quite distinctive—the slender plates, short styles and stout paraphyses of the male and the strongly produced last ventral segment of the female are unlike any other species in the area.

52. *Scaphytopius* (*Cloanthanus*) *pallidicapitatus* Hepner

Scaphytopius (*Cloanthanus*) *pallidicapitatus*, Hepner, L. W., Jour. Kan. Ent. Soc., XIX: p. 103, 1946.

Resembling *castranus* but darker, more distinct pattern on crown and with shorter aedeagus. Length: female 4 mm., male 4 mm.

Color: Crown fulvous marked with brown; wedge, irregular band before eyes and posterior margin without markings. Pronotum gray with sparsely spaced dark dots, vittae visible on lateral margins. Scutellum yellow to fulvous, darkest near basal corners. Face yellow to fulvous with sparsely spaced dots throughout, especially on lateral margins of genae; sharksmouth small; apex of clypellus only slightly darkened. Forewings semihyaline white, darkened posteriorly; veins brown, darkest on posterior and costal margins.

Structural Characteristics: Crown slightly longer than width between eyes, anterior margin slightly convex on each side of blunt apex; wedge relatively small. Pronotum about as long as crown, almost two and one-half times as wide as length at middle and about five times length behind eyes. Clypeus slightly over twice as long as width at ocelli, slightly sinuate near antennae. Clypellus definitely constricted near base and enlarged near apex. Face in lateral view convex. Forewings with vein-like markings in brachial cell, about eleven recurved veins to costa and sometimes extra veins in clavus.

Genitalia: Valve about as long as greatest width, posterior margin distinctly convex on each side of truncate lobe on median third. Plates slender. Paraphyses slender, extending slightly beyond apex of plates, apices pointed. Aedeagus in lateral view very short, slightly curved and parallel-margined. Styles about four times as long as basal width, almost parallel-margined to rounded outer margin before sharply pointed apical process.

Last ventral segment of female about twice as wide as length at middle, lateral margins slightly convergent, posterior margin rounded to very small median notch.

Types: Holotype ♂, allotype ♀, and 3 ♂ and 2 ♀ paratypes, Mission, Texas, July 5, 1938, R. H. Beamer, in the Snow Entomological Collections. Additional paratypes from Texas as follows: 2 ♀ ♀, Starr Co., July 30, 1928, 4 ♀ ♀, 2 ♂ ♂, July 5, 1938, R. H. Beamer; 1 ♀, Starr Co., July 30, 1928, L. D. Beamer; 1 pair, Hidalgo Co., July 30, 1928, R. H. Beamer and 3 pairs, 12 miles west of Mission, Dec. 26, 1945, R. H. Beamer.

Host Plants: The host plant is not known.

Comparative Notes: The very light crown, with speckled face, is distinctive. A specimen from Calcasieu Parish, La., is probably this species, but the abdomen is missing. This species is near *brevis* but the genitalia are different.

53. *Scaphytopius* (*Cloanthanus*) *nigriviridis* (Ball)

Platymetopius nigriviridis, Ball, E. D., Ent. News, XX: p. 163, 1909.

Resembles *trilineatus* in the female, but much smaller and lighter; the male has a much shorter crown, somewhat resembling *castranus*, but more slender and without dots on dorsum. Length: female 4.5 mm., male 3.8 mm.

Color: Crown greenish and with three or four black vittae on each side of median suture, restricted to apical two-thirds. Pronotum yellowish-green, usually darkest on disc, without markings except for sometimes an indication of vittae. Scutellum slightly lighter than pronotum and either without markings or, at most, with two or three short brown lines along anterior margin. Face greenish-yellow, without markings except for a few brown vermiculations along base in area of sharksmouth and sometimes behind eye; sharksmouth short in the male, long in the female. Forewing semihyaline ivory on clavus, brachial, apical and anteapical cells, colorless on remainder of wing; sometimes clouded with brown or with five brown spots on inner half of clavus and apical half of corium; veins colorless except for two or three recurved veins to costa.

Structural Characteristics: Crown about one and one-half times as long as width between eyes in male, two and one-half times basal width in female; anterior margin convex on each side of broadly pointed apex in male, somewhat concave on each side in female; wedge short in male, half length of crown in female. Pronotum three-fourths as long as crown in male, one-half length of crown in female; two and one-fourth times as wide as length at middle and four times length behind eyes. Clypeus about twice as long as width at ocelli in male, two and two-thirds times width in female; only slightly sinuate at antennae, if at all. Clypellus slender, only slightly enlarged at apex. Face in lateral view convex in male, almost straight in female. Forewing with about five recurved veins on costa (with only two or three darkened) and sometimes extra cross-veins in clavus.

Genitalia: Valve wider than greatest length, posterior margin slightly concave near base, remainder evenly rounded; anterior margin concave on each side of relatively long median lobe. Paraphyses extending well beyond plates, enlarged, bulb-like near sharp apices. Aedeagus in lateral view broad and "U"-shaped. Styles short, less than three times as long as basal width, sinuate near middle, lobed on dorsal margin just before short, slender, outward-projecting apical process.

Last ventral segment of female about twice as wide as length at middle, lateral margin slightly convex and converging; posterior margin with slight concavity at middle, small lobe on each side and another small lobe on each outer margin, giving a four-lobed appearance.

Types: Holotype ♀, allotype ♂, Tiajuana, Calif., June 15, 1908, in the National Museum, Washington, D. C., here designated.

Material Studied: (Nevada) Las Vegas. (California) Dulzura. (Arizona) Arivaca, Congress Jct., Hereford, Baboquivari Mts., Santa Rita Mts., Alamo, Yarnell, Tucson Mts., Tubac, Mescal, Patagonia, Miami, Huachucua Mts., Pima Co., Hereford and Bradshaw Mts. (New Mexico) Eddy Co., and White City. (Texas) Davis Mts.

Host Plants: Ball (1932) writes "—taken by the writer in abundance, both nymphs and adults, on *Hymenoclea monogyra* in southern Utah and Arizona." Specimens were examined from Las Vegas, Nevada, labeled *"Hymenoclea salsola."*

Comparative Notes: The greenish color readily separates this species from any other in the genus found in the Southwest. The difference in the length of the crown is not always so great, as some short crowned females will be found, although never so short as in the males.

54. *Scaphytopius* (*Cloanthanus*) *nigriviridis dixianus* (Ball)

Platymetopius nigriviridis var. *dixianus*, Ball, E. D., Ent. News, XX: p. 163, 1909.

Resembles *nigriviridis* but brownish in color and with aedeagus longer and less curved. Length: female 4.5 mm., male 4 mm.

Color: Crown ivory to yellow with brown lineations on apical two-thirds; same color pattern as in *nigriviridis.* Pronotum ivory with vittae indicated by brown dots. Face as in *nigriviridis*, with the green replaced by yellow. Forewings more opaque ivory than *nigriviridis*, with most of wing, excepting brachial cell, containing brown clouded areas, especially in female; usually about three dark recurved veins in costa, others ivory to yellow.

Structural Characteristics: About the same as in *nigriviridis*, except usually with somewhat shorter crown.

Genitalia: About the same as in *nigriviridis* but with aedeagus in lateral view stout, almost parallel-margined, only slightly curved; and with paraphyses narrower near apex.

Types: Holotype female, St. George, Utah, July 24, 1908, in the National Museum, Washington, D. C., here designated. Allotype ♂ and 30 ♂ parallotypes, Wickenburg, Ariz., July 27, 1933, R. H. Beamer, in the Snow Entomological Collections. Additional ♂ parallotypes as follows: (Utah) 1, St. George, Sept. 28, 1928, E. W. Davis and 3, St. George, July 28, 1935, light trap. (California) 3, Palm Spgs., Dec. 22, 1941, R. H. Beamer and 1, Mt. Spgs., July 25, 1938, R. H. Beamer. (Arizona) 2, Tucson, June 18, 1933, R. H. Beamer; 5, Tucson, Nov. 19, 1931, and 1, Sept. 14, 1930, E. D. Ball; 4, Tucson, June 18, 1933, P. W. Oman; 7, Gila Bend, April 26, 1935, E. D. Ball; 19, Red Rock, Aug. 28, 1933, P. W. Oman; 2, Congress

Jct., Aug. 15, R. H. Beamer; 1, Ajo, July 23, 1938, R. H. Beamer and 3, Yuma, Oct. 30, 1931, E. D. Ball.

Host Plants: Ball (1932) writes "—has been taken sparingly from *Hymenoclea salsola* in the same regions."

Comparative Notes: Specimens collected in the winter have a somewhat shorter crown than those collected in the summer. This form seems to be restricted to Arizona and adjacent areas of California and Utah, a somewhat narrower range than for *nigriviridis.*

55. *Scaphytopius* (*Cloanthanus*) *heldoranus* (Ball)

Nasutoideus heldoranus, Ball, E. D., Can. Ent., LXIII: p. 226, 1931.

Resembling *desertanus* but with large black spot near apex of crown and black lines to posterior margin and with genital paraphyses. Length: female 3.8 mm., male 3.4 mm.

Color: Crown white to ivory with large, irregular black blotch near apex and three black lines from this to base; usually a less distinct line inside each eye. Pronotum gray with dark dots, vittae usually faintly indicated. Scutellum white to ivory with a few dark markings along base and on disc. Face light with black dots, lightest on disc of clypeus, darkest behind eye and between anterior margin of eyes; line behind eye and long sharksmouth at least indicated. Forewings opaque white, scattered brown dots throughout; veins consisting of brown dots anteriorly, becoming black lines on costa and at apex.

Structural Characteristics: Crown about one and one-half times as long as width between eyes, almost straight on each side of bluntly pointed apex; wedge short and an irregular circle. Pronotum about three-fourths as long as crown, slightly more than twice as broad as length at middle and about four and one-half times length behind eyes. Clypeus about two and one-half times as long as width at ocelli, slightly concave along sharksmouth, somewhat constricted at antennae. Clypellus stout, only slightly enlarged, if any, near apex. Face in lateral view distinctly convex. Forewing with typical venation, several vein-like markings in brachial cell and about ten recurved veins to costa.

Genitalia: Valve about one and one-half times as wide as length at middle, posterior margin broadly rounded, anterior margin convex. Paraphyses long, straight and slender to sharp apices. Aedeagus small, "J"-shaped, slightly broadest near apex. Styles almost three times as long as basal width, sinuate near middle, slightly lobed on outer margin before finger-like apical process.

Last ventral segment of female about twice as wide as median length, lateral margins convergent, posterior margin convex, with a small, bluntly pointed, median process.

Types: Holotype ♀, allotype ♂, Tombstone, Arizona, June 15, 1930, E. D. Ball, in the National Museum, Washington, D. C. One pair of paratypes, Huachucua Mts., June 15, 1930, E. D. Ball, on hand for study.

Additional Material Studied: (Arizona) Mustang Mts., Oak Creek Canyon, Tombstone, Huachucua Mts. and Patagonia. (New Mexico) Organ, White City and Carlsbad. (Texas) Ft. Stockton, El Paso Co. and Marathon.

Host Plants: Ball (1932) writes "—breeding abundantly on the wild rubber plant (*Parthenium incanum*) in southeastern Arizona."

Comparative Notes: This small desert species is easily recognized by the opaque white forewings and the large black spot at apex of crown.

56. *Scaphytopius* (*Cloanthanus*) *vittifrons* Hepner

Scaphytopius (Cloanthanus) vittifrons. Hepner, L. W., Jour. Kan. Ent. Soc., XIX: p. 104, 1946.

A distinctively marked species, with fuscous-margined, light vitta from sharksmouth to apex of clypeus. Length: female 4.5 mm., male 3.7 mm.

Color: Crown mottled fulvous to brown with broad, fuscous-margined light vittae as follows: along anterior margin from eye to eye, wedge, a long vitta on disc on each side of median suture and an irregular area along median margin of each eye. Pronotum mottled yellow to fulvous with typical vittae distinct and dark-margined. Scutellum yellowish, darkest next each basal corner. Clypeus yellowish, mottled with brown, with fuscous-bordered light marks as follows: line along basal margin joining ocelli, sharksmouth, vitta from near sharksmouth to apex. Clypellus and lorae same color as clypeus, but with fewer dark markings. Genae about same as clypeus, with fuscous-bordered light vittae as follows: behind eye, from apex of eye to lateral margin and next lorae. Forewings opaque white with irregular dark fulvous or light brown clouded areas covering about half of entire wing; veins darkening posteriorly and on costa.

Structural Characteristics: Crown about twice as long as width between eyes, longest in female, anterior margin almost straight on each side of pointed apex; wedge about two-fifths length of crown.

Pronotum about three-fourths as long as crown, proportionately shorter in female, twice as wide as length at middle and three and two-thirds times length behind eye. Clypeus over twice as long as width at ocelli, lateral margins sinuate at antennae. Clypellus only slightly enlarged near apex. Face in lateral view slightly concave between anterior margin of eyes. Forewing with a few vein-like marks in brachial cell and about ten recurved veins to costa.

Genitalia: Valve about three-fourths as long as greatest width, posterior margin convex on each side of bluntly pointed apex; anterior margin with short, broad lobe. Paraphyses long, slender and sharply pointed. Aedeagus in lateral view short, curved and almost parallel-margined. Styles almost four times as long as basal width, sinuate on basal third, small lobe on outer margin before long, slender process on apical third.

Last ventral segment of female almost twice as wide as length at middle, lateral margin slightly convex; posterior margin almost straight except for small median lobe.

Types: Holotype male, Concan, Texas, July 6, 1936, R. H. Beamer, in the Snow Entomological Collections. Allotype female, Chisos Mts., Texas, Sept. 19, 1938, D. J. and J. N. Knull, in the Knull Collection, Ohio State University, Columbus, Ohio. One ♀ paratype, El Paso Co., Texas, Aug. 30, 1940, D. J. and J. N. Knull.

Host Plants: The host plant is not known.

Comparative Notes: So far as known, this is the only species north of Mexico with the vitta on the middle of the clypeus, although there are several larger, similarly marked species in México.

57. *Scaphytopius* (*Cloanthanus*) *slossonae* (Van Duzee)

Platymetopius slossoni, Van Duzee, E. P., Ann. Ent. Soc. Amer., III: p. 222, 1910.

Resembles *acutus* but smaller, more slender, and with a sharper crown. Length: female 4.5 mm., male 4 mm.

Color: Crown fulvous with light markings as follows: thin line along anterior margin, wedge, long broad arcuate line on disc on each side of median suture and two pairs of dots on posterior margin. Light areas are thinly and irregularly lined with brown. Pronotum fulvous, much darker than crown, lightest along anterior margin, scattered brown dots, especially in male; vittae irregular but distinct. Pronotum yellow to fulvous with typical markings. Clypeus, clypellus and lorae yellow except on basal fourth; brown along basal margin between eyes except for long sharksmouth.

Genae lightest next clypeus, dark along lateral margins, vitta behind eye and near ocellus distinct. Forewing semihyaline fulvous with large milky aeroles throughout, heavy fuscous vermiculations in male, lighter in female, darkest on outer anteapical and adjoining costa; veins fuscous in male, lighter in female.

Structural Characteristics: Crown about two and one-fourth times as long as width between eyes, anterior margin straight on each side of sharply pointed apex; wedge about half length of crown. Pronotum about three-fifths as long as crown, two and one-fourth times as wide as length at middle and three and one-half times length behind eyes. Clypeus almost two and one-half times as long as width at ocelli with slight or no constriction at antennae; shallow concavity along sharksmouth. Clypellus relatively slender and enlarged at apex. Face in lateral view concave between anterior margin of eyes. Forewing with vein-like markings in brachial cell, eight or nine recurved veins to costa and sometimes extra cross-veins in clavus.

Genitalia: Valve slightly wider than length at middle, posterior margin convex on each side of bluntly pointed apex; anterior margin with short median lobe. Paraphyses long, slender, pointed and parallel-margined. Aedeagus slender, almost parallel-margined, slightly curved near base. Styles almost four times as long as basal width, slightly sinuate on basal third, lobed on outer margin before short, slender, outwardly curved apical process.

Last ventral segment of female about three-fifths as long as greatest width, latero-posterior margin almost evenly rounded.

Types: I was unable to locate the types, but one of the Van Duzee series from Crescent City, Florida, was on hand for study.

Additional Material Studied: (Florida) Ft. Myers, Homestead, Cocoanut Grove, Crescent City, Cedar Keys, Sanford, Lacoochee, Fruitville, Yankeetown, Ft. Mead, Gainesville, La Belle, Palm Beach, St. Marys River, Clearwater, Wildwood, Ft. Pierce, Jacksonville, Edgewater and Dunnellon. (Louisiana) Opelousas.

Host Plants: Ball (1932) writes "—was taken—in abundance everywhere in Florida. In several places larvae and adults were found on pure stands of a narrow-leaved sunflower (*Helianthus angustifolius*)."

Comparative Notes: This species is occasionally confused with *cinereus* in Florida, but in *slossonae* the area between sharksmouth and basal margin of clypeus is darker than remainder of clypeus, while in *cinerus* it is about the same color as remainder of clypeus.

58. *Scaphytopius* (*Cloanthanus*) *rubellus* (Sanders and DeLong)

Platymetopius rubellus, Sanders and DeLong, Ann. Ent. Soc. Amer., XII: p. 231, 1919.

Resembling *acutus* but with more slender, pointed crown, reddish in color and with coiled genital paraphyses. Length: female 5 mm., male 4.5 mm.

Color: Crown mottled reddish-fulvous with yellowish markings as follows: thin line along anterior margin, wedge, arcuate vittae on disc often obsolete except at middle, typical spots along posterior margin. Pronotum about same color as crown, vittae usually indicated. Scutellum same as crown, light markings faintly indicated. Face reddish-fulvous, lightest on disc of clypeus, sharksmouth long, vitta behind eye and one near ocellus faint, but visible. Forewing semihyaline reddish-fulvous with light aeroles, especially at apex; veins concolorous, becoming fuscous at apex and on costa.

Structural Characteristics: Crown as long as width between eyes in male, longer in female, anterior margin straight to slightly concave on each side of sharply pointed apex; concavity along wedge and median suture; wedge very narrow and about half length of crown. Pronotum slightly more than half as long as crown, about two and one-fourth times as wide as length at middle and three and one-half times length behind eye. Clypeus about two and one-fourth times as long as width at ocelli in male, longer in female, shallow concavity along sharksmouth and very little constriction at antennae. Clypellus slightly enlarged near apex. Face in lateral view strongly concave between anterior margin of eyes. Forewing with vein-like marks in brachial cell, about nine recurved veins to costa and extra veins in clavus.

Genitalia: Valve almost as long as greatest width, posterior margin definitely convex on each side of bluntly pointed apex; anterior margin concave on each side of truncate lobe on median third. Paraphyses slender, a complete coil on outer half; apices sharp. Aedeagus in lateral view with slender, slightly curved shaft. Styles almost four times as long as basal width, sinuate near middle, lobe on dorsal margin before finger-like process on apical fourth.

Last ventral segment of female almost twice as wide as length at middle, lateral margins convex and slightly convergent; posterior margin notched on each side of distinct, rounded lobe on median fourth.

Types: Lectotype ♂, lectoallotype ♀, Battle Point, Virginia, June 22, 1918, Sanders, here designated, in the DeLong Collection Ohio State University, Columbus, Ohio.

Material Studied: (Florida) Jacksonville, Sanford, La Belle, Branford, Suwanee Spgs. and Ft. Mead. (Georgia) Okefenokee Swamp and Prattsburg. (Alabama) Prattsville. (Louisiana) Natchitoche Parish. (Tennessee) Clarksville. (South Carolina) Florence and McClellansville. (North Carolina) Rocky Point and Wilmington. (D. C.) Washington.

Comparative Notes: This reddish species with the very sharp, slender crown is quite distinctive. Most like *argutus* in color, it has a much more pointed crown.

59. *Scaphytopius (Cloanthanus) cinereus* (Osborn and Ball)

Platymetopius cinereus, Osborn and Ball, Proc. Iowa Acad. Sci., IV: p. 193, 1897.
Platymoideus oviedus, Ball, E. D., Can. Ent., LXIII: p. 227, 1931.
Platymetopius parvus, Lathrop, Ohio Jour, Sci., XVII: p. 122, 1917.

Resembles *acutus* but smaller, yellowish in color and markings of forewing consisting primarily of dots. Length: female 4.5 mm., male 4 mm.

Color: Crown yellowish with dark fulvous irrorations throughout, light markings indicated as follows: wedge, broken oblique lines from anterior margin to base next median suture and two pairs of dots on posterior margin, one next each eye and another on each side of median suture. Pronotum more darkly marked than crown, excepting distinct light vittae. Scutellum yellow with typical markings. Clypeus, clypellus and lorae yellow, excepting long sharksmouth, lighter; dark irrorations across clypeus between eyes. Genae irrorate with dark, lightest along margin of clypeus, vitta behind eye and shorter ones near ocellus and antenna, distinct. Forewing semihyaline white with a faint fulvous tinge, numerous dark dots throughout; veins darkening posteriorly.

Structural Characteristics: Crown about one and one-half times as long as width between eyes, anterior margin almost straight on each side of pointed apex; wedge almost half length of crown. Pronotum about two-thirds as long as crown, two and one-half times as wide as length at middle and four times length behind eye. Clypeus slightly more than twice as long as width at ocelli, slightly constricted near antennae; shallow concavity along sharksmouth. Clypellus distinctly widest near apex. Forewing with vein-like marks in brachial cell, eight or nine recurved veins to costa and usually extra cross-veins in clavus.

Genitalia: Valve about as long as greatest width, posterior margin slightly convex and converging to a rounded apex; anterior margin concave on each side of rounded lobe on median third.

Paraphyses slender, coiled around aedeagus on outer half; apices very sharp. Aedeagus with wedge-shaped base, shaft in lateral view, broad, curved and bluntly pointed. Styles about three times basal width, sinuate near middle, dorsal margin lobed just before short, bluntly pointed, finger-like, apical process.

Last ventral segment of female one and two-thirds as wide as length at middle, lateral margins convex; posterior margin with small lobe on each side of median notch.

Types: Lectotype ♂, Ames, Iowa, June 4, 1896, in the Iowa State College collection, Ames, Iowa. Lectoallotype ♀, same data, here designated. These were on hand for study.

The types of *oviedus* are in the National Museum, Washington, D. C.

The types of *parvus* were destroyed in the Clemson College fire, but a paratype male was in the Osborn Collection, and DeLong has designated an allotype from his collection.

Material Studied: Many specimens from throughout the East from Texas to Minnesota eastward. This is probably the commonest grass species in this area.

Host Plants: Ball (1932) writes "Attention was called in the original description to the fact that this species is only found in open grasslands and it was, therefore, inferred that it was a grass feeding species. With the present knowledge of food habits of the group it appears more likely that the food plant will prove to be some one of the shrubs or shrub-like plants that are found in such situations. *P. parvus* Lathrop is apparently a synonym of this species as he states that the male has a right-angled vertex and the female is 4 mm. long with orange on scutellum, characters that apply to *cinereus* but not to what he described as *cinereus* in his South Carolina list.

"*P. oviedus* Ball. This species either has several host plants on which it is apparently equally at home or else several species, for which distinctive characters have not been discovered, are involved. The type material was taken along with the nymphs on a low mat forming heather—but either this or a closely allied species is abundant, both nymphs and adults, on a wire-stemmed Euphorbiaceae (*Chamaesyce* sp.) that forms large red mats in dry places and again on a finely branching aster-like plant abundant along the margins of wet places in Florida. *P. cinereus* of Lathrop's South Carolina list is no doubt this species as it is described as too small and too long-headed in the male for the true *cinereus* Osb. & Ball."

Fletcher (1930) writes "Grass in low places in old fields. Also grass in pine woods, Beaumont, Texas. Native grassland. Throughout year."

Osborn writes, "It appears to develop especially on three different kinds of grasses, *Andropogon scoparius,* Michx., *Bouteloua hirsuta* Lag. and *curtipendula* (Michx.) Torrl, the latter two species probably being its most common hosts."

Comparative Notes: Ball separates *oviedus* from *cinereus* by size and the presence of orange on the scutellum of *cinereus* but there was much gradation in size, and color of scutellum did not necessarily hold true. As one examined a series, it was found that the ones in Florida are the smallest and those further north the largest, just as the case in some other species, especially *frontalis.*

60. *Scaphytopius (Cloanthanus) guterranus* (Ball)

Platymoideus guterranus, Ball, E. D., Can. Ent., LXIII: p. 226, 1931.

Resembling *acutus* but smaller and with numerous irrorations on crown. Length: female 4.5 mm., male 4 mm.

Color: Crown mottled fuscous and light, excepting light markings as follows: wedge, broken oblique line from anterior margin halfway between eye and wedge to posterior margin on each side of median suture; on posterior margin two pairs of spots, one next each eye and one on each side of median suture. Pronotum same color as crown, vittae irregular, but usually present. Scutellum fulvous to orange with typical markings present. Clypeus ivory to light fulvous, dark irrorations between anterior margin of eyes excepting white sharksmouth. Clypellus and lorae about same color as clypeus, usually some irregular dark clouded areas; apex of clypellus darkened. Genae darker than clypeus, somewhat mottled, vitta behind eye and shorter ones near ocellus and antenna, distinct. Forewing semihyaline light fulvous with lighter aeroles, although often fulvous areas are reduced and most of wing is light; dark irrorations throughout; veins brown, becoming fuscous at apex and on costa.

Structural Characteristics: Crown one and one-half times as long as width between eyes in male, longer in female; anterior margin almost straight on each side of pointed apex; wedge about one-third length of crown. Pronotum about two-thirds as long as crown in male, half as long as crown in female, slightly over twice as wide as length at middle and three times length behind eye. Clypeus about two and one-half times as long as width at ocelli, shallow concavity along sharksmouth, slightly sinuate at antennae. Clypellus enlarged near apex. Face in lateral view slightly concave between eyes. Forewing with several vein-like marks in brachial cell and eight or nine recurved veins to costa.

Genitalia: Valve about as long as greatest width, posterior margin distinctly convex on each side of a truncate lobe on median third. Plates slender. Paraphysis slender, extending slightly beyond apex of plates, apex pointed. Aedeagus in lateral view very short, slightly curved and parallel-margined. Styles about four times as long as basal width, almost parallel-margined to rounded outer margin before sharply pointed apical process.

Last ventral segment of female about twice as wide as length at middle, lateral margins slightly convergent, posterior margin rounded to a very small median notch.

Types: Holotype ♀, allotype ♂, Yarnell Hts., Ariz., Oct. 8, 1929, E. D. Ball, in National Museum, Washington, D. C. One pair of paratypes, same data, on hand for study.

Additional Material Studied: (Utah) Smithsfield. (Arizona) Coconimo Co., Flagstaff, Sunset Pk., Yarnell, Yavapai Co., Navajo Co., St. Johns, Grand Canyon, Williams, Ashfork, Granite Dell, Kaibab and Safford. (New Mexico) Tijique, Mountain Park, Santa Fe, Las Vegas, Silver City and Jemez Spgs.

Host Plants: Ball (1932) writes "Nymphs and adults of this species were found in abundance on *Gutierrezia californica* in northern Arizona."

Comparative Notes: The relatively long crown, almost entirely covered with vermiculations, resembles no other species with the possible exception of the much larger *trilineatus.*

61. *Scaphytopius* (*Cloanthanus*) *acutus* (Say)

Jassus acutus, Say, Jour. Acad. Nat. Sci. of Phil., VI: p. 306, 1931.
Jassus modestus, Of. Vet. Akad. Forh., XI: p. 255, 1854.
Platymetopius acutus var. *dubius,* Van Duzee, E. P., Ann. Ent. Soc. Amer., III: p. 220, 1910.
Cloanthanus filamentus, DeLong, D. M., Ohio Jour. Sci., XLV: p. 22, 1945.
Cloanthanus tenuis, DeLong, D. M., Ohio Jour. Sci., XLV: p. 22, 1945.

Resembles *latus* but with different pattern on a shorter crown and with genital paraphyses almost parallel-margined. Length: female 5.2 mm., male 4.8 mm.

Color: Crown mottled fulvous with light markings as follows: thin, broken line along anterior margin; wedge; arcuate or straight line on disc from near apex to base on each side of median suture;

two pairs of dots along posterior margin, one next each eye and another next median suture, the latter are often united. Pronotum darker than crown, lightest along anterior margin, few irrorations, vittae evident. Scutellum yellow to orange with typical light markings. Clypeus, clypellus and lorae bright yellow excepting brown irrorations on both sides of yellow sharksmouth and black line along apex of clypellus. Genae fuscous except for broad area next clypeus, vitta behind eye and shorter one near ocellus. Forewing semihyaline fulvous with fuscous dots and vermiculations, excepting milky aeroles throughout; veins brown, becoming fuscous to black at apex and on costa.

Structural Characteristics: Crown slightly over one and one-half times as long as width between eyes, slightly convex on each side of bluntly pointed apex; wedge about one-third length of crown. Pronotum slightly shorter than crown, about two and one-fourth times as wide as length at middle, and three and one-half times length behind eyes. Clypeus about twice as long as width at ocelli, slightly constricted at antennae. Clypellus enlarged near apex. Forewings with vein-like marks in brachial cell and eight or nine recurved veins to costa.

Genitalia: Valve about one and one-fourth as wide as length at middle, posterior margin convex near bluntly pointed apex; anterior margin rounded. Paraphyses with basal bulb-like enlargement, slightly enlarged on outer half before sharp apices. Aedeagus "J"-shaped, narrowest on outer third before bluntly pointed apex. Valves long, about four times as long as basal width, slightly sinuate near basal third, slightly lobed on outer margin with a sharply pointed process on apical fifth; a small process on outer margin just before apical process. Pygofer with broad concavity on outer margin on basal half.

Last ventral segment of female one and three-fifths as wide as length at middle, lateral margins slightly convergent, posterior margin slightly convex with a slight median notch.

Types: Evidently the Say types of this species have been lost or destroyed. DeLong (1945) erected a neotype, which is in his collection.

Host Plants: DeLong (1923) writes "may be found on *Calamagrostis canadensis* in a wet meadow habitat." Lowry (1933) reports "grasses and sedges" as the hosts. Osborn (1915) writes "—from bushes, grass and sweet fern—willows, potato and various plants." This species is apparently found on a large number of hosts.

