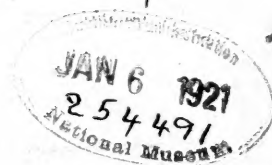


PROCEEDINGS
OF THE
CALIFORNIA ACADEMY OF SCIENCES

FOURTH SERIES

Vol. IX

1919



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1919

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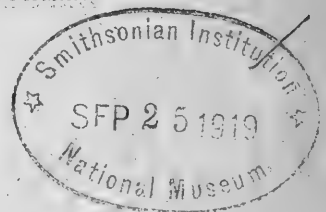
I

Notes on West American Chitons—II

BY

S. STILLMAN BERRY, REDLANDS, CALIFORNIA

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I

NOTES ON WEST AMERICAN CHITONS—II.

BY S. STILLMAN BERRY, REDLANDS, CALIFORNIA

3. ON THE GENERIC OR SUBGENERIC POSITION OF CERTAIN
WEST AMERICAN CHITONS

Specimens now in hand of the two Australian species, *Ischnochiton australis* (Sowerby) and *I. novæhollandiæ* Gray, make it evident that most of the species from other regions which have been associated with them in the section or subgenus *Ischnoradsia* of Shuttleworth, of which the former species must be taken as the type, have no true relations with them whatever. One of our West North American species which has clearly been incorrectly included here is the aberrant *Ischnochiton trifidus* Carpenter, 1864. As this species appears to have no close connection with any other known to us, while it offers several rather remarkable features of its own, I propose to make it the type of a new group, *Tripoplax*, which for the time being may be tentatively referred to *Ischnochiton* as a subgenus. In the true *Ischnoradsia*, not only is the sculpture, especially that of the lateral and terminal areas, of a different order, but the girdle scales are relatively quite large, thick and heavy, and bear a conspicuous vertical carination on their outer aspect. In the West American species the lateral and terminal areas have only a rela-

June 16, 1919

tively small number of low, flat, smooth, even ribs, and the proportionally much smaller girdle scales, which become even more minute toward the margin, are without any undue outer thickening or carination. In passing it may be noted that the so-called "Ischnoradsias" of Northern Japan can evidently be associated neither with the Australian species nor with *I. trifidus*. This phase of the matter will be treated more in detail upon a subsequent occasion in connection with a discussion of the radular characters.

Ischnochiton regularis (Carpenter 1855) was referred by Pilsbry ('92, p. 142) to his section *Radsiella*, evidently because of its radsiod valves. But *Radsiella*, as he has it, is an even more heterogeneous assortment than *Ischnoradsia*, the species referred to it including not only *I. tridentatus* Pilsbry from Lower California as type, and *I. regularis*, but also *I. viridulus* (Couthouy) from Tierra del Fuego, the *I. trifidus* above mentioned, and *I. tigrinus* (Krauss) from the Cape of Good Hope. I am not sure that the actual degree of relationship is sufficiently close for the association of any two of these in the same group: certainly the three West American forms have each striking peculiarities to distinguish them. Quite recently Thiele (:10, p. 112, 113) has shown that the radular characters of *regularis* indicate an affinity with the otherwise very different appearing *Lepidozona* and *Callistochiton*. This fact, together with the multiplication of insertion slits and other shell characters, causes me to propose here a second new group, *Rhombochiton*, to rank near or under *Lepidozona*, with *I. regularis* (Carpenter) as type. On my labels I am retaining both of these groups under *Ischnochiton* until certain further investigations upon which I am engaged can be carried through to completion. I do not think that our present knowledge of the detailed morphology of either the shell or the radula can be implicitly trusted to provide the key for working out the true relationships of all these groups, so as conservative a treatment as possible seems now the safest to adopt.

Through the kindness of Professors J. C. Merriam and B. L. Clark of the University of California, there have been

placed in my hands for study a few specimens of chitons from the collection of the late Dr. J. G. Cooper, which are of interest as having presumably been determined by Dr. P. P. Carpenter. Among these I have been interested to find a single specimen, represented by a few loose valves, of the very insufficiently known "*Trachydermon gothicus*" of Carpenter ('64, p. 649; '66, p. 212). This bears the Catalogue Number 2388 [S. S. B. 478], and was taken by Dr. Cooper at San Pedro, California, on shells of *Haliotis*. At near the same time a second specimen came to me through the generosity of Mr. W. H. Golisch of the Southwest Museum. This one, which is fortunately complete, was found by Mrs. Golisch at Dead Man's Island, San Pedro, California, in 1909 [S. S. B. 1060]. For some time I have felt that *gothicus* constituted a distinct element of its own in the heterogeneous mixture comprised in the Carpenterian genus *Trachydermon*, yet I was not altogether prepared to find revealed a second species of my own group *Dendrochiton* (Berry :11, p. 487), of which *D. thamnopus* (Berry) stands as the type and, up till now, the only known species. This group was founded largely because of its girdle characters, and of course one would not expect the complex and fragile setæ to persist in dried specimens such as these, but in the specimen found by Mrs. Golisch a few pore-like dots are evident opposite the sutures in situations corresponding to the position of the major series of setæ in *D. thamnopus*. From this circumstance, coupled with the fact the shell characters of the two species are evidently but elaborations of the same general plan, I think there is no question that the two are congeneric. On the other hand their specific separation would appear to be easy. The more conspicuous features in which *D. gothicus* differs from *thamnopus* are:

(1) the greater elevation and more acute angle of the ridge;

(2) the much narrower, more numerous (about 13 on the central valves), and straighter ribs of the pleural areas, blending into a rather obscure, fine, irregular, longitudinal threading on the jugal tract;

(3) the relatively solid texture of the interspaces between the pleural ribs; in *thamnopus*, under moderately high

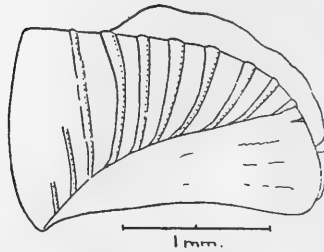


Fig. 1. *Dendrochiton thamnopus* (Berry). Camera sketch of dorsal aspect of right side of valve v of type [8a], from off Monterey.

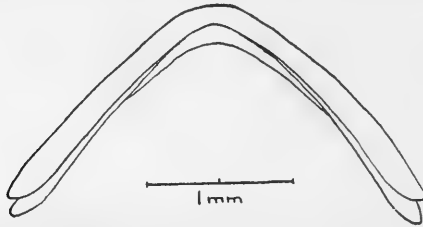


Fig. 2. *Dendrochiton thamnopus* (Berry). Camera outline of valve v of type [8a], anterior elevation.

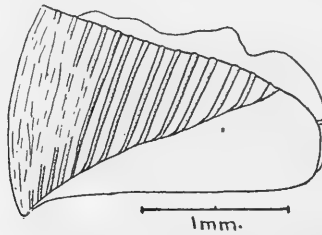


Fig. 3. *Dendrochiton gothicus* (Carpenter). Camera sketch of dorsal aspect of right side of valve iv of specimen [478] from San Pedro.

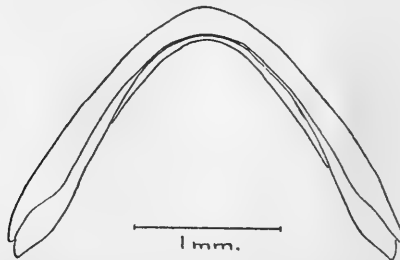


Fig. 4. *Dendrochiton gothicus* (Carpenter). Camera outline of valve iv [478], anterior elevation.

power (x36), these interspaces are conspicuously spongy, while in *gothicus* they are not;

(4) the heavier granulation of the lateral areas.

The two species are of about the same size, and both are brilliantly colored. As a further aid in separating them, I append the accompanying rather rough sketches (text figs. 1-4). No doubt the receipt of good alcoholic material of *gothicus* will reveal additional important features of taxonomic value in the girdle. *Gothicus* is so far recorded only from the immediate vicinity of the San Pedro Channel, *thamnoporus* from Monterey Bay. In the original description of the latter species, a *lapsus calami* resulted in the spelling *thamnopora*. The correction to *thamnoporus* is made in accordance with Article 19 of the International Code.

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4. NEW CHITONS COLLECTED BY DR. HAROLD HEATH IN MONTEREY BAY, CALIFORNIA

From time to time considerable interesting material in the way of chitons preserved in alcohol, principally from collections made by himself in the neighborhood of Pacific Grove, California, has been placed in my hands for study by Dr. Harold Heath of Stanford University. On the whole the list of species represented in his collections in this region is much the same as that given by Pilsbry ('98) some twenty years ago from material taken by the same collector, but three of the forms now before me, including a member of one genus totally new to our fauna, appear to have been previously undescribed. Preliminary descriptions of these are accordingly given below.

Genus *Leptochiton* Gray 1847¹

Subgenus *Xiphiozona* Berry 1919

Leptochiton (*Xiphiozona*) *heathi* Berry 1919

Pl. 1, figs. 1-2; pl. 2

Diagnosis: Shell small, oval, well arched, the jugum obscurely angled; side slopes strongly convex.

Anterior valve with numerous (100-120), closely placed, radial series of minute, low, round, flattened pustules, usually distinct from one another and not overlapping. Median valves not beaked, their sculpture similar to that of the anterior valve; lateral areas not raised, poorly defined, their

¹I am not entirely certain as to the proper generic name to be used for most of our West American Lepidopleurids. Iredale (:14, p. 127-128) has lately reminded us that by reason of Gray's own designation *Chiton cinereus* must be regarded as the orthotype of his genus *Leptochiton*. This is a Linnean species belonging, as shown by Hanley, to quite a different group than the shells which have been referred to *Leptochiton* by most or all subsequent authors. If this were all, we would at once be barred from using *Leptochiton* in the present connection at all, and this is evidently the opinion of Iredale. But the trouble comes in when we remember, as has been pointed out by Pilsbry ('92, p. 14), that *L. cinereus*, as interpreted by Gray, appears not to be the Linnean form, but really the *Chiton asellus* of Spengler, which is a Lepidopleurid. Whether, under a strict construction of the International Code, we must call *Chiton cinereus* Linnaeus the type of *Leptochiton* Gray, or whether *cinereus* Montagu, Gray, et al. (*non* Linnaeus) can be retained in this office, I cannot decide without access to more of the relevant literature than is now available to me. Nor, if *Leptochiton* be unavailable, can I suggest just what name had best be used in place of it. One has, of course, the option to fall back, for the time being, on the old blanket name *Lepidopleurus* Risso, that long-enduring receptacle for every chiton without recognizably developed insertion plates one is otherwise uncertain what to do with. But as the Californian species seem none of them to be properly congeneric with *L. cajetanus* (Poli), the Mediterranean-Atlantic species which is the type of Risso's genus, I prefer for the present to retain *Leptochiton* with the explanation above given.

granules less regular than those just described, those of the central areas showing a tendency to overlap or coalesce so as to form distinct longitudinal riblets. Posterior valve with similar sculpture; semicircular; mucro conspicuous, much elevated, projected posteriorly, and almost overhanging; posterior slope steep and strongly concave. Margins of tegmentum everywhere finely crenulate.

Interior of valves grayish white, translucent, minutely pitted; median valves thickened at the middle; posterior valve with a conspicuous V-shaped, laterally branching callus. Sinus broad. Sutural laminae triangular.

Girdle narrow, for the most part with a pilose covering of excessively minute, short, pointed spinelets, among which are interspersed sundry long, conspicuous, stiletto-like, or more often curved spines, appearing especially numerous in the neighborhood of the sutures. Marginal spines minute.

Ctenidia 12-16 on a side, extending past the middle of the 6th valve.

Radula with strongly bidentate major laterals.

Color of dorsal surface a warm yellowish brown, very finely and copiously, though variously, mottled with longitudinal and radial streaks of a dark slaty gray. Girdle with dorsal mottlings or almost unicolorous.

Measurements: Long. 13.1, diam. 7.0 mm.

Type: An alcoholic specimen [S. S. B. 123], comprising Cat. No. 3513 of the author's collection. Paratypes deposited in the collections of the California Academy of Sciences, the Academy of Natural Sciences of Philadelphia, the United States National Museum, and the Department of Zoology of Stanford University.

Type Locality: 15 fathoms, off Monterey, California; H. Heath, summer, 1908; 12 specimens.

Remarks: I have had this species in hand for a number of years without hitherto being able to attach a satisfactory name to it. It is a well marked and not at all a rare form, chiefly characterized by its peculiar coloration and a girdle armature quite unlike that of any of the better known West American species of the genus. For a time I was (very doubtfully) inclined to identify the species with the insufficiently understood *L. nexus* Carpenter 1864, but Carpenter's description

(I have seen no specimens to accord with it) differs too markedly to render such a disposition satisfactory, even if we accept the specimens mentioned by him as a variegated variety of *nexus* (cf. Pilsbry, '92, p. 11) as surely conspecific with the type. Recently the receipt from Dr. W. A. Hilton of Pomona College of a specimen dredged by him in 10 fathoms, off Laguna Beach, California [S. S. B. 404], which agrees very fairly with Carpenter's description of his "variety", confirms the separate identity of the Monterey species, although it evidently belongs to the same section of the genus.

L. heathi is particularly marked by its elevated, roundly Gothic-arched outline, poorly delimited lateral areas, steep slope back of the projecting mucro, and minute girdle scales.

The specific name selected is in honor of Dr. Harold Heath, who collected the type.

Genus *Hanleya* Gray 1857

Hanleya spicata, new species

Pl. 1, fig. 3

Diagnosis: Shell small, oblong, rather elongate, lateral outline nearly straight.

Valves sharply beaked; lateral areas distinct, but not conspicuous except by transmitted light, not ridged or grooved. Sculpture consisting of numerous rounded tubercles (transparent by transmitted light) irregularly scattered over the lateral areas, but over the central areas slightly smaller and disposed in 14-16 ill-defined, slightly oblique, longitudinal series, most crowded and irregular near the jugum. Head valve sculptured like the lateral areas. Tail valve with mucro somewhat in front of the middle, elevated.

Girdle of moderate width, beset dorsally with numerous, faintly striate, glassy spicules of three main types: 1) very small, ovoid, pointed spinelets, forming a rather loose covering over the entire girdle, these being plainly striate near their apices; 2) elongate, dagger-like, marginal spinelets; and 3) a few scattered, needle-like spines, often over twice the length of the marginal spicules, some of these distributed here and there over the general surface of the girdle, but the greater proportion occurring in loose groups of 5-8 at each

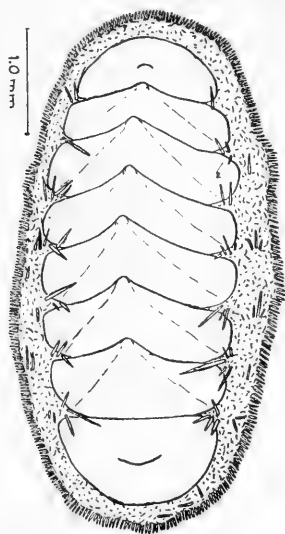


Fig. 5. *Hanleya spicata* Berry. Camera sketch of dorsal aspect of type [63].

suture, where they extend well up between the valves; though distinct, these groups scarcely tuft-like, and unaccompanied, so far as noted, by evidence of sutural or intersutural pores.

Ctenidia about 8 on each side.

Color everywhere a pale brown or brownish white, deepening in tone at the beaks, but without other markings.

Measurements: Long. 4.5, diam. 2.0 mm.

Type: A specimen mounted in balsam [S. S. B. 63], Cat. No. 4102 of the author's collection.

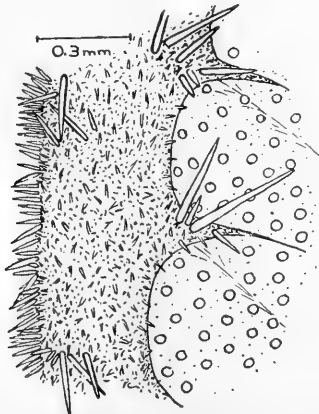


Fig. 6. *Hanleya spicata* Berry. Camera sketch of edge of valves ii and iii, with adjacent portion of girdle [63].

Type Locality: From ledge off Point Pinos, Monterey Bay, California; depth "probably 200 feet"; H. Heath, summer, 1904; 1 specimen.

Remarks: This small species possesses no very remarkable characters of its own, except the presence of the conspicuous groups of sutural spines on the girdle. It is undoubtedly nearest to the circumpolar *H. hanleyi* (Bean 1844), from which the sutural spines and more sparse granulation (cf. Pilsbry, '92, pl. 3, f. 72) are here relied upon to distinguish it. The girdle also appears notably wider in proportion to the width of the valves, upon which it somewhat encroaches at the sutures. The specimen is quite likely not mature, so it is uncertain just how much value should be reposed in the features outlined. Eventually *H. spicata* may prove only a variant of the older species, but the balance of evidence at the present time appears to me in favor of its distinctness.

The species itself is not of so great interest as the fact that it for the first time establishes the genus *Hanleya* in Pacific waters. Thiele, however, (:09, p. 15) has reported a specimen of *H. hanleyi* from Plover Bay, Siberia (Bering Sea).

Genus *Mopalia* Gray 1847

Mopalia phorminx Berry, 1919

Pls. 3-5

Diagnosis: Shell small, elongate-oval, only moderately elevated; dorsal ridge carinate; side slopes straight. Entire surface finely granulose.

Anterior valve with 8 radiating series of coarse, closely placed, downwardly directed, almost overlapping, pointed pustules, 9-10 in a series, one or rarely two series of smaller and more widely separated but otherwise similar granules occurring in alternation; in addition to above, each posterior margin dentated by a series of larger, more elongate, backwardly directed tubercles, so that including these the number of primary radial series is 10; between the posterior series and the next of the primary series in front are three of the secondary series above noted, the median of which is composed of larger tubercles than the other two.

Median valves: lateral areas not in themselves raised, but in front showing a strong, diagonal, rib-like succession of about 10 coarse, somewhat overlapping pustules like those of the primary series on the head valve; on the sutural margin behind a series of large, backwardly directed tubercles like those of the postero-marginal series of the head valve; the flattened area between these two series heavily and closely pustulose with 2-5 variously sized, radial series of granules, with sometimes also one or two similar series in front of the main diagonal rib. Central areas on each side elegantly sculptured with 10-14 sharp, flexuose, longitudinal ribs, curved at first with the concavity inward, but the longer ribs showing a secondary curve in the reverse direction toward the anterior margin; outer ribs more or less broken behind, sometimes resulting in the formation of the aberrant series of granules already noted; inner face of ribs buttressed by numerous, irregular, claw-like, transverse ridges extending part way across the otherwise merely granular interspaces; inside ribs more oblique and shorter, in valves iii-vii fusing anteriorly with a single rather weak, median rib along the ridge; valve ii with the jugal rib bifurcating anteriorly, a new median rib developing between the forks, the adjacent ribs of the central areas at the same time more or less anastomosing.

Posterior valve with the mucro little elevated, strongly posterior in position, the area in front of it sculptured like the central areas of the median valves, but with only 7-8 ribs on a side; posterior area coarsely, irregularly, concentrically rugose, the rugosities best developed in front, where they tend to form a sort of pseudo-rib; slope behind mucro slightly concave.

Interior of anterior and intermediate valves slightly thickened across the middle. Posterior valve with a strong crescentic callus behind, and a strong, V-shaped, median callus. Teeth short and broad, their bounding fossa at the base shallow but distinct. Sutural laminae of intermediate valves wide, arcuate, in tail valve more angular at margin; sinus narrow and relatively deep. Insertion slits with rather indistinct radial lines of transversely slit-like pores leading into them. Eaves short and inconspicuous. Anterior valve with

8, intermediate valves with 1-1, posterior valve with 1-1 slits and a strong bay or sinus in the medio-posterior margin.

Girdle rather narrow, clothed above with a fine armature of numerous, microscopically minute spinelets, and in addition bearing a large number of beard-like setæ in several series, one, which we may denote as the primary or sutural, comprising much larger, darker colored, and very definitely placed bristles, as compared with those of the other series, one standing in the angle of each suture, two behind the tail valve, and perhaps six or seven around the head valve; remaining setæ more numerous near margin; all more or less broken in the specimen at hand. Individual setæ long, slender, bearing numerous, slender, recurved, hair-like branches along the upper side.

Ctenidia 14 on a side.

Color of outer surface of shell a soiled brownish cream, abundantly painted and mottled with light yellowish brown. Interior of shell white. Girdle brownish.

Measurements: Maximum length of type specimen, 16.5; maximum width, 9.0; altitude, 3.0; length of shell only, 15.0; width of tegmentum in valves iv. and v., 7.0 mm.

Type: A specimen preserved in alcohol [S. S. B. 549], comprising Cat. No. 1769 of the author's collection.

Type Locality: On a fragment of rock from ledge off Point Pinos, Monterey Bay, California; "depth probably 200 ft."; H. Heath, summer, 1904; one specimen.

Remarks: This very odd appearing little chiton is evidently a member of the same group as the two Carpenterian species, *sinuata* and *imporcata*, but is readily distinguishable from either by its unique and very elegant pattern of sculpturing, notably by such details as the heavy pustulation of the lateral tracts and the sinuous, buttressed riblets of the central areas.

No specimens other than the type have thus far come to hand.

The specific name is derived from the Greek *φόρμιξ*—a much ornamented kind of lyre, and is chosen primarily with reference to the above-mentioned sculpturing of the central areas.

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5. A NEW MOPALIA FROM SOUTHEASTERN ALASKA

The first note in the present series (Berry, :17) was devoted to a preliminary discussion of a collection of chitons collected by Mr. George Willett in southeastern Alaska, chiefly at Forrester Island, from 1913 to 1916. Some of this material, particularly among the smaller Mopaliidæ, I found myself unable at that time to identify to my satisfaction. Certain later material which has since been handed me by Mr. Willett shows that one of the species represented, although one of the most interesting of all the Mopalias, is apparently an undescribed form. A diagnosis is accordingly offered below.

Mopalia egretta Berry 1919

Pls. 6-7

Diagnosis: Shell rather small, elongate-oval in outline, moderately elevated, with a sharply carinate, somewhat pinched-in, dorsal ridge; side slopes slightly, though distinctly arcuate; valves slightly beaked. General surface very finely pitted rather than granulose.

Anterior valve with eight radiating series of strong, regularly increasing, closely ranked, rather smoothly rounded tubercles, 7-8 in a series; posterior edge of valve dentated by a pair of similar series of larger, more compressed and backwardly directed tubercles; entire surface between these rib-like series rather finely sculptured by a quite uniform reticulum of pitting and netting arranged almost in a checker pattern; all sculpture worn or obsolete toward apex.

Median valves with lateral areas strongly elevated; general surface of these sculptured like the anterior valve; bounded behind by a sutural series of 9-10 strong, oblique tubercles dentating the suture, and in front by a much wider, stronger diagonal rib, formed by the partial coalescence of its component, strongly transversely elongate, compressed tubercles, and often more or less bifurcated by a shallow furrow down its center. Central areas very neatly sculptured by strong, inwardly arching, longitudinal riblets, traversed by slightly more zigzag, and otherwise rather less regular, obliquely arcuate riblets radiating from the beak and ridge, the whole forming a very regular net-like reticulum, the meshes of which are represented by fairly deep, squarish pits, always larger and deeper toward the sides; the posteriormost of the radial threads characteristically stronger than any of those in front, and the pits enclosed between it and the diagonal rib larger and deeper than those in front of it, thus sharply setting off the diagonal rib and lateral areas from the central areas; jugal area in the posterior two or three valves with a very narrow smooth tract on the ridge, the netted sculpturing in the other valves extending clear over, merely becoming a little less regular on the ridge where the central areas come together.

Posterior valve with the mucro at about the posterior third of the tegmentum, scarcely elevated; diagonal ribs weaker than those of the intermediate valves; area in front sculptured similarly to the central areas of the intermediate valves, but with fewer ribs on a side, and although the pits in front of the diagonal ribs are a little larger than the remainder, the difference is less conspicuous here than in the other valves; posterior area sculptured with irregularly nodulose, longitudinal ribs, corresponding in position to the

tubercles of the diagonal rib and the riblets in front, the innermost ones bending in abruptly behind toward the deep, acute, Λ -shaped caudal sinus.

Interior of anterior valve with the eight whitish radial lines leading to the marginal slits very conspicuous, each accompanied by a series of seven or eight transversely slit-like pores in the overlying translucent articulamentum. Intermediate valves with a slight transverse thickening across the middle; whitish lines radiating to the slits as in the anterior valve, but the overlying pores 12 or more in number. Posterior valve with 2-3 of the pores conspicuous below the slits, but the white lines not visible, perhaps because of the heavy, transverse, posterior callus; an oblique thickening also extends forward on each side of the central depression leading to the sutural sinus. Teeth in all valves but the last short, broad, squarish; insertion slits bounded on each side by conspicuous tile-like upturnings of the edges of the teeth and sutural laminae. Sutural laminae of intermediate valves exceedingly thin and fragile, very broad, only slightly arcuate in front, the sinus small and narrow; posterior valve with proportionally rather longer, more sinuous laminae, the narrow sinus sharply squared at the base; caudal sinus of articulamentum about as in tegmentum but more rounded at apex.

Eaves short, thin, sharp; very slightly projecting over the thin layer of coarsely spongy tissue beneath. Anterior valve with 8, intermediate valves with 1-1, posterior valve with 1-1 slits.

Girdle moderately wide, only slightly encroaching at the sutures; sharply slit posteriorly; dorsal surface covered with numerous very minute spines or scales, with larger dirk-shaped spinelets at the margin; inner central portion devoid of setae; sutural setae conspicuous, long, erect, comprising each a long, slender, curved, amber-colored bristle, from the basal portion of which are given off on the upper side numerous nearly straight, long slender, needle-like, whitish aciculæ; four such setae around the head valve, one in the angle of the first six sutures, one nearly halfway out on the girdle on each side opposite the last suture, and one very strongly tufted unpaired seta in the caudal sinus a little less than half

way between the shell margin and the apex of the slit in the girdle; remaining series of setæ about four in number, much smaller, all on the outer third of the girdle, those of the more marginal series very minute and more bushy (i. e., their spines less asymmetrically arranged) than the sutural setæ, those of the inner series progressively larger and except for their smaller size and somewhat shorter aciculæ similar in general makeup to the sutural setæ.

Ctenidia about 20 on a side.

Color of tegmental surface of shell a rather light brownish or brick red, with more or less brownish-maroon and gray-buff maculation, the latter color usually prevailing on the third valve and sometimes the seventh as well; in one specimen the sides of valve vii being light yellow. Upper surface of girdle green in the type, reddish in all other specimens. Interior flesh tinted, shading darker in the deeper portions.

Measurements: Maximum length of type specimen, 20.0; maximum width, 11.2; altitude, 3.7; length of shell only, 18.3; width of tegmentum in valve iv., 8.5 mm.

Type: A specimen preserved dry [S. S. B. 281], entered as Cat. No. 3939 of the author's collection. A paratype collected in 25 fathoms by Willett in 1914 [S. S. B. 285] is deposited in the collection of the California Academy of Sciences, and another taken in 15-20 fathoms in 1917 [S. S. B. 641] is in the private collection of Mr. George Willett².

Type Locality: 20 fathoms, Forrester Island, Alaska; George Willett, August 5, 1915; two specimens.

Remarks: Though ranking among the smaller and less conspicuous forms, close acquaintance reveals *M. egretta* as one of the most beautiful of all the *Mopalias*. It is one of the Forrester Island species which Mr. Willett obtained on several occasions, though never in any numbers, and to which I referred on pp. 239-240 of the first paper of the present series. His discovery of another specimen in 1917 served to confirm the validity of the diagnostic characters I

²A specimen in alcohol [284] and a series of dislocated valves [640] have also been drawn upon for portions of the foregoing description and therefore rank as paratypes. These are at present in the author's collection.

had previously outlined in MS. and convinced me that the species was properly regarded as distinct. It is not closely similar to any of our other West American types except only the peculiar little *M. sinuata* of Carpenter. With this, in dried specimens at least, one finds a degree of careful discrimination necessary, although the present species is distinguished by the following important and, in the scanty material I have had available, apparently constant characters:

- 1.) Considerably larger size (\times about $1\frac{1}{2}$).
- 2.) Much less high-arched outline.
- 3.) Distinctly arcuate side slopes.
- 4.) Bright reddish coloration.
- 5.) Distinctly raised lateral areas.
- 6.) Heavier and more coarsely pustulose diagonal rib.
- 7.) Heavier dentation of the sutures, which is strong and distinct in *egretta*.
- 8.) Fewer and coarser longitudinal ribs of central areas in shells of the same size.
- 9.) Strong pitting and appearance of an incipient secondary riblet in front of the diagonal rib.

Unfortunately none of the Forrester Island *sinuata* were preserved in alcohol, so a direct comparison of the girdle characters as they exist in adequately preserved material cannot be made, though even the dried shells indicate that here also are interesting differences. A single alcoholic specimen of *egretta* [284] has furnished the basis for the description of the girdle given in the foregoing diagnosis. A curious circumstance in both this and the dried specimens is that the setæ frequently carry one or more encrusting foraminifera.

The specific name *egretta* is chosen because of the resemblance of the sutural setæ to small egret plumes.

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:17. Notes on West American Chitons—I. <Proceedings California Academy Sciences, (4), v. 7, pp. 229-248, text figs. 1-4, September, 1917.

6. A NEW LEPIDOZONA FROM SOUTHERN CALIFORNIA

For several years past various specimens have been accumulating in my hands which do not seem referable to any of the described species. Some of these, particularly from among the *Mopaliidæ*, I shall withhold for the present in the hope of securing more or better material, but there are certain ones of which I either have had ample material, or else see no immediate hope of getting more, or which are likely to be referred to in forthcoming papers of this series, hence must needs be published. A preliminary diagnosis of one of these forms is therefore offered in the following pages, while others will be published in succeeding papers of the series. These descriptions are purposely made as brief as the exigencies of an exact identification of the species referred to will permit. The results of my examination of the radula, the microscopy of the girdle armature, and some other features are held over for a later work, in which it is intended to describe, illustrate, and discuss all the western North American species in as much detail as possible.

***Ischnochiton* (Lepidozona) *asthenes* Berry 1919**

(Pl. 8)

Diagnosis: Shell small, thin, nearly lusterless, oblong-oval, moderately elevated, carinate along the ridge, the side slopes convex; valves barely beaked behind. General surface strongly rough-scaly-granulose, this condition prevailing over the head valve, the lateral and jugal areas of the intermediate valves, and the jugal and posterior areas of the tail valve; on the pleural areas obscured or replaced by the fine sculpturing.

Anterior valve with 11 or rarely 12 low, broad, rounded ribs or flutings, bearing traces of radial series of minute, easily abraded pustules, 2-4 in a series, though in absolutely non-abraded specimens there would no doubt be a few more; grooves between ribs shallow and narrow, but fairly distinct.

Intermediate valves with lateral areas distinctly raised and strongly radically bicostate³, the ribs broad, flattened, or the center of each even somewhat obsoletely grooved, their dividing

³The lateral areas are apparently rarely tricostate, as witnessed by the second valve of one of the specimens.

sulcus narrow, but distinct; each rib ornamented by two or sometimes only one series of small, easily abraded pustules similar to those of the anterior valve, 2-5 in a series; central areas on each side sharply and finely sculptured with 15-18 narrow, minutely granulose, longitudinal riblets, finely interlatticed between so as to resemble knitted work; jugal tract usually devoid of distinct ribbing or other sculpturing except the scaly granulation already noted, though sometimes a continuation of the pleural sculpturing is evident extending to the ridge as a more or less obsolete, irregular reticulum.

Posterior valve with mucro well in front of the middle, and the posterior slope nearly straight; region behind mucro with sculpture similar in nature to that of the anterior valve, but in every way weaker and sometimes nearly obsolete; region in front sculptured like the central areas of the intermediate valves.

Articulamentum transparent, hyaline, that of the intermediate valves somewhat thickened across the middle. Sutural laminae thin, sharp-edged, broadly arcuate, connected across the sinus by a short, very delicate, weakly and rather irregularly dentate plate, apparently surmounted by an extremely thin, delicate, anteriorly projecting rounded process of the tegmentum forming a sort of "false beak". Insertion teeth sharp, distinct, their edges perhaps sometimes very weakly crenulate. Eaves thin, more or less fluted, rather projecting, but shorter than the teeth. In a dissected specimen anterior valve with 9, intermediate valves with 1-1, posterior valve with 12 slits.

Girdle very delicate and fragile in dried specimens; moderately wide; covered dorsally with a rather irregularly imbricating armature of delicately ribbed-striate, convex scales, rather small, but not proportionally to the size of the shell, the ribs about 8-11 in number on each scale.

Color of outer surface of shell a yellowish brown, under a lens seen to be more or less mottled with a deeper tone. Girdle usually maculated above by alternating bands of brown and tan, corresponding respectively in position with the sutures and valves. Interior of shell hyaline or slightly porcellanous, underlain with white, and with the gray or brown of the tegmentum showing through.

Measurements: Maximum length of largest specimen [471a], 9.5; maximum width, 5.9; altitude, 1.4; length of shell only (est.), 8.5; width of tegmentum of valve iv., 3.9 mm.

Type: A shell preserved dry [S. S. B. 466], entered as Cat. No. 3913 of the author's collection. Paratypes have been deposited in the collections of the California Academy of Sciences, the Academy of Natural Sciences of Philadelphia, the United States National Museum, and the private collection of Mr. Allyn G. Smith.

Type Locality: Under stones at low tide, White's Point, Los Angeles County, California; Allyn G. Smith, August 14-18, 1916; 70 specimens.

Remarks: It is a surprise to find a littoral species of such abundance apparently undescribed, yet after the most exhaustive comparisons possible to me, I have been unable to identify this very neat little species with any of the described forms. I have been at particular pains in this connection to re-examine the descriptions of the numerous *Ischnochitons* described by Carpenter from Central and Southern California, more especially since several of these still lack authentic rediscovery and are but very insufficiently known. Without access to the original specimens this naturally becomes a hazardous task, but nevertheless I feel reasonably safe in the conclusion reached.

The descriptions of *I. scabricostatus* remind one very much of the present species, but fortunately I have seen authentic specimens of this, and the comparison shows that it differs distinctly in its conspicuously greater elevation, more numerous ribs (3-5) of the lateral areas, and also (24-30) of the anterior valve, and the fact that the lateral areas are only slightly raised. The two species resemble one another in the short, wide, dorsal girdle scales, more polished and perhaps somewhat smaller in *scabricostatus*, and in the scaly-granular character of the surface of the shell.

I. retiporosus of northern waters impresses one as perhaps being somewhat near of kin, but still no special comparison is necessary to distinguish them.

Minus a good lens, *I. asthenes* might at first glance be confounded with the young of *Callistochiton decoratus* punc-

tocostatus Pilsbry, but differs in 1) the lower and more regular radial ribs of the anterior valve; 2) the much more numerous ribs and finer reticulation of the central areas; 3) the more strongly carinate ridge; 4) the two rows of easily abraded pustules on each rib of the lateral areas; 5) the fine granulation of the lateral areas, and 6) the posterior area of the tail valve being finely granular, perhaps sometimes with small pustules like those of the lateral areas, but not distinctly ribbed.

The specific name chosen has reference to the fragile nature of the valves and girdle.

NOTE: Owing to an unlooked for delay in the publication of the foregoing paper, and the necessity of using the names in another connection, certain of the taxonomic terms originally intended to be used for the first time here have already been briefly characterized in *Lorquinia*, v. 2, pp. 44-47, January 6, 1919. This reference should therefore be added to the preceding bibliographies of relevant literature.)

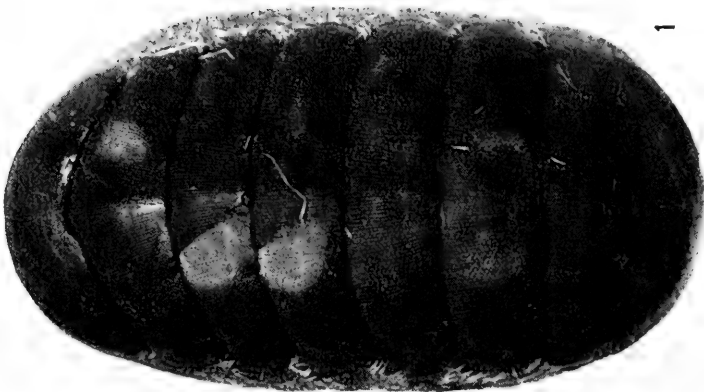
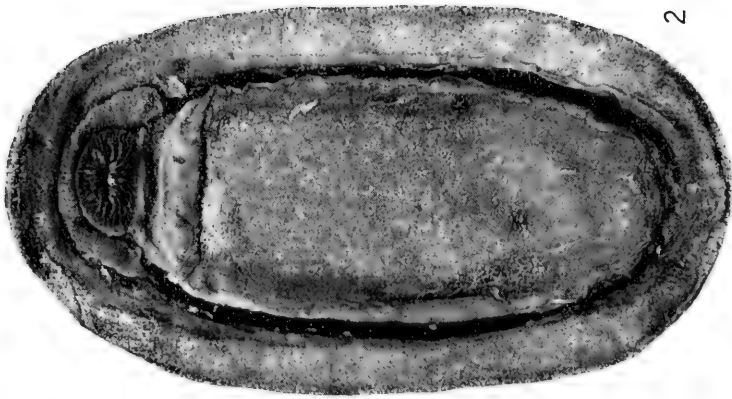
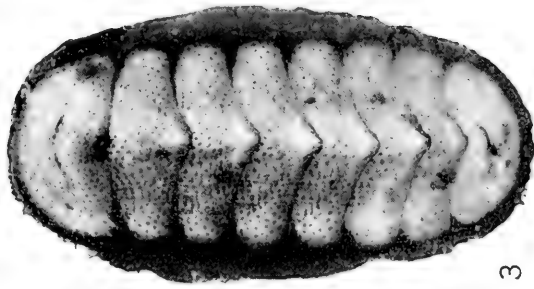
All of the illustrations in the accompanying plates are from photographs by John Howard Paine.

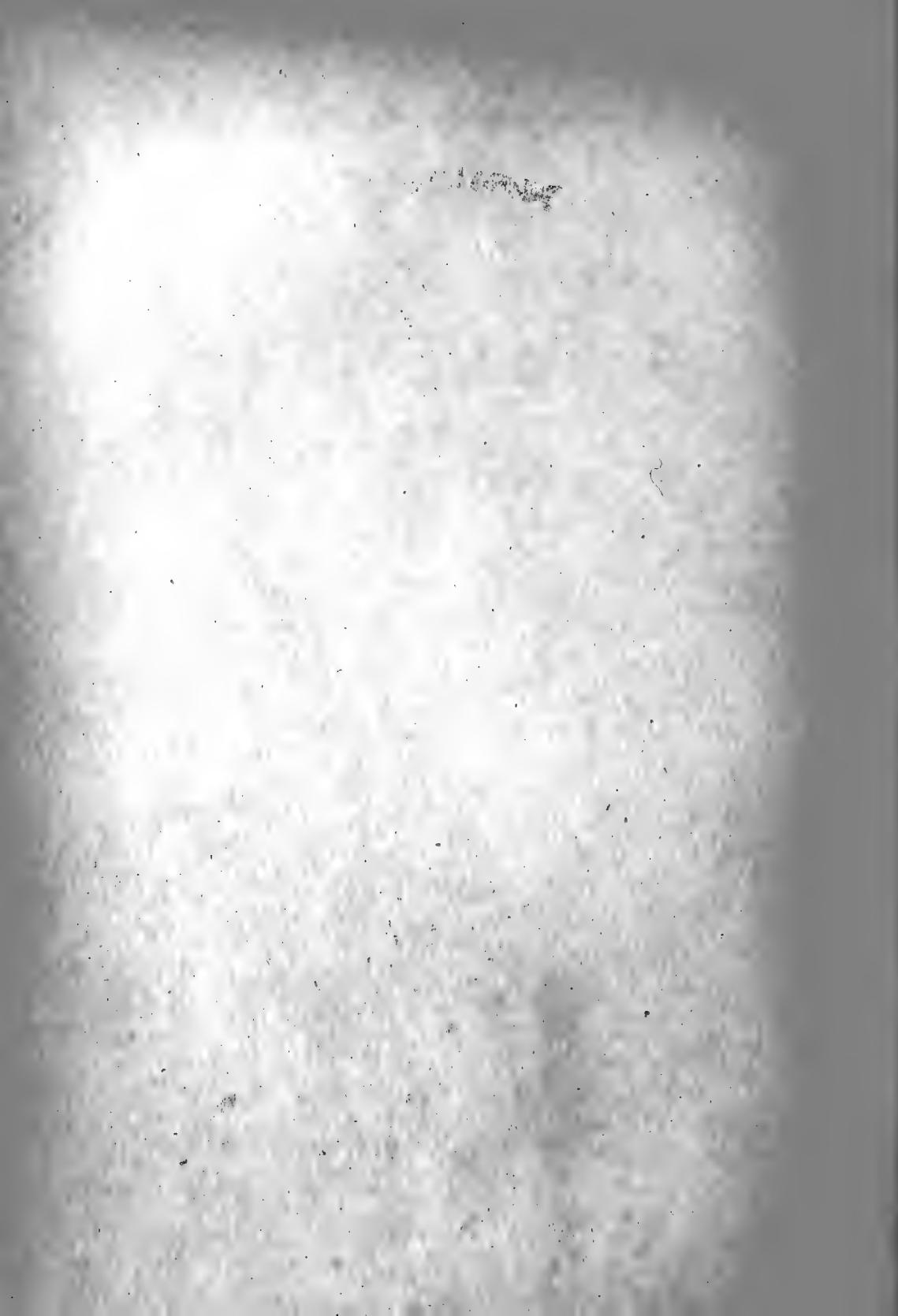
EXPLANATION OF PLATE 1

Fig. 1. *Leptochiton heathi* Berry. Dorsal view of entire animal (type)
[123]: x 7.