Comparative Notes: This species is the most variable one in the genus, both in external characters and internal genitalia. Color may vary from almost black to a light fulvous, the crown may vary considerably in length, and the lorae may vary from almost black to fulvous. The styles vary from long to rather short. The only constant character is the broadly concave margin of the pygofer on basal half, often the only character that will separate this species from similar ones. Several attempts were made to separate this species into subspecies, but there are gradations from one extreme to the other. Until more is known regarding the host relationships, it is best to consider them as one species, especially with the good character furnished by the outer margin of the pygofer.

62. *Scaphytopius* (*Cloanthanus*) *oregonensis* (Baker)

Platymetopius oregonensis, Baker, Can. Ent., XXXII: p. 49, 1900.

Resembling *acutus* but larger, lighter in color, margins of face not infuscated and with shorter crown. Length: female 6 mm., male 5.5 mm.

Color: Crown fulvous with brown irrorations, light markings, as follows: thin line along anterior margin, wedge, indistinct, irregular arcuate line on each side of median suture on disc. Pronotum about same color as crown but with few or no irrorations, vittae usually evident only on lateral margins. Scutellum slightly darker than crown with typical light markings. Clypeus, clypellus and lorae ivory to yellow, excepting distinct long sharksmouth and dark dots between this and posterior margin. Genae fulvous, darkest on lateral margins, vitta behind eye and shorter one near ocellus distinct. Forewings semihyaline fulvous with milky aeroles throughout, especially on costa; veins concolorous near base, becoming brown to fuscous at apex and on costa.

Structural Characteristics: Crown of male about one and one-third times width between eyes, longer in female, anterior margin straight to slightly convex on each side of pointed apex; wedge almost half length of crown. Pronotum about two-thirds as long as crown, two and one-fourth times as wide as length at middle and three and one-half times length behind eyes. Clypeus slightly over twice as long as width at ocelli, only slightly constricted at ocelli, shallow concavity along sharksmouth. Clypellus slender, only slightly enlarged near apex. Face in lateral view straight in male, slightly concave between antennae in female. Forewings with several vein-like markings in brachial cell, about nine recurved veins to costa and often extra cross-veins in clavus.

Genitalia: Valve slightly wider than length at middle, roughly triangular, posterior margin almost straight on each side of bluntly pointed apex; anterior margin with short, broad, median lobe. Paraphyses stout, broadest near outer fourth before sharp apices. Aedeagus in lateral view narrowest at base, broadest near middle; apex bluntly pointed. Styles short, about two and one-half times as long as basal width, sinuate just before middle, lobed on outer margin before sharply pointed process on apical fifth.

Last ventral segment of female almost as long as basal width, lateral margins somewhat converging, posterior margin rounded.

Types: Dr. P. W. Oman writes regarding the type of this species, "Oreg. 2509 Collection Carl F. Baker. Associated notes indicate that this specimen was collected at Portland, Ore., 9-18-97, A. P. Morse." This male specimen in National Museum, Washington, D. C. Allotype female, Canyonville, Ore., July 12, 1935, R. H. Beamer, here designated, in the Snow Entomological Collections. Parallotype ♀ ♀, as follows: (California) 3, Santa Cruz Mts., Aug. 13, 1938, R. I. Sailer; 1, Santa Cruz Mts., Aug. 13, 1938, R. H. Beamer; 10, Santa Rosa, Aug. 16, 1938, R. H. Beamer; 1, Santa Rosa, Aug. 16, 1938, D. W. Craik; 4, Santa Rosa, Aug. 16, 1938, L. W. Hepner; 5, Jamesburg, Aug. 11, 1938, R. H. Beamer; 4, Jamesburg, Aug. 11, 1938, L. W. Hepner; 2, Jamesburg, Aug. 11, 1938, R. I. Sailer; 5, Lockwood, July 24, 1935, R. H. Beamer; 3, Dunsmuir, June 29, 1935, R. H. Beamer; 1, Dunsmuir, Aug. 13, 1912, E. D. Ball; 1, Dunsmuir, June 28, 1935, P. W. Oman; 3, Towie, Aug. 20, 1938, R. H. Beamer; 2, Towie, Aug. 20, 1938, R. I. Sailer; 3, Lompoc, Aug. 7, 1938, R. I. Sailer; 1, Occidental, Aug. 16, 1938, R. H. Beamer; 1, Niles, July 15, 1933, R. H. Beamer and 1, Redding, June 29, 1933, P. W. Oman. (Oregon) 7, Le Grand, Aug. 29, 1909, E. D. Ball; 1, Le Grand, July 16, 1921, E. W. Davis; 2, Medford, Aug. 14, 1912, E. D. Ball and 1, Ashland, Aug. 13, 1912, E. D. Ball. (Washington) 6, Wenatchee, Aug. 18, 1912, E. D. Ball. (Idaho) 2, Moscow Mt., Sept. 15, 3, Sept. 18 and 1, Sept. 24, J. Gillette. (Utah) 2, Logan Canyon, Sept. 9, 1934, T. O. Thatcher; 3, Logan Canyon, Aug. 21, 1934, Smith and Thatcher and 1, Logan Canyon, July 31, 1933, G. F. Knowlton. (Montana) 1, Missoula, Aug. 11, 1931, R. H. Beamer. (British Columbia) 1, Vernon, Aug. 5, 1931, R. H. Beamer.

Host Plants: Specimens were examined with the following host data on them: *Arctostaphyleae manzanita*, Occidental, Calif.; *A.*

patula, Towie, Calif.; *Holodiscos discolor, Medicago sativa, Ceoanthus sanguineus* and *Pteridium aquilium*, Moscow Mts., Idaho, and buck brush, Logan Canyon, Utah. Ball (1932) writes "—was swept by the writer both larvae and adults in abundance from mixed clumps of wild roses and snowberries (*Symphoricarpos*) at Wenatchee and Le Grand, Oregon."

Comparative Notes: There is a light *acutus* in the same range with *oregonensis* but the latter species has a shorter crown, is larger and lacks the concavity on the outer margin of the male pygofer. The males are sometimes quite dark and are almost invariably darker than females.

63. *Scaphytopius* (*Cloanthanus*) *latus* (Baker)

Platymetopius latus, Baker, Can. Ent. XXXII: p. 50, 1900.
Platymetopius cuprescens, Osborn, Report of N. Y. St. Entomologist, p. 517, 1905.

Resembles *acutus* but with less distinct markings on a longer crown, lighter on margins of genae, shorter male plates and longer last ventral segment of the female. Length: female 5.5 mm., male 5 mm.

Color: Crown fulvous, darkest on disc with light wedge and sometimes faintly evident, long arcuate marks on disc. Pronotum about same color as disc of crown, lightest along anterior margin. Scutellum fulvous, darkest next each basal corner, typical markings distinct. Face yellow to fulvous, darkest on lateral margin and along base of clypeus; long sharksmouth faint but distinct. Forewing fulvous on clavus, darker on corium, dark vermiculations on corium, light aeroles near apex, darkest on outer anteapical; veins fulvous, becoming brown to fuscous at apex and on costa.

Structural Characteristics: Crown about twice as long as width between eyes, somewhat concave on disc, straight on each side of rounded, but acutely pointed apex; wedge about one-third length of crown. Pronotum slightly more than twice as wide as length at middle, three and one-half times length behind eyes. Clypeus about two and one-fourth times width at ocelli, only slightly constricted at antennae; shallow concavity along sharksmouth. Clypellus relatively broad and slightly enlarged near apex. Face in lateral view slightly concave between anterior margin of eyes. Forewing with numerous vein-like marks in brachial cell, about twelve recurved veins to costa and usually extra cross-veins in clavus.

Genitalia: Valve about one and one-third as wide as length at middle, posterior margin oval; anterior margin with relatively large, truncate, median lobe. Paraphyses stout, bulb-like, basal area elongate, greatly enlarged on outer fifth; spine-like process at apices. Aedeagus in ventral view narrowest on outer half. Styles stout, two and one-half times as long as basal width, sinuate near basal third, lobed on outer margin before stout, bluntly-pointed process on apical third.

Last ventral segment of female about one and one-third as wide as length at middle, lateral margins converging, posterior margin with broad lobe on each side of small median notch.

Types: Holotype ♀, "Colo. 882, Collection Carl F. Baker, Collected Ft. Collins, Colo., 8-11." in the National Museum, Washington, D. C. Allotype ♂, here designated, "Colo." (only data) in Snow Entomological Collections. Parallotype ♂♂ as follows: (Utah) 1, Ogden, July 24, 1912. (North Dakota) 1, Lake Metigoshe, July 30, 1937, R. H. Beamer. (Minnesota) 2, Fairbanks, Aug. 13, 1937, R. H. Beamer; 2, Eveleth, Aug. 12, 1937, R. H. Beamer; 1, St. Anthony Peak, June 28, 1910, "E. P." and 1, Cook Co., Aug. 21, 1938, H. T. Peters. (Wisconsin) 3, Brule, Aug. 16, 1937, R. H. Beamer; 1, Cheboygan Co., July 16, 1936, M. W. Sanderson; 1, Cheboygan Co., July 14, 1931, H. B. Hungerford and 1, Cheboygan Co., July 11, 1933, Harold Peters. (New Hampshire) 1, Notchland, Aug. 20, 1934, R. H. Beamer. (Canada) 2, Newaygo, July 30, 1929, Parrish. (Manitoba) 1, Russell, Aug. 1, 1937, R. H. Beamer; 2, Birch River, Aug. 3, 1937, R. H. Beamer and 1, Mafeking, Aug. 3, 1937, R. H. Beamer.

Host Plants: Material examined from Itasca Park, Minnesota, were collected on *Pinus banksiana*.

Comparative Notes: This species is apparently rare in Colorado and Utah, but is rather common in the Northeast and has been known as *cuprescens* Osborn.

64. *Scaphytopius* (*Cloanthanus*) *argutus* De Long

Cloanthanus argutus, DeLong, D. M., Ohio Jour. Sci., XLV: p. 24, 1945.
Scaphytopius hastus, DeLong, D. M., Ohio Jour. Sci., XLV: p. 24, 1945.
Scaphytopius lanceus, DeLong, D. M., Ohio Jour. Sci., XLV: p. 24, 1945.

Resembling *acutus* but lighter along margins of genae, darker outer wings, and paraphyses enlarged near apex. Length: female 5 mm., male 4.5 mm.

Color: Crown fulvous, sometimes darkest on disc with light markings as follows: thin line along anterior margin, wedge, long arcuate vitta on each side of median suture and usually two pairs of large dots along posterior margin. Pronotum usually darker than crown, typical vittae usually faintly indicated. Scutellum about same color as crown, with typical markings. Clypeus, clypellus and lorae yellow to fulvous, darkest along posterior margin excepting long sharksmouth. Genae darker than clypeus, lightest next clypeus, and vitta behind eye and near ocellus distinct. Forewing opaque fulvous to reddish-fulvous with white aeroles at apex of clavus and apex of corium, dark vermiculations; veins fuscous.

Genitalia: Valve about one and one-fourth times as wide as length at middle, posterior margin rounded to bluntly pointed apex; anterior margin concave on each side of broad, rounded lobe on median third. Paraphyses extending well beyond plates and, except for basal bulb, almost parallel-margined to outer fourth, where they are enlarged, long, plate-like, before sharp apices. Aedeagus in ventral view, much narrower near apex, in lateral view with short, broad "arrow head"—like basal process and slightly curved shaft, narrowed to a blunt apex. Styles about three times as long as basal width, sinuate near middle, long lobe on dorsal margin just before finger-like apical process.

Types: Types of *argutus* and *lanceus* in the DeLong collection, Ohio State University, Columbus, Ohio. Types of *hastus* in Illinois Natural History Survey collection, Urbana, Illinois. Holotype of *argutus,* and paratypes of *lanceus* and *hastus* on hand for study.

Additional Material Studied: (Florida) Hilliard. (Georgia) Prattsburg and Griffin. (Alabama) Burnsville and Tuskegee. (Mississippi) Fulton, Ireland, and Shuqulak. (Louisiana) Caddo Parish. (South Carolina) Tigerville and Lexington. (Tennessee) Clarksville, Magnolia, Coal Creek, Elk Valley and Chattanooga. (North Carolina) Walnut. (Kentucky) Cadiz. (Arkansas) Polk Co. (Indiana) Gary.

Host Plants: The host plant is not known.

Comparative Notes: This species varies a great deal in size, color and with some variation in the male genitalia. The distinctive characters are the brownish, almost opaque wings, the fulvous face and the aedeagus much smaller at apex than at middle, when viewed from ventral side. Sometimes the crown is lighter than forewings.

65. *Scaphytopius (Cloanthanus) fuscicephalus* Hepner

Scaphytopius (Cloanthanus) fuscicephalus, Hepner, L. W., Jour. Kan. Ent. Soc., XIX, p. 105, 1946.

Resembles *argutus* but with crown darkest on disc and aedeagus straight and parallel-margined in ventral view. Length: female 4.8 mm., male 4.1 mm.

Color: Crown mottled fulvous and brown, darkest on disc; wedge light. Pronotum fulvous flecked with dark, vittae evident. Scutellum dark fulvous, darkest near basal corner, typical markings present. Face yellowish, slightly darker behind eyes and along basal margin between ocelli, with dark-margined light markings as follows: sharksmouth, vitta behind eye and shorter one near ocellus. Forewings translucent brown, veins and many vermiculations, darker; white aeroles throughout.

Structural Characteristics: Crown about twice as long as width between eyes, anterior margin almost straight on each side of sharply pointed apex; wedge about two-fifths length of crown. Pronotum about three-fifths as long as crown, two and one-fourth times as wide as length at middle and three and one-half times length behind eye. Clypeus slightly more than twice as long as width at ocelli, only slightly, if any, sinuate at antennae. Clypellus only slightly enlarged near apex. Face in lateral view concave between anterior margin of eyes. Forewings often with extra veins in clavus, vein-like markings in brachial cell and about ten recurved veins to costa.

Genitalia: Valve about three-fourths as long as greatest width, posterior margin bell-shaped; anterior margin with broad, short, median lobe. Paraphyses long, slender and only slightly enlarged near apices. Aedeagus in ventral view parallel margined; in lateral view slightly curved near base. Styles about two and one-half times as long as basal width, sinuate near middle, lobed on outer margin before finger-like process on apical third.

Last ventral segment of female almost twice as wide as median length, latero-posterior margin rounded.

Types: Holotype ♂, allotype ♀, Lawrence, Kansas, Sept. 4, 1941, L. W. Hepner, in the Snow Entomological Collections. Paratypes as follows: (Kansas) 1 ♂, Cherokee Co., Apr. 9, 1938, R. H. Beamer; 1 ♂, Coffeyville, June 15, 1939, 1 ♂, June 24, 1939, and 1 ♂, July 16, 1939, L. W. Hepner; 1 ♀, Douglas Co., July, 1926, E. L. Bales; 1 ♂, Douglas Co., Aug. 28, 1928, 1 ♂, Aug. 17, 1928 and 1 ♂, June 21, 1928, P. B. Lawson; 4 ♀ ♀, Atchison Co., July 8, 1924, E. P. Breakey.

Host Plants: The host plant is not known.

Comparative Notes: Specimens were on hand from Texas and New Mexico which were evidently of this species. It is separated from *argutus* by the different aedeagus and much darker crown.

66. *Scaphytopius* (*Cloanthanus*) *viridicephalus* Hepner

Scaphytopius (*Cloanthanus*) *viridicephalus*, Hepner, L. W., Jour. Kan. Ent. Soc., XIX: p. 105, 1946.

Resembling *slossonae* but with shorter, greenish crown, and darker male. Length: female 4.2 mm., male 3.6 mm.

Color: Crown greenish-fulvous, especially in female, with wedge, long arcuate markings on disc and two pairs of large dots on posterior margin at least indicated. The male often is only faintly tinged with green, but may be distinguished from other species by the crown being much lighter than the forewing. Pronotum darker than crown, sparsely punctate with dark in the male, vittae distinct. Scutellum about same color as pronotum with typical light markings present. Face greenish-fulvous in female, light green in male, slightly darkest along lateral margin of genae, long sharksmouth, vitta behind eye and another near ocellus faintly indicated. Forewing of male semihyaline fulvous with dark vermiculations throughout, very dark on apex, veins concolorous at base, darkening and becoming fuscous at apex and on costa. Forewing of female bright fulvous throughout, a few milky aeroles throughout, no vermiculations; veins concolorous. Occasionally a female with one or two recurved veins darkened will be found.

Structural Characteristics: Crown about twice as long as width between eyes, anterior margin straight on each side of pointed apex; wedge over one-third length of crown. Pronotum about three-fifths as long as crown, two and one-half times as wide as length at middle and four and one-half times length behind eye. Clypeus about two and one-fourth times width at ocelli, only slightly constricted at antennae. Clypellus definitely enlarged near apex. Face in lateral view almost straight. Forewing with about seven recurved veins to costa, claval veins approaching each other at cross vein and sometimes extra cross veins in clavus.

Genitalia: Valve about one and one-fourth as wide as length at middle, posterior margin convex on each side of bluntly pointed apex; anterior margin slightly concave on each side of median lobe. Paraphyses with basal, bulb-like enlargement, almost parallel-margined to enlargement near sharp apices. Aedeagus in lateral view, slightly curved, smallest near blunt apex. Styles stout, about three times as long as basal width, sinuate just before middle, lobed on dorsal margin before finger-like process on apical third.

Last ventral segment of female about twice as wide as length at middle, latero-posterior margin rounded to a small median lobe.

Types: Holotype ♂, allotype ♀ and 4 ♂ and 8 ♀ paratypes, Shuqualak, Mississippi, July 16, 1930, P. W. Oman, in the Snow Entomological Collections. Additional paratypes as follows: (Mississippi) 2 ♂♂, Shuqualak, July 16, 1930, R. H. Beamer; 1 ♀, Shuqualak, July 16, 1930, L. D. Tuthill; 1 ♀, Meridian, July 17, 1930, L. D. Tuthill; 1 ♀, Hamilton, July 15, 1930, R. H. Beamer; 1 ♀, Fulton, July 14, 1930, R. H. Beamer and 1 ♂, Columbus, July 16, 1930, R. H. Beamer. (Alabama) 1 ♀, Marion Jct., July 16, 1930, R. H. Beamer. (Texas) 2 ♂♂, Brownsville, Dec. 27, 1945, and 2 ♀♀, June 29, 1938, R. H. Beamer; 8 ♀♀, 1 ♂, Brownsville, May 25, 1939, and 1 pr., Aug. 8, 1937, D. J. and J. N. Knull; 11 ♀♀, 8 ♂♂, Brownsville, May 31, 1933, and 19 ♀♀, 24 ♂♂, May 29, 1933, P. W. Oman and 2 ♀♀, Benchley, April 30, 1941, D. J. and J. N. Knull.

Host Plants: The host plant is not known.

Comparative Notes: In some of the series, some specimens have a distinctively green head, while others will hardly be green at all, but a dark fulvous in the male, lighter in the female.

67. *Scaphytopius* (*Cloanthanus*) *utahensis* Hepner

Scaphytopius (Cloanthanus) utahensis, Hepner, L. W., Jour. Kan. Ent. Soc., XIX: p 107, 1946.

Resembling *graneticus* but larger, somewhat lighter in color, with broader aedeagus and paraphyses. Length: female 5 mm., male 4.8 mm.

Color: Crown fulvous flecked with brown, darkest next median suture, except for light markings as follows: line along anterior margin, wedge, long arcuate line on disc on each side of median suture. Pronotum fulvous flecked with dark, vittae irregular but present. Scutellum fulvous with a few irregular brown markings on basal half and a large brown spot inside each basal corner. Face light fulvous to yellow, with fuscous-bordered light markings as follows: sharksmouth, vitta behind eye and a shorter one in front of eye near ocellus. Forewing semihyaline fulvous with veins and many vermiculations, brown.

Structural Characteristics: Crown about twice as long as width between eyes, anterior margin almost straight on each side of apex. Pronotum about two-thirds as long as crown, two and one-fourth times as wide as length at middle and three and one-half times length behind eye. Clypeus about two and one-third times as long as width at ocelli, lateral margins slightly sinuate at antennae. Clypellus slender, only slightly enlarged near apex. Face in lateral view straight. Forewing with vein-like marks in brachial cell and about twelve recurved veins to costa.

Genitalia: Valve almost as long as greatest width, posterior margin oval, anterior margin with broad, short, truncate lobe. Paraphyses slender on basal three-fifths, gradually enlarged almost to sharp apices. Aedeagus in ventral view almost parallel-margined; in lateral view, long, curved near base, almost parallel-margined to blunt apex. Styles almost four times as long as basal width, sinuate near middle, lobed on outer margin before short, slender finger-like apical process.

Last ventral segment of female about one and one-half times as wide as median length, latero-posterior margin rounded, slightly notched at middle.

Types: Holotype ♂, allotype ♀, and 4 ♀ and 1 ♂ paratypes, Alton, Utah, Aug. 11, 1936, R. H. Beamer, in the Snow Entomological Collections.

Host Plants: The type series was collected on *Rhus* sp.

Comparative Notes: This species is a tannish color and rather more slender than related species.

68. *Scaphytopius* (*Cloanthanus*) *graneticus* (Ball)

Platymoideus graneticus, Ball, E. D., Can. Ent., LXIII: p. 226, 1931.

Resembling *acutus* but smaller, with lateral margins of genae lighter and pygofer without basal concavity on outer margin. Length: female 4.8 mm., male 4.3 mm.

Color: Crown mottled fulvous and brown, often darkest on disc; light markings as follows: thin, sometimes broken line along anterior margin, wedge, long arcuate vitta on disc on each side of median suture and usually four large dots on posterior margin. Pronotum about same color as crown, darkest on disc, typical light vittae at least indicated. Scutellum yellow to orange with typical light markings. Clypeus, clypellus and lorae yellow, excepting brown markings around long sharksmouth and along posterior margin between eyes. Genae yellow next clypeus, darkening and becoming fulvous on lateral margins; vitta behind eye and near ocellus, distinct. Forewing semihyaline fulvous with many brown vermiculations, especially in male; veins darkening posteriorly, becoming black on costa.

Structural Characteristics: Crown about twice as long as width between eyes in female, shorter in male, anterior margin straight on each side of sharp apex; wedge over one-third length of crown. Pronotum about two-thirds as long as crown; two and one-third times as wide as length at middle and about three and one-half times length behind eyes. Clypeus about two and one-half times width at ocelli, constricted at antennae, concave along sharksmouth. Clypellus relatively slender and somewhat enlarged near apex. Face in lateral view straight to slightly concave between anterior margin of eyes. Forewings with several vein-like markings in brachial cell, about ten recurved veins to costa and often extra cross-veins in clavus.

Genitalia: Valve about one and one-third times as wide as length at middle, posterior margin convex on each side of rounded apex; anterior margin rounded. Paraphyses slender, with relatively small basal, bulb-like enlargement; enlarged on apical fourth before sharp apex. Aedeagus in lateral view, slender, slightly larger and curved on basal half. Styles about three times as long as basal width, sinuate near middle, lobe on outer margin before slender, finger-like process on apical fifth.

Last ventral segment of female about one and two-thirds as wide as length at middle, latero-posterior margin evenly oval.

Types: Holotype ♀, Granite Dell, Ariz., July 17, 1929, allotype ♂, Williams, Arizona, Aug. 15, 1929, E. D. Ball, in the National Museum, Washington, D. C. One pair of paratypes, same data as holotype, on hand for study.

Additional Material Studied: (Arizona) Prescott, Yavapai Co., Granite Dell, Oak Creek Canyon and Kaibab Forest. (California) Leona Hts., Alameda Co., Lemon Cove. Redding, Delta, Big Bear Lake, Dunsmuir, Mint Canyon, Santa Rosa, Atascadero, Alpine and Stinton Beach.

Host Plants: Ball (1932) writes "Females of this species were taken in some numbers from wild grapes near Prescott, Arizona, July 17. It was apparently the last end of a brood as there were no nymphs or males present at that time. A single male was taken from wild grapes in the mountains above Williams, Arizona, Aug. 15."

Comparative Notes: This species is somewhat like *argutus* from the East, but the genitalia are somewhat different. It varies considerably, the specimens from California being much darker than those from Arizona.

69. *Scaphytopius (Cloanthanus) canus* Hepner

Scaphytopius (Cloanthanus) canus, Hepner, L. W., Jour. Kan. Ent. Soc., XIX: p. 107, 1946.

Resembling *trilineatus* but larger, lighter in color, with a light face and genital paraphyses much larger near apex. Length: female 6 mm., male 5.6 mm.

Color: Crown light fulvous with brown irrorations, light markings as follows: line along anterior margin, wedge, irregular arcuate line on disc on each side of median suture and an indication of another line parallel to this just inside eyes. Pronotum usually slightly darker than crown, darkest on disc and sparsely sprinkled with brown dots; vittae usually evident only on lateral margins. Scutellum about same color as crown with typical markings. Clypeus, clypellus and lorae light fulvous, except for sharksmouth and irregular brown markings along base of clypeus; apex of clypellus brown. Forewings light fulvous with brown dots throughout; veins fulvous, becoming fuscous on costa.

Structural Characteristics: Crown about twice as long as width between eyes in male, slightly longer in female, anterior margin almost straight on each side of slender, but bluntly pointed apex; wedge almost half length of crown. Pronotum slightly over half length of crown, about two and one-half times length behind eyes. Clypeus almost two and one-half times width at ocelli, slightly sinuate at antennae; shallow concavity along sharksmouth. Clypellus stout, slightly enlarged near apex. Face in lateral view slightly concave between anterior margin of eyes. Forewings with many vein-like marks in brachial cell, about twelve recurved veins to costa and often extra veins in clavus.

Genitalia: Valve about three-fourths as long as greatest width, posterior margin straight on each side of bluntly pointed apex, anterior margin convex. Paraphyses enlarged near sharp apices. Aedeagus "J"-shaped, almost parallel-margined throughout. Styles over twice as long as basal width, sinuate near middle, distinct lobe on outer margin before rather small apical process.

Last ventral segment of female about three-fourths as long as greatest width, convex and converging on lateral margins; posterior margin straight.

Types: Holotype ♂, allotype ♀, 10 ♀ and 11 ♂ paratypes, Pine Valley, California, July 27, 1938, R. H. Beamer, in the Snow Entomological Collections. Additional paratypes as follows: (California) 2 ♀ ♀, Quatay, July 19, 1941, R. H. Beamer; 1 ♀, Santa Cruz Mts., Aug. 13, 1938, R. H. Beamer.

Host Plants: The type series was collected on *Garrya veatchii* which is probably the host plant.

Comparative Notes: This species resembles *trilineatus,* but has a shorter crown and the face is light. The general color is much lighter than *trilineatus.* It is evidently restricted to southern California.

70. *Scaphytopius (Cloanthanus) trilineatus* (Ball)

Platymetopius trilineatus, Ball, E. D., Ent. News, XXVII: p. 204, 1916.
Platymetopius pexatus, Van Duzee, E. P., Proc. Calif. Acad. Sci., XLI: p. 415, 1925.

Resembles *acutus,* but with longer crown, dark face and distinct genitalia. Length: female 5.2 mm., male 5 mm.

Color: Crown mottled brown or fuscous and ivory, with light areas as follows: relatively broad line along anterior margin; wedge; irregular arcuate line from near apex to base on each side of median suture; two pairs of large dots on posterior margin, one next each eye and another on each side of median suture, often continuous with the long arcuate vittae on disc. Pronotum about the same color as crown with vittae fairly distinct. Scutellum fulvous to brown with typical markings. Face brown to reddish-brown with small light dots throughout, lightest on long sharksmouth and coarse vermiculations along base between eyes; darkest on lateral margin of genae; vitta behind eye and shorter ones near ocellus and antenna distinct. Forewing opaque fulvous on disc, apex and part of clavus, remainder semihyaline white in patches, scattered vermiculations throughout; veins dark.

Structural Characteristics: Crown almost two and one-half times as long as width between eyes, anterior margin almost straight on each side of sharp apex; disc somewhat concave; wedge over half length of crown. Pronotum slightly less than half as long as crown, two and one-third times as wide as length at middle and four times length behind eyes. Clypeus over two and one-half times as long as width at ocelli, definitely constricted at antennae; concavity along sharksmouth. Clypellus somewhat enlarged near apex. Face in lateral view somewhat concave between anterior margin of eyes. Forewings with several vein-like marks in brachial cell, about eleven recurved veins to costa and usually extra cross-veins in clavus.

Genitalia: Valve about seven-tenths as long as greatest width, posterior margin rounded; anterior margin with broad, short median lobe. Paraphyses long, slender and hardly enlarged at all before sharp apices. Aedeagus roughly "L"-shaped, short, almost parallel-margined throughout. Styles slender, over twice as long as basal width, small lobe on outer margin before process on apical fifth.

Last ventral segment of female about three-fourths as long as greatest width, lateral margins straight and converging; posterior margin straight and converging on each side of a shallow, slender median notch.

Types: Holotype ♂, San Margareta, Calif., Aug. 6, 1912, E. D. Ball, in the National Museum, Washington, D. C. Allotype ♀ and 12 ♀ parallotypes, Anza, California, July 29, 1938, R. H. Beamer, in the Snow Entomological Collections. Additional ♀ parallotypes as follows: 1, Anza, July 29, 1938, R. I. Sailer; 2, Santa Rosa, Aug. 16, R. H. Beamer; 4, Santa Cruz Mts., Aug. 13, 1938, R. H. Beamer; 3, Santa Cruz Mts., Aug. 13, 1938, R. I. Sailer; 1, Lompoc, Aug. 7, 1938, R. I. Sailer; 1, Alpine, July 19, 1941, R. H. Beamer; 1, Arroyo Seco River, Aug. 8, 1938, R. H. Beamer; 1, Jacumba, July 17, 1940, R. H. Beamer; 1, Towie, Aug. 20, 1938, R. H. Beamer and 20, Boulevard, July 26, 1938, R. H. Beamer.

Host Plants: Ball (1932) writes "This California species was taken by the writer in number from *Rhus trilobata* in several places in the mountains around Prescott, Arizona." Ball was evidently referring to the subspecies *spicatus,* found in Arizona. Numerous specimens were collected in California in 1938 on *Arctostaphyleae* sp.