Fig. 2. *Leptochiton heathi* Berry. Ventral view of entire animal (type)
[123]: x 7.

Fig. 3. *Hanleya spicata* Berry. Dorsal view of entire animal (type)
[63]: x 15½.





EXPLANATION OF PLATE 2

Fig. 1. *Leptochiton heathi* Berry. Dorsal view of head valve of paratype [124a]: x 12½.

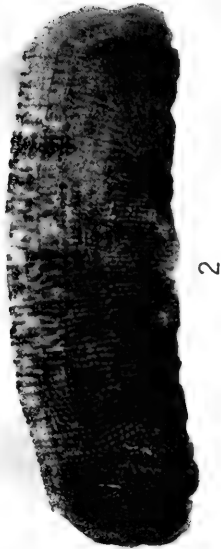
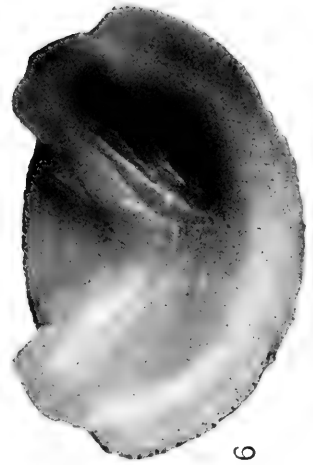
Fig. 2. *Leptochiton heathi* Berry. Dorsal view of fourth valve of paratype [124a]: x 12½.

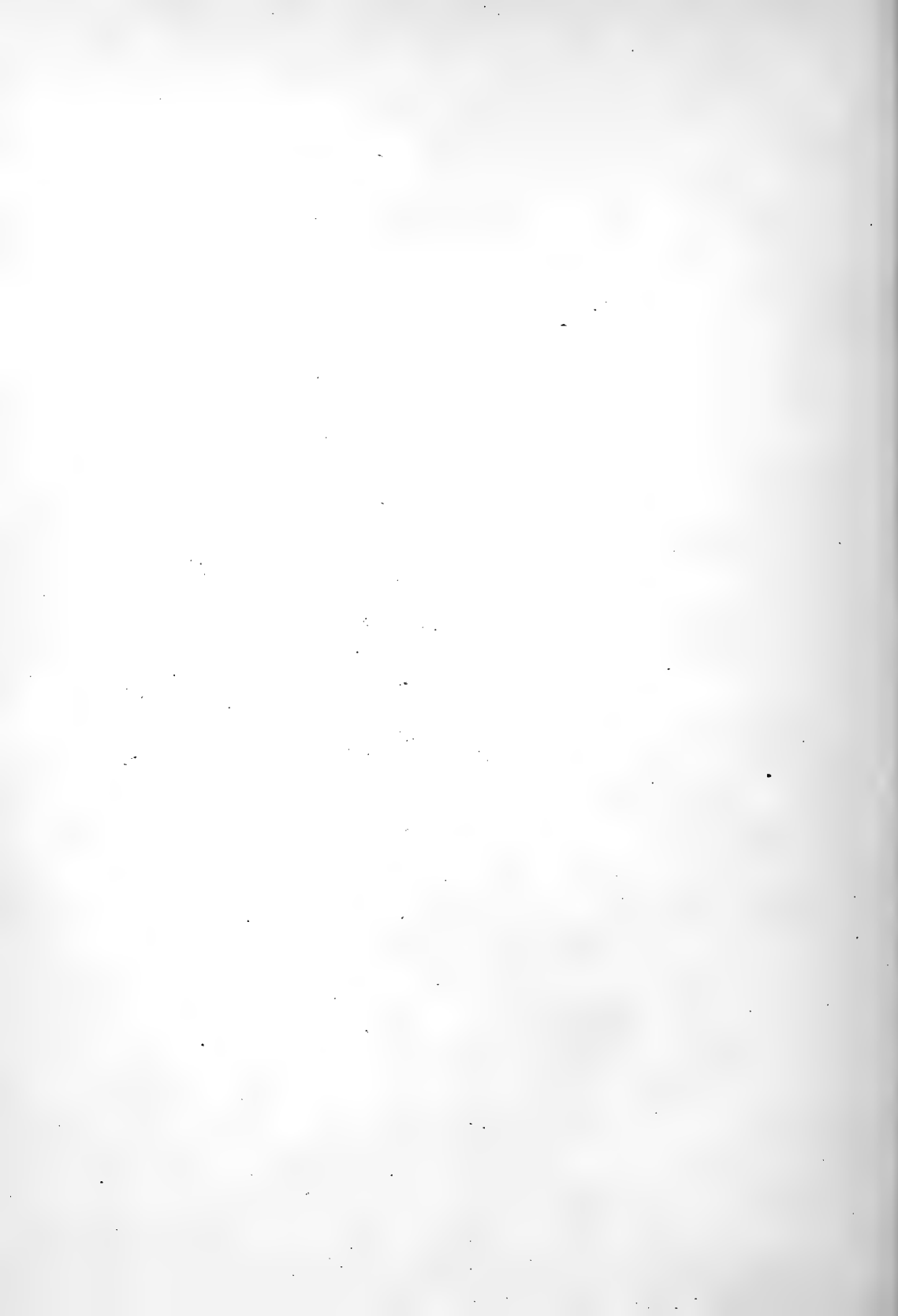
Fig. 3. *Leptochiton heathi* Berry. Dorsal view of tail valve of paratype [124a]: x 12½.

Fig. 4. *Leptochiton heathi* Berry. Interior view of head valve of paratype [124a]: x 12½.

Fig. 5. *Leptochiton heathi* Berry. Interior view of fourth valve of paratype [124a]: x 12½.

Fig. 6. *Leptochiton heathi* Berry. Interior view of tail valve of paratype [124a]: x 12½.



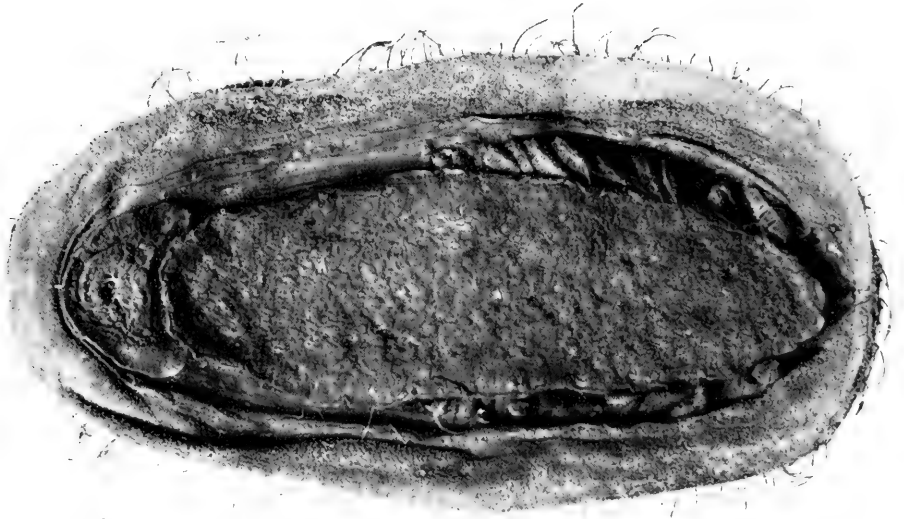




EXPLANATION OF PLATE 3

Fig. 1. *Mopalia phorminx* Berry. Dorsal view of entire animal (type) after removal of valves i, v, and viii [549]: x 7.

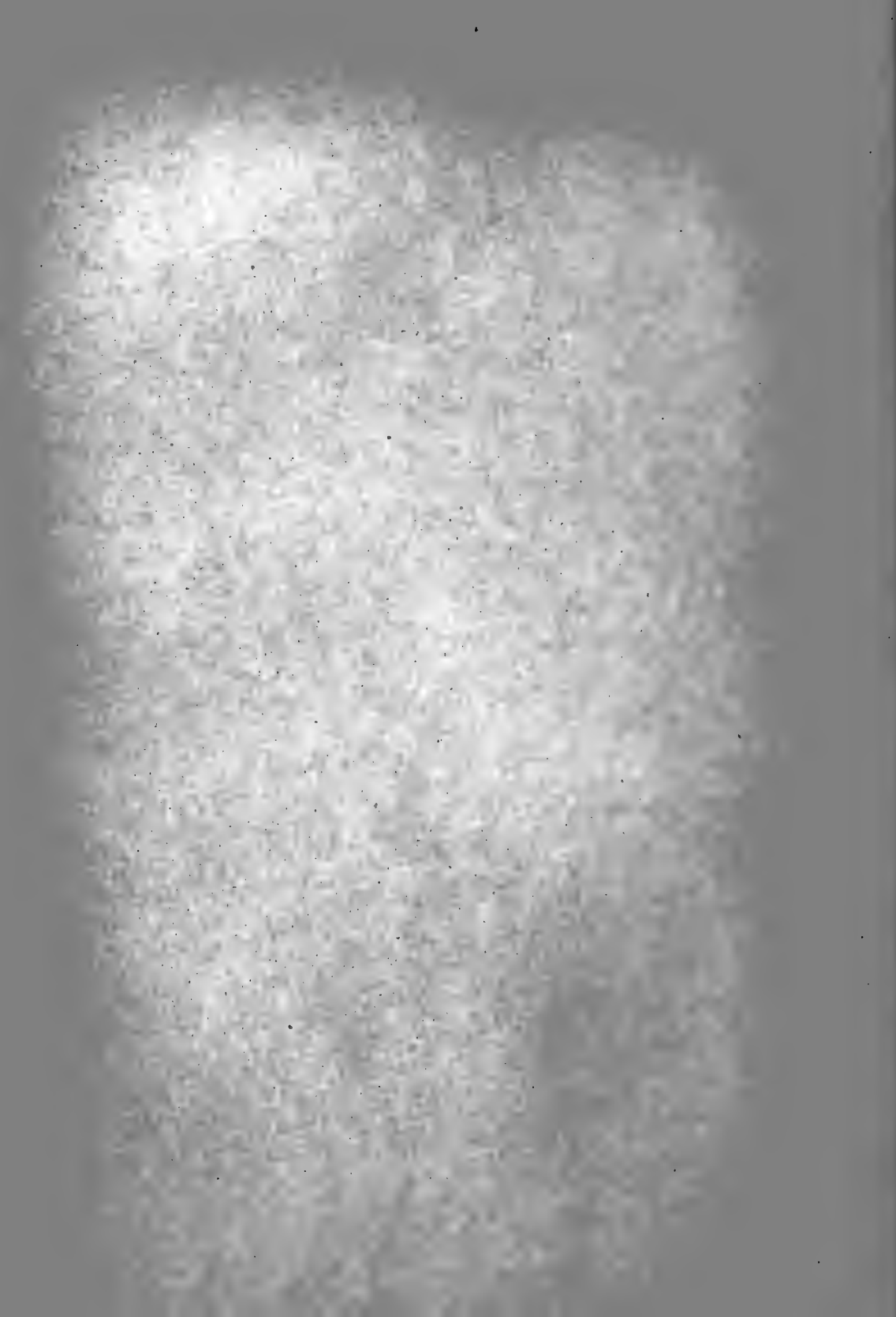
Fig. 2. *Mopalia phorminx* Berry. Ventral view of entire animal (type) [549]: x 7.



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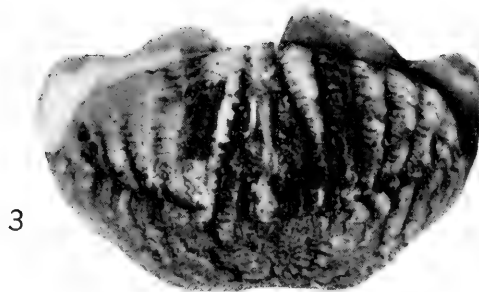
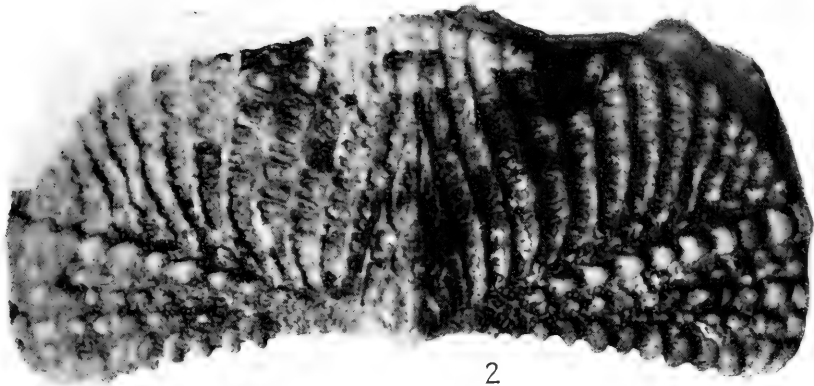
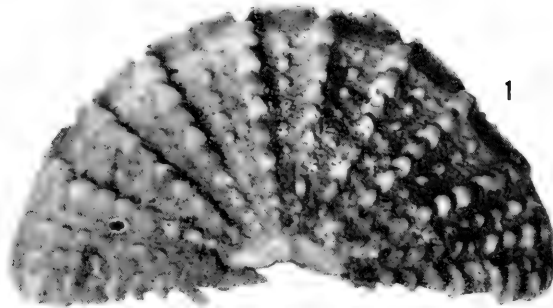


EXPLANATION OF PLATE 4

Fig. 1. *Mopalia phorminx* Berry. Dorsal view of head valve of type [549]: x 15.

Fig. 2. *Mopalia phorminx* Berry. Dorsal view of valve v of type [549]: x 15.

Fig. 3. *Mopalia phorminx* Berry. Dorsal view of tail valve of type [549]: x 15.



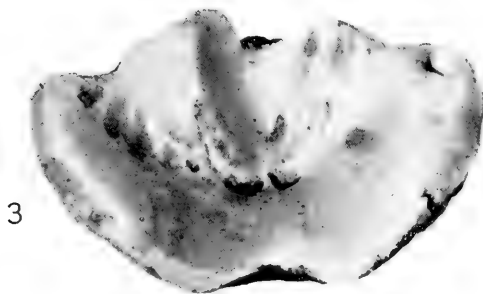
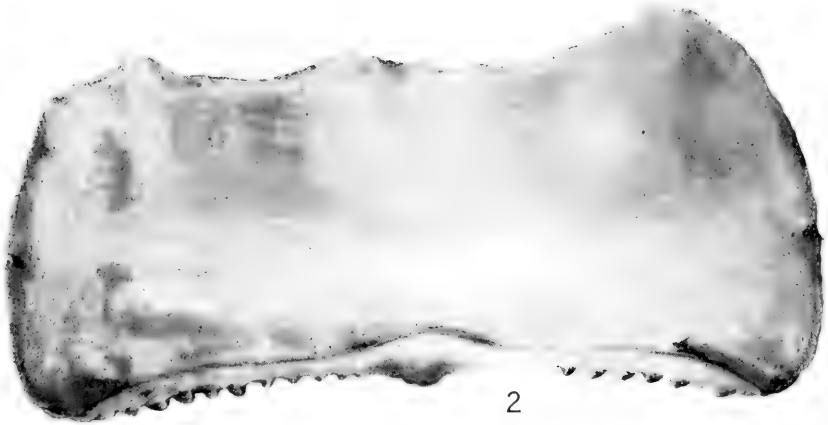
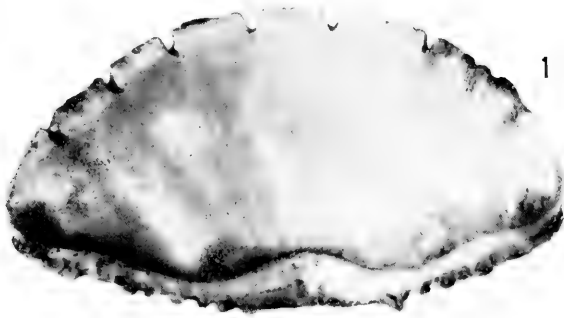


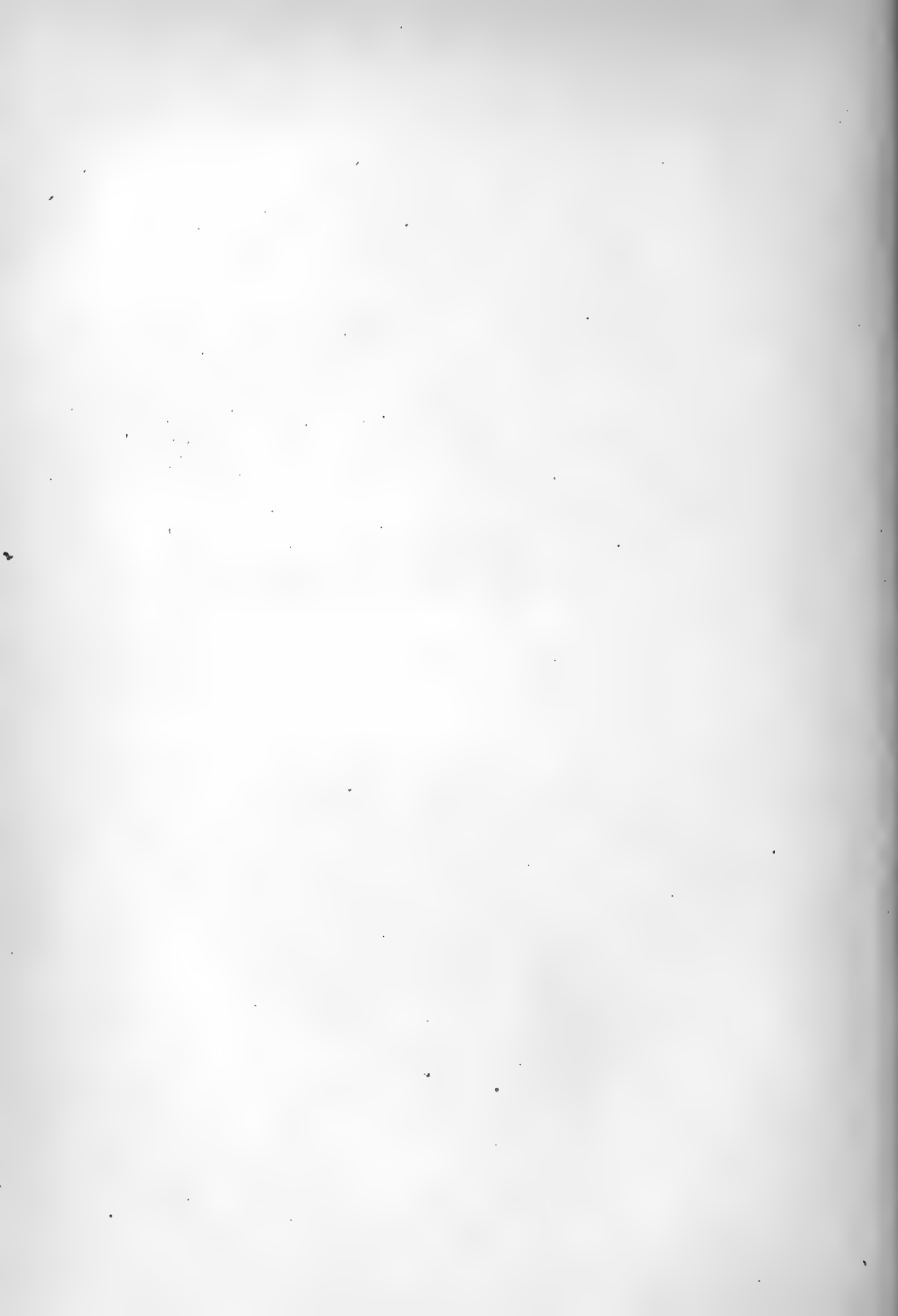
EXPLANATION OF PLATE 5

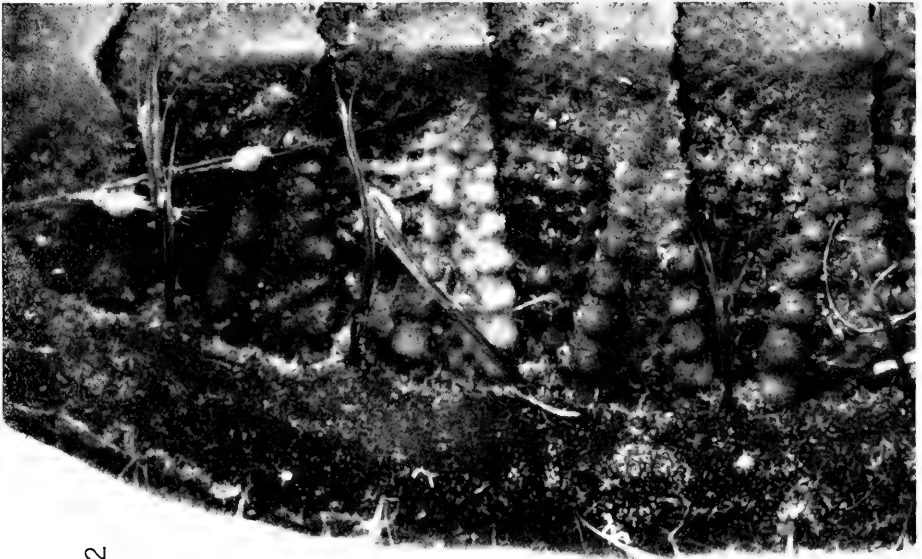
Fig. 1. *Mopalia phorminx* Berry. Interior view of head valve of type [549]: x 15.