Comparative Notes: The dark face separates this species from *canus* and the truncate plates from *spicatus*. This species varies a great deal in color, although usually it is darker than the other two species mentioned above.

71. *Scaphytopius* (*Cloanthanus*) *trilineatus spicatus* Hepner

Scaphytopius (*Cloanthanus*) *trilineatus* subsp. *spicatus,* Hepner, L. W., Jour. Kan. Ent. Soc., XIX: p. 108, 1946.

Resembling *trilineatus* but lighter with fulvous areas of forewing restricted to apical cells and with plates sharply pointed. Length: female 5.5 mm., male 5 mm.

Color: Crown mottled ivory and fuscous with light markings as follows: thin line along anterior margin; long wedge; irregular arcuate vitta on each side of median suture from near apex to base and usually two pairs of large dots on posterior margin, one next each eye and another on each side of median suture. Pronotum about same color as crown, lightest on anterior and lateral margins, vittae distinct. Scutellum ivory, dark irrorations and typical light markings. Face ivory with fine brown to fuscous irrorations excepting long sharksmouth and coarser irrorations along posterior margin, darkest on lateral margins of genae. Forewing semihyaline white except for small fulvous area in apical cells, fuscous vermiculations and veins throughout.

Structural Characteristics: Crown over twice as long as width between eyes in male, twice width between eyes in female, shallow concavity on disc, anterior margin straight to slightly concave on each side of pointed apex; wedge about half length of crown. Pronotum about half as long as crown, about two and one-fourth times as wide as length at middle and four times length behind eyes. Clypeus over two and one-half times as long as width at ocelli, concavity along sharksmouth, sinuate at antennae. Clypellus enlarged near apex. Face in lateral view concave between anterior margin of eyes. Forewing with several vein-like marks in brachial cell, about twelve recurved veins to costa and sometimes extra crossveins in clavus.

Genitalia: Valve about one and one-half times as wide as length at middle, posterior margin rounded; anterior margin with broad, short, median lobe. Paraphyses with slight basal enlargement, slightly broadened just before sharp apices. Aedeagus in lateral view roughly "L"-shaped, short, almost parallel-margined throughout. Styles about two and one-half times as long as width at base, slightly sinuate just before middle, outer lobe on dorsal margin just before finger-like process on apical fifth.

Last ventral segment of female about one and one-half times as wide as length at middle, lateral margins converging; posterior margins with lobe on each side of relatively prominant median notch.

Types: Holotype ♂, allotype ♀, and 27 ♀ and 5 ♂ paratypes, Miami, Ariz., Aug. 6, 1941, R. H. Beamer, in the Snow Entomological Collections. Additional paratypes as follows: (Arizona) 1 ♀, Miami, July 22, 1932, R. H. Beamer; 7 ♀ ♀, 8 ♂ ♂, Yarnell, July 29, 1933, 4 ♀ ♀, 1 ♂, July 27, 1933, and 2 ♀ ♀, July 25, 1932, R. H. Beamer; 1 ♀, Yarnell Hts., July 2, 1929, R. H. Beamer; 1 pair, Yarnell, June 19, 1937, D. J. and J. N. Knull; 2 ♀ ♀, Yarnell Hts., June 21, 1935, 2 ♀ ♀, Oct. 8, 1929, 2 ♀ ♀, July 21, 1929, and 1 ♀, Aug. 20, 1929, E. D. Ball; 9 ♀ ♀, 6 ♂ ♂, Yarnell Hts., June 29, 1933, P. W. Oman; 1 pair Yavapai Co., July 1, 1929, and 1 ♀, Aug. 9, 1927, R. H. Beamer; 1 ♂, Granite Dell, Aug. 14, 1935, R. H.

Beamer; 1 ♀, Granite Dell, Oct. 6. 1929, and 4 ♀♀, July 17, 1929, E. D. Ball; 3 ♀♀, Prescott, July 29, 1933, R. H. Beamer; 1 ♀, Prescott, June 30, 1939, and 1 ♀, June 8, 1941, D. J. and J. N. Knull; 3 ♀♀, Prescott, N. F., July 6, 1937, 3 ♀♀, July 14, 1940, and 1 ♂, June 20, 1937, D. J. and J. N. Knull; 1 ♀, Santa Rita Mts., Aug. 18, 1935, R. H. Beamer; 1 ♀, Gila Co., Aug. 5, 1927, R. H. Beamer; 4 ♀♀, Hereford, Aug. 22, 1935, R. H. Beamer; 2 pairs, Huachucua Mts., July 20, 1937, D. J. and J. N. Knull; 2 ♀♀, Huachucua Mts., Oct. 19, 1931, E. D. Ball; 1 ♀, Oak Creek Canyon, July 13, 1940, D. J. and J. N. Knull; 1 ♀, Chiricahua Mts., Sept. 14, 1938, 1 ♀, June 15, 1939, and 1 ♂, Aug. 28, 1940, D. J. and J. N. Knull; 1 ♂, Devil's Canyon, Aug. 25, 1938, D. J. and J. N. Knull; 2 ♂♂, Faraway Ranch, Aug. 11, 1931, E. D. Ball; 1 ♀, Glenn Oaks, July 19, 1929, and 1 ♂, July 18, 1929, E. D. Ball. (New Mexico) 1 ♀, Silver City, Aug. 23, 1936, R. H. Beamer.

Host Plants: The specimen from Silver City was collected on Mountain Mahogany. Ball (1932) was evidently referring to this form when he gave *Rhus trilobata* as the host plant of *trilineatus*.

Comparative Notes: The males of this species can be separated from *trilineatus* by the sharp plates and the female by the absence of the notch on the last ventral segment.

72. *Scaphytopius* (*Cloanthanus*) *abbreviatus* (DeLong)

Platymetopius abbreviatus, DeLong, D. M., Tenn. St. Board of Entomology, XVII: p. 39, 1916.

Platymetopius parvus var. *niger*, DeLong, D. M., Ohio Jour. Sci., XLV: p. 27, 1945.

Color: Crown brown mottled with yellow, light markings as follows: thin line along anterior margin; wedge; indistinct arcuate line on disc on each side of median suture; typical large dots along posterior margin. Pronotum darker than crown, heavily irrorate, vittae visible. Scutellum about same color as crown, with typical markings. Face fulvous irrorate with brown, darkest on lateral margin of genae; sharksmouth, vitta behind eye and shorter ones near ocelli and at antennae, light. Forewings semihyaline fulvous with white aeroles and brown irrorations throughout; veins fuscous.

Structural Characteristics: Crown about one and one-half times as long as width between eyes, slightly concave on each side of bluntly pointed apex; wedge about one-third length of crown. Pronotum about three-fourths length of crown, two and one-third times as wide as length at middle and three and one-half times length behind eye. Clypeus about two and one-third times as long as width at ocelli, only slightly constricted, if any, at antennae; shallow concavity along sharksmouth. Clypellus enlarged at apex. Face in lateral view definitely concave between anterior margin of eyes. Forewing with numerous vein-like marks in brachial cell, about nine recurved veins to costa and often extra cross-veins in clavus.

Genitalia: Valve about two-thirds as long as greatest width, posterior margin convex on each side of teat-like apex. Paraphyses long, slender and sharply pointed. Aedeagus in lateral view "L"-shaped, almost parallel-margined throughout. Styles almost five times as long as basal width, constricted on basal third, small lobe on outer margin before slender process on outer two-fifths.

Last ventral segment of female about two-thirds as long as greatest width, latero-posterior margin rounded.

Types: Lectotype ♀, Tullahoma, Tenn., Aug. 2, 1915, D. M. DeLong, here designated, in the DeLong Collection, Ohio State University, Columbus, Ohio. Allotype ♂, Tullahoma, Tenn., Aug. 3, 1915, D. M. DeLong, here designated, in the DeLong collection, Ohio State University, Columbus, Ohio. Additional ♂ parallotypes as follows: (Florida) 13, Sanford, July 25, 1934, R. H. Beamer; 3, Sanford, Aug. 8, 1939, R. H. Beamer; 1, Sanford, Aug. 8, 1939, A. T. Hardy; 3, Pensacola, July 12, 1934, R. H. Beamer; 1, Yankeetown, July 17, 1934, R. H. Beamer; 3, Lacoochee, Aug. 18, 1930, R. H. Beamer; 1, Branford, July 16, 1934, R. H. Beamer; 2, Branford, July 31, 1930, P. W. Oman; 1, Homestead, Aug. 9, 1930, R. H. Beamer; 1, Ft. Myers, Aug. 14, 1930, R. H. Beamer; 3, July 16, 1939, La Belle, R. H. Beamer; 1, July 16, 1939, La Belle, P. B. Lawson; 4, Suwanee Spgs., Aug. 2-3, 1939, R. H. Beamer; 1, Likely, July 24, 1934, R. H. Beamer; 1, Wildwood, Aug. 2, 1930, R. H. Beamer; 1, Hilliard, Aug. 6, 1939, R. H. Beamer and 1, Dunnellon, July 12, 1939, R. H. Beamer. (Georgia) 3, Griffin, Aug. 12, 1939, R. H. Beamer; 2, Okefenokee Swamp, Aug. 3, 1934, R. H. Beamer and 1, Folkston, Aug. 2, 1934, R. H. Beamer. (Alabama) 1, Burnsville, July 20, 1930, P. W. Oman; 2, Marion Jct., July 16, 1930, L. D. Tuthill; 2, Prattsville, July 21, 1930, R. H. Beamer; 1, Tuskegee, July 22, 1930, P. W. Oman and 1, Montgomery, July 1, 1939, R. H. Beamer. (Mississippi) 2, Shuqualak, July 16, 1930, R. H. Beamer; 1, Fulton, July 14, 1930, L. D. Tuthill; 2, Fulton, July 14, 1930, R. H. Beamer; 4, Columbus, July 16, 1930, R. H. Beamer; 1, Columbus, July 16, 1930, P. W. Oman; 1, Columbus, July 16, 1930, L. D. Tuthill and 2, Hamilton, July 15, 1930, L. D. Tuthill. (Louisiana) 5, Nachitoches Parish, Aug. 16, 1928, R. H. Beamer; 1, Caddo Parish, Aug. 19, 1928, L. D. Beamer and 1, Beauregard Parish, Aug. 16, 1928, E. I. Beamer. (Tennessee) 3, Clarksville, Oct. 8, 1914.

Host Plants: Ball (1932) writes "The writer found it fairly common on *Ceanothus americanus* at Sanford, Florida."

Comparative Notes: This is one of the commonest species found in the Southeast. The entire face is marked, but the clypeus is lighter than the margins of the genae, separating it from *triangularis*, and it is much darker than *cinereus*. It may be found as far north as New Jersey. The genitalia are variable but the long, slender paraphyses, "L"-shaped aedeagus and long process on style readily separate it from any other. The frons of the Florida species are much lighter than those from further north.

73. *Scaphytopius (Cloanthanus) triangularis* DeLong

Cloanthanus triangularis, DeLong, D. M., Ohio Jour. Sci., XLV: p. 27, 1945.

Resembles *acutus* but with dark face and paraphyses enlarged near apex. Length: female 4.8 mm., male 4.2 mm.

Color: Crown mottled brown and light, often darkest on disc, with light markings as follows: thin line along anterior margin; wedge; irregular vittae on disc, either straight or arcuate; irregular area before eyes; typical light spots along posterior margin. Pronotum slightly lighter than crown, heavily irrorate with dark, vittae usually visible. Scutellum lighter than pronotum with typical markings. Face fulvous irrorate with dark, excepting wedge, vitta behind eye and shorter ones near ocelli and antennae. Forewing semihyaline fulvous with light aeroles and fuscous vermiculations throughout; veins brown, becoming fuscous on apex and costal margin.

Structural Characteristics: Crown about twice as long as width between eyes, anterior margin straight on each side of pointed apex; wedge about half length of crown. Pronotum three-fifths as long as crown, two and one-third times as wide as length at middle and three and one-half times length behind eyes. Clypeus over twice as long as width at ocelli, shallow concavity along sharksmouth, only slightly sinuate at antennae. Clypellus only slightly enlarged near apex. Face in lateral view concave between anterior margin of eyes. Forewing with vein-like marks in brachial cell, about ten recurved veins to costa and sometimes extra cross-veins in clavus.

Genitalia: Valve about one and two-fifths as wide as length at middle, posterior margin rounded; anterior margin with short, broad, median lobe. Paraphyses with slight enlargement at base, and somewhat enlarged just before sharp apices. Aedeagus in lateral view slightly curved, largest just before middle, bluntly pointed. Styles almost three times as long as basal width, sinuate near basal third, lobe on dorsal margin before slightly curved, finger-like process on apical third.

Last ventral segment of female with lateral margins short, posterior margin almost straight on each side of blunt apex.

Types: Types in Illinois Natural History Survey collection, Urbana, Illinois. One ♂ paratype was on hand for study.

Additional Material Studied: (Kansas) Douglas Co. and Leavenworth Co. (Illinois) Union Co. (Indiana) Gary and Tippecanoe Co. (Tennessee) Clarksville. (Maryland) Annapolis. (South Carolina) Charleston. (Mississippi) Meridian, Lincoln Co. and Tishomingo Co. (Alabama) Prattsville, Etowah Co. and Tuskegee. (Florida) La Belle and Ft. Mead.

Host Plants: The original description gave *Crataegus* sp. as the host. Specimens from Etowah Co., Ala., were labeled as from *Prunus angustifolia* and the author has collected the species in Kansas from rose.

Comparative Notes: The dark brown face separates this species from most, since it has a shorter, broader crown than *rubellus*.

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———, 1932. The food plants of the leafhoppers formerly included in the genus *Platymetopius* Burm. Can. Ent., vol. 44, pp. 251-255.

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DELONG, D. M. 1916. The leafhoppers or Jassoidea of Tennessee. Bull. Tenn. St. Brd. of Ent., vol. 5, pp. 1-113.

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———, 1943a. A new genus (*Tumeus*) and six new species of leafhoppers closely related to *Cloanthanus*, Homoptera, Cicadellidae. Bull. Brook. Ent. Soc., vol. 38, pp. 168-174.

———, 1943b. The Mexican leafhoppers of the genus *Cloanthanus* and *Schaphytopius* (Homoptera-Cicadellidae). Lloydia, vol. 6, pp. 157-195.

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FITCH, ASA. 1851. Catalogue with references and descriptions of the insects collected and arranged for the State Cabinet of Natural History. Ann. Report State Cab. Nat. Hist., N. Y., vol. 4, pp. 43-69.

FLETCHER, R. K. 1930. A study of the insect fauna of Brazos Co., Tex., with special reference to the Cicadellidae. Ann. Ent. Soc. Amer., vol. 23, pp. 33-54.

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GIBSON, E. H., and COGAN, E. S. 1915. A preliminary list of the Jassoidea of Missouri with notes on species. Ohio Jour. Sci., vol. 16, pp. 71-78.

HORSFALL, J. L. 1916. Additions to the Jassoidea of Missouri. Ohio Jour. Sci., vol. 16, pp. 354-355.

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———, 1900a. A list of Hemiptera collected in the vicinity of Bellaire, Ohio. Ohio Nat., vol. 1, pp. 11-12.

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———, 1905. Report of progress of study of the Hemiptera of Ohio and descriptions of new species. Ohio Nat., vol. 5, pp. 273-276.

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———, 1928. The leafhoppers of Ohio. Bull. Ohio Biol. Surv., vol. 3, pp. 119-374.

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PROVANCHER, L. 1889. Deuxieme sous-order les Homopteres. Petite faune entomologique du Canada, precede d'un traite elementaire d'entomologie. vol. 3, pp. 207-292.

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———, 1894a. Descriptions of some new North American Homopterous insects. Bull. Buffalo Soc. Nat. Sci., vol. 5, pp. 205-216.

———, 1894b. A list of the Hemiptera of Buffalo and vicinity. Bull. Buff. Soc. Nat. Sci., vol. 5, pp. 167-204.

———, 1894c. A catalogue of the described Jassoidea of North America. Trans. Amer. Ent. Soc., vol. 21, pp. 245-317.

———, 1905. List of Hemiptera taken in the Adirondack Mts. Bull. N. Y. St. Mus., No. 97, pp. 546-556.

———, 1907. Notes on Jamaica Hemiptera: A report on a collection of Hemiptera made on the Island of Jamaica in the spring of 1906. Bull. Buff. Soc. Nat. Sci., vol. 8, pp. 3-79.

———, 1908. A list of Hemiptera taken by W. J. Palmer, about Quinze Lake in 1907. Can. Ent., vol. 40, pp. 157-160.

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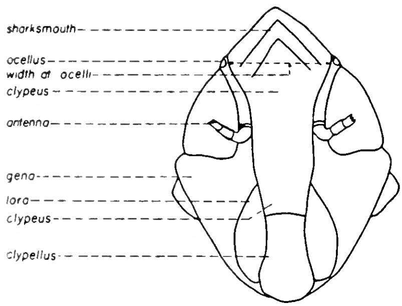
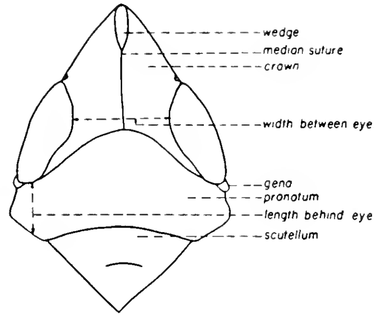
YOUNG, D. B. 1910. Additional list of Adirondack insects. Bull. N. Y. State Museum No. 141, pp. 123-125.

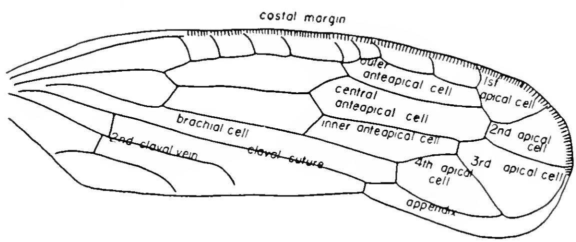
PLATE XXIII



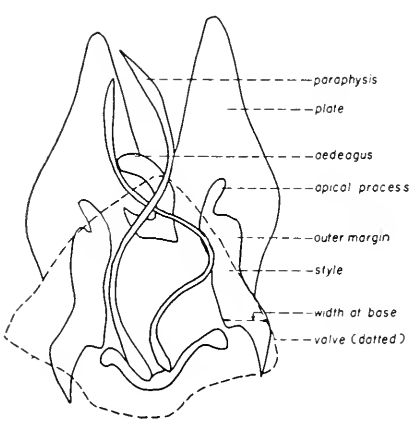
VENTRAL VIEW- HEAD



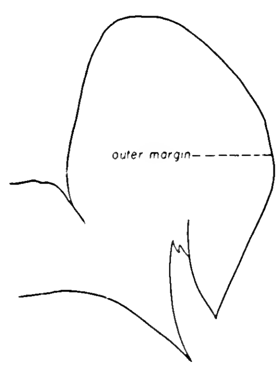
DORSAL VIEW - HEAD, PRONOTUM and SCUTELLUM



FOREWING



GENITALIA- VENTRAL VIEW



PYGOFER

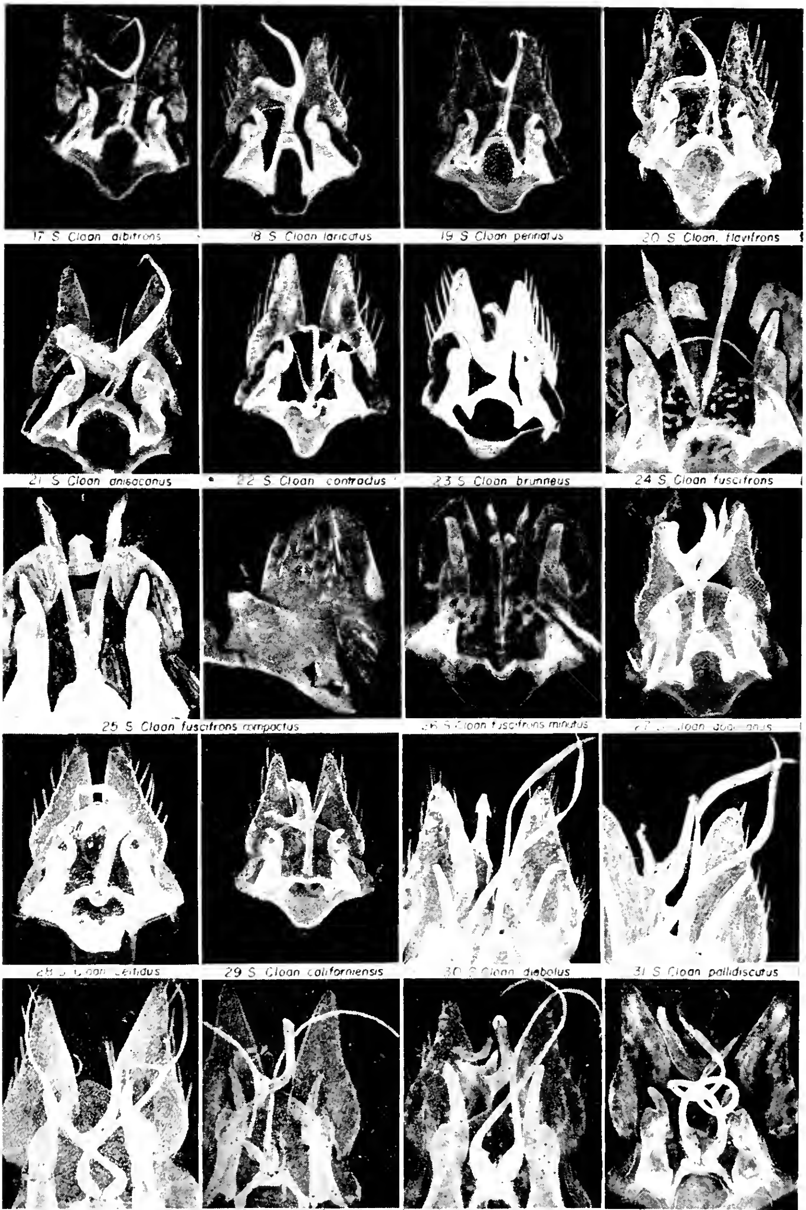
SCAPHYTOPIUS (CLOANTHANUS) ANGUSTATUS (OSBORN)

Scaphytopius (Cloanthanus) angustatus (Osborn).

PLATE XXIV

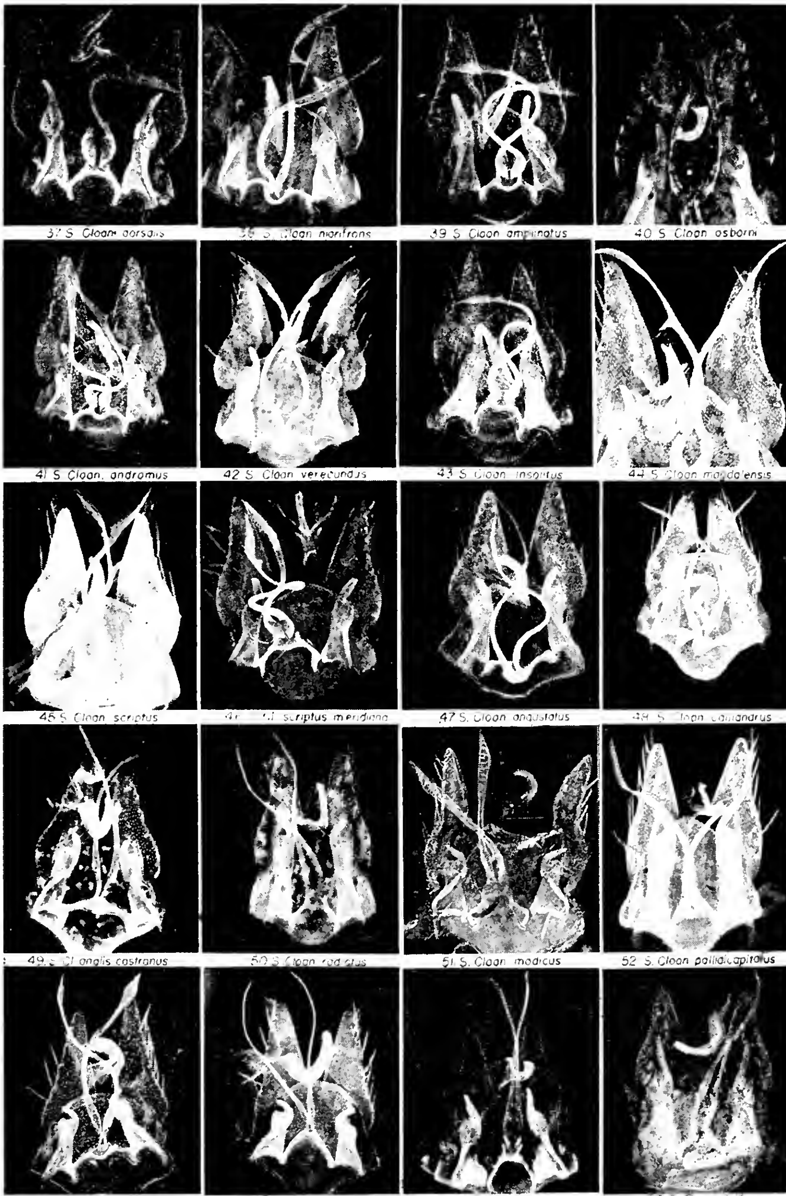
Male genitalia of the Scaphytopini.

PLATE XXV



Male genitalia of the Scaphytopini.

PLATE XXVI

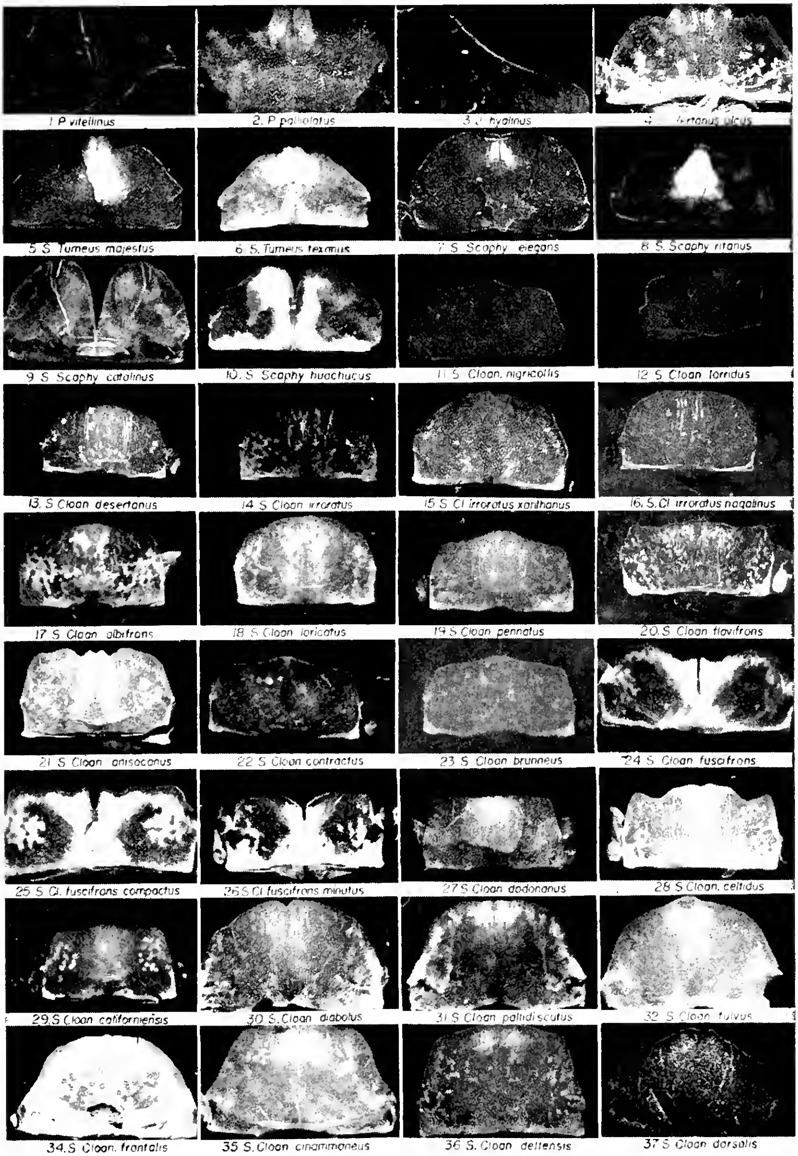


Male genitalia of the Scaphytopini.

PLATE XXVII

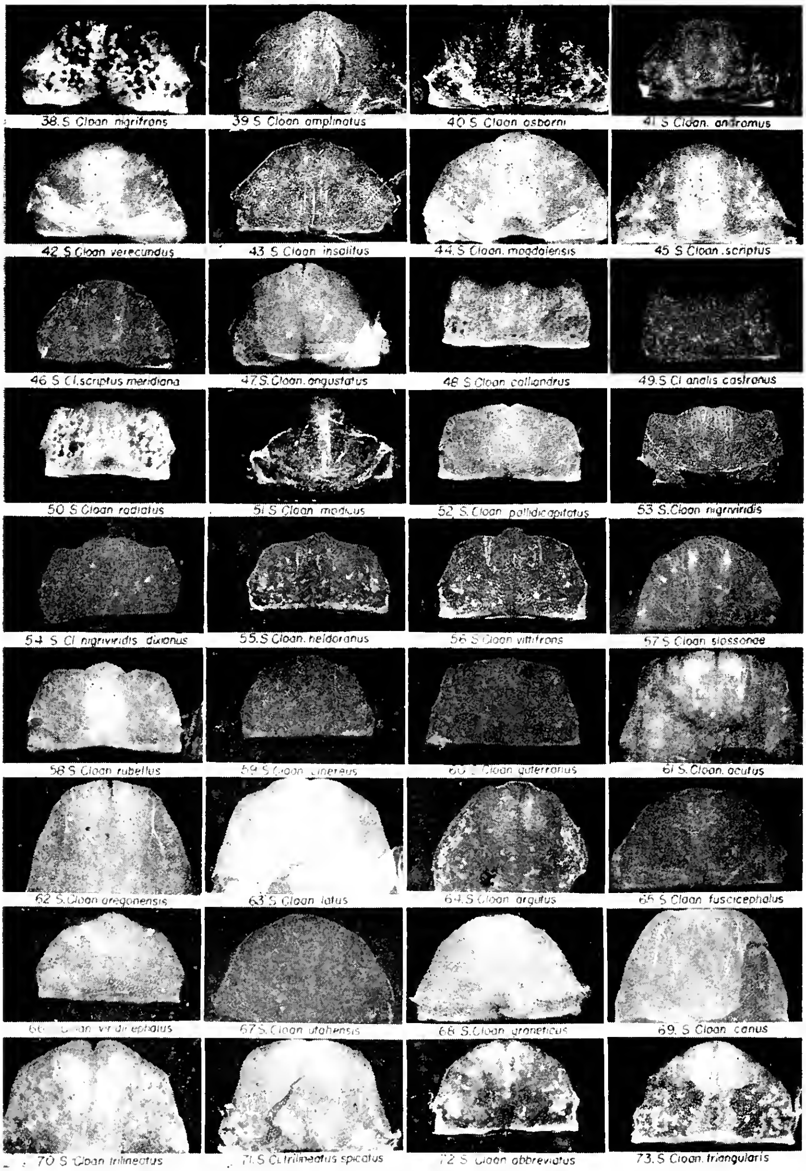
Male genitalia of the Scaphytopini.