Fig. 2. *Mopalia phorminx* Berry. Interior view of valve v of type [549]: x 15.

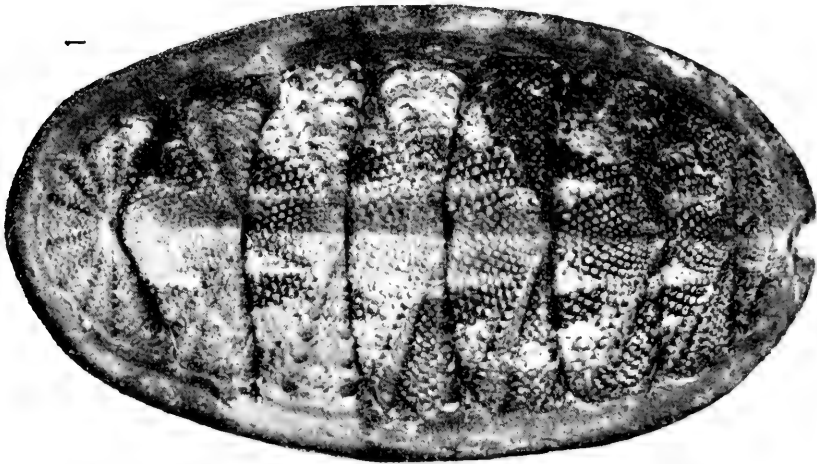
Fig. 3. *Mopalia phorminx* Berry. Interior view of tail valve of type [549]: x 15.







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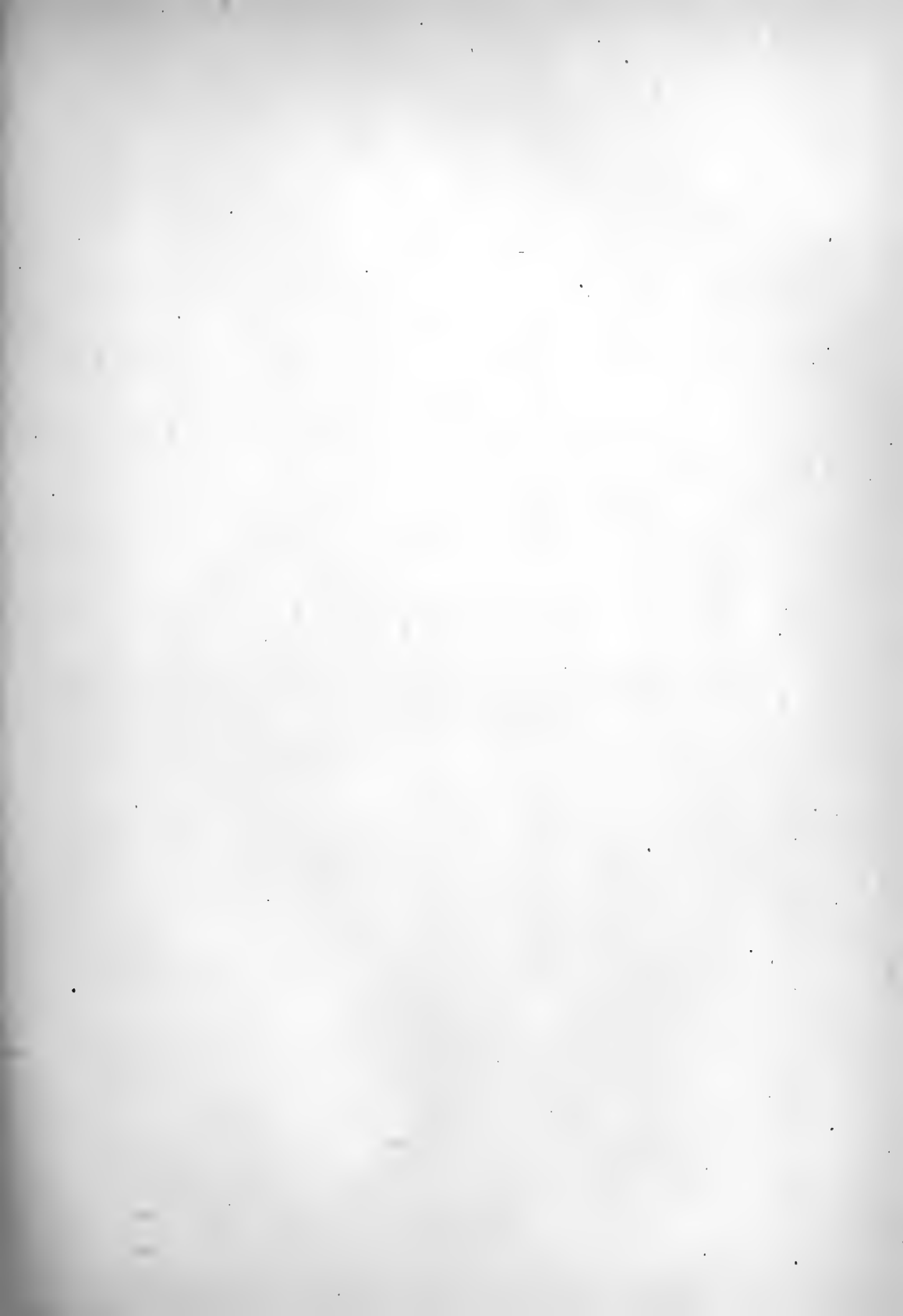




EXPLANATION OF PLATE 6

Fig. 1. *Mopalia egretta* Berry. Dorsal view of type specimen [281]: x 5½.

Fig. 2. *Mopalia egretta* Berry. Left side of valves ii-v and adjacent region of girdle of paratype [284]: x 15.



EXPLANATION OF PLATE 7

Fig. 1. *Mopalia egretta* Berry. Dorsal view of head valve of paratype [640]: x 12½.

Fig. 2. *Mopalia egretta* Berry. Dorsal view of valve vi of paratype [640]: x 12½.

Fig. 3. *Mopalia egretta* Berry. Dorsal view of tail valve of paratype [640]: x 12½.

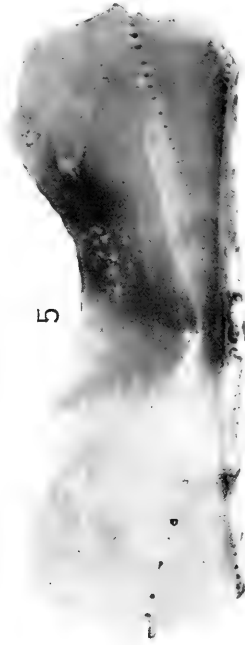
Fig. 4. *Mopalia egretta* Berry. Interior view of head valve of paratype [640]: x 12½.

Fig. 5. *Mopalia egretta* Berry. Interior view of valve vi of paratype [640]: x 12½.

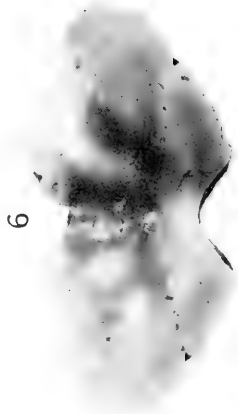
Fig. 6. *Mopalia egretta* Berry. Interior view of tail valve of paratype [640]: x 12½.



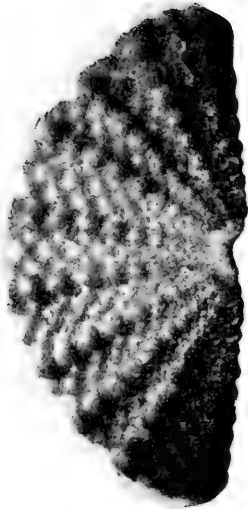
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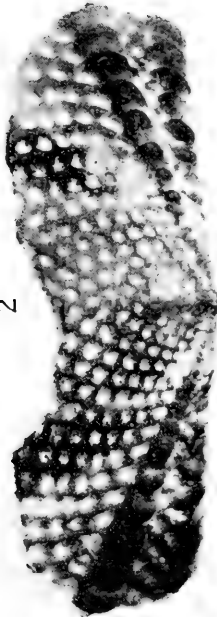
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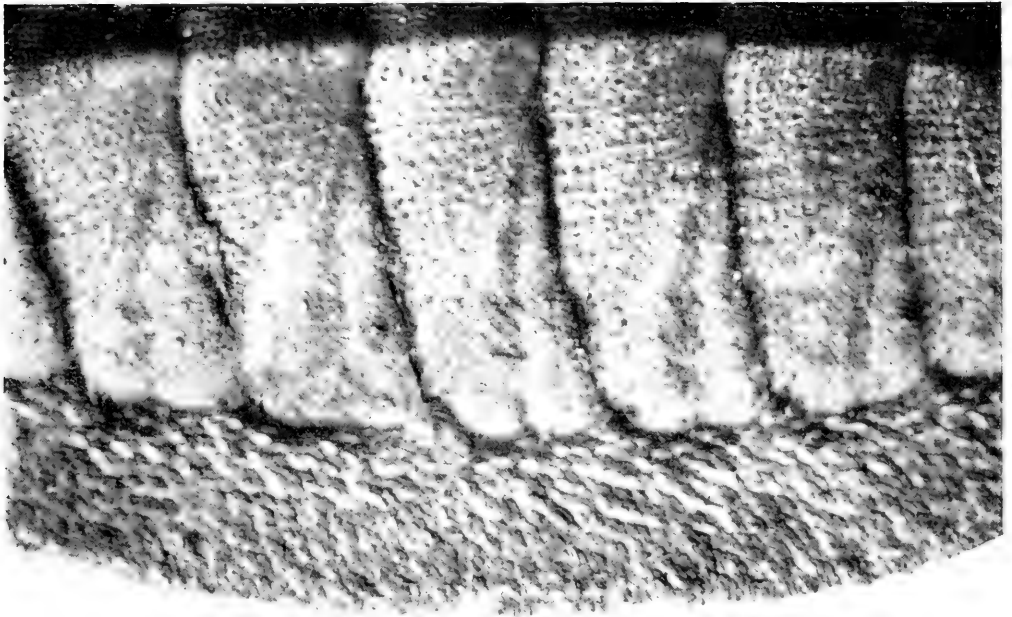




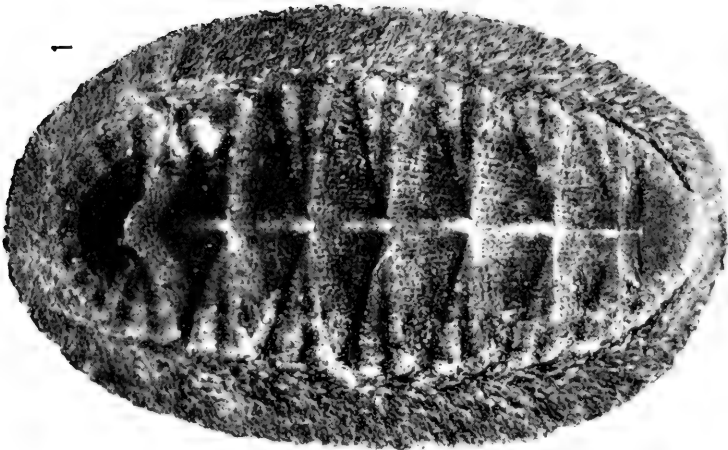
EXPLANATION OF PLATE 8

Fig. 1. *Ischnochiton asthenes* Berry. Dorsal view of paratype [471a]: x 10.

Fig. 2. *Ischnochiton asthenes* Berry. Left side of valves ii-vi and adjacent region of girdle of paratype [471a]: x 21.



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PROCEEDINGS
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II

Life - Zone Indicators in California

BY

HARVEY MONROE HALL

Associate Professor of Botany, University of California

AND

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Director of the Museum of Vertebrate Zoology, University of California

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LIFE-ZONE INDICATORS IN CALIFORNIA

BY

HARVEY MONROE HALL

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INTRODUCTION

An increasing number of naturalists, both botanists and zoologists, are finding in the life-zone system a useful means of handling the facts of distribution. The satisfactory diagnosis of life-zones in the field has been dependent hitherto upon an extensive familiarity with the occurrence of plants and animals over large areas, and this has been possible only to a few persons with abundant opportunity for field work. It is the experience of the present writers that certain critical species can be selected as "life-zone indicators", through the recognition of which the zonal position of any one locality

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may be determined with approximate accuracy without an exhaustive study of the entire flora and fauna. The object of the present paper is to make available a partial list of the plants and vertebrate animals which may be depended upon to establish the zonal identity of any locality within the State of California, and so to make it possible for the inexperienced person to "find himself" zonally.

THE LIFE-ZONE CONCEPT

Field biologists of the Pacific Coast are in general agreement as to the value of the life-zone concept. It not only fits in with well established facts but has direct practical application in studies dealing with the ecology and geographic distribution of plants and animals. That there are difficulties in its application, and that there are numerous apparent inconsistencies among life-zone workers, is readily admitted. However, these will doubtless be cleared up as we come to a more intensive study of environments and to a more careful application of the fundamental laws of geographic distribution. In this connection it should perhaps be pointed out that the life-zones as here accepted are not to be compared with the mountain regions of Schimper (1898) and others, nor even with the so-called life "zones" or belts of some workers in our own country. We here refer to those classifications which are based largely upon altitude and latitude and sometimes upon topography. Such zones or belts may be somewhat useful in popular treatises, but are of slight scientific value since their use entirely ignores the local conditions which often greatly modify zonal position.

The idea that life-zones are altitudinal or latitudinal is correct only in a very general way or incidentally. They are, instead, primarily biologic, that is, they are composed of and determined by a certain assemblage of plant and animal species, and are affected by altitude or latitude only as these modify the climate, more especially the temperature during the critical periods of an organism's existence. This effect of a change in latitude or altitude is sometimes overshadowed by the influence of local conditions, resulting in the so-called misplacement and spotting of zones. So frequent is this the

case that the distribution of a taxonomic group can be accurately stated in terms of latitude and altitude only by making the range so inclusive as to render the statement of but general interest.

It is just this failure to recognize the importance of local disturbing conditions that has led some investigators to under-value both the scientific basis and the utility of the life-zone concept. The more important local influences which interfere with the normal, orderly succession of life-zones may be specified and briefly discussed as follows:

1. *Slope exposure.* Next to altitude and latitude this is apparently the most important determinant of temperature and consequently of zone positions in our western states. As may be determined mathematically, the amount of heat received by a slope with the most favorable gradient is 1.4 times as great as that received by an equal area of level land, other conditions being constant (Hall, 1902, p. 34). It is evident, from such considerations, that any life-zone will occur at higher altitudes on southerly facing slopes (in the Northern Hemisphere) than it will on level areas, and that it will be correspondingly depressed on northerly facing slopes.

2. *Air currents.* It is well known that cold air flows down the cañons in mountainous districts, especially at night. This results in a depression of life-zones, particularly in narrow valleys and cañons. On the other hand, proximity of a desert area or other source of warm air often greatly elevates the position of life-zones on mountain slopes, because of the warm ascending currents. (See Merriam, 1899, p. 51; Shreve, 1914, pp. 197-202.)

3. *Streams carrying cold water.* The effect upon the growth conditions of plants whose roots are in moist soil near these streams is considerable, as indicated by the persistent manner in which species of the higher zones fringe the water courses at lower levels. As an alpine stream descends to the plains, its rise in temperature is much less than is generally supposed. This is indicated by thermometric observations (not yet published) made in the mountains of Colorado by Dr. Gideon S. Dodds.

4. *Evaporation from moist soil.* This likewise depresses the temperature and works in harmony with No. 3. The effect is also noticeable around lakes and moist depressions. The influence is sometimes very local. It is even possible that in tall forests the tree species may belong to one life-zone whereas the communities beneath these trees may contain herbaceous plants and terrestrial animals from the zone next above. In such cases we must consider, in addition to evaporation, such influences as shading, the movement of cold air, the effect of cold water, etc.

5. *Proximity to large bodies of water.* Water is usually an equalizer of temperature, but the presence of unusually cold or warm bodies and ocean currents must be taken into account.

6. *Influence of lingering snow banks and of glaciers.* Because of peculiar topography snow accumulates much more abundantly in some places than in others. These deep snow fields require a longer time for their complete melting, or may persist throughout the summer, thus acting as refrigerators for the immediate neighborhood. The effect is often very local and gives rise to a "spotting" of life-zones which cannot be accounted for on other grounds. Glaciers may produce similar effects.

7. *Changes in the vegetable covering.* Forest fires, avalanches, and other denuding agents may result in a change from a previously existing life-zone to the one next below (Merriam, 1899, p. 51). As the laws of plant succession become operative the species will again change to those of the climax formation, and there will be going on in the meantime a nice adjustment between temperature conditions and plant covering, each acting upon the other. In such cases relicts are sometimes present. These may persist for many years side by side with species brought in by the changed conditions. Such phenomena are exceedingly perplexing to the student of life-zones.

8. *Extent of a mountain area.* The larger a mountain mass the less will be the effect of surrounding influences. For example, in a desert region the zones will occur at

lower altitudes on a broad, massive mountain than they will on a sharp, isolated peak. (See Grinnell and Swarth, 1913, p. 216.)

9. *Rock surfaces.* Rocky slopes, outcroppings, and talus are usually warmer than surrounding areas, and the life-zones are raised in consequence.

10. *Miscellaneous local influences.* The explanation of the apparently abnormal occurrence of a species at stations far removed from the zone in which it is usually found should be sought in a minute examination of local conditions. The influence of man is especially important, and one must be certain that the species is actually established.

THE SELECTION OF LIFE-ZONE INDICATORS

When all of the numerous disturbing "factors" are taken into account we may be able to explain many of the apparent incongruities in the position of life-zones as we find them in nature. In the meantime, it is our clear duty to map these zones in as definite a manner as possible, using for this purpose the occurrence of stenothermic species of animals and plants rather than any preconceived idea as to the temperature or other environmental factor. In selecting these indicative species, or "life-zone indicators", as they are called, one must have regard for a number of considerations. A few of the criteria which the authors have used in making selections for the indicators enumerated beyond may be set forth as follows:

1. Only breeding records have been taken into account. This applies to plants as well as to animals, for seeds are sometimes carried above the normal position for the species. The resulting seedlings may live through several or many seasons and yet not be able to reproduce because of insufficient summer heat. Conversely, plants and animals may be carried to stations below their proper zone, there persist and even reproduce during a few favorable seasons, but without becoming thoroughly established. It is thus evident that the sporadic occurrence of a few individuals does not necessarily

indicate the presence of a zone of which the species is characteristic.

2. In the case of plants, perennials are usually preferred to annuals (Coville, 1893, p. 17).

3. The more abundant a species the greater is its value as a life-zone indicator. Rare or local species may be restricted by other factors than those which influence zone position. A dearth of facilities for dispersal may account for the restricted occurrence of a species which would otherwise inhabit two or more zones. Conversely, organisms with effective provision for wide dispersal may be considered as having been already distributed and tried out over a number of zones, so that their absence from any one of them may be taken as evidence that they are there unable to persist.

4. Certain indicators may be absolutely constant as to their zonal position in one portion of their range but quite unreliable when the entire range of the species is taken into account. This may be due to a variety of causes, chief of which is perhaps the possible development of hardy strains in one portion of the range and not in another. Allowance should also be made for the presence of biotypes which may be so similar in external characters as to escape detection by the taxonomist but which react differently to their environment. Whatever the cause, it should be borne in mind that in a few cases a particular indicator may be of no value when widely separated faunas or floras are to be compared.

5. Since the delimitation of life-zones as outlined by Merriam is accepted in the main by the present authors, these zonal limits are determined as far as possible by means of indicators listed by Dr. Merriam himself, especially in his later publications (Merriam, 1899, etc.). Since the nomenclature first proposed by Merriam has now become well established we consider it highly undesirable that any other should be promulgated. Uniformity in the use of terms applied to the various zones is essential to ready intelligibility and to scientific accuracy. However, the present authors do not commit themselves as to the exact temperature factors limiting the various life-zones and the distribution of species as laid down in some detail by Merriam (Merriam, 1898).

RECOMMENDED PRECAUTIONS

It is perhaps needful here to warn those who make use of our lists of indicators that life-zones are not often abruptly defined one against the other, but that belts of some width may mark their boundaries, where overlapping or mixing of ingredients occurs. If the locality to be tested happens to be situated in such an indifferent position, trouble will naturally be encountered and the true state of affairs will not be discovered without a floral and faunal reconnaissance radially in different directions; if on a steep slope, a few rods may suffice; if on more level ground, some miles may need to be traversed.

Another thing to keep in mind is that only a few of the species here listed for a given zone will be likely to occur in any one locality. Various faunal and associational divisions of life-zones exist (Grinnell, 1914, p. 64), so that the critical species are usually limited in their distribution to but a portion of their life-zone. But every such subdivision is represented in our lists by two or more species.

Then it is possible that some of our "indicators" have been selected as such through an incomplete knowledge of their distribution; in other words, in some cases where a species is at first supposed to be an "indicator" (that is, a species not occurring in two or more zones, but in only one), as its distribution becomes better known the less closely may it be found restricted within the limits of one zone, and therefore the poorer "indicator" it becomes. However, a majority of the species of both plants and animals we have selected are conspicuous and well-known species, easily detected. In some of the cases there is more or less "spilling over" locally from the critical zone, in one direction or the other or in both directions, though not involving an entire adjacent zone; and with such species letters are affixed by which the zone or zones in which it also occurs are designated. With each of these species, its metropolis is so emphatically within the zone for which it is listed, that its value as an indicator is paramount, especially when the observer takes pains to verify the presence of two or more indicators—the more the better. With migratory birds the zonal position indicated is, of course, that of the *breeding* area.

Axiomatic is the tenet that accurate systematic determination of species must be the foundation for any distributional study.

For life-zone maps relating to California, either for the entire state or for particular areas within the state, the following papers should be consulted: C. Hart Merriam, 1898; C. Hart Merriam, 1899; H. M. Hall, 1902; J. Grinnell, 1908; A. O. U. Committee, 1910; J. Grinnell, 1913; J. Grinnell and H. S. Swarth, 1913; J. Grinnell, 1915. Useful discussions of the life-zone system of distributional treatment of plants and animals will be found in the following papers: C. Hart Merriam, 1899; H. M. Hall, 1902; J. Grinnell, 1915. (For full titles of all these papers, see list of "Literature Cited" on a subsequent page of the present contribution.)

LISTS OF LIFE-ZONE INDICATORS

LOWER SONORAN ZONE

Species closely restricted to this zone, and particularly characteristic of it, are marked with a star (*). Species marked U occur also in the Upper Sonoran Zone.

Plants

- Ephedra californica Wats.
- Pleuraphis rigida Thurb.*
- Tridens pulchellus (H. B. K.) Hitchc.
- Washingtonia filifera Wendl.*
- Hesperocallis undulatus Wats.*
- Yucca brevifolia Engelm. U
- Yucca mohavensis Sarg.
- Agave deserti Engelm.
- Anemopsis californica Hook. U
- Phoradendron californicum Nutt.
- Rumex hymenosepalus Torr.
- Atriplex hymenelytra (Torr.) Wats.
- Atriplex lentiformis (Torr.) Wats.*
- Spirostachys occidentalis Wats.
- Mirabilis froebellii Greene
- Lepidium fremontii Wats.
- Isomeris arborea Nutt. U
- Crossosoma bigelovii Wats.

LOWER SONORAN ZONE—Continued

Acacia greggii Gray*
Astragalus aridus Gray
Astragalus limatus Sheldon
Astragalus pomonensis M. E. Jones
Cassia armata Wats.*
Cercidium torreyanum (Wats.) Sarg.*
Lupinus odoratus Heller
Olneya tesota Gray*
Parkinsonia microphylla Torr.*
Parosela californica (Wats.) Vail
Parosela emoryi (Gray) Heller
Parosela schottii (Torr.) Heller
Parosela spinosa (Gray) Heller
Prosopis glandulosa Torr.*
Prosopis pubescens Benth.*
Sesbania macrocarpa Mühl.
Fagonia californica Benth.*
Larrea divaricata Cav.*
Thamnosma montana Torr. & Frem.
Krameria canescens Gray
Krameria parvifolia Benth.*
Condalia parryi (Torr.) Weberbauer
Malvastrum exile Gray
Sphæralcea emoryi Gray
Sphæralcea orcuttii Vas. & Rose
Fouquieria splendens Engelm.*
Eucnide urens (Gray) Parry
Petalonyx nitidus Wats.
Petalonyx thurberi Gray
Echinocactus lecontei Engelm.
Echinocactus polycephalus Engelm.
Opuntia acanthocarpa Engelm. & Big.
Opuntia bernardina Engelm.*
Opuntia echinocarpa Engelm. & Big.*
Opuntia engelmannii Salm-Dyck
Oenothera brevipes Gray
Asclepias subulata Dec.*
Philibertia linearis heterophylla Gray
Coldenia palmeri Gray

LOWER SONORAN ZONE—Continued

- Lippia nodiflora* Michx.
Hyptis emoryi Torr.
Salazaria mexicana Torr.*
Datura meteloides DC. U
Datura thomasi Torr.
Lycium andersonii Gray
Nicotiana glauca R. Grah.
Nicotiana trigonophylla Dunal
Mohavea breviflora Coville
Mohavea viscida Gray
Chilopsis linearis (Cav.) Sweet*
Beloperone californica Benth.
Cucurbita palmata Wats.
Acamptopappus sphærocephalus Gray
Amphiachyris fremontii (T. & G.) Gray*
Aster carnosus Gray
Aster spinosus Benth.
Aster tortifolius (T. & G.) Gray*
Atrichoseris platyphylla Gray
Baccharis emoryi Gray
Baccharis sergiloides Gray
Baileya multiradiata pleniradiata (Harv. & Gray) Coville
Baileya pauciradiata Harv. & Gray
Bebbia juncea (Benth.) Greene*
Brickellia arguta Rob.
Brickellia desertorum Coville
Brickellia frutescens Gray
Brickellia incana Gray
Brickellia multiflora Kell.
Chænactis macrantha Eat.
Chænactis stevioides H. & A.
Chrysothamnus paniculatus (Gray) Hall
Chrysothamnus teretifolius (Dur. & Hilg.) Hall U
Conyza coulteri Gray
Dicoria canescens T. & G.
Dysodia cooperi Gray
Dysodia porophylloides Gray
Encelia farinosa Gray*
Encelia frutescens Gray U

LOWER SONORAN ZONE—Continued

Eriophyllum pringlei Gray
Eriophyllum wallacei Gray
Franseria dumosa Gray*
Geræa canescens T. & G.
Gutierrezia lucida Greene*
Heterotheca grandiflora Nutt.*
Hoffmanseggia densiflora Benth.
Hofmeisteria pluriseta Gray
Isocoma veneta acradenia (Greene) Hall
Lepidospartum squamatum Gray*
Lygodesmia exigua Gray
Malacothrix californica DC.
Malacothrix coulteri Gray
Malacothrix glabrata (Eat.) Gray
Monoptilon bellioides (Gray) Hall
Nicolletia occidentalis Gray
Palafoxia linearis Lag.
Pectis papposa Harv. & Gray
Perityle emoryi Torr.
Peucephyllum schottii Gray
Pluchea sericea (Nutt.) Coville
Porophyllum gracile Benth.
Psathyrotes annua (Nutt.) Gray
Psathyrotes ramosissima (Torr.) Gray
Psilostrophe cooperi (Gray) Greene
Tetradymia comosa Gray
Trichoptilium incisum Gray
Viguiera deltoidea parishii (Greene) Rose
Viguiera laciniata Gray

Amphibians

Batrachoseps major Camp
Bufo cognatus cognatus Say
Bufo cognatus californicus Camp
Bufo punctatus Baird & Girard
Bufo alvarius Girard

LOWER SONORAN ZONE—Continued

Reptiles

- Coleonyx variegatus (Baird)
 Dipso-saurus dorsalis (Baird & Girard)
 Uma notata Baird
 Callisaurus ventralis ventralis (Hallowell)
 Crotaphytus silus Stejneger
 Sauromalus ater Duméril
 Uta stansburiana elegans Yarrow U
 Uta stansburiana hesperis Richardson U
 Uta graciosa (Hallowell)
 Uta ornata Baird & Girard
 Sceloporus magister Hallowell
 Phrynosoma platyrhinos Girard
 Phrynosoma m'callii (Hallowell)
 Xantusia vigilis Baird
 Cnemidophorus tigris tigris Baird & Girard
 Cnemidophorus tigris mundus Camp U
 Cnemidophorus hyperythrus beldingi (Stejneger)
 Leptotyphlops humilis (Baird & Girard)
 Thamnophis marcianus (Baird & Girard)
 Chilomeniscus cinctus Cope
 Sonora occipitalis (Hallowell)
 Sonora episcopa (Kennicott)
 Lampropeltis conjuncta Cope
 Rhinocheilus lecontei Baird & Girard
 Coluber flagellum frenatus (Stejneger)
 Arizona elegans Kennicott
 Tantilla eiseni Stejneger
 Crotalus atrox Baird & Girard
 Crotalus mitchellii (Cope)
 Crotalus cerastes Hallowell
 Testudo agassizii (Cooper)

Birds

- Lophortyx gambeli gambeli Gambel
 Melopelia asiatica trudeaui (Audubon)
 Falco mexicanus Schlegel U
 Micropallas whitneyi whitneyi (Cooper)

LOWER SONORAN ZONE—Continued

Otus asio gilmani Swarth
Dryobates scalaris cactophilus Oberholser
Centurus uropygialis uropygialis Baird
Colaptes chrysoides mearnsi Ridgway
Phalænoptilus nuttalli nitidus Brewster
Chordeiles acutipennis texensis Lawrence
Calypte costæ (Bourcier)
Tyrannus vociferans Swainson
Pyrocephalus rubinus mexicanus Sclater
Pica nuttalli (Audubon) U
Molothrus ater obscurus (Gmelin)
Icterus cucullatus nelsoni Ridgway
Pipilo aberti Baird
Guiraca cærulea salicarius Grinnell
Piranga rubra cooperi Ridgway
Vireo belli pusillus Coues
Vireo belli arizonæ Ridgway
Vermivora lucizæ (Cooper)
Dendroica æstiva sonorana Brewster
Mimus polyglottos leucopterus (Vigors)
Toxostoma lecontei lecontei Lawrence
Toxostoma crissale Henry
Heleodytes brunneicapillus couesi (Sharpe)
Auriparus flaviceps flaviceps (Sundevall)
Polioptila plumbea (Baird)
Polioptila californica Brewster

Mammals

Scapanus latimanus grinnelli Jackson
Scapanus latimanus campi Grinnell & Storer
Notiosorex crawfordi crawfordi Baird
Macrotus californicus Baird
Myotis velifer (J. A. Allen)
Myotis occultus Hollister
Myotis yumanensis yumanensis (H. Allen)
Myotis californicus pallidus Stephens
Pipistrellus hesperus hesperus (H. Allen)
Pipistrellus hesperus merriami (Dobson) U

LOWER SONORAN ZONE—Continued

- Euderma maculatum* (J. A. Allen)
Corynorhinus rafinesquii pallescens Miller
Antrozous pallidus (LeConte)
Antrozous pacificus Merriam U
Eumops californicus (Merriam)
Canis ochropus estor Merriam
Vulpes macrotis macrotis Merriam
Vulpes macrotis muticus Merriam
Vulpes macrotis arsipus Elliot
Urocyon cinereoargenteus scotti Mearns
Procyon lotor pallidus Merriam
Mephitis estor Merriam
Onychomys torridus pulcher Elliot
Onychomys torridus tularensis Merriam
Onychomys torridus ramona Rhoads
Peromyscus crinitus stephensi Merriam
Peromyscus eremicus eremicus (Baird)
Peromyscus eremicus fraterculus (Miller)
Sigmodon hispidus eremicus Mearns
Neotoma albigula venusta True
Neotoma intermedia intermedia Rhoads U
Neotoma intermedia desertorum Merriam U
Thomomys bottæ angularis Merriam
Thomomys bottæ pascalis Merriam
Thomomys bottæ pallescens Rhoads
Thomomys perpallidus perpallidus Merriam
Thomomys perpallidus albatus Grinnell
Thomomys perpallidus aureus J. A. Allen
Thomomys perpallidus perpes Merriam
Thomomys perpallidus mohavensis Grinnell
Thomomys operarius Merriam
Perognathus longimembris brevinasus Osgood
Perognathus bombycinus Osgood
Perognathus inornatus inornatus Merriam U
Perognathus inornatus neglectus Taylor
Perognathus formosus Merriam U
Perognathus penicillatus penicillatus Woodhouse
Perognathus penicillatus stephensi Merriam
Perognathus fallax fallax Merriam

LOWER SONORAN ZONE—Continued

- Perognathus fallax pallidus Mearns
 Perognathus californicus ochrus Osgood
 Perognathus spinatus spinatus Merriam
 Perodipus tularensis Merriam
 Perodipus swarthi Grinnell
 Perodipus dixonii Grinnell
 Perodipus mohavensis Grinnell
 Perodipus ingens Merriam
 Perodipus microps Merriam U
 Perodipus levipes Merriam
 Dipodomys deserti Stephens
 Dipodomys merriami simiolus Rhoads
 Dipodomys merriami parvus Rhoads
 Dipodomys merriami nitratoides Merriam
 Dipodomys merriami exilis Merriam
 Citellus tereticaudus tereticaudus (Baird)
 Citellus tereticaudus chlorus Elliot
 Citellus tereticaudus eremionomus Elliot
 Citellus mohavensis (Merriam)
 Ammospermophilus leucurus leucurus (Merriam) U
 Ammospermophilus nelsoni nelsoni (Merriam)
 Ammospermophilus nelsoni amplus Taylor
 Lepus californicus richardsoni Bachman
 Lepus californicus deserticola Mearns U
 Sylvilagus auduboni vallicola Nelson
 Sylvilagus auduboni arizonæ (J. A. Allen)
 Cervus nannodes Merriam
 Odocoileus hemionus eremicus (Mearns)
 Ovis canadensis nelsoni Merriam U

UPPER SONORAN ZONE

Species closely restricted to this zone, and particularly characteristic of it, are marked with a star (*). Species marked L occur also in the Lower Sonoran Zone; those marked T occur also in the Transition; those marked C occur also in the Canadian.

Plants

- Ephedra viridis Coville
 Cupressus macnabiana Murray
 Cupressus sargentii Jepson
 Juniperus californica Carr. L

UPPER SONORAN ZONE—Continued

- Pinus monophylla* Torr. & Frem.*
Pinus sabiniana Dougl.
Pinus tuberculata Gordon
Stipa pulchra Hitchc. L
Lilium rubescens Wats.
Nolina parryi Wats.
Yucca whipplei Torr.*
Juglans californica Wats.
Castanopsis chrysophylla minor DC.
Quercus agrifolia Nee.
Quercus douglasii H. & A.
Quercus dumosa Nutt.*
Quercus wislizenii DC.
Eriogonum fasciculatum Benth. L
Aristolochia californica Torr.
Atriplex confertifolia (Torr. & Frem.) Wats. L
Eurotia lanata (Pursh) Moq. L
Grayia spinosa (Hook.) Moq. L?
Sarcobatus vermiculatus (Hook.) Torr. L
Dendromecon rigidum Benth.*
Dicentra chrysantha H. & A.
Ribes gracillimum Cov. & Britt.
Ribes malvaceum Smith
Ribes speciosum Pursh
Adenostoma fasciculatum H. & A.*
Adenostoma sparsifolium Torr.
Cercocarpus betulæfolius Nutt.*
Cercocarpus parvifolius Nutt.
Photinia arbutifolia (Ait.) Lindl. T
Prunus ilicifolia (Nutt.) Walp.
Purshia tridentata (Pursh) DC. T
Cercis occidentalis Torr.*
Hosackia glabra (Vogel) Torr.
Pickeringia montana Nutt.*
Ptelea baldwinii T. & G.
Rhus diversiloba T. & G. T
Rhus ovata Wats.
Rhus trilobata Nutt.
Aesculus californica (Spach) Nutt.

UPPER SONORAN ZONE—Continued

- Ceanothus crassifolius* Torr.*
Ceanothus cuneatus (Hook.) Nutt.*
Ceanothus divaricatus Nutt.*
Ceanothus oliganthus Nutt.
Ceanothus perplexans Trel.
Ceanothus vestitus Greene
Malvastrum fasciculatum (Nutt.) Greene L
Hypericum concinnum Benth. T
Mentzelia aurea (Lindl.) Baill.
Mentzelia lævicaulis (Dougl.) T. & G. L
Datisca glomerata (Presl) B. & W. T
Garrya pallida Eastw.
Garrya rigida Eastw.
Garrya veatchii palmeri (Wats.) Eastw.
Arctostaphylos canescens Eastw.
Arctostaphylos glandulosa Eastw.
Arctostaphylos glauca Lindl.
Arctostaphylos manzanita Parry
Arctostaphylos pungens H. B. K.
Arctostaphylos viscida Parry
Styrax californica Torr.
Fraxinus dipetala H. & A.
Gilia californica (H. & A.) Benth.
Salvia apiana Jepson L
Salvia clevelandii (Gray) Greene
Salvia leucophylla Greene
Salvia mellifera Greene
Salvia spathacea Greene
Sphacele calycina Benth.
Trichostema lanatum Benth.
Castilleia foliolosa H. & A.
Pentstemon cordifolius Benth.
Pentstemon heterophyllus Lindl.
Pentstemon ternatus Torr.
Artemisia californica Less. L
Artemisia tridentata Nutt. T C
Brickellia microphylla (Nutt.) Gray
Ericameria arborescens (Gray) Greene
Senecio eurycephalus T. & G.