PLATE XXVIII



Female genitalia of the Scaphytopini.

PLATE XXIX



Female genitalia of the Scaphytopini.

SPECIES INDEX

Errata

For University of Kansas Science Bulletin, vol 31, pt. 2, no. 17, 1947. A Bibliography of Mexican Amphibiology by Edward H. Taylor.

(Failure to return to the printer the corrected galley proof has resulted in certain errors in this paper.)

p. 543, line 28: read, Kriechtiere

p. 544, line 42: insert, figures 1-3

p. 545, line 40: read, parásitos

p. 546, line 8: read, Compt. Rend. Acad. Sci.; line 43: delete period after "Bericht"

p. 547, line 23: read, *Bufo beldingi*

p. 549, line 40: after Mexico insert II; line 46: read, género; line 50: read, Ciénega

p. 550, line 1: read, Ciénega

p. 555, line 5: read, República; line 17: read, República; line 42: Actually two titles are included here

p. 557, lines 31, 32: delete entire reference

p. 560, line 20: read, Funkhouser; line 43: read, beschrieben

p. 562, lines 20-27: list these references under Cancino Gomez, Isaac; line 42: read, 1831, pp. 1-110

p. 565, line 30: read, Bravo Hollis, Margarita

p. 566, line 21: read, Funkhouser

p. 567, line 34: read, Amphibienkentnisse; read, nebst; line 35: read, Bemerkungen; line 48: read, Mexikanische

p. 568, line 18: read, Wiesbaden

p. 569, line 21: read, Würzburg; line 26: read, Marherr, Erich

p. 570, line 38: read, Systems

p. 571, line 2: read, Kolbenmolche: line 38: read, Moore, J. Percy; line 46: read, Sollberger

p. 574, line 28: read, herpetologischen

p. 575, line 41: read, Nieto Roaro, Daniel

p. 578, line 5: read, Systematic

p. 579, line 34: read, Rumpfmuskulatur; line 38: read, Rumpfmuskulatur; line 39: read, insbesondere

p. 581, line 8-9: read, Entrega 5, 1882, pp. 58-82

p. 585, line 31: read, Cuesta Terron, Carlos; lines 36, 37: delete reference. This appears under Cuesta Terron on page 554

p. 587, line 8: Actually two titles included here

p. 589, line 17: for Clay read Crécy

THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN

VOL. XXXI, pt. II.] NOVEMBER 1, 1947 [No. 17

A Bibliography of Mexican Amphibiology

By EDWARD H. TAYLOR

NO COMPREHENSIVE bibliography dealing with the amphibiology of Mexico has ever been published. The present wide interest in this subject practically demands that such a publication be made available to the numerous workers in this new field. For the past 15 years during my extensive work on Mexican faunas I have been collecting literature dealing with this particular subject, and the following annotated list of titles dealing with the amphibiology of Mexico is offered to fill this need. It is as complete as I have been able to make it for taxonomic works, but I feel that further research might reveal other titles of significance dealing with anatomy and physiology of Mexican species.

It is possible that some of the titles listed, purporting to treat of the "Mexican axolotl," may actually not do so. However, in most cases the authors believed that the European bred stock of the *axolotl* was from species originating in Mexico. Certain of these papers have not been read by me.

About fifty of the titles were added by Dr. Hobart M. Smith who had the kindness to read the manuscript and check the reference. He has my heartfelt gratitude.

ACKERMANN, J.

1933. Ueber die Innervierung der Haut des Axolotls (*Ambystoma mexicanum*). Bull. Acad. Polonaise Sci. (Sect. B), 1933, No. 2, pp. 1-12, pl. 1.

AHL, ERNST.

1927 Ueber neue oder seltene Froschlurche aus dem Zoologischen Museum Berlin. Sitz. Ges. nat. Freunde, 1926 (May 1, 1927), pp. 111-117.
Type description of *Bufo eiteli*.

1932. Neu oder selten eingeführte Fische, Lurche und Kreichtiere. Das Aquarium, Jan., 1932, pp. 1-4, ill.
Rhinophrynus dorsalis discussed and figured.

1934. Ueber eine Sammlung von Reptilien und Amphibien aus Mexiko. Zool. Anz., 106, No. 7-8, Apr. 15, 1934, pp. 184-186, text fig. 1.
Type description of *Hyla leonhard-schultzei* and notes on other species.

ALLEN, MORROW J.

1933. Report on a collection of amphibians and reptiles from Sonora, México with the description of a new lizard. Occ. Papers Mus. Zool., Univ. Michigan, No. 259, Apr. 3, 1933, pp. 1-15.

Lists *Scaphiopus couchii*, *Bufo alvarius*, *Pternohyla fodiens*, *Gastrophryne texensis*.

ANONYMOUS.

1865. Reproduction of the Axolotl. Nat. Hist. Rev., 1865, pp. 454-455.

1866. Nyere Jagltagelser om Axolotlen (Med traesnit.) Tidsskr. pop. Fremstilling af Naturvidensk, 3 R., 3, 1866, pp. 325-330.

1870. Kunstliche Bildung einer weissen Rasse u Metamorphose des Axolotl. (auszug.) Naturforscher (Sklarek), 3, 1870, p. 196. (*Fide* Duméril, in Compt. Rend., 70, 1870, p. 782.)

1876a. Az Axolotl atvaltozasarol amblystomava. Term. Tud. Közl. 8 Köt, 1876, pp. 439-440 (See Weismann, Zeit. Wiss. Zoll. 25, Suppl.)

1876b. Fortpflanzung des Amblystoma (übersetzung). Naturforscher (Sklarek), 9, 1876, pp. 215-216. (See Blanchard, in Compt. Rend., 82, 1876, p. 716.)

1876c Eine neue Deutung des Axolotl (auszug). Naturforscher (Sklarek), 9, 1876, pp. 114-115.

1877. Reproduction des Axolotls transformees en Amblystomes. Journ. Zool. (Gervais), 6, 1877, pp. 152-153.

1879. Zur Metamorphose des Axolotl. Gäa., 15, 1879, pp. 186-187.

ATKINSON, D. A.

1907. Notes on a collection of batrachians and reptiles from Central America. Ohio Naturalist, 7, May 1907, pp. 151-157.

Hyla taeniopus listed from Morales, Guatemala. Probably erroneously identified.

BAIRD, SPENCER F.

1849. Revision of the North American tailed-batrachia, with descriptions of new genera and species. Journ. Acad. Nat. Sci. Philadelphia, (2), 1, 1849, pp. 281-294.

Type description of *Amblystoma mavortia*.

1854. Descriptions of new genera and species of North American frogs. Proc. Acad. Nat. Sci. Philadelphia, 7, 1854-1855 (April, 1854), pp. 59-62.

Contains the type descriptions of *Hyla eximia*, *Hyla vanvlietii*, *Hyla affinis*, *Rana montezumae*, and *Scaphiopus couchii*.

1859. Reptiles of the boundary. (In) United States and Mexican boundary survey under the order of Lieut. Col. W. H. Emory, 1859, 2, Reptiles, pp. 1-35, pls. 1-41.

The "type description" of *Batrachyla longipes* consists of 1-3 on plate 37. *Bufo alvarius* is described by Girard from the "Valley of the Gila and Colorado."

BAIRD, SPENCER F., and GIRARD, CHARLES.

1852. Characteristics of some new reptiles in the museum of the Smithsonian Institution. Proc. Acad. Nat. Sci. Philadelphia, 6, 1852-1853 (Oct., 1852), p. 173.

Type descriptions of *Amblystoma proserpine*, *Bufo punctatus*, *Rana areolata*, and *Bufo granulosus*, all from Texas.

BARBOUR, THOMAS.

1922. Three new neotropical Salientia. Proc. Biol. Soc. Washington, 35, Oct. 17, 1922, pp. 111-114.

Eleutherodactylus dunnii and *Syrrhopus* (sic) *mystaceus* are described.

1923. The reappearance of Batrachyla longipes. Proc. New England Zoöl. Club, 8, June 5, 1923, pp. 81-83.

Reports a specimen of *Elentherodactylus* (sic) *longipes* (= *Eleutherodactylus batrachylus* Taylor).

1926. Reptiles and amphibians. Houghton Mifflin Company, Boston and New York, 1926, pp. xxii + 125.

The axolotl figured, p. 99.

1927. *Cauphias* rediscovered. Copeia 1927, No. 165, pp. 96-98.

BARBOUR, THOMAS, and COLE, LEON J.

1906. Reptilia, Amphibia, and Pisces. (In) Vertebrata from Yucatán. Bull. Mus. Comp. Zoöl., 50, No. 5 (part.), 1906-1907 (Nov. 1906), pp. 146-155.

The following specimens are reported: *Rana virescens areolata, Bufo valliceps, Bufo marinus, Hyla phlebodes, Hyla baudinii, Triprion petasatus* and *Spelerpes yucatanus*.

BARBOUR, THOMAS, and LOVERIDGE, ARTHUR.

1929. Typical reptiles and amphibians. Bull. Mus. Comp. Zoöl., 69, No. 10, June 1929, pp. 205-360.

Lists a few specimens from México.

BARNES, D. H.

1826. An arrangement of the genera of batracian animals, with a description of the more remarkable species. Amer. Journ. Sci. Arts (Sillimans Journal), (1), 11, Oct. 1826, pp. 268-297.

Proteus mexicanus is discussed and its synonyms given.

BEDRIAGA, JACQUES V.

1877. Bemerkungen über die Umwandlung des Axolotl in ein Amblystoma. Zool. Garten, 18, 1877, pp. 132-133.

BELDING, L.

1887a. Collecting in the cape region of Lower California. The West American Scientist, 3, No. 24, Apr. 1887, pp. 93-97.

Mentions discovery of a new toad (*Bufo beldingi*).

1887b. Reptiles of the cape region of Lower California. *Ibid*, pp. 97-99.

List of five amphibians.

BELTRAN, ENRIQUE.

1941. Opalinidos parasitos en anfibios Mexicanos. Rev. Soc. Mex. Historia Natural, 2 (2 & 3), pp. 127-136, pl. 3.

BERT, PAUL.

1869. Ablation chez au Axolotl des branchies et des poumons. Compt. Rend. et Mém. Soc. Biol. Paris, (4) 5, 1868 (1869), C. R. pp. 21-22.

1880. (Influence des lésions du cerveau sur les appareils de coloration des axolotls). Compt. Rend. et Mém. Soc. Biol. Paris, (7), 1, 1879 (1880), C. R. p. 65.

BINDEWALD, CARL A. E.

1914. Das Vorderhirn von Ambystoma mexicanum. Arch für Mikr. Anat., 84, Abt. 1, pp. 1-74, 1 pl., text figs. A-B.

BLANCHARD, EMILE.

1876a. Reproduction of Amblystoma. Ann. Mag. Nat. Hist., (4), 17, 1876, pp. 414-415.

1876b. Reproduction de l'Amblystome, observée au Muséum. Compt. Rend., 82, 1876, pp. 716-717.

1879. Sur la ponte des Amblystomes au Muséum d'historie naturelle. (Extr.) Rev. des Sciences, 4, 1879, p. 167.

BLANCHARD, RAPHAEL.

1882a. (Review of Velasco's study on the habits of the ajolote.) Rev. Sci., May 13, 1882, pp.

1882b. (Review of Velasco's study.) La Naturaleza, 6, 1882, pp. 60-61.

A translation of the preceding article.

BLATCHLEY, W. S.

1893. On a collection of batrachians and reptiles from Mount Orizaba, Mexico, with descriptions of two new species. Proc. U. S. Nat. Museum, 16, No. 922, 1893, pp. 37-42.

Type descriptions of *Spelerpes orizabensis* and *Spelerpes gibbicaudus* appear. Also records *Spelerpes bellii* (= *B. gadovii* Dunn), *Bufo intermedius, Hyla eximia* and *Hyla miotympanum.*

BLUM.

1880. Der mexikanische Kiemenmolch oder Axolotl (Ambystoma mexicanum Cope (tigrinum), seine Züchtung u. Pflege. Isis (Russian), 5, 1880, pp. 59-61, 67-68, 75-77.

BOETTGER, OSCAR.

1892. Katalog der Batrachier-Sammlung im Museum der Senckenbergischen Naturforschenden Gesellschaft in Frankfurt am Main. Frankfort, 1892, pp. x + 73.

Numerous Mexican species listed.

1893. Ein neuer Laubfrosch aus Costa Rica. Bericht. Senck. Natur. Ges., 1892-1893 (1893), pp. 251-252.

Hyella fleischmanni described from San José, Costa Rica.

BOGDANOFF, N.

1873. (On the transformation of the axolotl) (In Russian) Trud. C. Peterb. ectect. 4, 1873, pp. lxxxiii-lxxxiv.

BOGERT, CHARLES M., and OLIVER, JAMES A.

1945. A preliminary analysis of the herpetofauna of Sonora. Bull. Amer. Mus. Nat. Hist., 83, (6), pp. 297-426, figs. 1-13, pls. 30-37, table 1, maps 1, 2.

BOULENGER, EDWARD G.

1913. Experiments on the metamorphosis of the Mexican axolotl (*Ambystoma tigrinum*), conducted in the society's garden. Proc. Zool. Soc. London, No. 28, May 20, 1913, pp. 403-413, text figs. 75-76.

BOULENGER, GEORGE ALBERT.

1881. Leptodactylus caliginosus Girard et L. albilabris Günther. Bull. Soc. Zool. France, 6, 1881, pp. 30-35.

1882a. Catalogue of the Batrachia Salientia s. Ecaudata in the collection of the British Museum, 2nd Ed., 1882, pp. xvi + 503, pls. 1-30.

Treats of the known fauna of this group, in México.

1882b. Catalogue of the Batrachia Gradienta s. Caudata and Batrachia Apoda in the collection of the British Museum. 2nd Ed., 1882, pp. viii + 127, pls. 1-9.

1882c. Description of a new genus and species of frogs of the family *Hylidae*. Ann. Mag. Nat. Hist., (5), 10, No. 58, Oct. 1882, pp. 326-328.

Genus *Pternohyla*, and *Pternohyla fodiens* are described. *Hyla venulosa* and *Hyla dacnicolor* are discussed.

1883a. Descriptions of new species of lizards and frogs collected by Herr A. Forrer in Mexico. Ann. Mag. Nat. Hist., (5), 11, 1883, pp. 342-344.

The following type descriptions are given: *Rana forreri, Rana pustulosa* and *Hypopachus oxyrrhinus*.

1883b. Notes on little-known species of frogs. Ann. Mag. Nat. Hist. (5), 11, 1883, pp. 17-20.

1883c. Reptilia and Batrachia. Zoological Record, 19, 1882, pp. 1-28.

States that *Spelerpes yucatanus* Peters and *Spelerpes yucatanicus* Boulenger are identical. "Peters' description appears to have a few days priority over the Recorder's," p. 26.

1884. Reptilia and Batrachia. Zoological Record, 20, 1883, pp. 1-24.

Refers *Bufo belding* to *Bufo punctatus*.

1887. Descriptions of new reptiles and batrachians in the British Museum (Nat. Hist.), Part III. Ann. Mag. Nat. Hist., (5), 20, No. 115, July 1887, pp. 50-53.

Describes *Hyla copii* from El Paso,Texas, on the Mexican border.

1888a. On a rare American newt, *Molge meridionalis* Cope. Ann. Mag. Nat. Hist., (6), 1, No. 1, Jan. 1888, p. 24.

1888b. Note on the classification of the Ranidae. Proc. Zool. Soc. London, pt. 2, Feb. 10, 1888, pp. 204-206.

Discusses the genus *Syrrhopus* (sic), placing *Malachylodes* Cope and *Hypodiction* Cope in synonymy.

1888c. Descriptions of new Brazilian batrachians. Ann. Mag. Nat. Hist., (6), 1, No. 3, Mar. 1888, pp. 187-189.

Discusses the genus *Eupemphix* (= *Engystomops* [part.]), and refers the genus to the Bufonidae.

1891. Notes on American batrachians. Ann. Mag. Nat. Hist., (6), 8, No. 48, Dec. 1891, pp. 453-458.

Hylella sumichrasti. Notes that *Exerodonta Sumichrasti* Brocchi and *Hylella platycephala* Cope are synonyms, and that Brocchi's name is oldest.

1895a. A synopsis of the genera and species of apodal batrachians with description of a new genus and species *Bdellophis vittatus*. Proc. Zool. Soc. London, 1895, pp. 410-414, pls. 23-24.

1895b. Reptilia and Batrachia. Zoological Record, 31, 1894, pp. 1-44.

Regards *Hylella chrysops* Cope as a synonym of *Hylella fleischmanni* Boettger.

1898. Fourth report on additions to the batrachian collection of the Natural History Museum. Proc. Zool. Soc. London, June 7, 1898, pp. 473-482, pls. 38-39.

Type descriptions of *Hylodes alfredi* and *Borborocoetes mexicanus*. Figures of both are given.

1899. Descriptions of new batrachians in the collection of the British Museum (Natural History). Ann. Mag. Nat. Hist., (7), 3, 1899, pp. 273-277, pls. 11, 12.

Proposes *Hyla underwoodi nom. nov.* for *Hyla microcephala* Boulenger (nec Cope).

1902. Reptilia and Batrachia. Zoological Record, 38, 1901, pp. 1-33.

Proposes *Hyla smithi nom. nov.* for *Hyla nana* Günther (nec *Hyla nana* Boulenger).

1903. Descriptions of new batrachians in the British Museum. Ann. Mag. Nat. Hist., (7), 12, No. 71, Nov. 1903, pp. 552-557.

Type descriptions of *Eupemphix gadovii* and *Hylodes beatae* appear.

1910. Axolotl. *In* Encycl. Brit., Ed. 11, 3, pp. 68-70.

Excellent historical discussion, with bibliography (not in later editions).

1917. Descriptions of new frogs of the genus Rana. Ann. Mag. Nat. Hist., (8), 20, No. 120, Dec. 1917, pp. 413-418.

Describes *Rana tarahumarae* from Ioquiro and Barranca del Cobre, Sierra Tarahumara, N. W. México.

1919. Synopsis of the American species of Rana. Ann. Mag. Nat. Hist., (9), 3, No. 16, Apr. 1919, pp. 408-419.

Rana montezumae, Rana tarahumarae, Rana halecina (includes *Rana forreri*), *Rana pustulosa, Rana palmipes.* He discusses Peters' genus *Ranula.*

1920. A monograph of the American frogs of the genus Rana. Proc. Amer. Acad. Arts Sci., 55, No. 9, Aug. 1920, pp. 413-480.

Mexican forms treated here are: *Rana montezumae, Rana halecina, Rana draytonii, Rana tarahumarae, Rana pustulosa,* and *Rana palmipes.*

BRAGG, ARTHUR N.

1941. Tadpoles of Scaphiopus bombifrons and Scaphiopus hammondii. The Wasmann Collector, 4, No. 3, Apr. 1941, pp. 92-94.

BRAVO H., MARGARITA.

1943a. Dos nuevos nematodos parásitos de anuros del sur de Puebla. Anal. Inst. Biol., 14, (1), pp. 69-78, pls. 1-3.

1943b. Estudio sistematico de los trematodos parásitos de los "ajolates" de México. Anal. Inst. Biol., 14, (1), pp. 141-159, pls. 1-5.

BRAVO, H., MARGARITA, and CABALLERO C., EDUARDO.

1940. Nematodos parásitos de los batracios de México. IV. Anal. Inst. Biol. México, 11, pp, 239-247, pls. 1-3.

Bufo marinus and *Rhyacosiredon altamirani* studied.

BROCCHI, PAUL.

1877a. Sur le système nerveux de l'axolotl (Siredon mexicanus). Bull. Soc. Philom. Paris, (7), 1, 1876-1877 (1877), pp. 21-24.

1877b. Note sur les nerfs trijumeau et facial de l'axolotl. Bull. Soc. Philom. Paris, (7), 1, 1876-1877 (1877), pp. 59-61.

1877c. De l'absence du grand sympathique chez l'axolotl. Bull. Soc. Philom. Paris, (7), 1, 1876-1877 (1877), pp. 71-73.

1877d. Description d'un nouveau genre de Phaneroglosse Hylaeforme (Plectrohyla guatemalensis). Bull Soc. Philom. Paris, (7), 1, No. 2, 1876-1877 (1877), pp. 92-93.

Genus *Plectrohyla* described.

1877e. Note sur quelques batraciens hylaeformes recueillis au Mexique et au Guatemala. Bull. Soc. Philom. Paris, (7), 1, No. 3, 1876-1877 (1877), pp. 122-132.

Hyla plicata, the genus *Cauphias,* and *Cauphias crassus* are described as new. *Hyla baudinii* and *Hyla eximia* are discussed.

1877f. Sur quelques Batraciens Raniformes et Bufoniformes de l'Amérique Centrale. Bull. Soc. Philom. Paris, 1876-1877 (1877), (7), 1, No. 4, pp. 175-197.

The following Mexican species are described: *Cystignathus fragilis, Leuiperus* (sic) *mexicanus, Bufo levifrons, Rhinophrynus rostratus.* The *Rana maculata* from "Totonicapam, Mexique" is probably from Guatemala.

1879. Sur divers Batraciens anoures de l'Amérique Centrale. Bull. Soc. Philom. Paris, (7), 3, No. 1, 1878-1879 (1879), pp. 19-24.

The type description of the following species appear: *Exerodonta Sumichrasti, Hyla paenulata* (from Guatemala), *Hylodes Augusti* Dugès, *Hylodes lineatus* ("Attitlan Mexique" but probably from Guatemala), *Scaphiopus dugesii* and *Bufo mexicanus.*

1881 to
1883. Études des batraciens de l'Amérique Centrale (In) Mission Scientifique au Mexique et dans l'Amérique Centrale, Part 3. Sec. 2, 1881-1883, pp. 1-122, pls. 1-21. Issued as follows: Livr. 1, 1881, pp. 1-56. pls. 1-5, 9, 10. Livr. 2, 1882, pp. 57-96, pls. 6-8, 11-15. Livr. 3, 1883, pp. 97-122, pls. 7, 12, 16, 17, 17bis, 18, 18bis, 19, 20, 20bis, 21.

The following Mexican species are described as new: *Spelerpes laticeps, Spelerpes sulcatum* and *Spelerpes punctatum.* (The descriptions of *Hylodes lineatus* and *Exerodonta sumichrasti,* said to be the original, are not.)

BROWN, ARTHUR ERWIN.

1908. Generic types of Nearctic reptilia and amphibia. Phila. Acad. Nat. Sci., Proc. 1908, 59, pp. 112-127.

BURT, CHARLES W.

1932. Some Mexican herpetological records. Copeia, 1932, No. 3, Oct. 7, p. 158.

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1942. Influence de la pigmentation mélanique sur l'intensité de la respiration cutanée d'un Vertebré inferior, *Axolotl mexicanum* Shaw. C. R. Acad. Sci. Paris, 214 (5), pp. 238-241.

CABALLERO Y C., EDUARDO.

1933. Nematodos parásitos de los batracios de México. Anal. Inst. Biol. Mex., 4, No. 3 and 4, 1933, pp. 187-190, figs. 1-6.

Dermophis mexicanus.

1938. Revisión y clave de las especies del género *Glypthelmins.* Anal. Inst. Biol. Mex., 9, 1938, pp. 121-149, figs. 1-11.

Rana montezumae.

1940. Nuevos genero y especie de Hirudineo perteneciente a la subfamilia HAEMADIPSINAE. Anal. Inst. Biol. Mex., 11, No. 2, 1940, pp. 573-583, fig. 1-7.

Rhyacosiredon altamirani, Oedipus.

1942a. Tremátodos de las Ranas de la Cienaga de Lerma, México. 1. Anal. Inst. Biol. Mex., 12, No. 2, 1942, pp. 623-641, figs. 1-6.

Rana montezumae and *Rana pipiens.*

1942b. Tremátodos de las Ranas de la Ciénega de Lerma, Estado de México III. Redescription de una forma Norte americana de Haematolacchus y algunas consideraciones sobre *Glypthelmins californiensis* Cort 1919, (1). Anal. Inst. Biol. Mex., 13, No. 1, 1942, pp. 71-79, figs. 1-2.

1944. Estudios helmintológicos de la region ancercosa de México y Guatemala, Nematoda. Anal. Inst. Biol. Mex., 15 (1), pp. 87-108, figs. 1-18.

CABALLERO Y C., EDUARDO and BRAVO HOLLIS, MARGARITA.

1940. Nemátodos parásitos de los batracios de México. IV. Anal. Inst. Biol. 11, pp. 239-247, pls. 1-3.

CABALLERO Y C., EDUARDO, BRAVO HOLLIS, MARGARITA, and CERECERO, M. C.

1944. Estudios helmentológicos de la región ancocercosa de México y de la Republica de Guatemala. Trematodo I. Anal. Inst. Biol. Mex., 15 (1), p. 59-72, figs. 1-7.

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1851. Sull. Anatomia dell'Axolotl. Mem. dell'Accad. di Bologna, 3, 1851, pp. 269-362.

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CAMERANO, LORENZO.

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Describes *Dromoplectrus* with *Bufo anomalus* the type, and discusses *Bufo intermedius, Bufo occipitalis* sp. nov.

CAMPBELL, BERRY.

1931. Notes on Batrachoseps. Copeia, 1931, No. 3, Oct. 30, pp. 131-134.

Batrachoseps attenuatus leucopus, Baja California.

CARBONNIER, M.

1883. Notes on the habits and the rearing of the axolotl Amblystoma mexicanum (translated from the French by Tarleton H. Bean). Proc. U. S. Nat. Mus., 5, 1882 (1883), pp. 221-222.

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1885. Die postembryonale Entwicklung der Epidermis des Siredon pisciformis. Arch. Mikr. Anat., 24, pp. 19-49, pls. 2, 3.

CHAUVIN, MARIE V.

1876. Ueber die Verwandlung der mexicanischen Axolotl in Amblystoma. Zeit. wiss. Zool., 27, No. 4, 1876, pp. 522-535.

1883. Ueber die Fortpflanzung des Amblystoma. Zool. Anz., 6, No. 149, Sept. 24, 1883, pp. 513-515.

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1885. Ueber die Verwandlungsfähigkeit des mexikanischen Axolotl. 1885, pp. 365-389.

CLEMENTS, DOROTHY I.

1938. Histological studies of the effect of iodine on the Old Mexican axolotl (*Amblystoma tigrinum*) during metamorphosis. Proc. Zoöl. Soc. London 108 (B), pp. 551-574, pls. 1-3, fig. 1.

COLE, C. E.

1928. Notes on the breeding of the Mexican axolotyl. S. Aus. Nat. 9, (4), pp. 63-65.

COPE, EDWARD DRINKER.

1860. Descriptions of reptiles from tropical America and Asia. Proc. Acad. Nat. Sci. Philadelphia, 12, 1860, pp. 368-374.

Discusses *Spelerpes bellii* and *Geotriton carbonarius*.

1862. Catalogues of the reptiles obtained during the explorations of the Parana, Paraguay, Vermejo, and Uraguay rivers, by Capt. Thos. J. Page, U. S. N.; and of those procured by Lieut. N. Michler, U. S. Top. Eng., Commander of the expedition conducting the Survey of the Atrato River. Proc. Acad. Nat. Sci. Philadelphia, 14, Sept. 1862, pp. 346-359.

Describes *Hyla muricolor* from Mirador, Veracruz, *Hyla callidryas* from Panamá, and *Hyla phaeota* from Turbo, Darien. He proposes the genus *Scytopis* and considers the recent breaking up of the genus *Bufo* and refers Mexican species to the following genera: *Chilophryne cognata, Phrynoidis alvarius, Bufo simus, Bufo anomalus, Bufo insidior* and *Bufo punctatus*.

1863. On Trachycephalus, Scaphiopus and other American Batrachia. Proc. Acad. Nat. Sci. Philadelphia, 15, 1862 (1863) pp. 43-54.

Type descriptions of *Hyla miotympanum, Scaphiopus multiplicatus, S. varius,* and *S. rectifrenis*. Also lists *Hyla griseus* (Mexico?), *Hyla baudinii, Scaphiopus couchii*. Places *Spelerpes chiropterus* under AMBLYSTOMIDAE.

1864a. Contributions to the herpetology of tropical America. Proc. Acad. Nat. Sci. Philadelphia, 16, 1864, pp. 166-181.

Original description of *Phyllomedusa dacnicolor* from near Colima. *Paludicola pustulosus* from River Truando in New Granada. *Agalychnis callidryas* and *A. moreletii* are mentioned.

1864b. On the limits and relations of the Raniformes. Proc. Acad. Nat. Sci. Philadelphia, 16, 1864, pp. 181-183.

Proposes the family RHINOPHRYNIDAE.

1865a. Sketch of the primary groups of Batrachia s. Salientia. Nat. Hist. Rev., 1865, pp. 97-120.

Key to genera.