UPPER SONORAN ZONE—Continued

Amphibians

- Aneides lugubris lugubris* (Hallowell) T
Batrachoseps attenuatus (Eschscholtz) T
Ambystoma tigrinum (Green)
Hyla arenicolor Cope L
Rana aurora draytonii Baird & Girard T

Reptiles

- Sceloporus occidentalis occidentalis* Baird & Girard T
Sceloporus occidentalis bi-seriatus Hallowell L
Sceloporus orcutti Stejneger
Gerrhonotus scincicauda scincicauda (Skilton) T
Gerrhonotus scincicauda webbiai Baird L
Xantusia henshawi Stejneger
Plestiodon skiltonianum Baird & Girard T
Thamnophis ordinoides hammondii (Kennicott) L T
Diadophis amabilis Baird & Girard T
Lampropeltis californiæ (Blainville)
Coluber lateralis (Hallowell)
Coluber tæniatus (Hallowell)
Crotalus exsul Garman
Crotalus tigris Kennicott

Birds

- Lophortyx californica vallicola* (Ridgway) L T
Gymnogyps californianus (Shaw)
Strix occidentalis occidentalis (Xantus) T
Dryobates nuttalli (Gambel)
Melanerpes formicivorus bairdi Ridgway T
Phalænoptilus nuttalli nuttalli (Audubon)
Phalænoptilus nuttalli californicus Ridgway
Calypte anna (Lesson)
Aphelocoma woodhousei (Baird)
Aphelocoma californica californica (Vigors)
Aphelocoma californica oocleptica Swarth T
Aphelocoma californica immanis Grinnell
Icterus parisorum Bonaparte
Astragalinus lawrencei (Cassin)

UPPER SONORAN ZONE—Continued

- Ammodramus savannarum bimaculatus* Swainson
Chondestes grammacus strigatus Swainson L
Spizella atrogularis (Cabanis)
Amphispiza belli (Cassin)
Amphispiza nevadensis canescens Grinnell
Aimophila ruficeps ruficeps (Cassin)
Pipilo crissalis crissalis (Vigors)
Pipilo crissalis carolæ McGregor
Pipilo crissalis senicula Anthony L
Vireo huttoni huttoni Cassin
Vireo vicinior Coues
Dendroica nigrescens (Townsend) T
Toxostoma redivivum redivivum (Gambel) L
Toxostoma redivivum sonomæ Grinnell
Catherpes mexicanus punctulatus Ridgway T
Thryomanes bewicki eremophilus Oberholser
Thryomanes bewicki charienturus Oberholser
Thryomanes bewicki drymæcus Oberholser
Thryomanes bewicki spilurus (Vigors) T
Bæolophus inornatus inornatus (Gambel)
Bæolophus inornatus murinus Ridgway
Bæolophus inornatus griseus (Ridgway)
Psaltriparus minimus minimus (Townsend) T
Psaltriparus minimus californicus Ridgway
Psaltriparus plumbeus (Baird)
Chamæa fasciata henshawi Ridgway
Chamæa fasciata fasciata (Gambel)
Polioptila cærulea obscura Ridgway

Mammals

- Sorex californicus californicus* Merriam
Sorex sinuosus Grinnell
Myotis orinomus Elliot
Corynorhinus rafinesquii intermedius H. W. Grinnell
Ursus californicus Merriam T
Ursus magister Merriam T
Urocyon cinereoargenteus californicus Mearns T
Bassariscus astutus raptor (Baird) T
Onychomys leucogaster brevicaudus Merriam

UPPER SONORAN ZONE—Continued

- Onychomys leucogaster fuscogriseus* Anthony
Reithrodontomys megalotis longicaudus (Baird) T L
Peromyscus truei truei (Shufeldt)
Peromyscus truei gilberti (J. A. Allen) T
Peromyscus truei martirensis (J. A. Allen)
Peromyscus crinitus crinitus (Merriam)
Peromyscus californicus californicus (Gambel) T
Peromyscus californicus insignis Rhoads
Thomomys bottæ mewa Merriam
Thomomys bottæ diaboli Grinnell
Thomomys bottæ nigricans Rhoads T
Thomomys scapterus Elliot T
Perognathus longimembris panamintinus Merriam L
Perognathus californicus californicus Merriam
Perognathus californicus femoralis J. A. Allen
Perodipus perplexus Merriam
Perodipus venustus Merriam T
Perodipus elephantinus Grinnell
Perodipus streatori Merriam
Perodipus panamintinus Merriam
Perodipus leucogenys Grinnell T
Perodipus monoensis Grinnell
Dipodomys californicus californicus Merriam
Dipodomys californicus trinitatis Kellogg
Microdipodops californicus Merriam
Microdipodops polionotus Grinnell
Citellus mollis stephensi (Merriam)
Eutamias pictus (J. A. Allen) T
Eutamias panamintinus (Merriam)
Eutamias sonomæ Grinnell T
Eutamias merriami merriami (J. A. Allen) T
Eutamias merriami kernensis Grinnell & Storer T
Eutamias merriami mariposæ Grinnell & Storer T
Lepus californicus californicus Gray
Lepus californicus wallawalla Merriam T
Sylvilagus auduboni auduboni (Baird)
Sylvilagus bachmani bachmani (Waterhouse)
Sylvilagus bachmani cinerascens (J. A. Allen)
Sylvilagus bachmani mariposæ Grinnell & Storer

TRANSITION ZONE

Species closely restricted to this zone, and particularly characteristic of it, are marked with a star (*). Species marked U occur also in the Upper Sonoran Zone; those marked C occur also in the Canadian.

Plants

- Abies concolor L. & G. C?
 Abies venusta (Dougl.) Koch
 Cupressus macrocarpa Hartw.
 Libocedrus decurrens Torr.*
 Pinus lambertiana Dougl.*
 Pinus muricata Don
 Pinus ponderosa Dougl. (typical form)*
 Pinus radiata Don
 Pseudotsuga taxifolia (Poir.) Britt.
 Sequoia gigantea (Lindl.) Dec.
 Sequoia sempervirens (Lamb.) Endl.*
 Taxus brevifolia Nutt. C
 Torreya californica Torr.
 Camassia quamash (Pursh) Greene C
 Clintonia andrewsiana Torr.
 Lilium pardalinum Kell. U
 Lilium parryi Wats.
 Scoliopus bigelovii Torr.
 Smilax californica (DC.) Gray
 Trillium ovatum Pursh
 Trillium sessile chloropetalum Torr.
 Trillium sessile giganteum H. & A.
 Iris hartwegii Baker
 Iris hartwegii australis Parish
 Iris missouriensis Nutt.
 Castanopsis chrysophylla (Dougl.) DC.
 Corylus rostrata californica DC.
 Pasania densiflora (H. & A.) Oersted
 Quercus chrysolepis Liebm. U
 Quercus kelloggii Newb.*
 Asarum caudatum Lindl.
 Asarum hartwegii Wats.
 Actæa spicata arguta (Nutt.) Torr. C
 Vancouveria parviflora Greene
 Boykinia major Gray

TRANSITION ZONE—Continued

- Heuchera micrantha* Dougl.
Mitella diversifolia Greene
Mitella ovalis Greene
Saxifraga peltata Torr.
Tellima grandiflora (Pursh) Dougl.
Whipplea modesta Torr.
Chamæbatia foliolosa Benth.*
Cratægus rivularis Nutt.
Fragaria californica C. & S.
Fragaria californica crinita (Rydb.) Hall
Fragaria chiloensis Duch.
Fragaria virginiana platypetala (Rydb.) Hall C
Geum macrophyllum Willd.
Horkelia tenella (Wats.) Rydb.
Horkelia tridentata Torr.
Physocarpus capitatus (Pursh) Ktze. U
Prunus demissa (Nutt.) Walp. U
Rubus leucodermis Dougl.
Rubus parviflorus Nutt. U C
Rubus spectabilis Pursh
Hosackia crassifolia Benth. U
Hosackia macrantha Greene
Lathyrus sulphureus Brewer
Geranium incisum Nutt.
Acer circinatum Pursh
Acer macrophyllum Pursh*
Ceanothus cordulatus Kell. C
Ceanothus integerrimus H. & A. U
Ceanothus palmeri Trel.
Ceanothus prostratus Benth.*
Ceanothus thyrsiflorus Esch.
Ceanothus velutinus Dougl. C
Viola lobata Benth.
Viola sarmentosa Dougl.
Angelica tomentosa Wats.
Cicuta douglasii (DC.) C. & R.
Cœlopleurum maritimum C. & R.
Aralia californica Wats.
Cornus nuttallii Aud.*

TRANSITION ZONE—Continued

Pyrola aphylla Sm.
 Pyrola picta Sm. C
 Sarcodes sanguinea Torr. C
 Arbutus menziesii Pursh U
 Arctostaphylos patula Greene C
 Gaultheria shallon Pursh
 Rhododendron californicum Hook.
 Rhododendron occidentale (T. & G.) Gray
 Vaccinium ovatum Pursh
 Frasera neglecta Hall
 Frasera nitida Benth. U
 Frasera tubulosa Cov.
 Draperia systyla (Gray) Torr.*
 Cynoglossum occidentale Gray
 Agastache urticifolia (Benth.) Ktze. C
 Scutellaria angustifolia Pursh
 Scutellaria californica Gray
 Pentstemon labrosus Hook.
 Kelloggia galioides Torr. C
 Adenocaulon bicolor Hook.
 Anaphalis margaritacea occidentalis Greene
 Antennaria argentea Benth.
 Antennaria rosea Greene C
 Petasites speciosa (Nutt.) Piper
 Rudbeckia californica Gray

Amphibians

Plethodon croceator Cope
 Aneides ferreus (Cope)
 Aneides iëcanus (Cope)
 Ambystoma ensatum (Eschscholtz)

Reptiles

Sceloporus graciosus graciosus Baird & Girard U
 Sceloporus graciosus vandenburgianus Cope
 Gerrhonotus cœruleus Wiegmann U
 Charina bottæ (Blainville)

TRANSITION ZONE—Continued

- Thamnophis ordinoides atratus (Kennicott) U
 Thamnophis ordinoides elegans (Baird & Girard) C
 Contia mitis Baird & Girard U
 Lampropeltis pyromelana multicincta (Yarrow)

Birds

- Oreortyx picta plumifera (Gould) C
 Bonasa umbellus sabini (Douglas) C
 Columba fasciata fasciata Say
 Accipiter velox (Wilson) C
 Strix occidentalis caurina (Merriam)
 Glaucidium gnoma californicum Sclater
 Glaucidium gnoma grinnelli Ridgway U
 Xenopicus albolarvatus albolarvatus (Cassin) C
 Xenopicus albolarvatus gravirostris Grinnell C
 Sphyrapicus varius daggetti Grinnell
 Chætura vauxi (Townsend)
 Selasphorus alleni Henshaw U
 Nuttallornis borealis (Swainson) C
 Cyanocitta stelleri frontalis (Ridgway) C
 Cyanocitta stelleri carbonacea Grinnell
 Carpodacus purpureus californicus Baird
 Zonotrichia nuttalli Ridgway
 Junco oreganus pinosus Loomis
 Piranga ludoviciana (Wilson) C
 Tachycineta thalassina lepida Mearns
 Lanivireo solitarius cassini (Xantus)
 Vermivora ruficapilla gutturalis (Ridgway)
 Dendroica occidentalis (Townsend)
 Oporornis tolmiei (Townsend)
 Nannus hiemalis pacificus (Baird)
 Certhia familiaris occidentalis Ridgway
 Sitta pygmæa pygmæa Vigors
 Sitta pygmæa leuconucha Anthony
 Penthestes rufescens rufescens (Townsend)
 Penthestes rufescens neglectus (Ridgway)
 Penthestes rufescens barlowi (Grinnell)
 Hyllocichla guttata slevini Grinnell

TRANSITION ZONE—Continued

Mammals

- Scapanus townsendii (Bachman) C
 Scapanus latimanus sericatus Jackson
 Neurotrichus gibbsii gibbsii (Baird)
 Neurotrichus gibbsii hyacinthinus Bangs
 Sorex montereyensis montereyensis Merriam
 Sorex montereyensis mariposæ Grinnell
 Sorex pacificus Baird C
 Myotis longicrus longicrus (True) U
 Myotis longicrus interior Miller U
 Lasionycteris noctivagans (LeConte)
 Urocyon cinereoargenteus sequoiensis Dixon U
 Peromyscus boylei boylei (Baird) U
 Peromyscus boylei rowleyi (J. A. Allen) U
 Phenacomys longicaudus True
 Thomomys alpinus awahnee Merriam
 Zapus orarius Preble C
 Eutamias quadrimaculatus (Gray)
 Eutamias townsendi ochrogenys Merriam C
 Eutamias hindsi (Gray)
 Eutamias merriami pricei (J. A. Allen) U
 Sciurus griseus griseus Ord
 Sciurus griseus nigripes Bryant
 Sciurus griseus anthonyi Mearns
 Sylvilagus nuttalli nuttalli (Bachman) U
 Sylvilagus nuttalli grangeri (J. A. Allen) U
 Sylvilagus bachmani ubericolor (Miller)
 Cervus roosevelti Merriam

CANADIAN ZONE

Those species marked T occur also in the Transition Zone; those marked H occur also in the Hudsonian.

Plants

- Abies grandis Lindl. T?
 Abies magnifica Murr.
 Abies magnifica shastensis Lemmon
 Picea sitchensis (Bong.) T. & M. T?
 Pinus contorta Dougl. T

CANADIAN ZONE—Continued

- Pinus monticola Don H
 Pinus murrayana Balf. H
 Pinus ponderosa jeffreyi (Balf.) Vas. T
 Allium validum Wats. H
 Populus tremuloides Michx. T
 Salix glauca villosa (Don) Anders. H
 Castanopsis sempervirens (Kell.) Dudley T H
 Quercus vaccinifolia Kell.
 Lewisia triphylla (Wats.) Rob. H
 Aconitum columbianum Nutt.
 Caltha biflora DC. H
 Delphinium glaucum Wats. H
 Mitella breweri Gray H?
 Mitella pentandra Hook. H
 Saxifraga arguta Don
 Saxifraga bryophora Gray H
 Pirus occidentalis Wats. H
 Potentilla breweri Wats. H
 Potentilla flabellifolia Hook. H
 Acer glabrum Torr. T
 Pyrola minor Linn.
 Arctostaphylos nevadensis Gray H
 Vaccinium occidentale Gray H
 Polemonium pulcherrimum Hook. H
 Mimulus lewisii Pursh H
 Pentstemon gracilentus Gray
 Pedicularis grœnlandica Retz. H
 Arnica longifolia Eat. H
 Erigeron salsuginosus Gray H
 Hieraceum gracile detonsum Gray H

Reptiles

- Sceloporus occidentalis taylori Camp
 Gerrhonotus palmeri Stejneger

Birds

- Dendragapus obscurus sierræ Chapman T
 Astur atricapillus striatulus Ridgway

CANADIAN ZONE—Continued

Otus flammeolus (Kaup)
Sphyrapicus thyroideus thyroideus (Cassin)
Chordeiles minor hesperis Grinnell T
Stellula calliope (Gould) T
Empidonax hammondi (Xantus)
Empidonax wrighti Baird T
Perisoreus obscurus obscurus Ridgway
Perisoreus obscurus griseus Ridgway H
Hesperiphona vespertina californica Grinnell T
Carpodacus cassini Baird H
Melospiza lincolni lincolni Audubon
Passerella iliaca canescens Swarth
Passerella iliaca fulva Swarth
Passerella iliaca monoensis Grinnell & Storer
Passerella iliaca mariposae Swarth
Passerella iliaca stephensi Anthony T
Passerella iliaca brevicauda Mailliard T
Oreospiza chlorura (Audubon) T
Sitta canadensis Linnæus T
Regulus satrapa olivaceus Baird T
Myadestes townsendi (Audubon) T
Hylocichla guttata sequoiensis (Belding) H
Ixoreus naevius naevius (Gmelin)

Mammals

Neosorex bendirei bendirei (Merriam)
Myotis lucifugus altipetens H. W. Grinnell H
Ursus americanus Pallas T
Vulpes cascadenis Merriam H
Vulpes necator Merriam H
Martes caurina sierræ Grinnell & Storer H
Martes pennanti pacifica (Rhoads) H
Mustela muricus (Bangs) H
Evotomys obscurus Merriam
Evotomys californicus Merriam
Microtus montanus dutcheri Bailey H
Thomomys jacinteus Grinnell & Swarth
Thomomys alpinus alpinus Merriam H

CANADIAN ZONE—Continued

- Thomomys monticola monticola (J. A. Allen) H
 Thomomys monticola premaxillaris Grinnell
 Thomomys monticola mazama Merriam H
 Zapus major Preble H
 Zapus trinotatus alleni Elliot H
 Erethizon epixanthum epixanthum Brandt T
 Aplodontia rufa californica (Peters) T H
 Eutamias amoenus amoenus (Allen) T
 Eutamias amoenus monoensis Grinnell & Storer
 Eutamias speciosus speciosus (J. A. Allen) H
 Eutamias speciosus frater (J. A. Allen) H
 Eutamias speciosus inyoensis Merriam H
 Eutamias senex (J. A. Allen) T
 Glaucomys sabrinus flaviventris Howell
 Glaucomys sabrinus lascivus (Bangs) T
 Glaucomys sabrinus californicus (Rhoads) T
 Lepus washingtoni klamathensis Merriam

HUDSONIAN ZONE

Species marked C occur also in the Canadian Zone; those marked A occur also in the Arctic-Alpine.

Plants

- Pinus albicaulis Engelm.
 Pinus balfouriana Murr. C?
 Tsuga mertensiana (Bong.) Sarg.
 Polygonum shastense Brewer A
 Draba corrugata Wats. A
 Ribes montigenum McCl.
 Potentilla fruticosa Linn. C
 Fragaria sibbaldifolia Rydb. C
 Epilobium obcordatum Gray A
 Cassiope mertensiana Don
 Kalmia polifolia microphylla (Hook.) Rehder A
 Artemisia norvegica Fries
 Erigeron compositus Pursh A
 Erigeron ursinus Eat. A
 Macroneuma discoidea Nutt. C

HUDSONIAN ZONE—Continued

- Macronema suffruticosa Nutt. A
Stenotus acaulis Nutt. C

Amphibians

- Spelerpes platycephalus Camp

Birds

- Picoides arcticus (Swainson)
Nucifraga columbiana (Wilson) C
Pinicola enucleator californica Price
Zonotrichia leucophrys (Forster)
Hyalocichla guttata polionota Grinnell C

Mammals

- Gulo luscus luteus Elliot
Citellus beldingi (Merriam)
Eutamias alpinus (Merriam)
Ochotona schisticeps schisticeps (Merriam)
Ochotona schisticeps muiri Grinnell & Storer C A
Ochotona schisticeps albatu Grinnell A
Ovis canadensis sierræ Grinnell C

ARCTIC-ALPINE ZONE

Species marked H occur also in the Hudsonian Zone.

Plants

- Trisetum congdonii Scribn. & Merr.
Carex breweri Boott
Salix arctica petræa Anders.
Oxyria digyna Camptd. H
Lewisia pygmæa (Gray) Rob. H
Ranunculus eschscholtzii Schlect.
Draba breweri Wats.
Saxifraga tolmiei T. & G. H
Horkelia pygmæa (Gray) Rydb.
Sibbaldia procumbens Linn. H

ARCTIC-ALPINE ZONE—Continued

Podistera nevadensis Wats.
 Primula suffrutescens Gray H
 Polemonium eximium Greene
 Pentstemon davidsonii Greene
 Antennaria media Greene H
 Hulsea algida Gray
 Hulsea nana Gray
 Raillardella argentea Gray H
 Senecio petrocallis Greene

Birds

Leucosticte tephrocotis dawsoni Grinnell

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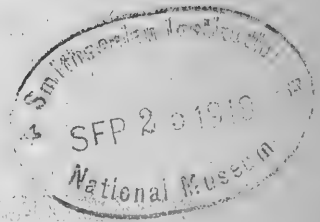
III

Notes on Mammals collected principally in
Washington and California between
the Years 1853 and 1874 by
Dr. James Graham Cooper

BY
WALTER P. TAYLOR
U. S. Biological Survey

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III

NOTES ON MAMMALS COLLECTED PRINCIPALLY
IN WASHINGTON AND CALIFORNIA BETWEEN
THE YEARS 1853 AND 1874 BY DR.
JAMES GRAHAM COOPER

BY
WALTER P. TAYLOR
U. S. Biological Survey

INTRODUCTION AND ACKNOWLEDGMENTS

Dr. James Graham Cooper was one of the most active students of birds and mammals on the Pacific Coast in the middle nineteenth century. In view of the importance of his pioneer work in mammalogy, it has seemed desirable to list all the west coast specimens of mammals collected by him which are still extant and accessible, to note their condition, and to determine, so far as possible, their systematic status according to current conceptions.

The 114 specimens examined are distributed as follows: in the Museum of Vertebrate Zoology at the University of California, Berkeley, California, 57; in the United States National Museum, Washington, D. C., 45; and in the Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts, 12.

July 12, 1919

It is highly probable that a number of Dr. Cooper's specimens were deposited in the Museum of the California Academy of Sciences, San Francisco, California; but if so, they were destroyed in the great fire of 1906.

Doubtless a few of Dr. Cooper's mammal skins are still to be found in widely scattered places among the museums and colleges of this country and possibly Europe. Of 83 specimens of Cooper mammals listed in the catalogue of the United States National Museum, only 45 could be located on January 1, 1918. It is not unlikely that most of the missing specimens have been distributed to other institutions, in accordance with the policy of distribution and exchange followed by Professor Spencer F. Baird.

It is of interest to note that Dr. Cooper collected types or cotypes¹ of the following eight species of North American mammals, seven of which belong to the Pacific Coast (names given first are as used in publications by Cooper):

Scalops Townsendii=*Scapanus orarius orarius* True. Shoalwater Bay, Pacific County, Washington.

Sorex vagrans=*Sorex vagrans vagrans* Baird. Shoalwater Bay, Pacific County, Washington.

Neosorex navigator=*Neosorex palustris navigator* Baird. Fort Vancouver, Washington, according to label; actually, the headwaters of either the Naches River or the Yakima River, Washington.

Lasiurus noveboracensis=*Nycteris borealis teliotis* (H. Allen). Probably from southern California."

Neotoma occidentalis=*Neotoma cinerea occidentalis* Baird. Shoalwater Bay, Pacific County, Washington.

Arvicola pauperrima=*Lagurus pauperrimus* (Cooper). "Great Plains, W. T."

[?] *Spermophilus obsoletus*=*Citellus obsoletus* (Kennicott). Western Nebraska.

Tamias Townsendii=*Eutamias cooperi* (Baird). Klickitat Pass, altitude 4500 ft., Cascade Mts., Washington.

Four of the above species were described in manuscript by Cooper. These are *Sorex vagrans*, *Neosorex navigator*, *Neo-*

¹ Cotype used as designating one of two or more specimens together forming the basis of a species, no type having been selected, and the specimens having been collected at the same locality.

toma occidentalis, and *Arvicola pauperrima*. Of these the last-named only was actually published by him (1868c, p. 535), the others having been published by Baird on the basis of Cooper's notes and specimens (see Baird, 1855, p. 335; 1857, pp. 11, 15).

According to the standards of the day the specimens collected by Dr. Cooper were well prepared. The skull was always left within the skin, and stuffed with cotton, as with birds now. The fore feet were either disposed irregularly forward along the sides of the neck, or folded back on the breast and sewed to the skin. There was no uniformity in arrangement of the hind feet, which were usually folded forward beneath the belly, though sometimes crossed back of the body. The tail was never skinned, being disposed posteriorly, or if deemed too long for this, folded forward beneath the abdomen. The body was stuffed with cotton, and the belly slit was sometimes sewed up and sometimes not. These methods naturally did not make for either uniformity or durability. In spite of this, however, most of the material is in fairly good condition after an interval of nearly sixty years.

Dr. Cooper's usual method of labelling was as follows: On the front of the label he wrote, with pen or pencil, his running number, the scientific name of the animal, the sex (using ♂ for males and ♀ for females), the locality (usually including the state, but not in the case of specimens from the Colorado Valley), the date (the year indicated by an apostrophe and the two last figures, as '61 for 1861), and his initials. On the reverse side of the label he ordinarily entered eleven measurements, (nose to eye; nose to ear; head; head plus body; tail; tail plus hair; fore-foot; hind-foot; front, back, and width of ear).

A list of all of Dr. Cooper's published contributions to mammalogy which have been seen by the writer is included in the literature cited (p. 118).² All references published by Cooper to species of which I have examined specimens collected by him have so far as possible been referred to their proper places in this list according to current nomenclatural standards.

² It is of interest to note that Dr. Cooper's most important work on the mammals of California does not appear over his name at all, being incorporated in Titus Fey Cronise's *The Natural Wealth of California* (Chapter VII, pp. 434-448).

I wish to make cordial acknowledgment for helpful suggestions and criticism to Messrs. E. W. Nelson, T. S. Palmer, and Edward A. Preble of the United States Biological Survey. For access to the collections in their charge, the loan of material, or for other courtesies I am indebted to Dr. Joseph Grinnell, Director of the Museum of Vertebrate Zoology, University of California; Mr. Gerrit S. Miller, Jr., Curator of Mammals, United States National Museum, and Mr. Samuel Henshaw, Director of the Museum of Comparative Zoology, Harvard University, as well as to Dr. Glover M. Allen, secretary of the Boston Society of Natural History. Mr. Vernon Bailey, Major Edward A. Goldman, and Dr. Hartley H. T. Jackson, of the Biological Survey, very kindly assisted in the identification of certain specimens. For information regarding the life and scientific activities of Dr. Cooper I am indebted to Dr. William H. Dall, of the U. S. National Museum, Washington, D. C.; Mr. James S. Cooper, of Oakland, California, and to Mr. W. Otto Emerson, Hayward, California. For valued advice in connection with the paper and for critical reading of the manuscript I am under obligation to Dr. Barton Warren Evermann, Director of the Museum, California Academy of Sciences.

HISTORICAL NOTES

James Graham Cooper was born June 19, 1830, in New York City. His father, William Cooper (1798-1864) was one of the most prominent of the earlier New York naturalists, having been an "Original Member" of the New York Lyceum of Natural History, now the New York Academy of Sciences, and an active scientific worker throughout his life. James G. Cooper graduated from the College of Physicians and Surgeons in 1851, spending the two years following in the hospitals of New York. The most active period of his life as a field naturalist was embraced in the 13 years from 1853 to 1866. It began on April 27, 1853, when he signed a contract with Governor Isaac I. Stevens, of Washington Territory, to act as one of the physicians to the Pacific Railroad Survey Expedition, which was detailed to explore the route along the Forty-seventh and Forty-ninth parallels; it

closed in 1866, when he settled down to the practice of his profession at Santa Cruz, California. In the year 1871 he located in Ventura County, where he remained until 1875. He then moved to Hayward, California, where he resided until his death on July 19, 1902.

A biographical account of Dr. Cooper has already been published (see Emerson, 1899 and 1902); it will nevertheless be profitable, so far as accessible records will permit, to make note of his movements year by year during the period when he was most active as a collector.

Dr. Cooper was assigned to the western division of the Pacific Railroad Survey Expedition to which allusion is made above, serving as surgeon and naturalist under Captain, later Major General, George B. McClellan. Cooper left New York May 5, 1853, in company with Lieutenant J. K. Duncan, reporting to Captain McClellan at Fort Vancouver, Washington Territory, on June 14, having made the trip by way of Panama. The expedition was organized at Fort Vancouver, and the actual exploration began July 18, 1853. The work was carried forward until the middle of the following November, the country traversed including the Klickitat Pass region between Mt. St. Helens and Mt. Adams, the eastern side of the Cascade Mountains, the Yakima Valley, the Okanagan River north at least to Lake Oyosa [= Lake Osoyoos] (see Cooper, W., 1860, p. 378), the Colville district, the Spokane Plains, and the vicinity of Fort Walla Walla. On November 15 the party reached Fort Dalles, Oregon (Suckley and Cooper, 1860, p. x), returning to Fort Vancouver soon thereafter.

The published writings of Dr. Cooper indicate that he made his headquarters at Fort Vancouver for nearly a year or until February 20, 1854. At this time he traveled to the mouth of the Columbia River³ (1860a, p. 33), remaining there and at Shoalwater Bay during the following spring. On March 26, 1854, Cooper made an excursion in a sailboat up the "Willopah," [=Willapa] a river which empties into the north end of Shoalwater Bay (1860a, p. 20). Specimens are on record (Baird, 1858, pp. 777, 916) which he collected at Steilacoom in March and April of this year.

³ Specimens were collected at least at the Mouth of the Columbia, March 2 and 9; and Cape Disappointment, no date given (Baird, 1859, pp. 805, 882).

The Survey was disbanded on April 1, 1854, and Captain McClellan ordered Dr. Cooper to report to Governor Stevens at Fort Vancouver (see Emerson, 1899, p. 3). The specimens were sent to Professor Baird in Washington, D. C., and thither Cooper is erroneously said to have repaired "for the purpose of preparing his report." Cooper remained at Shoalwater Bay until July 18, 1854, ". . . collecting all that his private means would allow. He then crossed the unexplored Coast Range, on foot, with a party of citizens, and traveled to Puget Sound, where he remained a month, collecting specimens about Fort Steilacoom, in company with Dr. Suckley, returning to Shoalwater Bay in September by way of the Cowlitz and Columbia rivers" (Suckley and Cooper, 1860, p. x).

Specimens of birds taken by Cooper at Shoalwater Bay during the month of August as well as September are listed by Baird (1858, pp. 242, 405, 446, 570), so that his return to this locality may have been a few days earlier than is stated above.

The following winter (1854-1855) was spent on Shoalwater Bay, where, on October 7, 1854, he began to make meteorological observations.

"Late in February, 1855, Dr. Cooper went up the coast to Gray's Harbor and joining the Indian treaty commission under Gov. Stevens, on the Chehalis, ascended that river and proceeded again to Puget Sound, intending to accompany the Governor in May to the Blackfoot council at Fort Benton, and thence to return to the Atlantic Coast by way of the Missouri River. Meantime he made a voyage down the sound to the Straits of Fuca [=Juan de Fuca], spent a month collecting on Whitby's Island [=Whidby's Island] and another near Steilacoom. Unexpected disappointments and losses prevented the journey eastward which he had proposed, and he found it necessary to return to Shoalwater Bay in July. There he remained until October 4,⁴ when, by the kind invitation of Captain Alden, he sailed in the Coast Survey steamer *Active* to San Francisco" (Suckley and Cooper, 1860, p. x).

Shortly afterward he spent six weeks collecting specimens in the Santa Clara Valley, California, later proceeding south-

⁴ During August he made a side trip to Astoria, Oregon (Baird, 1857, p. 303).

ward to Panama en route to New York; and he evidently remained in the east until the spring of 1857 (Suckley and Cooper, 1860, p. x). During these early explorations Cooper had spent six weeks in California and approximately two years and three months in Washington Territory.

On April 22, 1857, Dr. Cooper was appointed surgeon to the South Pass Wagon Road Expedition. The party of William M. Magraw, the Superintendent of the expedition to which Dr. Cooper was attached, left Independence, Missouri, about July 1 (See Campbell, 1859, pp. 5, 6), reaching the headwaters of Sweetwater River late in September, "too late to proceed with safety through the South Pass and into the Wasatch Range, in consequence of the severity of the winter in that region and the hostile attitude of the inhabitants of Utah toward the authorities of the United States at this time." In consequence of these considerations the party was disbanded on "Popo Agie, a tributary of Wind River." Some members of the expedition returned to the frontier, others accompanied the chief engineer, Mr. F. W. Lander, to Washington, a few were left on the Popo Agie River in charge of the public property, and a large number volunteered into the service of the army of Utah, selecting their superintendent as their captain. From records⁵ of specimens collected by Dr. Cooper we learn that movements of the expedition were approximately as follows: The greater part of May and June was spent at Independence, Missouri, records of specimens collected at this point embracing the period between May 6 and June 30; July found the party moving in a general north-westerly direction toward Fort Kearney, Nebraska; Fort Laramie [Wyoming], the most westerly point reached by Cooper (see Suckley and Cooper, 1860, p. xi), was reached the latter part of August, the first specimens having been collected at this locality on August 27; the diminished expedition had not started on the return journey before October 5 (Baird, 1858, p. 322), but must have moved soon thereafter, for October 10 found the party at a point 100 miles east of Laramie; October 19, 40 miles west of Fort Kearney; October 28, 100 miles east of Fort Kearney; and November 5, 50 miles west of Leavenworth.

⁵ In the mammal catalogs, U. S. National Museum; in Baird's *Mammals of North America*, 1857; and *Birds of North America*, 1858.

There ensues a period covering the years 1858-1859 for which I have not found any published summary of Dr. Cooper's activities. That he made a trip to Florida in 1859 is indicated by the fact that specimens of mammals numbered 145264-145269, United States National Museum, were collected by him in that State during that year, the only precise localities mentioned being New Smyrna [east coast of Florida, Volusia County] and the Miami River [Biscayne Bay, Dade County]. At the latter locality specimens were taken March 25 to 31, inclusive. While in New York and the east at this period his time was doubtless occupied in writing. Three reports, each of which must have entailed considerable labor, shortly appeared, comprising Cooper's accounts of the botany and mammals of the route of the western division of the Stevens Survey (see Cooper, 1860a and 1860b, and Suckley and Cooper, 1860).

In 1860 we find Dr. Cooper making his first real transcontinental trip, in the capacity of contract surgeon with a detachment of recruits from New York to "Fort Columbus, Department of Oregon."⁶ This assignment occupied him until October 19, 1860, but his contract was continued until December 1 of that year. From Dr. Cooper's contributions to the *American Naturalist* under the title "The Fauna of Montana Territory,"⁷ which deal with the observations and collections made by him on this trip, we learn that his itinerary in the Rocky Mountain and Pacific region included Fort Benton, Montana, and Forts Colville and Vancouver, Washington. On October 9, 1860, Dr. Cooper collected the type of *Lagurus pauperrimus*, one of the most interesting specimens he ever secured, on the Great Plains of the Columbia River. "Again as a student," says Emerson, "we find him collecting along the coast from San Francisco to San Diego (1899, p. 4)".

It was not long before Dr. Cooper was serving once more as contract surgeon in the Army, with headquarters at Fort Mojave,⁸ on the Colorado River (See Cooper, 1869, pp. 182,

⁶ Fort Vancouver.

⁷ See *Amer. Nat.*, vol. 2, 1868, pp. 528-538, 596-600, vol. 3, 1869, pp. 31-35, 73-84, 124-127.

⁸ Fort Mojave: Arizona side of the Colorado River, close to the point at which the boundary lines of Nevada, California and Arizona meet (see Whitney's Map of California and Nevada, State Geological Survey of California, 2nd ed., 1874).

470; 1870a, p. 66; 1871b, p. 756). The expedition left Los Angeles on December 4, 1860, arriving at the post two weeks later on December 19. While stationed at Fort Mojave Cooper undoubtedly collected on both sides of the Colorado River, usually labelling the specimens gathered "Fort Mojave, Col'do V." or "Fort Mojave, Col'do R." without distinction as to state or territory. In a few cases records of species actually collected or observed on the Arizona side only were without doubt credited to California (see Cooper, 1890, p. 215).

On May 28, 1861, Dr. Cooper started on his return journey to the coast (Cooper, 1869, p. 480; 1870a, p. 66) which was completed in approximately 14 days. May 29 found the party in the Providence Mountains (Cooper, 1870c, p. 252); on June 6 it had reached Camp Cady on the lower Mojave River (a specimen of *Peromyscus m. sonoriensis*, No. 5625, Univ. Calif. Mus. Vert. Zool., collected at this locality on June 6, is extant); on June 8 the expedition had arrived at the headwaters of the Mojave River near Cajon Pass (Cooper, 1861, p. 123); and presumably they reached Los Angeles about two days later.

Altogether Cooper spent more than five months at Fort Mojave; on the basis of the work at this point he described two new species of birds and one land tortoise, and listed five mammals, 16 birds, and three reptiles as new for California (Cooper, 1861; Grinnell, 1902, p. 104).

San Diego was evidently his next important collecting locality, though at this period he apparently spent a short time only at this point.

Late in 1860 the Geological Survey of California was organized by J. D. Whitney. The Department of Zoology of the Survey was instituted and Dr. Cooper appointed to the place of Zoologist (Whitney, 1865, p. xi) on July 1, 1861. Shortly after his appointment he traveled by land from San Diego to San Francisco. He remained in the city until August 9, on which date he made a trip to Monterey by water, where he was occupied in making collections from August 12 to September 26 (Cooper 1870b, p. 45; 1871b, pp. 756-757). About this time he must have worked in the

vicinity of Santa Cruz also; for several specimens of *Peromyscus californicus* (Nos. 8547-8549, U. S. Nat. Mus.) are labelled "Santa Cruz, 1861."

From November 4, 1861, to May 24, 1862, we again find him at San Diego (Cooper, 1870a, p. 68), and Whitney records the fact (1870c, pp. ix and x) that "Dr. Cooper was steadily employed in collecting from December, 1860, to April, 1862, and during a considerable portion of the year 1863, being assisted for six months of 1862 by Dr. Edward Palmer. The regions examined were chiefly the Colorado Valley near Fort Mojave, the route to the coast from that fort, the vicinity of San Diego and San Pedro, and Santa Barbara and the islands off the coast." The accessible data pertaining to the period in question consist of a few scattered specimens and published notes. From these we learn that Dr. Cooper was in Stockton in February, 1863; that he collected in Santa Clara and San Mateo counties in March, 1863; that he was at Oakland and Santa Barbara in April; at the latter locality again in May; at Santa Barbara Island⁹ in May and June, where he spent six weeks during this and the succeeding month; on Catalina Island in June and July, as well as during the last days in October; on San Clemente and San Nicolas islands for a few days about the first of July; on the mainland in the neighborhood of San Pedro later in July; in the Sierran foothills in August; and for twenty days in September in the high Sierras between the altitudes of 5000 and 8000 feet, not far from Lake Tahoe (Cooper 1870a, p. 73).

"In 1864 portions of the Sierra Nevada and the coast from Baulines [=Bolinás] Bay to Santa Cruz were zoologically explored" (Whitney, 1870, p. x). On May 24 of this same year Governor Low commissioned Dr. Cooper Assistant Surgeon in the Second Cavalry, California Volunteers, with which regiment he served until its muster out (Emerson, 1899, p. 4).

According to Whitney (1870, p. x), Dr. Cooper was engaged in 1865 in the preparation of reports, and subsequent to that time he is said to have visited at the expense of the

⁹ That the entry "Santa Barbara I." on Cooper's specimen labels refers to Santa Barbara Island and not to the Santa Barbara group is indicated by a reference to the locality in one of his shell papers (1863a, p. 56). He says: "The island is about seventy-five miles from the town [of Santa Barbara], and thirty-five from the nearest main land."

Survey portions of the State not before sufficiently explored. Mention is made also that he did "a large amount of gratuitous work, in the way of elaborating the materials in various branches of the zoology of the Pacific Slope . . ." In September, 1865, Dr. Cooper was at Tulare Lake (Cooper, 1870c, p. 107); and specimens collected by him in October and November, 1865, at Drum Barracks¹⁰ and Wilmington have been examined and included among the "Specimens Examined," *postea*.

It is of interest¹¹ to note that while Cooper was stationed in the vicinity of San Pedro he entertained a notable visitor in the person of Elliott Coues, who travelled overland from Fort Whipple, Arizona, to the coast during the early fall of 1865 (Coues, 1866, pp. 259-275). Coues's opinion of Cooper is indicated in the following reference (1. c., p. 260). "Fort Mojave, on the Colorado River, in about lat. 35°, is interesting to us as the locality whence were lately procured two rare and curious new birds by Dr. J. G. Cooper, so well known as an indefatigable and accurate naturalist . . ." On page 269 of the same contribution Coues writes of enjoying Cooper's hospitality during his stay at San Pedro, referring to Cooper's conversation as ". . . an encyclopedia of interesting biographies of the birds of the Pacific Coast."