1865b. Third contribution to the herpetology of tropical America. Proc. Acad. Nat. Sci. Philadelphia, 17, Oct. 1865, pp. 185-198.

Describes *Pharyngodon petasatus, Hyla gracilipes, Hyla staufferi, Smilisca daulinia, Spelerpes orculus, Spelerpes cephalicus, Spelerpes lineolus*.

1866a. On the structures and distribution of the genera of the arciferous Anura. Journ. Acad. Nat. Sci. Philadelphia, (2), 6, pt. 1, July 1866, pp. 67-112, pl. 25.

1866b. Fourth contribution to the herpetology of tropical America. Proc. Acad. Nat. Sci. Philadelphia, 18, 1866, pp. 123-132.

Bufo coccifer, from Arriba, Costa Rica, and *Engystoma ustum* from Guadalajara are described as new. *Triprion* proposed for *Pharyngodon*, preoccupied.

1867a. On the reptilia and batrachia of the Sonoran province of the Nearctic Region. Proc. Acad. Nat. Sci. Philadelphia, 18, 1866, pp. 300-314.

Type descriptions of *Hyla curta* and *Bufo frontosus*. Lists also *Hyla regilla, Scaphiopus couchii, Bufo punctatus,* from the cape region of Baja California.

1867b. Fifth contribution to the herpetology of tropical America. Proc. Acad. Nat. Sci. Philadelphia, 18, 1866, pp. 317-323.

The type description of *Lithodytes rhodopis,* said to be near *L. griseus* of the same region (Orizaba).

1867c. On the families of the raniform Anura. Journ. Acad. Nat. Sci. Philadelphia, (2) 6, Part II, Art. 4, Sept. 1867, pp. 189-205.

Systoma ustum mentioned.

1868a. A review of the species of the Amblystomidae. Proc. Acad. Nat. Sci. Philadelphia, 19, 1867, pp. 166-211.

Amblystoma mexicanum and *Amblystoma mavortium* var. *proserpine* are discussed.

1868b. An examination of the Reptilia and Batrachia obtained by the Orton expedition to Ecuador and the upper Amazon, with notes on other species. Proc. Acad. Nat. Sci. Philadelphia, 20. Mar. 1868, p. 96-140.

Describes *Bufo argillaceus* from Colima, México.

1869a. On the origin of genera. Proc. Acad. Nat. Sci. Philadelphia, 20, Oct. 1868, pp. 242-300.

Certain Mexican species and genera mentioned.

1869b. Sixth contribution to the herpetology of tropical America. Proc. Acad. Nat. Sci. Philadelphia, 20, 1868, pp. 305-313.

Lists *Spelerpes lineolus* from Córdoba, Veracruz, and *Geotriton carbonarius* from Yucatán.

1869c. A review of the species of the Plethodontidae and Desmognathidae. Proc. Acad. Nat. Sci. Philadelphia, 21, 1869 (May), pp. 93-118.

Treats of *Opheobatrachus lineolus, Oedipus carbonarius, Oedipus variegatus, Spelerpes bellii, S. cephalicus, S. chiropterus.* Type descriptions of *Oedipus rufescens, Spelerpes leprosus* and *Thorius pennatulus* appear.

1869d. Seventh contribution to the herpetology of tropical America. Proc. Amer. Philos. Soc., 11, July 1869, pp. 147-169, pls. 9-11.

Describes *Liyla rugulosa,* from Tehuantepec; also lists the following: *Cystignathus melanonotus, C. gracilis* and *Ranula affinis.*

1871a. On Siredon metamorphosis, etc. Amer. Journ. Sci. Arts., (3), 1, Feb. 1871, pp. 89-90.

States that the metamorphoses observed by Prof. Duméril were not of *Siredon mexicanus.*

1871b. Ninth contribution to the herpetology of tropical America. Proc. Acad. Nat. Sci. Philadelphia, 22, 1871, pp. 200-224.

Lists *Systoma ustum, Bufo agua, Bufo sternosignatus* and *Lithodytes rhodopis.* from Tehuantepec.

1871c. On Siredon metamorphosis. Ann. Mag. Nat. Hist., (4), 7, 1871, pp. 246-247.

1874. Description of some species of reptiles obtained by Dr. John F. Bransford, assistant surgeon United States Navy, while attached to the Nicaraguan surveying expedition in 1873. Proc. Acad. Nat. Sci. Philadelphia, 25, pp. 64-72.

Type description of *Hyla ebraccata,* Nicaragua.

1875. Check-list of North American Batrachia and Reptilia, Bull. U. S. Nat. Mus. 1, pp. 1-104.

1876. On the Batrachia and Reptilia of Costa Rica. Journ. Acad. Nat. Sci. Philadelphia, (2), 8, 1876, pp. 93-154, pls. 23-28.

Type description of *Microphryne pustulosa* is given. *Bufo coccifer* is figured.

1877. Tenth contribution to the herpetology of tropical America. Proc. Amer. Philos. Soc., 17, No. 100, Aug. 1877, pp. 85-98.

Type descriptions of *Bufo canaliferus, Hyla spilomma, Hyla bistincta, Phyllobates cystignathoides* and *Cystignathus labialis.*

1878. Change by artificial means of a land to an aquatic salamander. Amer. Nat., 12, July 1878, pp. 468-469.

Mexican Ambystoma.

1879a. Eleventh contribution to the herpetology of tropical America. Proc. Amer. Philos. Soc., 18, No. 104, 1878-1880 (June 20, 1879 [Aug. 11 ?]) pp. 261-277.

Lists *Agalychnis dacnicolor* and *Bufo debilis* (probably *kelloggi*), from Mazatlán. From Guanajuato, *Spelerpes belli, Bufo punctatus, Bufo intermedius, Bufo monksiae* sp. nov., *Spea hammondi, Hyla eximia, Hyla arenicolor, Malachylodes guttilatus* sp. nov., *Cystignathus microtis* sp. nov., *Rana montezumae* and *Rana halecina* from Guanajuato; *Hypopachus variolosus* from Guadalajara; from Tehuantepec, *Oedipus rufescens, Oedipus carbonarius carbonarius, Oedipus carbonarius salvini, Siphonops mexicanus, Bufo agua, Bufo sternosignatus, Bufo canaliferus, Bufo coccifer, Bufo valliceps, Microphryne pustulosa, Engystoma ustum, Rhinophrynus dorsalis, Hyla miotympanum, Smilisca baudini, Hylella platycephala* sp. nov., *Lithodytes rhodopis, Lithodytes podiciferus, Syrrhophus leprus* sp. nov., *S. cystignathoides, Cystignathus melanonotus, Cystignathus perlaevis* sp. nov., *C. microtis, C. gracilis, C. labialis, Ranula affinis, Rana halecina.*

1879b. A contribution to the zoology of Montana. Amer. Nat., 13, No. 7, July 1879, pp. 432-441.

Bufo dipternus is described from Montana.

1879c. Another siredon. Amer. Nat., 13, 1879, pp. 456-457.

1880. On the zoological position of Texas. Bull. U. S. Nat. Mus., No. 17, 1880, pp. 1-51.

Diemyctylus miniatus meridionalis described from Matamoros, Tamaulipas, México. Other species mentioned.

1885a. Twelfth contribution to the herpetology of tropical America. Proc. Amer. Philos. Soc., 22, No. 118, 1884 (1885), pp. 167-194, figs. 1-8.

Lists *Rana halecina* from Monterrey, and *Dermophis mexicanus.*

1885b. A contribution to the herpetology of Mexico. Proc. Amer. Philos. Soc., 22, No. 120, Apr. 1885, pp. 379-404.

Lists *Spelerpes bellii, Bufo intermedius, Bufo agua, Hyla nigropunctata, Hyla gracilipes, Smilisca baudini, Lithodytes rhodopis, Hyla miotympanum Rana halecina* and *Hyla arenicolor. Hypodictyon* proposed for *H. ridens* (= *Phyllobates ridens* Cope), and includes *verruculatus* and *H. calceus* Peters. *Syrrhophus verrucipes* is described.

1887. Catalogue of batrachians and reptiles of Central America and Mexico U. S. Nat. Mus. Bull., No. 32, 1887, pp. 1-98.

Lists the known Mexican Amphibia. The genus *Diaglena* is proposed.

1888. (No title.) Amer. Nat., 22, No. 253, Jan. 1888, p. 80. Mentions a frog described by Boulenger as *Hyla coper* (sic) for (*copii*). In a footnote, it is referred to *H.(yla) arenicolor* Cope.

1889. The Batrachia of North America. Bull. U. S. Nat. Mus., No. 34, 1889, pp. 1-525, pls. 1-86, text figs. 1-119.
A few Mexican species recorded.

1893. Second addition to the knowledge of the batrachia and reptilia of Costa Rica. Proc. Amer. Philos. Soc., 31, No. 142, Nov. 17, 1893, pp. 333-347.
Comments on *Lithodytes rhodopis.*

1896. The geographical distribution of Batrachia and Reptilia in North America. Amer. Nat., Nov. and Dec. 1896, pp. 886-902, 1003-1026.
Many Mexican species mentioned with relation to the various faunal provinces.

1900. The crocodilians, lizards, and snakes of North America. Ann. Report U. S. Nat. Mus., 1898 (1900), pp. i-xviii, 155-1294, pls. 1-36, text figs. 1-347.
Spelerpes leprosus mentioned p. 757, and numerous amphibians are listed in the discussion of the faunal districts.

CORNALIA, EMILIO.
1868. Gli Axolots del Museo civico di Milano. Rendic. R. Istit. Lombard., (2), 1, 1868, pp. 383-388.

CUNNINGHAM, J. T.
1887. Siredon *in* Encycl. Brit. Ed. 9, 22, pp. 96-97.
A good historical account.

CUESTA TERRON, CARLOS.
1930. La Hyla eximia Baird. Anal. Inst. Biol. 1 (2), 1930, pp. 47-50, figs. 1-4.

DARESTE, C.
1874. Sur une particularitié physiologique de l'Axolotl. Compt. Rend., 78, 1874, pp. 1656-1657.

DAUDIN, F. M.
1803. Histoire Naturelle, Générale et particulière des reptiles. Vols. 1-8, Paris, Year X-XI (1802-1803). Vol. 8, 1803, pp. 1-439.
Describes a Mexican axolotl.

DECKERT, RICHARD.
1915. Review of two series of amphibians. Zoologica, 2, No. 1, Oct. 1915, pp. 1-34, figs. 1-6.
Certain Mexican species mentioned.

DE JAGER, E. F. J.
1939. Contributions to the cranial anatomy of the Gymnophiona. Further points regarding the cranial anatomy of the genus Dermophis. Anat. Anz., 88, No. 11-15, June 28, 1939, pp. 193-222, 9(=14) text figs.

DE LILLE, JOSE.
1934. Nota preliminar acerca de la accion fisiologica del veneno de Dermophis mexicanus. Anal. Inst. Biol., México, 5, No. 4, 1934, pp. 323-326.

DESAUSSURE.
1868. ( ) Verh. d. Schweiz Naturf. Gesell. Einsideln, 1868, pp.?
Observations on the Mexican axolotl.

DESOR, E.

1879. Quelques details sur les métamorphoses du Sirenodon (sic), Bull. Soc. Sci. Nat. Neuchâtel, 8, 1869-1870 (1870), pp. 266-269.

DÍAZ DE LEÓN, JESUS.

1904. Indice de los Batracios que se enquentran en la Republica Mexicana. Imprenta de Ricardo Rodriguez Romo. Aguascalientes, June 1904, pp. 1-40.

A compiled list of the Amphibia of México: 105 Salientia, 20 Urodela, and 1 Apoda are listed.

DICKERSON, MARY C.

1906. The Frog Book. New York, Doubleday, Page & Co. 1906, pp. xvii + 253. Color pls. 1-16, halftone pls. 1-95, 35 text figs.

DODDS, CLIFFORD T.

1923. A note on Bufo marinus. Copeia, 1923, No. 114, pp. 5-6. A specimen from Los Mochis, Sinaloa. Effect of venom on a dog.

DUGÈS, ALFREDO AUGUSTO DELSESCAUTZ

1869. Catálogo de animales vertebrados observados en la Repùblica Mexicana. La Naturaleza, 1, 1869-1870 (1869), pp. 137-145.

Lists *Rana Moctezumae* (sic), *R. halecina, R. longipes, Cystignathus caliginosus, Scaphiopus holbrooki, Hyla eximia, H. versicolor, Hylodes laticeps, Bufo agua, B. anomalus, B. intermedius, B. chilensis, Engystoma* sp. nov. ?, *Bolitoglossa mexicana, Siredon lichenoides* and *Siredon lichenoides* var. *alba* (pescado nutria), México.

1870. Una nueva especie de ajolote de la Laguna de Pátzcuaro. La Naturaleza, 1, 1869-1870 (1870), pp. 241-244, pl. 5.

Purports to be a type description of *Siredon Dumerilii;* the author states, "Sin: *Siredon Dumerilii,*" as if published elsewhere.

1872. Note sur une nouvelle espèce d'axolotl (le Siredon Dumerilii) (Extraite d'une lettre adressée à M. *** et datée de Guanajuato, mai 1870). Ann. Sci. Nat. Paris, (5), 15, Art. 17, 1872, pp. (1-2), pl. 10.

1878. Programa de un curso de zoologia. Guanajuato. 8vo. ix + 257 + 8. Numerous reptile and amphibian species mentioned.

1879. *Hylodes augusti,* A Dugès. (*In*) Brocchi, Sur divers batraciens anoures de l'Amérique Centrale. Bull. Soc. Philom. Paris, (7), 3, pp. 19-24.

1884. Elementos de zoologia. Mexico (city). 8vo. pp. viii-479, 11 pls. Reptiles and amphibians, pp. 320-347, pl. 7.

Practically a list of Mexican reptiles and amphibians; some of the reptile illustrations are original.

1888. Erpetología del valle de México. La Naturaleza, (2), 1, Cuad. 2-4, 1887-1890 (1888), pp. 97-146, pls. 11-13, three figs. in text.

Lists *Hyla eximia, Rana montezumae, Rana halecina, Bufo compactilis, Amblystoma carolinae, Amblystoma tigrinum, Siredon tigrinum* and *Siredon edule. Amblystoma Velasci* is proposed as a substitute for *Siredon tigrinum* Velasco.

1892. Descripción del esqueleto del Rhinophrynus dorsalis, D. B. La Naturaleza, (2), 2, Cuad. 2-4, 1891-1897 (1892), pp. 98-100, pl. 5, figs. 1-4.

1894. Amblystoma altamirani, A. Dug. La Naturaleza 2 (2nd Ser.), pp. 7-9, pl. 29, figs. 1-8.

1894. Lista de algunos reptiles y batracios de Tabasco y Chiapas, La Naturaleza (2), 2, Cuad. 7-8, 1892-1896 (1894), pp. 375-377.

Oedipus rufescens, Spelerpes mexicanus, Bufo marinus, B. canaliferus, Rhinophrynus dorsalis, Hyla miotympanum, Smilisca baudini, Leptodactylus melanonotus, Leptodactylus echinatus and *Dermophis mexicanus* are listed.

1895a. Fauna del estado de Guanajuato. (In) Memoria sobre la administracion publica del estado de Guanajuato presentada al congreso del misma por el C. Gobernador constitucional Lic. Joaquin Obregón Gonzales, El 1 de Abril de 1895 Morelia.

Lists *Spelerpes Bellii, Amblystoma tigrinum, Bufo compactilis, Bufo intermedius, Bufo punctatus, Hyla arenicolor, Hyla eximia, Hylodes Augusti, Malachylodes guttilatus, Hypopachus variolosus, Scaphiopus Dugesii, Rana virescens* and *Rana Draytoni.*

1895b. Description d'un Axolotl de Montagnes de las Cruces (Amblystoma altamirani A. Dugès). Imprimerie du Ministere de "Fomento," 1895, pp. 1-6, 1 pl.

Original description of *Amblystoma altamirani* Dugès.

1895c. Amblystoma altamirani, A. Dug. (*In*) Fernando Altamirano, Sobre algunos excursiones a las montañas del Ajusco y Sierranía de las Cruces. Informe que rinde á la Secretaría de Fomento el Director del Instituto Médico Nacional, México, 1895, pp. 1-64, 1 pl.

Description, pp. 5-9, in French, and a Spanish translation under the title "El Amblystoma altamirani, A. Dug." on pp. 9-13. The French description was reprinted in the following paper.

1896a. Amblystoma altamirani A. Dugès. La Naturaleza, (2), 2, Cuad. 10-11, 1891-1897 (1896), pp. 459-461, pl. 29.

1896b. Reptiles y batracios de los E. U. Mexicanos. La. Naturaleza, (2), 2, Cuad. 10-11, 1892-1896 (1896), pp. 479-485.

References to the then known Mexican species: *Oedipus rufescens, Spelerpes mexicanus, S. Mülleri, S. Bellii, S. leprosus, S. morio, S. chiropterus, Amblystoma tigrinum, A. altamirani, Siredon tigrinum, S. mexicanum, Bufo americanus, B. canaliferus, B. compactilis, B. marinus, B. intermedius, B. punctatus, Rhinophrynus dorsalis, Hyla arenicolor, H. eximia, H. miotympanum, Smilisca Baudini, Hylodes Augusti, Malachylodes guttilatus, Leptodactylus ocellatus, L. labialis, L. echinatus, L. microtis, L. melaenonotus, Hypopachus variolosus, Scaphiopus Dugesi, Rana sphenocephala, R. nigricans, R. virescens halecina, R. Montezumae, Dermophis mexicanus.*

1897. Influencia del medio ambiente sobre la readaptación. Mem. Soc. Cient. Ant. Alzate, 10, 1897, pp. 341-342.

(Account of an Ambystoma in adult state, except with degenerate non-filamentous branchiae, redeveloping fully formed branchiae when kept in an aquarium, while retaining all other adult characters.)

1901a. Experimento en un Ajolote. La Naturaleza, (2) 3, Cuad. 7-8, 1901, p. 562, pl. 36.

Amblystoma altamirani is discussed.

1901b. Sobre un Amblystoma altamirani. Mem. Soc. Cient. Antonio Alzate, 16, 1901, pp. 31-34, pl. 1.

DULITZ, ERNST.

1874. Züchtungsversuche mit einem Aquariumbewohner, dem axolotl (Amblystoma Axolotl). Gef. Welt., 3, 1874, pp. 195, 209-210.

1876. Züchtungsversuche mit dem Axolotl. Isis (Russian), 1, 1876, pp. 39-40, 47-48, 1 pl.

DUMÉRIL, ANDRÉ MARIE CONSTANT, BIBRON, GABRIEL and AUGUSTE HENRI ANDRÉ DUMÉRIL.

1841. Erpétologie générale ou Histoire naturelle compléte des 1854. Reptiles, Vols. 1-9 and Atlas. Paris 1834 to 1854.

Volume 8 (1841) and 9 (1854), treat of the Salientia and Urodela respectively. The atlas (1854) has a few illustrations of Mexican forms; a few Mexican species listed. Vols. 7 (both parts), 9, and the atlas were compiled by all three authors, but only André Duméril and Bibron are cited as authors of the other volumes.

DUMÉRIL, AUGUSTE.

1853. Memoire sur les Batraciens Anoures de la famille des hylaeformes ou rainettes comprenant la description d'un genre nouveau et de onze espèces nouvelles. Ann. Sci. Nat., (3) Zool. 19, 1853, pp. 135-179, pl. 7.

Contains the type descriptions of *Hyla moreletii*, (Guatemala) and *Hylodes laticeps*, Yucatán.

1863. Title?
Mem. Soc. Sci. Nat. Cherbourg, 9, 1863, pp. (23), fig. 10.

Siphonops mexicanus.

1865a. Reproduction, dans la Ménagerie des Reptiles au Muséum d'Histoire naturelle, des axolotls, Batraciens, Urodèles à branchies persistantes de Mexico (Siredon Mexicanus, vel Humboldti), qui n'avient encore jamais été vus vivants en Europe. Compt. Rend. l'Acad. Sci., 60, No. 14, 1865. pp. 765-767.

Cope has expressed the idea that the species treated here is not *Siredon mexicanus* as specimens were sent to Cope to examine.

1865b. Nouvelles observations sur les axolotls nés à la Ménagerie. Compt. Rend. l'Acad. Sci, 1865, p. 775

1865c. ———
Bull. Soc. Imp. d'Acclimat., II, 1865. p. 348.

1866a. Observations faites à la Ménagerie des reptiles du muséum d'histoire naturelle sur reproduction des Axolotls, Batraciens urodèles à branchies extérieures et sur les Métamorphose qu'ils y ont subies. Bull. Soc. Imp. Zool. d'Acclimat., (2), 3, 1866, pp. 79-89, figs.

1866b. Observations sur la reproduction dans la Ménagerie des reptiles du Muséum d'Histoire Naturelle, des Axolotls, Batraciens urodèles à branchies extérieures du Mexique, sur leur developMent et sur leurs métamorphoses. Nouv. Arch. Mus. d'Hist. Nat., 2, 1866, pp. 265-292, pl. 10 and figs.

1866c. Observations sur la reproduction des Axolotls (Extrait) from Bull. Soc. Imp. d'Acclimat., (2) 3, 1866, pp. 79-89.

1866d. (Extract of same.) Arch. Sci. Phys. et Nat. Genève, Nouv. period, 26, 1866, pp. 344-347.

1866e. On the Development of the Axolotl (Siredon mexicanus vel Humboldtii), Ann. Mag. Nat. Hist., (3), 17, 1866, pp. 156-157.

1867a. Description de diverses monstruositiés observée à la ménagerie des reptiles du Muséum d'Histoire Naturelle sur les Batraciens Urodèles a branchies extérieurs. Nouv. Arch. Mus. Hist. Nat., 3, 1867, (Mém.), pp. 119-130, pl. 5.

1867b. Experiencés démontrant que la vie aquatique des Axolotls, batraciens urodèles à branchies extérieures, se continue sans trouble apparent après l'ablation des houppes branchiales. Nouv. Arch. Mus. Hist. Nat., 3, 1867, Mém. pp. 189-192.

1867c. Experiments on the Axolotl. Ann. Mag. Nat. Hist., (3), 20, 1867, pp. 446-449.

1867d. Nouvelles observations sur les Axolotls, Batraciens urodèles, du Mexique, à branchies extérieures et expériences démontrant que la vie aquatique se continue, sans trouble apparent, après l'ablation des houppes branchiales. Bull. Soc. Imp. d'Acclimat. (2), 4, 1867, pp. 563-573, figs.

1867e. Métamorphoses des Batraciens urodèles â branchies extérieures du Mexique dits Axolotls, observées à la Ménagerie des Reptiles du Muséum d'Histoire Naturelle. Ann. Sci. Nat., (5), 7, 1867, pp. 229-254, 10 figs.

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1870b. Creátion d'une race blanche d'Axolotls à la Ménagerie des Reptiles du Muséum d'histoire Naturelle et remarques sur la transformacion de ces batraciens. Bull. Soc. Imp. d'Acclimat., (2), 7, 1870, pp. 267-270.

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1872. Notes complémentaires sur les Axolotls. Mém. Soc. Linn. Nord France, 2, 1868-1871 (1872) pp. 248-251

DUNN, EMMET REID.

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A few Mexican forms listed: *Oedipus bellii, O. leprosus, O. variegatus* and *O. yucantanus.*

1922a. A new salamander from Mexico. Proc. Biol. Soc. Washington, 35, Mar. 20, 1922, pp. 5-6.

Type description of *Oedipus townsendi.*

1922b. Two new insular Batrachoseps. Copeia, No. 109, Aug. 15, 1922, pp. 60-63.

Batrachoseps leucopus is described from North Island, Los Coronados, Baja California.

1922c. The sound-transmitting apparatus of salamanders and the phylogeny of the caudata. Amer. Nat., 56, pp. 418-427.

Lists the genera of salamanders and gives the number of species in each (pp. 426-427).

1922d. Notes on some tropical ranae. Proc. Biol. Soc. Washington, 35, Oct. 17, 1922, pp. 221-222.

The specimen of *Rana pustulosa* in the Museum of Comparative Zoölogy, reported from Sinaloa, is a specimen of *Rana montezumae* (*fide* Oliver, Occ. Papers Mus. Zoöl. Univ. Mich., No. 360, Nov. 20, 1937, p. 8).

1924a. New salamanders of the genus Oedipus with a synoptical key. Zool. Ser., Field Mus. Nat. Hist., 12, No. 7, May 19, 1924, pp. 95-100.

Several of the Mexican forms are included in the key.

1924b. New amphibians from Panamá. Occ. Pap. Boston Soc. Nat. Hist., 5, 1924, pp. 93-95.

Mentions *Oedipus lineolus* from México, and discusses *Oedipina.*

1926. The salamanders of the family Plethodontidae. Smith College, Northampton, Mass., 1926, viii + 441, figs. 1-11, maps 1-86, 1 pl.

Treats of several Mexican plethodontid salamanders.

1927. On the relationships of certain plethodont salamanders. Copeia, No. 165, Dec. 23, 1927, pp. 102-106.

1928a. The habitats of Plethodontidae. Amer. Nat., 62, 1928, pp. 236-248.

Mentions several Mexican salamander species.

1928b. Notes on Central American caecilians. Proc. New England Zoöl. Club, 10, Oct. 11, 1928, pp. 71-76.

Dermophis mexicanus mexicanus and *Gymnopis multiplicata* discussed.

1928c. A new genus of salamanders from Mexico. Proc. New England Zoöl. Club, 10, Nov. 3, 1928, pp. 85-86.

Rhyacosiredon described.

1931a. The herpetological fauna of the Americas. Copeia, 1931, No. 3, Oct. 30, pp. 106-119, figs. 1-6.

1931b. Present status of the axolotl problem. Anat. Rec. 51, No. 1, Suppl., Nov. 25, 1931, p. 90.

1936. The amphibians and reptiles of the Mexican expedition of 1934. Proc. Acad. Nat. Sci. Philadelphia, 88, Oct. 20, 1936, pp. 471-477.

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1939. Bathysiredon, a new genus of salamanders, from Mexico. Not. Nat., Acad. Nat. Sci. Philadelphia, No. 36, Nov. 9, 1939, p. 1.

1940. The races of Ambystoma tigrinum. Copeia, 1940, No. 3, Nov. 14, pp. 154-162.

Discusses *Ambystoma tigrinum velasci.*

1942. The American caecilians. Bull. Mus. Comp. Zoöl. 91 (6), pp. 437-540.

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Several Mexican genera treated.

EFIMOV, M. I.

1941a. Role of the brachial zone in the process of arising of the regenerated limb in the axolotl. C. R. Acad. Sci. Moscow (n. s.), 32 (6), pp. 451-453.

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EICHWALD, V.

1868. Mittheilung über den Axolotl (Brieflich an Prof. Geinitz). Sitzungb. Ges. Isis., Dresden, 1868, pp. 23-24.

EISMANN, GUST.

1876. Der Axolotl im Aquarium. Zool. Garten, 17, 1876, pp. 411-413.

FERRARI-PEREZ, FERNANDO.

1896. Catalogue of animals collected by the geographical and exploring commission of the Republic of Mexico. Proc. U. S. Nat. Mus., 9, 1886, pp. 125-199 (Part III, Reptiles and Amphibians, pp. 182-199).

Lists *Rana halecina, Lithodytes rhodopis, Bufo compactilis, B. intermedius, B. cognatus, B. marinus, B. valliceps, B. canaliferus, Hyla nigropunctata, H. gracilipes, Smilisca baudini, Amblystoma tigrinum* and *Spelerpes bellii.*

FISCHER, EDW.

1877. Die Umwandlung des Mexicanischen Axolotl in eine Salamanderform. Jahresber. Naturwiss. Ver. Magdeburg, 7, 1877, pp. 75-88.

FITZINGER, LEOPOLDO.

1843. Systema reptilium. Vindobonae, 1843, pp. 1-106 + vi.

FLOWER, STANLEY SMYTH.

1936. Further notes on the duration of life in animals. II. Amphibians. Proc. Zool. Soc. London, 1936, pp. 369-394.

The Mexican Axolotl (under *Ambystoma tigrinum*) mentioned.

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1942. Induction of triploidy and haploidy in axolotl eggs by cold treatment. Biol. Bull. 83 (3), pp. 367-374, pl. 1.

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FOWLER, HENRY W.

1913. Amphibians and reptiles from Ecuador, Venezuela and Yucatan. Proc. Acad. Nat. Sci., 65, pp. 153-176, pls. 5-10.

FOWLER, HENRY W., and DUNN, E. R.

1917. Notes on salamanders. Proc. Acad. Nat. Sci. Philadelphia, 69, Mar. 26, 1917, pp. 7-28, pls. 3-4.

A few Mexican forms are listed: *Amblystoma tigrinum, A. altamirani, Spelerpes belli, Oedipus variegatus, Thorius pennatribus* and *Oedipina lineolus.*

FREYTAG, GÜNTHER E.

1939. Morphologische Untersuchungen an Ambystomidenextremitäten. Abh. Ber. Mus. Nat. Vorg. Natur. Ver., Magdeburg, 7, heft 1, 1939, pp. 69-78, fig.

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FRIEDREICH, N., and GEGENBAUER, C.

1849. Der Schädel des Axolotl, beschreiben und abgebildet. Ber. von d. k. Zool. Anst. in Würzburg, 1849, pp. 28-34, 1 pl.

Siren pisciformis is the species under discussion.

GADOW, HANS.

1905. The distribution of Mexican amphibians and reptiles. Proc. Zool. Soc. London, June 6, 1905, pp. 191-244, figs. 29-32.

Dermophis mexicanus, Amblystoma tigrinum, A. altamirani, Thorius pennatulus, Spelerpes orizabensis, S. leprosus, S. chirop-

terus, S. variegatus, S. belli, Batrachoseps attenuatus, Scaphiopus dugesi, Rhinophryne dorsalis, Bufo valliceps, B. marinus, B. marmoreus, B. intermedius, Hyla baudini, H. eximia, H. staufferi, H. copei, Phyllomedusa dacnicolor, Hylodes rhodopis, H. beatae, Eupemphix gadovii, Leptodactylus albilabris, L. caliginosus, Borborocoetes mexicanus, Syrrhopus verruculatus, Paludicola mexicana, Engystoma ustum, Rana montezumae, R. halecina, R. palmipés; numerous other species are listed or discussed.

1908. Through southern Mexico being an account of the travels of a naturalist. London, pp. xvi, 527, frontisp. ill.

1910. The effect of altitude upon the distribution of Mexican amphibians and reptiles. Zool. Jahrb., Abt. für Syst. Geog. Biol. der Tiere. 19, No. 6, 1910, pp. 689-714, figs 1-6.

Very numerous species mentioned.

1923. Amphibia and Reptiles. In the Cambridge Natural History. Vol. 8, Macmillan and Co., London, 1923, pp. xiii+688, map, and figs. 1-181 in text.

Numerous Mexican species are mentioned: *Thorius pennatulus, Spelerpes infuscatus, Amblystoma tigrinum, Scaphiopus multiplicatus, Bufo marinus, B. agua, Rhinophrynus dorsalis, Ph.(yllomedusa) dacnicolor, Triprion petasatus* and *Pternohyla fodiens*

1930. Jorullo. The history of the volcano of Jorullo and the reclamation of the devastated district by animals and plants. Cambridge Univ. Press, London, pp. xviii + 100, frontis. map, 2 figs.

Many data on reptiles and amphibians of Michoacán.

GAIGE, HELEN THOMPSON.

1936. Some reptiles and amphibians from Yucatan and Campeche, Mexico. Carnegie Inst. Washington Publ., No. 457, Feb. 5, 1936, pp. 289-304.

Lists *Rhinophrynus dorsalis, Bufo marinus, B. valliceps, Leptodactylus labialis, L. melanotus* (sic), *Triprion petasatus, Agalychnis callidryas, A. moreletii, Hyla baudinii, H. culex, H. venulosa, Hypopachus inguinalis* and *Rana pipiens.*

1937. Some amphibians and reptiles from Tamaulipas. (*In*) The geology and biology of the San Carlos Mountains. Univ. Michigan Studies, Sci. Ser. 12, 1937, pp. 301-304.

Lists *Rana pipiens, Bufo marinus, B. punctatus,* and *B. valliceps.*

GARMAN, SAMUEL W.

1884. The North American reptiles and batrachians. A list of the species occurring north of the Isthmus of Tehuantepec, with references. Bull. Essex Inst., 16, Jan. 9, 1884, pp. 3-46, figs.

Lists species of Mexican amphibians.

1887. Reptiles and batrachians from Texas and Mexico. Bull. Essex Inst., 19, 1887, pp. 119-138.

Lists *Rana montezumae, R. berlandieri, Engystoma carolinense, Paludicola nitida, Bufo valliceps, B. cognatus, B. speciosus, B. compactilis, Hyla eximia, Scaphiopus couchii* and *Amblystoma mexicanum.*

GERSTÄCKER, A.

1868. (Ueber die Beobachtungen Dumérils an Ambystoma u. Siredon.) Zeit. Akklimatisat., N. F., Bd. 6, 1868, pp. 200-202.

GERVAIS, HENRI.

1872. Etat hydropique des Axolotls. Jour. Zool. (Gervais), 1, 1872, pp. 53-58.

1873. Hybridation des Axolotls par les Tritons. Journ. de. Zool. (Gervais), 2, 1873, pp. 245-249.

GEYER, H.

1926. Ueber Schilddrüsenverfütterung an Axolotl. Blätt. Aquar-Terrarienk., 37, 1926, p. 241.

GIRARD, CHARLES.

1854. A list of the North American bufonids, with diagnoses of new species. Proc. Acad. Nat. Sci. Philadelphia, 7, 1854-1855 (May 1854), pp. 86-88.

Lists the following from México: *Bufo woodhousii, B. speciosus* and *B. punctatus*. Type descriptions are given of *Bufo debilis, B. nebulifer,* and *B. insidior.*

GLOYD, H. K., and SMITH, H. M.

1942. Amphibians and reptiles from the Carmen Mountains, Coahuila. Bull. Chicago Acad. Sci., 6 (13), pp. 231-235.

GODET, PAUL.

1867. Sur les nouvelles observations de M. Duméril sur les Axolotls. (Siredon mexicanus vel Humboldtii.) Bull. Soc. Sci. Nat. Neuchâtel, 7. 1867, pp. 269-273.

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1925. Monografia e la rana llamada vulgarmente "rana de cueva" y cientificamente "Hyla bocourti" Günther, y por otros naturalistas "Hyla scapularis Hallowell," "Hyla regilla Baird and Girard" y "Hyla brunnea." Mem. Soc. Cient., "Antonio Alzate," 44, 1925, pp. 491-495.

1926. Ranita parda.-Hylodes venustus Gunther. Mem. Rev. Soc. Cient. "Antonio Alzate," 46, March to June, 1926, pp. 223-225.

GRIFFITHS, EDWARD, and PIDGEON, EDWARD.

1831. The class Reptilia, arranged by the Baron C. Cuvier, with specific descriptions. Vol. 9, of The Animal Kingdom arranged in conformity with its organization by the Baron Cuvier with additional descriptions of all the species hitherto named, and of many others. 1831, pp. 1-481, pls. 1-55 not numbered.

Siren pisciformis discussed and figured.

GRAVENHORST, J. L. C.

1829. Deliciae Musei zoologici Vratislaviensis Fasciculus Primus continens chelonios et Batrachia. Lipsiae, Leopoldi Vossii.

Treats of *Hypochthon pisciformis.*

GRAY, JOHN EDWARD.

1831. A synopsis of the species of the class Reptilia. pp. 1-110. (*In*) Griffith's The Animal Kingdom arranged in conformity with its organization by the Baron Cuvier, etc. Vol. 9, 1831.

Phyllhydrus pisceformormis (sic), *Salamandra variegata* (and in synonomy, *Salamandre platydactyla* Cuv., Mus. Paris) "Brown with irregular dorsal bands. Mexico."

1850. Catalogue of the specimens of amphibia in the collection of the British Museum. Part II. Batrachia Gradientia. 1850, pp. 1-72, pls. 3-4.

Contains references to certain Mexican species.

GÜNTHER, ALBERT CARL LUDWIG GOTTHILF.

1858. On the systematic arrangement of the tailless batrachians and the structure of Rhinophrynus dorsalis. Proc. Zool. Soc. London, June 22, 1858, pp. 339-352.

1859. Catalogue of the Batrachia Salientia in the collection of the British Museum. London 1858 (Feb. 12, 1859), pp. xvi + 160, pls. 1-12.

Lists the following from México: *Rana halecina, R. lecontii, Engystoma carolinense, E. rugosum, Bufo anomalus* sp. nov., *B. lentiginosus* Var. B., *B. musicus, B. agua, B. nebulifer, B. sternosignata, Hylodes laticeps, H. lichenosa* sp. nov., *H. versicolor, H. baudinii, H. euphorbiacea sp. nov., Nototrema marsupiatum, Rhinophrynus dorsalis.*

1868. First account of species of tailless batrachians added to the collection of the British Museum. Proc. Zoöl. Soc. London, 1868 (June 25), pp. 478-490, pls. 37-40.

Hylodes sallei described from México.

1869. Exhibition of specimens of the ova and young of the axolotl (Siredon mexicanum). Proc. Zool. Soc. London, 1869, p. 319.

1882. Notice of a second species of *Triprion.* Ann. Mag. Nat. Hist., (5), 10, No. 58, Oct. 1882, p. 279.

Type description of *Triprion spatulatus,* from Presidio, Sinaloa, México.

1885-1902. Biologia Centrali-Americana. Reptilia and Batrachia. 1885-1902, pp. xx + 326, pls. 1-76.

Treats of the Amphibian fauna in its entirety. Type descriptions of *Rana omiltemana, R. bonaccana, R. godmani, Syrraphus omiltemanus, Tomodactylus amulae, Hylodes plicatus, H. calcitrans, H. venustus, Hyla nana, H. taeniopus, H. godmani, Hylella picta.* Most of the species are figured.

HAHN, G.

1892. Las Ajolotes y su metamorfosis (translated from "Revue des questions scientifiques" Bruselas (2), I, 1892, p. 178), La Naturaleza, (2), 2, 1892, pp. 218-230. Original not seen.

HALLOWELL, EDWARD.

1852. Descriptions of new species of reptiles inhabiting North America. Proc. Acad. Nat. Sci. Philadelphia, 6, Oct. 1852, pp. 177-182.

Bufo dorsalis is described from New Mexico.

1856. Description of several species of Urodela, with remarks on the geographic distribution of the Caducibranchiate division of these animals and their classification. Proc. Acad. Nat. Sci. Philadelphia, 8, Feb. 1856, pp. 6-11.

Spelerpes mexicanus is referred to the family Bolitoglossidae.

1861. Report upon the Reptilia of the North Pacific Exploring Expedition, under the command of Capt. John Rogers, U. S. N. Proc. Acad. Nat. Sci. Philadelphia, 12, Oct. 1860, pp. 480-486. (Edited by E. D. Cope.)

Describes *Cystignathus melanonotus* (Nicaragua), *Hyla grisea* (? Nicaragua) and *Bufo melanogaster* (Nicaragua).

HARLAN, RICHARD.

1826. Description of several new species of batrachian reptiles, with observations on the larvae of frogs. Silliman's Journ. 10, (1), pp. 53-65.

Rana ocellata stated to occur in México.

HARTING, PIETER.

1865. Eijerlegging bevruchting en ontwikkeling van den Axolotl. Album der Natuur., 1865 (Wetench. bijblad.), p. 44.

1866. Metamorphose van den Axolotl. Album der Natuur., 1866 (Wetensch. bijblad), pp. 2-3.

1867. Verkregen polydactylie der Axolotls. Album der Natuur., 1867 (Wetensch. bijblad), p. 77.

1870. Ronddraaijing van de embryo in de eijeren van den Axolotl. Album der Natuur., 1870 (Wetensch. bijblad), p. 50.

1874. Menstruatie bij den Axolotl. Album der Natuur., 1874 (Wetensch. bijblad), p. 75.

1879. Hoe men Axolotls ten allen tijde tot het leggen van eieren brengt. Album der Natuur., 1879 (Wetensch. bijblad), p. 39 (Semper, Zoöl. Anz., 1, 1878, p. 176.)

HARTWEG, NORMAN.

1941. Notes on the genus *Plectrohyla,* with descriptions of new species. Occ. Papers Mus. Zool., Univ. Michigan, No. 437, June 30, 1941, pp. 1-10, pl. 1.

Plectrohyla sagorum and *Plectrohyla matudai* are described.

HARTWEG, NORMAN, and OLIVER, JAMES A.

1940. A contribution to the herpetology of the Isthmus of Tehuantepec. IV. Misc. Publ. Mus. Zool., Univ. Michigan, No. 47, July 13, 1940, pp. 1-31.

Lists *Bufo coccifer, B. marinus, B. marmoreus, Rhinophrynus dorsalis, Engystomops pustulosus, Leptodactylus labialis, L. melanonotus, Eleutherodactylus augusti, Hyla baudinii, H. staufferi, Microhyla usta, Rana pipiens.*

HARTWEG, NORMAN, and ORTON, GRACE.

1941. Notes on tadpoles of the genus *Plectrohyla.* Occ. Papers Mus. Zool., Univ. Michigan, No. 438, July 1, 1941, pp. 1-6, figs. 1-2.

The tadpoles of *Plectrohyla* "form a" and *Plectrohyla* "form b" are described.

HASSE, C.

1873. Ueber den Bau des Gehörorgans von Siredon pisciformis u. über die vergleichende Anatomie des Kiefersuspensorium. Anat. Stud. (Hasse), 4, 1873, pp. 611-647, 1 pl.

HAY, W.

1867. Monografia sobre el lago de Texcoco. Arch. de la Comm. Sci. du Mexique, 1867, II, pp. 311-333.

HECHT, MAX K., and MATALAS, BESSIE L.

1946. A Review of the Middle North American Toads of the Genus Microhyla. American Mus. Novit. No. 1315, Apr. 1, 1946, pp. 1-21, figs. 1-12. *Microhyla mazatlanensis* discussed.

HERRE, WOLF.

1935. Ueber Oligosemia spinosa Navás, einen fossilen Schwanzlurch aus dem spanischen Tertiär. Paleont. Zeit. 17, Nos. 1-2, Aug. 20, 1935, pp. 91-105, figs. 1-4.

Discusses the anatomy and figures the cranium of *Diemyctylus kallerti.*

1936. Ueber Rasse und Artbildung, Studien an Salamandriden. Abh. Ber. Mus. Natur. Vorges. Natur. Ver. Magdeburg, 6, No. 3, 1936, pp. 193-221.

HERRERA, ALFONSO L. (HIJO).

1890. Notas acerca de los vertebrados del valle de México. La Naturaleza (2), 1, Cuad. 7-9, 1890, pp. 299-342.

Lists *Hyla eximia, Rana montezumae, R. halecine, Bufo compactilis, Amblystoma carolinae, A. tigrinum, Siredon edule, Spelerpes morio* and *S. orculus.*

1891-1893. El clima del valle de México y la biologia de los vertebrados. La Naturaleza, (2), 2, Cuad. 1, 1891, pp. 38-64, and Cuad. 2-4, 1892, pp. 64-86, Cuad. 5-6, 1893, pp. 324-358.

Mentions *Bufo compactilis, Spelerpes morio, Amblystoma tigrinum, Spelerpes orculus, Scaphiopus dugesii* and *Rana halecina.*

1895. Catálogo de la colección de reptiles y batracios del Museo Nacional. Mexico, 1895, pp. 1-66.

The following species are listed: *Siphonops mexicana, Rana montezumae, R. halecina, Scaphiopus dugesi, Hyla eximia, H. versicolor Bufo americanus, B. compactilis, B. agua, B. musicus, Plethodon erythronotum, Spelerpes morio, S. mexicanus* and *Amblystoma tigrinum;* 2nd Edit. 1904, pp. 1-65. Same species listed.

1900. El Ajolote sufre la metamorfosis general en la clase de los batracios por aumento de nutricion y no por cambio de medio. La Naturaleza, (2), 3, Cuad. 5-6, 1899 (1900) pp. 367-376.

HERTWIG, OSCAR.

1874. Ueber das Zahnsystem der Amphibien und seine Bedeutund für die Genesis des Skelets der Mundhöhle. Arch. f. Mikros. Anat., 11, Supp. 1, 1874, pp. i-viii, 1-208, pls. 1-5.

HOLLIS, MARGARITA BRAVO.

1941. Revision de los generos *Diplodiscus* Diesing. 1836 y *megalodiscus* Chandler, 1923, (Trematodi: Paramphistomodea). I. Anal. Inst. Biol. Mex., 12, 1941, pp. 127-146.

1942. Revision de los generos *Diplodiscus* Diesing, 1836 y *megalodiscus* Chandler, 1923 (Trematoda: Paramphistomoidea). II. Anal. Inst. Biol., 12, 1942 pp. 643-661, figs. 1-8.

HOME, EVER.

1824. An account of the organs of generation of the Mexican Proteus, called by the natives Axolotl. Phil. Trans., 21, 1824, pp. 419-423, pls. 21-23. (See also Home, Lect. on Comparative Anat. 6, pls. 57, 58, 59).

1897. Lehrbuch der Zoologie 1897, p. 29, fig. 5.

HÖRSTADIUS, S., and SELLMAN, S.

1942. Experimental studies on the determination of the chondrocranium in *Amblystoma mexicanum.* Ark. Zool. Stockholm, 33A (13), pp. 1-8, figs.

HUMPHREY, R. R.

1935. Sex reversal in Amblystoma. VIII. Sex type of gonads developed from gonadic preprimordia of A. punctatum implanted in axolotl females. Proc. Soc. Exp. Biol. and Med., 33, pp. 102-104.

1938. Studies on sex reversal in Amphibia. XI. Reversal in A. tigrinum females induced by ectopic implantation of testis preprimordia. Anat. Rec. 72, pp. 451-467, pl. 1, table 1, figs. 1-2.

1939. The growth of gonads derived from heteroplastic transplants of their preprimordia in Amblystoma. Amer. Journ. Anat. 65, pp. 35-67, pls. 1-3, charts 1-4, tables 1-4.

1941. Adult Artificial hermaphrodites in Amblystoma tigrinum and mexicanum. Amer. Journ. Anat. 69, pp. 19-59, pls. 1-3, tables 1-2, figs. 1-13.

1942a. Sex of the offspring fathered by two Amblystoma females experimentally converted into males. Anat. Rec. 82 (3) (suppl.), p. 77.

1942b. Sex reversal and the genetics of sex determination in the axolotl (Amblystoma mexicanum). Anat. Rec. 84, (4) (suppl.), p. 15.

1942c. Sex inversion in the amphibia. Biol. Symp. 9, pp. 81-104, figs. 1-16.

1942d. Studies on sex reversal in Amblystoma. XII. Sterility after reversal of ovary to testis in the axolotl. Growth, 6 (3), pp. 185-201, figs. 1-6.

1943. A lethal recessive character in the Mexican axolotl (Amblystoma mexicanum). Anat. Rec. 85 (3) (suppl.), p. 32.

HUMPHREY, R. R. and BURNS, R. K., JR.

1939. An incompatibility manifested in heteroplastic parabiosis or grafting in Amblystoma due to a toxin of cutaneous origin. Journ. Exp. Biol. 81, pp. 1-42, figs. 1-14.

HUMPHREY, R. R., and FONKHAUSER, G.

1943. Two unusual haploid-diploid mosaics of mixed Amblystoma tigrinum ancestry. Anat. Rec. 87 (4) (suppl.), p. 23.

HUXLEY, T. H.

Amphibia. Encycl. Brit. Ed. 9, 1, pp. 750-771, figs. 1-26.

HUXLEY, T. H., and MITCHELL, P. C.

1910. Amphibia. Encycl. Brit., Ed. 11, 1, p. 883.

IVES, J. E.

1892. Reptiles and batrachians from northern Yucatan and Mexico. Proc. Acad. Nat. Sci. Philadelphia, 1891 (Jan. 19, 1892), pp. 458-463.

Lists *Rana virescens, Leptodactylus labialis, Bufo marinus* and *B. valliceps* from Yucatan; *B. monksiae, Rana montezumae* and *Amblystoma mexicanum* from other Mexican localities.

JENSEN, C. O.

1921. Partiel Metamorfose hos Amblystoma mexicanum. Vidensk. Medd. fra Dansk Naturh. Foren., 72, 1921, pp. 173-180. fig.

JOLY, N.

1868. Note sur des axolotls nés à la mènagerie des reptiles du Muséum d'histoire Naturelle de Paris, et rapportés vivants à Toulouse. Mém. l'Acad. imp. Sci. Insc. Bel.-Let. Toulouse, (6), 6, 1868, pp. 192-197.

1870. Sur la rotation de l'embryon dans l'oeuf des Axalotls du Mexique. (Lettre à M. Dumas.) Compt. Rend., 70, 1870, pp. 873-875.

1872. Etude sur la métamorphoses des Axolotls du Mexique (Siredon mexicanus Shaw). Developpment et rotation de leur embryon dans l'oeuf. Revue Scienc. Nat. 1, 1872, pp. 7-29.

JOURDAIN.

1877. Recherches sur le système circulatoire de l'Axolotl. Bull. Soc. Sci. Nancy, (2), 3, 1877, p. 27-28.

KEFERSTEIN, WILHELM.

1867. Ueber einige neue oder seltene Batrachier aus Australien und dem tropischen Amerika. Univ. Göttingen Nach. König. Gesell. Wiss., No. 18, July 24, 1867, pp. 341-363.

Contains the descriptions of the genus *Hypopachus*. (A part of this paper was republished in Wiegmann Arch. Natur., 1868, pp. 291-300, pls. 8-9 (not seen), *fide* Günther, Zool. Rec. for 1868.)

KELLOGG, REMINGTON.

1932. Mexican tailless amphibians in the United States National Museum. U. S. Nat. Mus. Bull., No. 160, 1932, pp. iv + 224, 1 pl., figs. 1-24.

Sixty-five species are recognized. The most important work on the Mexican Salientia.

KIRBY, JOSIAH.

1832. Herpetology. *In* Edinburgh Encyclopedia, 1st Amer. Ed., Vol. X, pp. 365-406.

KNAUER, DR. FRIEDRICH K.

1878. Naturgeschichte der Lurche (Amphibiologie). Wien 1878, pp. i-xx, 1-340, figs. 1-120, 4 karten, 12 tab. Discussion of *Siredon mexicana*.

KOCH, M.

1926. Zur Umwandlung des mexikanischen Axolotls mittels Schilddrüsenfütterung. Blatt. Aquar.-Terrarienk. 37, 1926, p. 245.

KOLLIKER, ALB.

1868a. Sur le développement des Axolotls. Verh. Schweiz. naturf. Ges. Einsiedeln, 52 Vers. 1868, pp. 87-89.

1868b. Remarques de plusieurs zoologistes sur la transformation de l'Axolotl. Verh. Schw. Naturf. Ges. Einsiedeln, 52, Vers. 1868, pp. 89-90.

1869. Ueber den mexikanischen Axolotl. Verh. Phys-medic. Ges. Wurzburg, N. F., 1, 1869, Sitzber. 1868, pp. xxiii-xxiv.

KOLLMAN, J.

1884. Das Ueberwintern von europäischen Frosch-und-Tritonlarven und die Unwaldung des mexikanischen Axolotl. Verh. Natur. Gesell. Basel 1883, pp. 387-398, fig. 1-2.

KRUMBIEGEL, I.

1928. Die Amphibienkenntreise im ältesten Amerika, nebat einigen ornithologischen Benarkungen. Zool. Anz. 1928, vol. 79, pp. 250-256, figs. 1-4.

LAFRENTZ, K.

1927a. Aus der Heimat des Axolotl. Blätt. Aquar.-Terrarienk, 38, 1927, p. 160.

1927b. Reptilien, Amphibien und Fische des mexikanischen Hochlandes. Blätt. Aquar.-Terrarienk., 38, 1927, pp. 318-325, 3 figs.

1928a. Neue Beobachtungen an Amphibien des mexikanischen Hochlandes. Blätt. Aquar.-Terrarienk., 39, 1928, pp. 89-92, 110-115, 5 figs.

Oedipus bellii, O. sulcatum (fig. 3), *Hyla eximia, Hyla sp.* (bocourti ?) (fig. 4), *Bufo compactilis,* fig. 5.

1928b. Reisebriefe aus Mexiko. Blätt. Aquar.-Terrarienk., 39, 1928, pp. 115-116, 1 fig.

1930a. Mexicanische Urnenpflanzenmolche (Oedipus sp.). Blätt. Aquar.-Terrarienk., 41. No. 4, Feb. 28, 1930, pp. 61-63, pl. 8.

This species is later described as *Oedipus macrinii,* in two publications.

1930b. Ein neuer Plethodont-Salamander aus Mexiko. (In) Beiträge zur Herpetologie Mexikos, Abh. Ber. Mus. Natur-Heimatk. naturw. Ver. Magdeburg, 6, No. 2, 1930, pp. 150-152.

Type description of *Oedipus macrinii.*

1930c. Untersuchungen über die Lebengeschichte mexikanischer Ambystoma-Arten. (In) Beiträge zur Herpetologie Mexikos, Abh. Ber. Mus. Natur. Heimatk. naturs. Ver. Magdeburg, 6, No. 2, 1930, pp. 91-127, three maps, pls. 2-3.

Treats of *Ambystoma dumerili, A. mexicanum, A. tigrinum velascoi* (Type description), and *A. altamirani.*

1931. Ein neuer Plethodont-Salamander aus Mexiko, *Oedipus macrinii* sp. n. Blätt. Aquar.-Terrarienk., 42, No. 4, Feb. 28, 1931, pp. 55-56, 1 fig.

Purports to be the original description of *Oedipus macrinii.*

LAMPE, EDUARD.

1902. Catalog der Reptilien und Amphibien Sammlung (Schlangen; Frosch-, Schwanz- und Schleichenlurche) des Naturhistorischen Museums zu Weisbaden. Jahrb. Nassau Ver. Naturk., 55, 1902, pp. 1-66.

Lists *Rana halecina, Engystoma ustum, Bufo valliceps, Scaphiopus dugesi, Molge viridescens and Amblystoma tigrinum.*

LAURENTI, JOSEPH NICOLAI.

1768. Specimen medicum, exhibens synopsin Reptilium emendatum cum experimentis circa venena et antidota reptilium Austriacorum. Viennae, 1768, pp. 1-214, pls. 1-5.

Type description of *Hyla venulosa.*

LESSONA, MICH.

1877. Nota di un Axolotl del museo zoologico di Torino. Atti. R. Accad. Sci. Torino, 13, 1877-1878 (1877) pp. 137-139.

LINNÉ, CAROLUS VON (LINNAEUS).

1758. Systema Naturae, 10th Edit. Vol. 1, 1758, p. 211.

Rana marina described.

LINSDALE, JEAN M.

1932. Amphibians and Reptiles from Lower California. Univ. California Public. Zool. 38, No. 6, June 24, 1932, pp. 345-386.

The following species are treated in this work: *Scaphiopus couchii, S. hammondii, Bufo boreas halophilus, B. cognatus, B. californicus, B. punctatus, B. woodhousii, Hyla arenicolor, H. regilla, Rana aurora draytonii.*

1933. A specimen of *Rana tarahumarae* from New Mexico. Copeia, No. 4, Dec. 27, 1933, p. 222.

LIPSETT, JAMES C.

1939. Cleavage and early development in species hybrids. Bull. School Med. Univ. Md., 23 (4), p. 212.

LOCKINGTON, W. N.

1880. List of California reptiles and batrachia collected by Mr. Dunn and Mr. W. J. Fisher in 1876. Amer. Naturalist, 14, 1880, pp. 295-296.

Batrachoseps attenuatus.

LONG, STEPHEN H.

1823. Account of an expedition from Pittsburgh to the Rocky Mountains performed in the years 1819 and '20. Vols. 1-2, Philadelphia, H. C. Carey and I. Lea, 1823, pp. 6 + 442 + xcviii.

Vol. 2 contains the original description of *Bufo cognatus* Say.

LÖNNBERG, EINAR.

1899. Salamanders with and without lungs. Zool. Anz., 22, Dec. 28. 1899, No. 604, pp. 545-548.

Spelerpes variegatus lacks lungs.

LUBACH, D.

1867a. Gevolgen van het wegnemen der Kieuwen bij den Axolotl. Album der Natuur., 1867 (Wetensch. bijblad.), p. 77 (see Duméril in Compt. Rend., 65, p. 242).

1867b. Regeneratie der ledematen bij den Axolotl. Album der Natuur., 1867 (Wetensch. bijblad.), p. 63.

1870. De Axolotls de Parijs. Album der Natuur., 1870 (Wetensch. bijblad), pp. 44-45. (See A. Duméril, Les Mondes, 1870, Apr. 21, p. 727.)

LÜTKEN, CHR.

1877. Nyere, Jagttagelser over Axolotl'en (Med traesnit). Tidskr. popul. Mremstilling af Naturvidensk, 5, R. 4, 1877, pp. 109-131.

LYDEKKER, RICHARD, CUNNINGHAM, J. T., BOULENGER, G. A., and THOMPSON, ARTHUR.

1912. Reptiles, Amphibia, Fishes and Lower Chordata. London, 1912, pp. xvi + 510, pls. 1-36, text figs. 32, 1 map.

MALBRANC, M.

1872. Ueber das Sperma von Siredon. Verh. d. Phys-medic Ges. Wurzburg, N. F., 3, 1872, pp. 136-140.

MALFATTI, GIOVANNI.

1873. Axolotls allevati nel Museo Civico. Atti. Soc. Ital. Sc. Nat., 16. 1873, pp. 141-147.

MARHERR, E.

1927. Zur Haltnung von Rana montezumae (Baird). Blätt. Aquar. Terr. Kunde 38, (18) 1927, pp. 373.

MARSH, O. C.

1868. Observations on the metamorphosis of Siredon into Amblystoma. Amer. Journ. Sci. Arts, (2), 46, Nov. 1868, pp. 364-374, 1 pl.

Mentions *Siredon mexicanus.*

1869a. Observations on the metamorphosis of Siredon into Amblystoma. Zoologist, (2), 4, 1869, pp. 1569-1580.

1869b. Observations on the metamorphosis of Siredon into Amblystoma. Proc. Boston Soc. Nat. Hist., 12, 1868-1869 (1869) pp. 97-98.

1869c. Siredon, a larval Salamander. (Abstr.) Amer. Nat., 2, 1869, p. 493.

MARTÍN DEL CAMPO, RAFAEL.

1932. Dermophis mexicanus (Dum. et Bibr.) (Apendice to "Nota acerca de la histologia de la piel de Dermophis mexicanus Dum. y Bibr." by L. Ochoterena.) Anal Inst. Biol., 3, No. 4, 1932, pp. 369-370.

A description and synonomy of *Dermophis mexicanus.*

1934. El organo de Bidder en Bufo marinus L. Anal. Inst. Biol. 5, No. 1, 1934, pp. 49-54, text figs. 1-4.

1936a. Contribuciones al conocimiento de la fauna de Actopan, Hgo. IV. Vertebrados observados en la epoca de las secas. Anal. Inst. Biol., 7, Nos. 2-3. 1936, pp. 271-286, figs. 1-7.

Amblystoma tigrinum, Scaphiopus hammondi multiplicatus, Bufo simus, Hyla arenicolor, Rana montezumae and *R. pipiens.*

1936b. Los batracios y reptiles segun los codices y relatos de los antiguos mexicanos. Anal. Inst. Biol., 7, 1936, pp. 489-512, figs. 1-18.

1937. Contribucion al conocimiento de los batracios y reptiles del valle del Mezquital, Hgo. Anal. Inst. Biol., 8, No. 1-2, 1937, pp. 259-266, figs. 1-5.

Amblystoma tigrinum, Oedipus bellii, Scaphiopus hammondi multiplicatus, Bufo simus, Hyla arenicolor, H. eximia, Rana montezumae and *R. verde.*

1940a. Los Vertebrados de Pátzcuaro. Anal. Inst. Biol., 11, No. 2, 1940, pp. 481-492.

Lists *Oedipus bellii, Bathysiredon dumerili, Hyla eximia* and *Rana pipins.*

1940b. Nota acerca de algunos vertebrados de las lagunas de Cempoala y sus alrededores. Anal. Inst. Biol., 11, No. 2, 1940, pp. 741-743, 1 fig.

Lists *Rhyacosiredon altamirani, Hyla lafrentzi,* and *Rana pipiens.*

1940c. Una observacion del desarrollo de *Tomodactylus nitidus.* Anal. Inst. Biol., 11, No. 2, 1940, pp. 745-746, 1 fig.

1941. Ensayo de interpretación del libro undécimo de la historia general de las cosas de Nueva España, de Fray Bernardino Sahagun III. Los Mamiferos. Anal. Inst. Biol. 12, 1941, pp. 489-506.

A few amphibians mentioned.

1942a. Relacion de algunos peces anfíbios y reptiles de Mazatlán, Sin. Anal. Inst. Biol., 12, (2) 1942, pp. 759-761.

1942b. Anfíbios, Reptiles y Aves de la región de Haujuapan de León, Oax, Anal. Inst. Biol. Mexico, XIII, No. 1, 1942, pp. 351-355.

A few amphibians mentioned.

MARTÍNEZ GRACIADA, MANUEL.

1891. Catálogos de la flora y la fauna del Estado de Oaxaca. Emp. del Estado. 1891 pp. 1-84 (Batracios 83-84).

A number of species listed.

MEARNS, EDGAR ALEXANDER.

1907. Mammals of the Mexican Boundary of the United States. U. S. Nat. Mus. Bull. No. 56, pt. 1, 1907, pp. xv + 530, figs. 1-126, pls. 1-13.

Mentions some amphibians of the Mexican boundary.

MEIER, HERMANN.

1872. Der Axolotl. Natur. (Ule und Müller), 21, Bd. 1872, pp. 244-246.

MERREM, BLASIUS.

1820. Versuch eines Systema der Amphibien. Tentamen systematis amphibiorum. Marburg, pp. xv+191, 1 pl.

MERTENS, ROBERT.

1930. Bemerkungen über die von Herrn Dr. K. Lafrentz in Mexiko gesammelten Amphibien und Reptilien. (In) "Beiträge zur Herpetologie Mexikos." Abh. Ber. Mus. Natur. Heimatk. Naturw. Ver. Magdeburg, 6, No. 2, 1930, pp. 153-161, 3 text figs.

Original description of *Gymnopis multiplicata oaxacae.* Also discusses *Bufo compactilis, Eleutherodactylus rugulosus, Hyla eximia, H. lafrentzi, H. sumichrasti, Rana pipiens,* and *R. montezumae.*

MERTENS, ROBERT, and WOLTERSTORFF, WILLY.

1929. Ein neuer Laubfrosch aus Mexiko. Zool. Anz. 84, No. 9-10, Aug. 25, 1929, pp. 235-241.

Hyla lafrentzi is described, from Desierto de los Leones, Mexico. México.

MEYER, R.

1865. Fortpflanzung der Kolbenmouche aus Mexiko (Axolotl) in Paris. Zool. Garten, 6, 1865, pp. 352-353, and 7, 1866, p. 155.

1876. Ueber Fortpflanzung der Amblystomen im pariser Museum. Zool. Garten, 17, 1876. pp. 380-381.

MILLER, LOYE, and MILLER, ALDEN.

1936. The northward occurrence of *Bufo californicus* in California. Copeia, No. 3, Nov. 15, 1936, p. 176.

MIVART, ST. GEORGE.

1887. On the axial skeleton of Urodela. Proc. Zool. Soc. London, Apr. 28, 1887, pp. 260-278, several figs.

Mentions some points on the skeleton of the Mexican Axolotl.

MOCQUARD, M. F.

1899a. Reptiles et batraciens recueillis au Mexique par M. León Diguet en 1896 et 1897. Bull. Soc. Philom. Paris. (9), 1, No. 4, 1898-1899 (1899) pp. 154-169, pl. 1.

Describes as new *Rana trilobata, Hyla rudis* and *Hyliola Digueti.* The following are discussed: *Rana lecontei, R. montezumae, Hypopachus variolosus, Hylodes augusti, Leptodactylus caliginosus, Hyliola Bocourti, Hyliola eximia, Hyliola staufferi, Bufo marinus, B. compactilis, B. alvarius, Scaphiopus dugesi.*

1899b. Contribution a la faune herpétologique de la Basse California. Nouv. Arch. Mus. Hist. Nat. Paris, (4) 1, 1899, pp. 297-343, pls. 11-13.

The following are mentioned or discussed: *Hyla regilla, H. plicata, H. staufferi, H. eximia, H. baudinii, H. venulosa, H. arenicolor, H. nigropunctata, Agalychnis callidryas, Triprion petasatus, Bufo coccifer ?, Scaphiopus couchii.* Describes the genus *Hyliola* and refers *bocourti, Hyla staufferi, Hyla plicata,* and *Hyla regilla* to it.

MOHR, JOHN LUTHER.

1941. Protozoanios parásitos de cincuenta Hyla eximia Baird, capturadas en Coyoacan, D. F., Mexico. Rev. Soc. Mex. Hist. Nat. 2 (4), pp. 261-266.

MOORE, JOHN ALEXANDER.

1944. Geographic variation in *Rana pipiens* Schreber of eastern North America. Bull. AMNH 82 (8), pp. 345-370, text figs. 1-3, pls. 61-66, tables 1-5.

MOORE, PERCY J.

1900. Post larval changes in the vertebral articulations of Spelerpes and other salamanders. Proc. Acad. Nat. Sci. Philadelphia, 1900, pp. 613-622.

The vertebrae of *Oedipus variegatus* and *Spelerpes bellii* are discussed.

MULAIK, STANLEY.

1937. Notes on *Leptodactylus labialis* (Cope). Copeia 1, pp. 72-73, fig.

MULAIK, STANLEY, and SALLBERGER, DWIGHT.

1938. Notes on the eggs and habits of *Hypopachus cuneus* Cope. Copeia 2, p. 90.

MÜLLER, F.

1878. Katalog der im Museum und Universitätskabinet zu Basel aufgestellten Amphibien und Reptilien nebst Anmerkungen. Verh. Naturf. Ges. Basel, 6, 1878, pp. 561-709, pls. 1-3.

Siredon pisciformis and *Spelerpes variegatus* are listed.

1885. Vierter Nachtrag zum Katalog der herpetologischen Sammlung des Basler Museums. Verh. Naturf. Ges. Basel, 7, No. 3, 1885, pp. 668-717, pls. 9-11.

Lists *Leptodactylus caliginosus* from Presidio bei Mazatlan.

Müller, J. W. von.

1865. Beiträge zur Geschichte, Statistik und Reisen in den Vereinigten Staaten, Canada und Mexiko. Vols. 1-3, 1865. (Zoologie von Mexico, Amphibien), Vol. 3, pp. 595-620.

Rana adtrita is described as new by Troschel. 37 other species of Salientia are listed, 7 Caudata, and 1 Apoda. Whether this actually is a list of specimens collected or merely a compilation is not evident. The list is especially untrustworthy.

Myers, George S.

1942. Notes on Pacific coast *Triturus*. Copeia, No. 2, July 10, 1942, pp. 77-82.

Deals with *Triturus torosus*.

Nicholls, George E.

1916. The structure of the vertebral column in the Anura Phaneroglossa and its importance as a basis of classification. Proc. Linn. Soc. London, 128 (1915-1916), pp. 80-92, figs. A-D.

Nieden, Fritz.

1913. Gymnophiona (Amphibia Apodo). Das Tierreich, Lief. 37, 1913, pp. x + 31.

Mexican species described.

1923. Anura I. Subordo Aglossa und Phaneroglossa, Sectio. 1, Arcifera. Das Tierreich, Lief. 46, 1923, pp. xxxii + 584.

Mexican species described.

1926. Anura II. Engystomatidae. Das Tierreich, Lief. 49, 1926, pp. xvi + 110.

Mexican species described.

Noble, G. K.

1918. The amphibians collected by the American Museum Expedition to Nicaragua in 1916. Bull. Amer. Mus. Nat. Hist., 38, Art. 10, June 20, 1918, pp. 311-347, pls. 14-19, figs. 1-6.

1921. The anterior cranial elements of Oedipus and certain other salamanders. Bull. Amer. Mus. Nat. Hist. 44, Art. 1, March 18, 1921, pp. 1-6, pls. 1-2.

The skull of *Spelerpes leprosus* is figured.

1922. The phylogeny of the Salientia I. The osteology and the thigh musculature; their bearing on classification and phylogeny. Bull. Amer. Mus. Nat. Hist., 46, 1922, pp. 1-87, pls. 1-23.

1924. Some neotropical batrachians preserved in the United States National Museum with a note on the secondary sexual characters of these and other amphibians. Proc. Biol. Soc. Washington, 37, Feb. 21, 1924, pp. 65-71.

Refers *Hyla fleischmanni* to *Centrolenella.*

1925. An outline of the relation of ontogeny to phylogeny within the amphibia II. Amer. Mus. Nov., No. 166, 1925, pp. 1-10.

1927a. The value of life history data in the study of the evolution of the amphibia. Ann. New York Acad. Sci., 30, Oct. 31, 1927, pp. 31-128, pl. 9.

1927b. The plethodontid salamanders; some aspects of their evolution. Amer. Mus. Nov., No. 249, 1927, pp. 1-26, figs. 1-10.

1931. The Biology of the Amphibia. McGraw-Hill, New York, 1931, pp. xiii-577, figs. 1-174.

Refers to certain Mexican species.

OCHOTERENA, ISAAC.

1932. Nota acerca de la histologia de la piel de Dermophis mexicanus Dum. y Bibr. Anal. Inst. Biol., 3, No. 4, 1932, pp. 363-369, text figs. 1-9.

OLIVER, JAMES A.

1937. Notes on a collection of amphibians and reptiles from the state of Colima, Mexico. Occ. Papers Mus. Zool., Univ. Michigan, No. 360, Nov. 20, 1937, pp. 1-28, pl. 1, text fig. 1.

Discusses *Bufo marinus, B. marmoreus, B. simus, Leptodactylus melanonotus, Eleutherodactylus mexicanus, Pternohyla fodiens, Agalychnis dacnicolor, Hyla baudinii, H. smithii, H. venulosa, Hypopachus oxyrhinus, Microhyla usta, Rana pipiens,* and *R. pustulosa.*

ORTON, GRACE.

1943. The tadpole of *Rhinophrynus dorsalis.* Occ. Pap. Mus. Zool. Univ. Mich., 472, pp. 1-3, pl. 1.

OSBORNE, HENRY LESLIE.

1900. A remarkable axolotl from North Dakota. American Naturalist, 34, No. 403, July 1900, pp. 551-562. figs. 1-4.

1901. On some points in the anatomy of a collection of axolotls from Colorado, and a specimen from North Dakota. American Naturalist, 35, No. 419, Nov. 1901, pp. 887-902, figs. 1-6.

Mentions the Mexican axolotl.

OWEN, RICHARD.

1844. Characters of a new species of Axolotl. Ann. Mag. Nat. Hist., 15, No. 88, July, 1844, p. 23, 1 fig.

Axolotes a generic designation said to have been used by Cuvier first. *Axolotes guttatus* given as a new name for Siredon mexicanus; *Axolotes maculata* a new species described from "In Mexico, in fluviis Sierrae Madre, Chihuahua, lat. 26° 6′ N., long. 106° 50′ W."

PANCERI, PAOLO.

1867. Gli axolotl recati per la prima volta in Napoli. Nuov. Cimento., 27, 1867, pp. 326-328.

1868. Gli axolotl recati per la prima volta in Napoli. Rendic. Accad. Sci. fis. Mat. Napoli 7, 1868, pp. 50-51.

1869. Intorno agli Axolotl cresciuti nell'Orto Botanico. Rendic. Accad. Sci. fis. Mat. Napoli. 8, 1869, pp. 147-148, 167-168.

PARKER, H. W.

1927. A revision of the frogs of the genera Pseudopaludicola, Physalaemus, and Pleurodema. Ann. Mag. Nat. Hist., (9), 20, No. 118, Oct. 1927, pp. 450-478.

Discusses *Pleurodema mexicana* (= *Eleutherodactylus mexicanus*) Brocchi and Paludicola (*Liuperus*) *nitidus*. Of the first, he states "—referred to this genus (*Pleurodema*) rather than to *Physalaemus* on account of the absence of any tarsal tubercle; its real position is still uncertain."

1934. A monograph of the frogs of the family Microhylidae. London, 1934, pp. viii + 208, figs. 1-67.

Mexican forms discussed: *Hypopachus oxyrhinus, Microhyla elegans* and *M. usta*.

PESTALOZZI, EMIL.

1878. Beitrag zur Kenntniss des Verdauungskanals von Siren pisciformis. Verh. Phys.-medic. Ges. Würzburg, N. F., 12, 1878, pp. 83-102.

PETERS, W.

1863. Bemerkungen mit über verschiedene Batrachier, namentlich über die Original-Exemplare der von Schneider und Wiegmann beschriebenen Arten des zoologischen Museums zu Berlin. Monatsb. Akad. Wiss. Berlin, 16, Feb. 1863, pp. 76-83.

Comments on *Bufo compactilis, B. horribilis, B. valliceps, B. cristatus* and *B. marmoreus*.

1869. Eine Mittheilung über mexicanische Amphibien, welche Hr. Berkenbusch in Puebla auf Veranlassung des Hrn. Legationsraths von Schlozer dem zoologischen Museum gesandt hat. Monatsb. Akad. Wiss. Berlin, Dec. 1869, pp. 874-881.

Liuperus nitidus, Hylodes Berkenbuschii and *Hyla microtis* are described as new. *Rana halecina, R. montezumae, Hyla eximia, Bufo compactilis* and *Engystoma mexicanum* are discussed or listed.

1871a. Ueber neue Amphibien (Hemidactylus, Urosaura, Tropidolepisma, Geophis, Uriechis, Scaphiopus, Hoplocephalus, Rana, Entomoglossus, Cystignathus, Hylodes, Arthroleptis, Phyllobates, Cephomantis), des Königl. Zoologischen Museums. Monatsb. Preuss. Akad. Wiss. Berlin, 1870 (1871), pp. 641-652, pls. 1-2.

1871b. Ueber einige Arten der heretologischen Sammlung des Berliner zoologischen Museums. Monatsb. Akad. Wiss. Berlin, 1871, pp. 644-652.

States that *Hyla microtis* Peters = *Hyla miotympanum* Cope.

1879a. Eine Mittheilung über neue Amphibien des Kgl. Zoologischen Museum (Euprepes, Acontias, Typhlops, Zamenis, Spilotes, Oedipus). Monatsb. Akad. Wiss. Berlin, Aug. 1879, pp. 774-779, pl. 1.

Spelerpes (Oedipus) infuscatus described from Haiti. Probably referable to a Mexican form.

1879b. Ueber die Eintheilung der Caecilien und ins besondere über die Gattungen *Rhinatrema* und *Gymnopis*. Monatsb. Akad. Wiss. Berlin, Nov. 24, 1879, pp. 924-943, 1 pl.

Comments on *Dermophis mexicanus* and *Gymnopis multiplicata* (from Veragua).

1882. Neue Art der urodelen Batrachier, Spelerpes (Oedipus) yucatanus, n. sp., aus Yucatan (Central America). Sitz. Ges. naturf. Fr. Berlin, Nov. 21, 1882, pp. 137-138.

PHILIPEAUX, J. M.

1867a. Sur la régénération des membres cher l'axolotl (*Siren pisciformis*) Compt. Rend., 64, 1867, pp. 1204-1205.

1867b. On the regeneration of the limbs in the Axolotl (Siren pisciformis). Ann. Mag. Nat. Hist., (3), 20, 1867, p. 149.

1867c. Sur la régénération des membres chez l'axolotl (*Siren pisciformis*). Ann. Sci. Nat., Zool., Ser. 5, 7, 1867, p. 238.

1871 Expérience montrant l'influence et la température sur la rapidité du développement des Axolotls. Arch. de Physiol., 4, 1871-72 (1871), p. 93.

PIATT, JEAN.

1934. The systematic status of Eleutherodactylus latrans (Cope). Amer. Mid. Nat., 15, No. 1, 1934, pp. 89-91.

POUCHET, GEORG.

1872. (Développement des leucocytes chez les embryons d'axolotls.) Compt. Rend. et Mém. Soc. Biol. Paris, (5), 2, 1870 (1872) (Compt. Rend.), p. 59.

1875. (Remarque sur l'hydropsie abdominale chez l'axolotl.) Compt. Rend. et Mém. Soc. Biol. Paris, (6), 1, 1874 (1875), C. R., pp. 139-140.

PROCTOR, JOAN B.

1921. On the variation of the scapula in the batrachian groups Aglossa and Arcifera. Proc. Zool. Soc. London, pp. 197-214.

(PUTNAM, F. W.)? EDITOR.

1868. Siredon, a larval salamander. American Naturalist, 2, No. 9, Nov. 1868, p. 493.

Comments on an article of O. C. Marsh.

1869. New salamander. American Naturalist, 3, No. 4, June 1869, p. 222.

Mentions a salamander *Thorius pennatribus* (sic) and attributes the name to Cope.

RATHKE, HUR.

1929. Bemerkungen über den Achotl oder mexikanischen Proteus. Meckel's Ark. Anat. Phys., 1929, pp. 212-222. (Also see Feruss., Bull. Sc. Nat. 21, 1830, pp. 476-477.)

REINHARDT, J., and LÜTKEN CH.

1861. Bidrag til Kundskab om Brasiliens Padder og Krybdyr. Vidensk. Meddel., Natur. Foren. Kjöbenhavn, Pt. 1, No. 10-15, 1861, pp. 143-242, pls. 3-6.

Original description of the genus *Hylella.*

1862. Bidrag til det vestindiske öriges og navnligen til de danskvestindiske öers Herpetologie. Vidensk. Meddel. Naturh. Foren. Kjöbenhavn., No. 10-18, 1862, pp. 153-290.

Certain Mexican species mentioned.

RICHARDSON, C. H., JR.

1912. The distribution of Hyla arenicolor Cope, with notes on its habits and variations. American Naturalist, 46, No. 550, Oct. 12, 1912, pp. 605-611, 1 map.

This species is reported from certain localities in Mexico.

ROARO, DANIEL NIETO.

1938. Estudio de la sangre de la Rana montezumae. Anal. Inst. Biol., 9, 1938, pp. 361-364, fig. 3.

ROARO, DANIEL NIETO, and BATALLA, MA. AUGUSTINA.

1935. Contribución al estudio hematológico de Dermophis mexicanus, Dum. y Bibr. Arch. Lat. Amer. Card. Hema., 5, No. 5, July-Aug., 1935, pp. 183-190, figs. 1-10.

RÖHRIG, W.

1875. Ueber den Axolotl in Gefangschaft. Zool. Gart., 6, 1875, pp. 314-315.

ROVIROSA, JOSE.

1888. El camaleon de Tabasco. La Naturaleza, (2), 1, Cuad. 2-4, 1888, pp. 156-160, pl. 15, figs. a-c.

Rhinophrynus dorsalis is treated.

RUTHVEN, ALEXANDER G.

1912a. The amphibians and reptiles collected by the University of Michigan-Walker expedition in southern Vera Cruz, México, Zool. Jahrb., 32, No. 4, 1912, pp. 295-332, pls. 6-11.

Reports *Dermophis mexicanus, Spelerpes variegatus, Rana austricola, R. palmipes, Leptodactylus caliginosus, L. albilabris, Engystomops pustulosus, Bufo valliceps, B. marinus, Rhinophrynus dorsalis* and *Hyla baudini* from Veracruz.

1912b. On some amphibians and reptiles from the state of Vera Cruz, Mexico. Fourteenth Rep. Michigan Acad. Sci., 1912, pp. 230-231.

Lists *Spelerpes variegatus, Rana palmipes, Leptodactylus caliginosus, Bufo valliceps and Hyla baudini.*

1913. The local distribution of the reptile-amphibian fauna in southern Vera Cruz and its bearing on the origin of the savannahs. Ann. Ass. Amer. Geog., 2, 1913. pp. 41-48. pls. 13-16.

SACC, F.

1870. Les exolotls du Jardin des Plantes. Bul. Soc. Sc. Nat. Neuchâtel, 8, 1870, pp. 192-193. (Possibly published in 1869).

SALVIN, OSBERT.

1860. On the reptiles of Guatemala, Proc. Zool. Soc. London, Dec. 11, 1860, pp. 451-461, pl. 32.

Bufo nebulifer reported in Mexico. *Hyla holochlora* (= *Agalychus moreletii*) is described.

SANDERS, OTTYS.

1938. Report on the collection of seventeen species of amphibians in Mexico. Proc. Texas Acad. Sci., 1938, pp. 18-20.

The following species are listed or discussed: *Hyla baudinii, H. staufferi, H. venulosa, H. miotympanum, Hylela* (sic) *picta, Leptodactylus melanotus* (sic), *Eleutherodactylus rhodopsis* (sic), *Syrrhopus* (sic) *campi, Hypopachus cuneus, Rana pipiens, Bufo marinus, B. valliceps, B. punctatus, Scaphiopus hammondi multiplicatus, S. couchii, Triturus kallerti* and *Oedipus platydactylus.*

SCANTIS, LEONE DE.

1870. Sulla riproduzione degli Axolotl del Mexico avvenuta nel Laboratorio di Anatomie comparata e Zoologia delle R. Università di Roma. Atti. R. Accad. d. Lincei, 24, 1870-1871 (1870), pp. 396-397 (Estratto) in, Annuar. Soc. Nat. Modena, 6, 1872, p. 62.

SCHARLINSKI, HANS.

1939. Nachtrag zum Katalog der Wolterstorff-Sammlung im Museum für Naturkunde und Vorgeschichte zu Madgeburg. Abh. Ber. Mus. Naturk. Vorges. Nat. Ver. Magdeburg, 7, 1, 1939, pp. 31-57.

Diemictylus (sic) *kallerti, Amblystoma mexicanum, A. tigrinum velascoi, A.* (*Rhyacosiredon*) *altamirani, A. dumereli* (sic), *Oedipus bellii, O. macrini* (sic).

SCHMIDT, KARL PATTERSON.

1922. The amphibians and reptiles of Lower California and the neighboring islands. Bull. Amer. Mus. Nat. Hist. 46, Art. 11, Dec. 7, 1922, pp. 607-707, pls. 47-57, figs. 1-13.

Lists *Batrachoseps attenuatus, B. leucopus, Plethodon croceater, Aneides lugubris lugubris, Scaphiopus couchii, S. hammondi, Bufo punctatus, B. boreas halophilus, Hyla arenicolor, H. regilla* and *Rana aurora draytoni.*

1936. Guatemalan salamanders of the genus Oedipus. Zool. Series Field Mus. Nat. Hist., 20, No. 17, Oct. 31, 1936, pp. 135-166, figs. 13-19.
The type description of *Oedipus flaviventris.* The following species of Oedipus are listed from Veracruz: *platydactylus, rufesens, lineolus, townsendi, chiropterus, bellii, pennatulus, cephalicus,* and *gadovii.*

1941. The amphibians and reptiles of British Honduras. Zool. Ser. Field Mus. Nat. Hist. 22 (8), pp. 475-510.

SCHMIDT, K. P., and OWENS, DAVID W.

1944. Amphibians and reptiles of northern Coahuila, Mexico. Zool. Ser. Field Mus. Nat. Hist. 29 (6), pp. 97-115.

SCHMIDT, OSCAR.

1857. Deliciae Herpetologicae Musei Zoologici Cracoviensis. Beschreibung der in K. K. Museum zu Krakau befindlichen von J. v. Warszewicz in Neu-Granada und Bolivia gesammelten ungeschwänzten Batrachier. Denk. K. K. Akad. Wiss. Math-Natur. Class, Wien, 14, pt. 2, 1857, (1858 ?), pp. 237-258, pls. 1-3, figs. 1-27.
The type description of *Bufo simus* from Panamá.

SCHNEIDER, G.

1940. Der Einfluss des Nervensystems auf die Regeneration der Gliedmassen der Axolotl. Bull. Acad. Sci. U.S.S.R., Ser. Biol., 3, pp. 388-404, figs.

SCHÖNBERGER, MARKWART.

1880. Zur Zucht des Axolotl in aquarium. Isis (Russian), 5, 1880, pp. 371-372.

SCHULTZE, MAX.

1867. Ueber die Metamorphose der Axolotl, im pariser Pflanzengarten. Vehr. nat. Ver., preuss. Rheinl. Westphalia, 24, 1867, Sitzb., p. 35.

SCLATER, P. L.

1871. (Remarks on the so-called Axolotls in the Society's Gardens.) Proc. Zool. Soc. London, pp. 41-42.

SEMPER, C.

1878. Ueber ein Methode, Axolotl-eierderzeit zu erzeugen. Zool. Anz. 1, 1878, pp. 176-179.

1879. Ueber das Eierlegen des Axolotl. Vehr. Phys.-Med. Ges. Würzburg, N. F., 13, 1879, Sitzb. f., pp. 41-42.

SEURAT, L. G.

1899. Concernant la Fauna de les lacs et de valle de Mexique laquets. Revista Soc. Cient. "Antonio Alzate," 1899, 12, pp. 65-70.

1900. Sobre la fauna de los lagos y lagunas del valle de México. La Naturaleza (2), 3, Cuad. 5-6, 1900, pp. 403-406 (Translation of the preceding article).
Siredon Humboldti, Siredon tigrinum, Siredon Dumerili and *Amblystoma tigrina.*

SHAW, GEORGE.

1798. The Naturalists Miscellany, 9, 1798, pls. 343-344.

The type description of *Gyrinus mexicanus.* The plates are drawn by Frederic P. Nodder.

1802. General Zoology or Sytematic Natural History. Vol. 3, Pt. 1, pp. vii + 312, pls. 1-86; Pt. II, pp. vii + 313-615, pls. 87-140.

Treats of *Siren pisciformis* and *Gyrinus mexicanus; Rana catesbeiana* is described.

SLEVIN, JOSEPH R.

1926. Notes on a collection of reptiles and amphibians from the Tres Marias and Revillagigedo Islands, and west coast of Mexico, with description of a new species of Tantilla. Proc. California Acad. Sci., (4), 15, No. 3, pp. 195-207, pl. 22, Apr. 26, 1926.

Hyla regilla is reported from Cerros Island.

1928. The amphibians of western North America. An account of the species known to inhabit California, Alaska, British Columbia, Washington, Oregon, Idaho, Utah, Nevada, Arizona, Sonora and Lower California. Occ. Papers California Acad. Sci., 16, Sept. 15, 1928. pp. 1-152, pls. 1-23.

Lists the following species from Sonora: *Scaphiopus couchii, Bufo alvarius, B. punctatus, B. woodhousii, Hyla arenicolor* and *Rana pipiens.* From Baja California, *Triturus torosus, Batrachoseps attenuatus leucopus, Ensatina croceater, Scaphiopus hammondii couchii, Bufo punctatus, B. boreas halophilus, Hyla regilla, H. arenicolor* and *Rana aurora draytonii.*

SMITH, HOBART MUIR.

1938. Notes on Reptiles and amphibians from Yucatan and Campeche, Mexico. Occ. Papers Mus. Zool., Univ. Michigan, No. 388, Oct. 31, 1938, pp. 1-22, pl. 1.

Bufo marinus, B. valliceps, Triprion petasatus, Hyla baudinii and *Hypopachus cuneus* are listed from Yucatán; *Rhinophrynus dorsalis, Bufo marinus, B. valliceps, Engystomops pustulosus, Leptodactylus labialis, L. melanonotus, Agalychnis dacnicolor, Hyla baudinii, H. loquax, H. staufferi, H. underwoodi, H. venulosa, Hypopachus cuneus, Microhyla elegans, Rana palmipes, R. pipiens* are listed from Campeche.

1939a. An annotated list of the Mexican amphibians and reptiles in the Carnegie Museum. Ann. Carnegie Mus., 27, Mar. 14, 1939, pp. 311-320.

The following species from Mexico are listed: *Oedipus bellii, Scaphiopus hammondi, Bufo valliceps, Leptodactylus melanonotus, Hyla baudinii, H. regilla, Rana pipiens* and *R. tarahumarae.*

1939b. Mexican herpetological novelties. Proc. Biol. Soc. Washington, 52, Dec. 15, 1939, pp. 187-196, pls. 1-2.

Type descriptions of *Eleutherodactylus spatulatus* and *Anotheca* (new genus, the genotype *Anotheca coronata*).

1939c. Notes on Mexican reptiles and amphibians. Zool. Series Field Mus. Nat. Hist. 24, No. 4, 1939, pp. 15-35, figs. 4.

1941a. Collecting Mexican reptiles and amphibians. From Expl. Field Work of the Smithsonian Inst. 1940 (1941), pp. 35-38, figs. 38-41.

1941b. Snakes, frogs and bromelias, Chicago Nat., 4, No. 2, 1941, pp. 35-43, ill.

Oedipus platydactylus, O. rufescens, Hyla staufferi, H. baudinii, H. venulosa are mentioned.

1943. Summary of the collections of snakes and crocodilians made in Mexico under the Walter Rathbone Bacon Traveling Scholarship. Proc. U. S. Nat. Mus., 93, pp. 393-504, figs. 13-15, pl. 32.

1944a. Additions to the list of Mexican amphibians and reptiles in the Carnegie Museum. Ann. Carn. Mus., 30, pp. 89-92.

Numerous species listed.

1944b. Notes on a small collection of reptiles and amphibians from Tabasco, México. Journ. Wash. Acad. Sci., 34 (5), pp. 154-156.

SMITH, HOBART M. and NECKER, WALTER L.

1944. Alfredo Dugès' types of Mexican reptiles and amphibians. Anal. Esc. Nac. Cienc. Biol. 3 (1 and 2), pp. 179-233, pls. 1-7.

SMITH, W. H.

1877. The tailed amphibians, including the Caecilians. Detroit, 1877, pp. 1-158.

SOKOLOFF, DEMETRIO and CABALLERO, EDUARDO.

1933. Primera contribucion al conocimiento de los parásitos de Rana montezumae. Anales del Instituto de Biologia, 4. (1), pp. 15-21, 7 figs.

SPEAR, JOHN C.

1872. Reports of explorations and surveys, to ascertain the practicability of a ship-canal between the Atlantic and Pacific Oceans, by way of the Isthumus of Tehuantepec. D. Report on the geology, mineralogy, natural history, inhabitants and agriculture of the Isthmus ofTehuantepec. Chapter V. Natural History. Cold-blooded vertebrates, determined by Edw. D. Cope. Washington. 42d Congress, 2d Sess., Senate Exec. Doc. No. 6, p. 137.

"Batrachia—Systoma ustum, Cope (Engystoma Mexicanum, Peters). Bufo agua, Bufo sternosignatus, Gthr. Hylodes rhodopis, Cope."

SPENGEL, J. W.

1883. Beobachtungen über das Leben des ajolotl in Mexiko. Biol. Centralblatt. 2, pp. 80-83.

1885. Zwitterbildungen bei Amphibien. Biol. Centralblatt. 4, No. 8, pp. 235-241.

STÄUBLE, A.

1942a. Ueber den Brustschulterapparat sowie die hypoxonische Rumpfinuskulatur bei den Amblystomidae und Hynobiidae. Rev. suisse Zool. Genève 49, pp. 241-246.

1942b. Ueber den Brustschulterapparat und die hypoxonische Rumpfinuskulatur der Urodelen, ins besondere bei *Hynobius peropus* Boul. und *Siredon mexicanum* Shaw. Rev. Suisse Zool. Genève 49, pp. 451-558, figs.

STEJNEGER, LEONARD.

A new tree toad from Costa Rica. Proc. U. S. Nat. Mus., 30, June 4, 1906, No. 1471, pp. 817-818.

Hyla phlebodes (=*Hyla underwoodi Boulenger*) is described

1910. The amphibian generic name Engystoma untenable. Proc. Biol. Soc. Washington, 23, Dec. 29, 1910, pp. 165-168.

Gastrophryne usta and *elegans* listed.

1911. Descriptions of three new batrachians from Costa Rica and Panama. Proc. U. S. Nat. Mus., 41, No. 1857, Aug. 14, 1911, pp. 285-288.

1915. A new species of tailless batrachian from North America. Proc. Biol. Soc. Washington, 28, June 29, 1915, pp. 131-132.

Describes *Syrrophus campi* from Brownsville, Texas.

STEJNEGER, LEONARD and BARBOUR, THOMAS.

1917. A check list of North American Amphibians and Reptiles. 1st edit. 1917, pp. iv, 5-126.

1923. Idem. 2nd edit. 1923, pp. x + 171.

1933. Idem. 3rd edit. 1933, pp. xiv + 185.

1939. Idem. 4th edit. 1939, pp. xvi + 207.

List the amphibia of Baja California.

STORER, TRACY I.

1925. A synopsis of the Amphibia of California. Univ. California Publ. Zool., 27, 1925, pp. 1-342, pls. 1-18, text figs. 1-42.

Illustrations of several species which also occur in México. Certain species mentioned as occurring in Baja California.

STRAUCH, A.

1870. Revision der Salamandriden-Gattungen nebst Beschreibung einiger neuen oder weniger bekannten Arten dieser Familie. Mém. Acad. Imp. Sci. St. Petersbourg, (7), 16, 1870, pp. 1-109, pls. 1-2.

STUART, L. C.

1934. A contribution to a knowledge of the herpetological fauna of El. Petén, Guatemala. Occ. Pap. Mus. Zool. Univ. Mich., no. 292, June 29, 1934, pp. 1-18.

Gastrophryne elegans discussed.

1935. A contribution to a knowledge of the herpetology of a portion of the Savanna region of central Petén, Guatemala. Misc. Publ. Univ. Mich. Mus. Zool., No. 29, 1935, pp. 1-56, pls. 1-4, map 1, text fig. 1.

1940. A new *Hypopachus* from Guatemala. Proc. Biol. Soc. Washington, 53, Feb. 16, 1940, pp. 19-22.

Nominal mention of *Hypopachus cuneus, variolosus, and oxyrhinus.*

1941a. Two new species of *Eleutherodactylus* from Guatemala. Proc. Biol. Soc. Wash. 54, pp. 197-200.

1941b. Another new *Hypopachus* from Guatemala. Proc. Biol. Soc. Washington, 54, Sept. 30, 1941, pp. 125-128.

Mentions the tadpoles of *Hypopachus cuneus nigroreticulatus* from Yucatán.

1942a. Descriptions of two new species of *Plectrohyla* Brocchi, with comments on several forms of tadpoles. Occ. Papers Mus. Zool. Univ. Michigan, No. 455, Jan. 5, 1942, pp. 1-14, figs. 1-4.

Forms compared with *P. sagorum* and *matudai* of Chiapas.

1942b. Una descripción preliminar de las provincias bióticas de Guatemala, fundada sobre la distribución del genero salamandrino. An. Soc. Geogr. Hist. Guatemala, 18, (1), pp. 29-38.

1943a. Comments on the herpetofauna of the Sierra de los Cuchumatanes. Occ. Pap. Mus. Zool. Univ. Mich. 471, pp. 1-28, pl. 1, tables 1-4, figs. 1-7, map 1.

1943b Taxonomic and geographic comments on Guatemalan salamanders of the genus *Oedipus*. Misc. Publ. Mus. Zool. Univ. Mich. 56, pp. 1-33. pls. 1-2.

SUMICHRAST, FRANCOIS

1873. Coup d'oeil sur la distribution geographique des Reptiles au Mexique. Arch. Sci. Phys. Nat., Vol. 46, pp. 233-250.

1880. Contribución a l'Histoire naturelle du Mexique. 1. Notes sur une Collection de Reptiles et de Batraciens de la parte occidentale de l'Isthme de Tehuantepec. Bull. Soc. Zool. Fr., 5, 1880, pp. 162-190.

1882. Enumeracion de los batracios observados en la parte oriental y. meridional de la República Mexicana. La Naturaleza, 6 Entrega 5, 1882, pp. 78-82, and Entrega 6, 1882, pp. 83-84.

Siphonops mexicanus, Oedipus rufescens, O. carbonarius, O. salvini, Spelerpes belli, S. chiropterus, S. cephalicus, S. lineolus, Thorius, pinnatulus, Bufo agua, B. intermedius, B. sternosignatus, B. valliceps, B. christatus (sic) *B. canaliferus,* ? *B. argillaceus, B. coccifer, Rhinophrynus dorsalis, Engystoma ustum, Microphryne (Paludicola) pustulosa, Syrrhophus leprus, S. cystignathoides, Hylodes lithodytes rhodopis, H. griseus,* ? *Hylodes conspicillatus, Hylodes (Lithodytes) podiciferus, Lihyla rugulosa, Hyla myotympanum* (sic), *H. bistincta, H. spilomma, H. staufferii,* ? *Hyla lichenosa, H. eximia, H. baudinii, Hylella platycephala, Agalychnis callidryas, Cystignatus* (sic) *melanonotus,* ? *Leptodactylus echinatus,* ? *Leptodactylus caliginosus, Cystignathus labialis, C. albilabris, C. caliginosus, C. gracilis, C. fragilis, Rana halecina, R. (Ranula affinis),* ? *Rana vallianti,* ? *Rana maculata.*

1881. Note additionelle a la premiére contribution a l'histoire naturelle du Mexique. Bull. Soc. Zool. France, 6, 1881, pp. 231-232.

Oedipus rufescens, O. carbonarius, Bufo coccifer, Hyla miotympanum, Hylella platycephala, Lithodytes podiciferus, Syrrhopus leprus, Cystignathus perlaevis, C. labialis are listed and discussed.

1881-
1882. Contribucion a la historia natural de Mexico. I. Notas acerca de una coleccion de reptiles y batracios de la parte occidental del istmo de Tehuantepec. La Naturaleza, 5, Entrega 16, 1881, pp. 268-270; Entrega 17, 1882, pp. 271-286; Entrega 18, 1882, pp. 287-293.

Rhinophrynus dorsalis, Engystoma ustum, Bufo agua, B. sternosignatus, B. valliceps, B. argillaceus, B. canaliferus, Microphryne (Paludicola) pustulosa, Cystignathus melanonotus, C. gracilis, Rana halecina, var. *berlandieri* ? *Rana (Ranula) affinis, Hylodes (Lithodytes) rhodopis, H. sallaei, Hyla rugulosa, H. (Smilisca) baudinii, H. staufferi, Oedipus Salvini, Siphonops mexicanus, Bufo coccifer, Cystignathus labialis, C. perlaevis, Hylodes (Lithodytes) podiferus, Syrrhophus leprus, Hylella platycephala* and *Oedipus rufescens.*

This is a translation from the French article, translated by D. Manuel Urbina. There is an "Adicion a la memoria anterior."

SUTTON, GEORGE MIKSCH and PETTINGILL, OLIN SEWALL, JR.

1942. Birds of the Gomez Farias region, southwestern Tamaulipas. Auk, 59, pp. 1-34, pls. 1-6.

TANNER, VASCO M.

1939. A study of the genus Scaphiopus; the spade-foot toads, Great Basin Nat., 1, No. 1, July 25, 1939, pp. 3-26, pls. 1-3.

TAUSCHENBERG, DR. O.

1894. Bibliotheca Zoologica II, Vol. 4. Leipzig, 1894, p. 3546.

Refers *Siredon dumerilii, Humboldtii lichenoides, mexicanus pisciformis,* and *tigrinus* to *Amblystoma tigrinum.*

TAYLOR, EDWARD HARRISON.

1933. Notes on type specimens of reptiles and amphibians in the "Alfredo Dugès" Museum, Guanajuato, Mexico. Copeia, No. 2, July 20, 1933, p. 97.

Ambystoma altamirani reported.

1937a. New species of Amphibia from Mexico. Trans. Kansas Acad. Sci., 39, 1936, (1937), pp. 349- 363, pls. 1-2.

Original descriptions of *Leptodactylus occidentalis, Eleutherodactylus pygmaeus, E. hobartsmithi.* The species *Hyla smithii* is discussed. All are figured.

1937b. New species of hylid frogs from Mexico with comments on the rare Hyla bistincta Cope. Proc. Biol. Soc. Washington, 50, Apr. 21, 1937, pp. 43-54, pls. 2-3.

Type descriptions of *Hyla robertmertensi, Hyla pinorum, Hyla erythromma* and a discussion of *Hyla bistincta.* All species figured.

1938a. Notes on the herpetological fauna of the Mexican state of Sonora. Univ. Kansas Sci. Bull., 24, No. 19, 1936 (Pub. date Feb. 16, 1938), pp. 475-503, pl. 43.

The following species are reported from Sonora: *Scaphiopus couchii, Bufo alvarius, B. punctatus, Hyla arenicolor, Rana pipiens, Pternohyla fodiens, Microhyla olivacea, Bufo woodhousii, B. marinus* and *B. compactilis.*

1938b. Notes on the herpetological fauna of the Mexican state of Sinaloa. Univ. Kansas Sci. Bull., 24, No. 20, 1936 (Feb. 16, 1938), pp. 505-537, pls. 44-46.

Discusses *Scaphiopus couchii, Bufo marinus, B. punctatus. B. valliceps, Leptodactylus occidentalis, Pternohyla fodiens, Diaglena spatulata, Agalychnis dacnicolor, Hyla baudinii, H. smithi, Microhyla olivacea, Rana pipiens.* The toad *Bufo kelloggi* is described as new.

1939a. Concerning Mexican salamanders. Uni. Kansas Sci. Bull., 25, No. 14, 1938 (July 10, 1939), pp. 259-313, pls. 24-29.

Type descriptions of the following species appear: *Ambystoma schmidti, Oedipus giganteus, O. smithi, O. altamontanus, O. manni, O. robertsi, O. multidentatus.* The following are discussed: *Rhyacosiredon altamirani, Oedipus bellii, O. leprosus, O. orizabensis, O. cephalicus, O. chiropterus, O. pennatulus, O. lineolus, O. salvinii* (= *Bolitoglossa flaviventris* [Schmidt]), *O. platydactylus* and *Gymnopis multiplicata oaxacae.*

1939b. New species of Mexican tailless Amphibia. Univ. Kansas Sci. Bull., 25, No. 17, 1938 (mailing date July 10, 1939), pp. 385-405, pls. 39-41, text figs. 1-2.

Type descriptions of *Hyla rickardsi, H. arborescandens, Eleutherodactylus cactorum, E. natator, Rana sierramadrensis.* All species are figured.

1939c. Frogs of the *Hyla eximia* group in Mexico, with descriptions of two new species. Univ. Kansas Sci. Bull., 25, No. 19, 1938 (July 10, 1939), pp. 421-445, pls. 46-48.

Type descriptions of *Hyla cardenasi, Hyla wrightorum. Hyla eximia, Hyla euphorbiacea, Hyla lafrentzi* and *Hyla regilla* are listed or discussed. Figures are given of most of the species.

1939d. A new bromeliad frog. Copeia, No. 2, July 12, 1939, pp. 97-100, fig. 1.

Hyla bromeliana is described and figured.

1940a. A new eleutherodactylid frog from Mexico. Proc. New England Zool. Club, 18, Jan. 24, 1940, pp. 13-16, pls. 1-2.

Type description of *Eleutherodactylus batrachylus* from Miquihuana, Tamaulipas, México.

1940b. A new *Rhyacosiredon* (Caudata) from western Mexico. Herpetologica, 1, No. 1, Jan. 29, 1940, pp. 171-176, pl. 17.

Rhyacosiredon rivularis is described as new. This and *Rhyacosiredon altamirani* are figured.

1940c. A new bromeliad frog from northwestern Michoacan. Copeia, No. 1, Mar. 30, 1940, pp. 18-20, fig. 1.

Hyla smaragdina is described and figured.

1940d. Two new anuran amphibians from Mexico. Proc. U. S. Nat. Mus., 89, No. 3093, 1940, pp. 43-47, pls. 1-3.

Describes *Syrrhophus smithi, Hyla dendroscarta*. Both species are figured, including the tadpoles of the latter.

1940e. A new Syrrhophus from Guerrero, Mexico. Proc. Biol. Soc. Washington, 53, Oct. 7, 1940, pp. 95-98, pl. 1.

Syrrhophus pipilans is described and figured.

1940f. New species of Mexican anura. Univ. Kansas Sci. Bull., 26, No. 11, 1940 (Nov. 27), pp. 385-405, pls. 43-44, text figs. 1-8.

Type descriptions of *Hyla hazelae, Hyla robustofemora, Hyla robertsorum, Syrrhophus latodactylus* and *Eleutherodactylus vocalis* appear.

1940g. New salamanders from Mexico with a discussion of certain known forms. Univ. Kansas Sci. Bull., 26, No. 12, 1940 (Nov. 27), pp. 407-439, pls. 45-48, text figs. 1-5.

Contains type descriptions of the following species: *Bolitoglossa dimidiata, Thorius pulmonaris, Thorius narisovalis, Ambystoma bombypella, Ambystoma amblycephala, Ambystoma ordinaria* and *Siredon lermaensis*. All are figured. The following are mentioned or discussed: *Thorius pennatulus* (= *Thorius troglodytes* and *Thorius dubitus*), *Siredon mexicana* and *Siredon dumerelli*.

1940h. Herpetological miscellany No. I. Univ. Kansas Sci. Bull., 26, No. 15, 1940 (Nov. 27), pp. 489-571, pls. 53-63, text figs. 1-7.

Type descriptions of *Bufo gemmifer, Bufo mazatlanensis, Tomodactylus angustidigitorum, Tomodactylus macrotympanum, Microbatrachylus* new genus, *Microbatrachylus albolabris, Microbatrachylus oaxacae, Microtrachylus minimus, Hyla melanomma, Hyla forbesi, Hypopachus cuneus nigroreticulatus, Hypopachus ovis, Hypopachus alboventer, Hypopachus maculatus* and *Hypopachus caprimimus*. The following species are discussed: *Microbatrachylus pygmaeus, M. hobartsmithi, Hyla arborescandens, H. erythromma, Hypopachus* (genus), *Hypopachus cuneus cuneus, Microhyla elegans, M. olivacea*. The new species and certain of the others are figured.

1940i. A new frog from the Tarahumara Mountains of Mexico. Copeia, Dec. 27, 1940, No. 4, pp. 250-253, fig. 1.

Type description of *Eleutherodactylus tarahumaraensis* from Mojarachic, Chihuahua, México.

1941a. New plethodont salamanders from Mexico. Herpetologica, 2, No. 3, Mar. 25, 1941, pp. 57-65, figs. 1-5.

Contains type descriptions of *Bolitoglossa unguidentis* from Cerro San Felipe, Oaxaca, and *Bolitoglossa orborea* from near Tianguistengo, Hidalgo. The premaxillary teeth of *Bolitoglossa smithi* are figured.

Eleutherodactylus sp. (= *E. hidalgoensis*), *Syrrhophus latodactylus, Tomodactylus macrotympanum* are mentioned or discussed. Figures are given of *Eleutherodactylus occidentalis, E. saltator, E. calcitrans,* the new species, and the various species of *Thorius.*

1941e. New amphibians from the Hobart M. Smith Mexican collections. Univ. Kansas Sci. Bull., 27, pt. 1, No. 8, Dec. 15, 1941, pp. 141-167, pls. 7-11, text fig. 1.

Type descriptions are given of *Bolitoglossa nigromaculata, Bolitoglossa occidentalis, Bolitoglossa xolocalcae, Bolitoglossa nigroflavescens, Eleutherodactylus dorsoconcolor, Eleutherodactylus matudai.* All of the species are figured.

1942a. Tadpoles of Mexican anura. Univ. Kansas Sci. Bull., 28, pt. 1, No. 3, May 15, 1942, pp. 37-55, pls. 1-3.

Tadpoles of Genus sp.?, *Plectrohyla matudai, Agalychnis dacnicolor, A. callidryas* (eggs), *Scaphiopus multiplicatus, Rana pustulosus, R. montezumae, Hypopachus caprimimus, H. alboventer.*

1942b. The frog genus Diaglena, with a description of a new species. Univ. Kansas Sci. Bull. 28, pt. 1, No. 4, May 15, 1942, pp. 57-65, pls. 4-5.

Type description of *Diaglena reticulata* with a discussion of the genus and of *Diaglena spatulata.*

1942c. New tailless amphibia from Mexico. Univ. Kansas Sci. Bull., 28, pt. 1, No. 5, May 15, 1942, pp. 67-89, pls. 6-9.

Type descriptions of the following appear: *Microbatrachylus montanus, M. imitator, Eleutherodactylus macdougalli, Centrolenella viridissima, Hyla rozellae.* Discussions of specimens of the following: *Eleutherodactylus mexicanus, Centrolenella fleischmanni, Hyla leucophyllata,* and *Hyla phaeota.* Most of the species are figured.

1942d. New Caudata and Salientia from Mexico. Univ. Kansas Sci. Bull., 28, pt. 2, No. 14, November 15, 1942, pp. 295-323, pls. 25-29.

The following new species are described: *Syrrhophus modestus* from Paso del Río, Colima, *Hyla beltrani,* Tapachula, Chiapas, *Eleutherodactylus bolivari,* Ixtapan del Oro, México, *Eleutherodactylus decoratus,* Banderia, Veracruz, *Eleutherodactylus hidalgoensis,* near Tianguistengo, Hidalgo.

1943a. A new Hylella from Mexico. Proc. Biol. Soc. Washington 56, pp. 49-52. *Hylella azteca* described.

1943b. A new ambystomid salamander adapted to brackish water. Copeia 3, pp. 151-156, figs. 1-3.

Ambystoma subsalsum described.

1943c. Herpetological novelties from Mexico. Univ. Kansas Sci. Bull., 29 (2), pp. 343-361, pls. 26-27.

Bolitoglossa cochranae, Rhyacosiredon leorae, Bufo perplexus, Bufo nayaritensis, Tomodactylus albolabris, Syrrhoplus nebulosus and *Microhyla mazatlanensis* are described.

1944a. A new genus and species of Mexican hylid frogs. Univ. Kansas Sci. Bull., 30 (1) (3), pp. 41-45.

Ptychohyla adipoventris described.

1944b. A new ambystomid salamander from the plateau region of Mexico. Univ. Kansas Sci. Bull., 30 (1) (5), pp. 57-61, pl. 8.

Ambystoma granulosum described.

1944c. The hylid genus *Acrodytes,* with comments on Mexican forms. Univ. Kansas Sci. Bull., 30 (1) (6), pp. 63-69, pl. 9.

Acrodytes inflata described.

1944d. Present location of certain herpetological and other type specimens. Univ. Kansas Sci. Bull., 30 (1) (11), pp. 117-187.

1944e. The genera of plethodont salamanders in Mexico, Pt. I. Univ. Kansas Sci. Bull., 30 (1) (12), pp. 189-232, pls. 12-15, figs. 1-2. Defines the new genera *Chiropterotriton, Pseudoeurycea Parvimolge* and *Magnadigita.*

TAYLOR, EDWARD H. and KNOBLOCH, IRVING W.

1940. Report on an herpetological collection from the Sierra Madre Mountains of Chihuahua. Proc. Biol. Soc. Washington, 53, Oct. 7, 1940. pp. 125-130.

Lists *Bufo simus, Hyla arenicolor* and *Rana pipiens.* Mentions *Ambystoma* larvae.

TAYLOR, EDWARD H. and SMITH, HOBART M.

1945. Summary of the collections of amphibians made in Mexico under the Walter Rathbone Bacon Traveling Scholarship. Proc. U. S. Nat. Mus. 95 (3185), pp. 521-613, pls. 18-32, figs. 58-61.

One hundred forty-six species discussed. Eight new forms are described: *Rhyacosiredon zempoalaensis, Ambystoma lacustris, Bolitoglossa cephalica rubrimembris, Bufo angustipes, Eleutherodactylus conspicuus, Eleutherodactylus avocalis, Syrrhophus rubrimaculatus* and *Acrodytes modesta.*

TAYLOR, EDWARD H. and WRIGHT, JOHN SUAREZ.

1932. The toad *Bufo marinus* (Linnaeus) in Texas. Univ. Kansas Sci. Bull., 20, No. 12, 1932 (Oct. 1), pp. 247-249.

Bufo marinus mentioned in México.

TEGETMEIER, WILLIAM BERNHARD.

1870. (Exhibition of living specimens of the Axolotl.) Proc. Zool. Soc. London, 1870, pp. 160-161, figs. 1-2.

An axolotl and a transformed specimen are figured, purporting to be *Siredon mexicanus.*

TERRON, CARLOS CUESTA.

1921. Datos para una Monographia de la fauna Erpetologica de la peninsula de la Baja California. Mem. Soc. Cien. Antonio Alzate, Tomo 39, pp. 161-171.

Numerous species listed.

1930. La Hyla eximia Baird. Anales del Inst. de Biologia, I, (2), pp. 47-50. figs. 1-4.

TEST, FREDERICK CLEVELAND.

1898. A contribution to the knowledge of the variations of the tree frog Hyla regilla. Proc. U. S. Nat. Mus., 21, No. 1156, 1898, pp. 477-492. pl. 39.

Hyla curta and *Hyla regilla laticeps* are placed in the synonymy of *Hyla regilla.*

TEVIS, LLOYD.

1944. Herpetological notes from Lower California. Copeia, 1, pp. 6-18, figs. 1-2.

TÖRÖK, AURÉL.

1872. A mexikoi Proteus vagy Axolotl. Természet. 4 efv. 1872, 18sz., pp. 186-191.

1877a. Dolgazotok a klozsvari t. egyetem élet-szovettani intézeteböl. II. Szövetalakulasok a Siredon pisciformis. Sejteiben. Adat azállati szerveset szövetfejlödéstanahoz. Erdél. Museum Egylet. Evkönyv. Uj Folyam. II. Köt. 5, szam. 1877, pp. 144-170 (with a German abstract).

1877b. überblick des ungarischen Textes über formative Diggerenzirungen in den Embryonalzellen von Siredon pisciformis. ibid. pp. 171-172.

1877c. über formative Differenzirungen in den Embryonalzellen von *Siredon pisciformis.* Ein Beitrag zur Histiogenese des Tierorganismus. Arch. Mikr. Anat., 13, 1877, pp. 756-783.

Tschudi, Johann Jacob von.

1839. Classification der Batrachier mit Berücksichtigung der fossilen Thiere dieser Abtheilung. Mem. Soc. Sci. Nat. Neuchâtel, 2, 1839, pp. 1-100.

Twitty, Victor Chandler.

1941. Data on the life history of *Ambystoma tigrinum californiense* Gray. Copeia, No. 1, Mar. 25, 1941, pp. 1-4.

States that *Ambystoma tigrinum californiense* has been artificially hybridized with *S. mexicanum.*

1942. The species of Californian Triturus. Copeia, No. 2, July 10, 1942, pp. 65-76, pls. 1-5.

Twitty, Victor C., and Elliot, H. A.

1934. The relative growth of the amphibian eye, studied by means of transplantation. Journ. Exper. Zool., 68, 1934, pp. 247-291, 22 text figs.

Siredon mexicanum mentioned.

Valliant, L.

1876. Sur la ponte des Axolotls transformés. Bull. Soc. Philom. Paris, 1876, pp. 13-15.

Van Denburgh, John.

1896a. A review of the herpetology of Lower California, Part II, Batrachians. Proc. California Acad. Sci. (2), 5, 1895 (Jan. 15, 1896), pp. 556-561.

The following species are listed: *Hyla regilla, H. curta, Scaphiopus couchii, Bufo punctatus, Batrachoseps attenuatus* and *Plethodon croceater.*

1896b. Additional notes on the herpetology of Lower California. Proc. Calif. Acad. Sci., (2), 5, 1896, pp. 1004-1008.

1905. The reptiles and amphibians of the islands of the Pacific Coast of North America from the Farallons to Cape San Lucas and the Revilla Gigedos. Proc. California Acad. Sci. (3), Zool. 4, No. 1, June 13, 1905, pp. 1-40, pls. 1-8.

Hyla regilla is reported from Cedros Island, Baja California.

Van Denburgh, John, and Slevin, Joseph R.

1914. Reptiles and amphibians of the islands of the west coast of North America. Proc. California Acad. Sci., (4), 4, Dec. 30, 1914, pp. 129-152.

Lists *Batrachoseps attenuatus* and *Autodax lugubris* from Los Coronados Islands; and *Hyla regilla* from Cedros Island.

1921. A list of the amphibians and reptiles of the peninsula of Lower California, with notes on the species in the collection of the Academy. Proc. California Acad. Sci., (4), 11, No. 4, July 8, 1921, pp. 49-72.

The following species are listed or discussed: *Batrachoseps attenuatus, Plethodon croceater (Aneides lugubris lugubris), Scaphiopus couchii, Bufo boreas halophilus, B. punctatus, Hyla regilla, H. arenicolor,* and *Rana draytoni.*

VELASCO, ALFONSO LUIS.

1894. Geografia y estadistica del estado de Zacatecas. Geograf. Estadist. Republica Mexicana, Vol. 15 (Mexico), 1894, pp. 1-324.

Lists *Rana halecina, Scaphiopus Holbrookii, Hyla eximia, Hyla versicolor, Hylodes laticeps, Bufo aqua, B. anomalus, B. intermedius, B. Chilensis.*

VELASCO, JOSÉ MARIA.

1879. Description metamorphosis y costumbres de una especie nueva del genero Siredon. La Naturaleza, 4, 1879, pp. 209-233, pls. 7-9.

1880. Anotaciones y observaciones al trabajo del Sr. D. A. Weismann sobre la trasformacion del ajolote mexicano en Amblistoma. La Naturaleza, 5, Entrega 3, p. 58; Entrega 4, pp. 59-74; Entrega 5, pp. 75-84.

The author's name appears on the covers of the various entregas but not with the title of the articles.

VETTER, B.

1877. über die Umwandlung des mexicanischen Acolotl in die Amblystomaform. Nach A. Weismann. Sitzber. Ges. Isis Dresden, 1876 (1877), pp. 28-29.

VILLADA, MANUEL M.

1879. Dictámen acerca del trabajo anterior. La Naturaleza, 4, 1879, pp. 234-236.

Remarks on Velasco's article (1879) on *Siredon tigrina.*

VION, RENE.

1869. Les Axolotols, compte-rendu d'une leçon de M. Aug. Duméril. Bull. Soc. Linn. Nord France, 1, 1866-67 (1869), pp. 421-431.

VULPIAN, A.

1867. Sur la reproduction das membres chez l'axolotl dans le cas de polydactylie acquise. Bull. Soc. Philom. Paris, (6), 4, 1867, p. 117.

WAGLER, JOHAN.

1828-1833. Descriptiones et Icones Amphibiorum. 3 parts. 36 plts.; pt. 1, 1828; pt. 2, 1830; pt. 3, 1833.

Siredon axolotl, pl. 20.

1830. Natürliches System der Amphibien mit vorangehender Classification der Säugethiere und Vogel. Ein Beitrag zur vergleichender Zoologie. Munchen, Stuttgart und Tübingen, 1830, pp. 1-354.

WALKER, CHARLES F.

1938. The structure and systematic relationships of the genus *Rhinophrynus.* Occ. Papers Mus. Zool., Univ. Michigan, No. 372, May 25, 1938, pp. 1-11, figs. 1-3.

Believes the genus worthy of family rank.

WEISMANN, DR. AUGUST.

1872. Ueber den Einfluss der Isolirung auf die Artbildung. Leipzig, 1872, pp.

Probably not *Siredon mexicana.*

1875. Ueber die Umwandlung des mexicanischen Axolotl in ein Amblystoma. Zeit. wiss. Zool., 25, Heft 3, suppl., 1875, pp. 297-334.

Treats of *Siredon mexicanus.*

1876. Axolotl u. Amblystoma. Zool. Garten, 17, 1876, pp. 1-8.

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The following species are listed from México: *Rana halecina berlandieri, R. montezumae, Scaphiopus couchii, S. varius varius, Spea multiplicata, Hyla arenicolor, H. eximia, H. regilla, H. curta, Bufo valliceps, B. lentiginosus cognatus, B. speciosus, B. beldingi, B. punctatus, B. debilis, Amblystoma mavortium* and *Siren lacertina.*

PRINTED BY
FERD VOILAND, JR., STATE PRINTER
TOPEKA, KANSAS
1947

21-6002

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