Dr. Cooper was married January 9, 1866, to Miss Rosa M. Wells, in Oakland, California. Soon thereafter we find him at Santa Cruz (Cooper, 1870, p. 107), where he may have resided until 1871. It will be remembered that on this date or soon thereafter he moved to Ventura County, locating at Saticoy; and that in 1875 he returned to Hayward, in the San Francisco Bay region.

The examination of specimens extant shows that in the spring of 1866 Dr. Cooper did some collecting at Santa Cruz; that he made a trip to the foothills of Placer County, as well as to the high Sierras in the vicinity of Lake Tahoe, during

¹⁰ Drum Barracks, Los Angeles County, California, about three miles northeast of Wilmington (see Whitney's map of California and Nevada, State Geological Survey of California, 2nd ed., 1874).

¹¹ It seems not improbable that the migration records for Santa Cruz published by Dr. Cooper in the Proceedings of the U. S. National Museum (1880, pp. 245-250) should be dated 1866 rather than 1865; for he was, for at least a part of that year, fully occupied elsewhere. If the records are bona fide personal observations made by Cooper at Santa Cruz in 1865, he must have been stationed there for a considerable period of time, the months from March to July in the spring, and September and October in the fall, being represented.

the spring and summer of 1870; and that he worked at Novato Point, Marin County, in November of the same year. In a paper published in the *American Naturalist* (1874, pp. 14-18) reference is made to "my late trip through the mountains [Cuyamacas, near San Diego]," but no specimens taken at this time have been found.

Dr. Cooper was one of the most active of the early members of the California Academy of Sciences, and was at different times connected with the institution in an official capacity. An inspection of the Proceedings shows that during the years 1862 to 1864, inclusive, Dr. Cooper was Curator of Zoology of the Academy; in 1868 he was named Curator of General Zoology; in 1869 he became Vice-President; during the two years following he was Librarian; on June 26, 1871, he was elected Corresponding Secretary; from 1887 to 1891 he was Director of the Museum; and from 1892 to 1896, Second Vice-President. In addition to these offices he was for some time Curator of Paleontology, and at the time of auxiliary clubs he was President of the Zoological Club (Emerson, 1899, p. 4).

From the published results of Cooper's early work, namely, that in Washington State (1853-1860) it appears that his earlier scientific interests were in general natural history. His later contributions (1861 and following), however, show a pronounced concentration of attention on zoological investigations, most of his work at this period having been done in ornithology and conchology. The number and quality of his published contributions demonstrate his merit as a scientific worker, always taking into consideration the standards of the day. His large accomplishments are all the more creditable in view of the handicap of a frame which was apparently never robust.

In Dr. Cooper's personality, activity and energy were associated with a becoming modesty and absence of a desire for self-aggrandizement. It might well be said of him, as it was of his father, that "With exceeding modesty and being, perhaps, over-cautious in naming new species, he generously permitted others to use his material, and sometimes to gain the credit that might have been his own (Fairchild, 1887, p. 72.)"

RECORD OF SPECIMENS EXAMINED

Scapanus latimanus latimanus (Bachman)

"*Scalops Townsendii*" (part), Cooper, Zoology, in Cronise, The Natural Wealth of California, 1868, p. 441. (Said to be common and universally known.)

Specimens examined.—Two: Nos. 5654, 5655, Mus. Comp. Zool. Harvard Univ. No. 5654: obverse of label "*Scalops Townsendi* Cal Monterey May 12 '74, J. G. C." No. 5655: obverse of label "*Scalops Townsendii* Haywood Cal. Apr. '75"; reverse, "Western mole."

Both these skins have been made over into modern study skins. The skulls are removed. The entire posterior portion of each cranium was evidently cut off in the original process of preparation.

Scapanus orarius orarius True

"*Scalops Townsendii*, Bach." (part), Cooper, Pac. R. R. Expl. and Surv., 12, book 2, 1860, p. 73. (Reported not common in any part of Washington Territory visited by Cooper; includes note on habits).

Specimens examined.—Two: Nos. 621/1772, 1381/37434, U. S. Nat. Mus. No. 621/1772: original label lost; according to label attached the specimen is a "*Scalops townsendii*" from "Shoalwater Bay, W. T. Sept. 54. Dr. J. G. Cooper 17"; reverse side of label bears four measurements. No. 1381/37434: original label lost; obverse side of label attached reads "1381 *Scalops townsendii* [in ink] minimus [in pencil] ♀ Shoalwater Bay, Aug. 30, 55 Dr. J. G. Cooper"; reverse, four measurements.

These specimens have both been made over and their skulls removed. Skull No. 1772 is in fair condition, though its posterior portion is broken off and temporal bones somewhat loosened. No. 1381/37434 is the type of *Scapanus orarius*. For detailed remarks on the condition of the specimen see Lyon and Osgood (1909, p. 234).

Sorex vagrans vagrans Baird

"*Sorex*—————?" Cooper, Zoology, in Cronise, The Natural Wealth of California, 1868, p. 441 (General note

on the shrews, on the systematic status and distribution of which Dr. Cooper evidently did not care to commit himself.)

"*Sorex vagrans* Cp." (probably part), Cooper, Proc. Cal. Acad. Sci., 4, 1870, p. 70 (Latitude of San Francisco said to be southern limit of distribution).

"*Sorex Suckleyi*, Baird" (probably part), Cooper, Proc. Cal. Acad. Sci., 4, 1870, p. 70 (Latitude of San Francisco said to be southern limit of distribution).

Specimens examined.—Two: No. 5629, Univ. Calif. Mus. Vert. Zool.; No. 1675, U. S. Nat. Mus. (in alcohol). No. 5629: obverse of label "Novato Point, Marin Co., Cal., Nov. 1st. 70 *Sorex* J. G. C."; reverse, ten measurements. No. 1675: original label missing; obverse of museum label attached reads "Smithsonian Institution, Washington, U. S. A. 1675 *Sorex vagrans* Shoalwater Bay W. T. Dr. J. G. Cooper."

No. 5629 prepared as study skin; skull inside; forefeet folded on breast, hind feet extended posteriorly; tail not skinned out, curled up posteriorly. No. 1675 is the type of the species; it is preserved entire in alcohol and is in good condition except that the hair has come off from the entire skin; for further remarks on the condition of the type, see Lyon and Osgood (1909, p. 251).

I am indebted to Dr. Hartley H. T. Jackson of the U. S. Biological Survey for confirming the identification of this specimen.

Neosorex palustris navigator Baird

"*Neosorex navigator* Cooper," Pac. R. R. Expl. and Surv., 12, book 2, 1860, p. 36 (" . . . one seems to be peculiar to the Territory, the water shrew [*Neosorex navigator*], caught while swimming a foot below the surface of one of the lakes at the head of the Yakima river, and at least 2,500 feet above the ocean"); Same, p. 73 ("But one specimen of this species was obtained during the expedition; this, according to the label now attached, was found at Fort Vancouver, but I am inclined to consider this a mistake, and that it was really taken while swimming under water in a lake near the summit of the Cascade mountains, August 31, 1853").

Specimen examined.—One: No. 629/1780, U. S. Nat. Mus.; original label lost; A "N. Pac. R. R. Survey" label is attached, the obverse of which reads "N. Pacific R. R. Survey, Gov. . . Stevens 629/1780 *Neosorex navigator* Type Ft. Vancouver, Columbia R., W. T. Dr. J. G. Cooper."; measurements in pencil on the back of the label.

Specimen in bad condition; for details see Lyon and Osgood (1909, p. 246).

Merriam has discussed the type locality of this form in the following words:

"It is evident that the type specimen, like many other alcoholic mammals collected in the early days, was not labeled until long after its capture, and that little dependence can be placed on either of the alleged localities. Furthermore, since the subgenus *Neosorex* is unknown from the Cascade region, and probably does not inhabit western Oregon or Washington, which region is occupied by the allied subgenus *Atophyrax*, it is highly improbable that the specimen came from either of the alleged localities. It agrees closely with specimens from western Montana, and probably came from some point in northern Idaho or the mountains east of Fort Colville, in extreme northeastern Washington, which region was visited by Dr. Cooper during the same expedition (1895, p. 92)."

Several facts germane to this problem can now be cited as tending to fix the type locality more definitely. Though *Neosorex palustris navigator* has never been taken on the humid coast belt in Washington, in which lies Fort Vancouver, specimens have been secured by the Biological Survey at the following localities in the Cascade Mountains: Signal Peak (on the Yakima Indian Reservation east of Mt. Adams), Mt. St. Helens, Mt. Adams, and Mt. Rainier.

According to Cooper (1860b, p. 73), as quoted above, the specimen under consideration (which became the type) was "taken while swimming under water in a lake near the summit of the Cascade mountains on August 31, 1853." But in another place Cooper refers (1860a, p. 36) to the capture of this animal, of which only one specimen was taken, on one of the lakes at the head of the Yakima River. On August

31, Captain McClellan and a small party¹² were engaged in explorations of Naches River and Naches Pass, while the head of the main Yakima River and Lakes Keechelus, Kachess, and Clealum were explored September 4 to 12 (Stevens, 1860, pp. 139-141). Evidently the type came either from the headwaters of the Naches River or from one of the lakes at the head of the main Yakima River. Since these places are within twenty miles of each other, the type locality of *Neosorex p. navigator* may be regarded as fixed with a fair degree of precision.

***Myotis californicus* (subspecies indet.)**

?“*V[espertilio] nitidus*” (part) and “*V. obscurus*” (part), Cooper, Zoology, in The Natural Wealth of California, 1868, p. 442.

“*Vespertilio nitidus* Allen” (part), Cooper, Proc. Cal. Acad. Sci., 4, 1868, p. 5 (“Lat. 49° W. T., to Cape St. Lucas and Texas.”)

“*Vespertilio obscurus* Allen” (part), Cooper, Proc. Cal. Acad. Sci., 4, 1868, p. 5 (“Oregon? to Cape St. Lucas”).

Specimen examined.—One: No. 7187, U. S. Nat. Mus. (in alcohol); an old label in the bottle, from which the writing has almost disappeared, reads “583 *Vespertilio* S D” According to the Museum catalog, in which the specimen was entered January 19, 1864, the bat was collected by “Mr. J. Cooper,” in California.

The specimen is in fair condition, except that the hair has sloughed off the skin of the posterior half of the body. The skull has not been removed.

***Myotis californicus quercinus* H. W. Grinnell.**

“*V[espertilio] nitidus*” (part), Cooper, Zoology, in Cronise, The Natural Wealth of California, 1868, p. 442.

Specimen examined.—One: No. 5601, Univ. Calif. Mus. Vert. Zool.; obverse of label “*Vespertilio nitidus* Allen, San

¹² It is probable that Dr. Cooper accompanied Captain McClellan on this side trip. Baird (1857, p. 465) lists a specimen of “*Hesperomys gambelii*” collected by Dr. J. G. Cooper on “Naches Pass, Cascade mountains, W. T.” on “July 1, 1854.” The date is evidently erroneous, for during July, 1854, Cooper was in western Washington (see p. 74); but the record appears to indicate that Cooper did collect on Naches Pass.

Diego Cal. Apr. 24th, 62. J. G. C.”; reverse, ten measurements.

Specimen mounted dorsal side down on a strip of brown paper, the wings extended and sewed to the paper with white thread; skull inside skin; specimen in excellent condition.

Not typical of *Myotis californicus quercinus* H. W. Grinnell, the terminal portions of the hairs below being buffy brown, as in *M. c. californicus*, rather than light buff, as in typical *quercinus*. Geographically, however, it should be referable to *quercinus*, unless it represents a wandering example of the more northerly race.

Eptesicus fuscus fuscus (Beauvois)

“*Scotophilus fuscus* Palisot (Allen),” Cooper, Proc. Cal. Acad. Sci., 4, 1868, p. 5 (Said to occur in the “whole United States to Vera Cruz, Mexico”).

“*Scotophilus fuscus*,” Cooper, Zoology, in Cronise, The Natural Wealth of California, 1868, p. 442.

Specimen examined.—One: No. 5600, Univ. Calif. Mus. Vert. Zool., original data “1502 *Scotophilus fuscus* { Palisot
Allen
Brown Bat, Mount Stanford,¹³ Cal. 7500 ft. alt. July 29, 70
J. G. Cooper”.

This specimen is mounted, dorsal side down, on a strip of brown paper, the wings being extended and sewed into the paper with black thread. The skull is inside the skin. Specimen in fairly good condition. Possibly faded a trifle, but very similar to pale-colored specimens of the form in collections.

Nycteris borealis teliotis (H. Allen)

“*Lasiurus noveboracensis*” (part), Cooper, Zoology, in Cronise, The Natural Wealth of California, 1868, p. 442.

“*Lasiurus Noveboracensis* Erxleben (Tomes)” (part), Cooper, Proc. Cal. Acad. Sci., 4, 1868, p. 5 (Said to occur in “whole United States and south to Chili.”)

¹³ Mount Stanford: Nevada County, California (see Whitney's Map of California and Nevada, State Geological Survey of California, 2nd ed., 1874), four or five miles a little north of east of Donner Lake, probably the present Castle Peak (see Truckee Sheet, U. S. Geological Survey, Topographic Map of the United States, 1906).

Specimen examined.—One: No. 84555, U. S. Nat. Mus.; original Cooper label missing; oldest label attached reads "*Atalapha teliotis* Cal. Acad. N. S." With regard to the source of this specimen, Dr. Allen, the describer of this species, says (1891, pp. 5, 6) "The specimen was forwarded to me by Mr. J. G. Cooper, of the California Academy of Natural Science" "Habitat unknown, but it is probably Southern California."

The skin is in alcohol; in poor state of preservation; for discussion of its condition see Lyon and Osgood (1909, p. 277.)

***Corynorhinus rafinesquii intermedius* H. W. Grinnell**

"*Synotus Townsendii* Cooper, (Wagner)," Cooper, Proc. Cal. Acad. Sci., 4, 1868, p. 6 (Said to occur in "Nebraska and Washington Territory to Utah [and Cal.]").

"*Synotus Townsendii*," Cooper, Zoology, in Cronise, The Natural Wealth of California, 1868, p. 442 (Said to be "found in the desert east of the Sierra," which is erroneous); Cooper, Proc. Cal. Acad. Sci., 4, 1871a, p. 124 (Refers to bats of this species found in a cave in El Dorado County).

Specimens examined.—Three: Nos. 5603, 5604, 5605, Univ. Calif. Mus. Vert. Zool. No. 5603: obverse of label "*Synotus Townsendii* Cooper ♀ Pioneer Cave ¹⁴ Placer Co. Cal. May 12th '70 J. G. Cooper"; reverse, nine measurements. No. 5604: obverse of label "*Synotus Townsendii* Cooper sp. ♀ Pioneer Cave, Placer Co. Cal, May 12 '70"; reverse, nine measurements. No. 5605: obverse of label "*Synotus Townsendii* Cooper Placer Co. Cal. May 12, 1870 ♀ J. G. Cooper Coll."; reverse, nine measurements.

Specimens prepared as study skins, dorsal side down, wings extended; skulls inside skins; abdominal incisions not sewed up in Nos. 5603 or 5605. No. 5604 mounted on a doubled piece of white paper, apparently two discarded pages from an old catalog of Cooper's, the wings being sewed to the paper with black thread. Specimens in fair condition except for No. 5605: The head of the latter has been broken off and is missing, and one wing is somewhat torn.

¹⁴ Pioneer Cave could not be located on any map examined.

The three specimens agree closely with a series of Mrs. Grinnell's *Corynorhinus rafinesquii intermedius* in the collection of the Museum of Vertebrate Zoology.

It is highly probable that the locality where these bats were actually secured is not far from the type locality of *C. r. intermedius* (Auburn, California).

***Antrozous pallidus pallidus* (LeConte)**

"*Antrozous pallidus*," Cooper, Zoology, in Cronise, The Natural Wealth of California, 1868, p. 442; Amer. Nat., 3, 1869, pp. 472, 478 (Fort Mojave).

"*Antrozous pallidus* Lec.," Cooper, Proc. Cal. Acad. Sci., 4, 1870, p. 74 (Colorado Valley).

"*Antrozous pallidus* Leconte, (Allen)" (part), Cooper, Proc. Cal. Acad. Sci., 4, 1868, p. 6 ("Columbia River to Cape St. Lucas and Texas").

Specimen examined.—One: No. 5602, Univ. Calif. Mus. Vert. Zool.; obverse of label "223 ♀ Ft. Mojave Coldo V May 1 '61 J. G. C."; reverse, ten measurements.

Specimen is stuffed, to lie on back, wings extended; in good condition.

Though somewhat faded, the specimen is still typical of this form.

***Vulpes macrotis arsipus* Elliot**

"*Vulpes velox* (Aud. and Bach.)," Cooper, Proc. Cal. Acad. Nat. Sci., 2, 1863, p. 121 (One specimen recorded from Fort Mojave, apparently from the California side of the Colorado River, as the species is listed under the heading "Known species new to the State of California").

"*Vulpes velox*," Cooper, Zoology, in Cronise, The Natural Wealth of California, 1868, p. 439 ("The Swift Fox is a small kind found on the desert plains of the interior"); Amer. Nat., 3, 1869, p. 476 (Reference made to specimen taken at Fort Mojave on March 30, 1861).

"*Vulpes velox* Say," Cooper, Proc. Cal. Acad. Sci., 4, 1870, p. 74 (Colorado Valley).

Specimen examined.—One: No. 5646, Univ. Calif. Mus. Vert. Zool., obverse of label "156 *Vulpes velox* ♂ Ft Mojave

Col'do R. Mch. 30 '61 J. G. C." ; reverse, eleven measurements, and a notation "I. brush grey". A separate label has the printed name pasted on "*Vulpes velox*, Aud. and Bach. Kit Fox; Swift Fox."¹⁵

Skin in poor condition, neither stuffed nor tanned. Bones of tail, feet, and partly of legs, attached; skull removed, neck stuffed with brown paper, left fore leg almost broken off; tail partly broken off, adherent by bones only.

The specimen closely resembles examples of *Vulpes macrotis arsipus* from the Colorado River in the collection of the Museum of Vertebrate Zoology.

Mephitis occidentalis holzneri Mearns

"*Mephitis occidentalis*" (part), Cooper, Zoology, in Cronise, The Natural Wealth of California, 1868, p. 436. (Common in California); Amer. Nat., 3, 1869, p. 186 ("Southern coast-slope" of California).

Specimen examined.—One, skull only: No. 7048, Mus. Comp. Zool. Harvard Univ.; original label missing; museum label reads "Museum Comp. Zool., Skull No. 7048 ♀ *Mephitis occidentalis* Baird, Cal. Saticoy, Apl. 1873." On cranium, apparently in Cooper's handwriting, appears the following: "*Mephitis* ♀ Saticoy, Cal. Apr. 1873 J. G. C."

Cranium in good condition, but with injury between left outer incisor and canine, and with small portion of right paroccipital process missing.

Mephitis occidentalis (subspecies indet.)

Specimen examined.—One, skin only: No. 5644, Mus. Comp. Zool. Harvard Univ.; original label missing; items from labels attached indicate that skin is from "California" and was collected by "Dr. J. G. Cooper."

Skin has been made over into a modern museum specimen. In the absence of a cranium it is not identifiable as between

¹⁵ In the case of certain Cooper specimens from the older collection of the University of California, now incorporated with the collection of the Museum of Vertebrate Zoology, printed strips bearing the scientific or vernacular names or both have been pasted on Cooper's original label. It is not improbable that this was the work of J. J. Rivers, who at one time did curatorial duty on the collections in the Department of Zoology at the University of California.

Mephitis occidentalis occidentalis and *M. o. holzneri*. It seems not unlikely, however, that this skunk came from Saticoy, as did the one listed on page——, and that it is referable to *holzneri*.

Lynx fasciatus fasciatus Rafinesque

“*L[ynx] fasciatus*,” Cooper, Pac. R. R. Expl. and Surv., 12, book 2, 1860, p. 32 (Peculiar to forests of western Washington.)

“*Lynx fasciatus* Raf.,” Cooper, Pac. R. R. Expl. and Surv., 12, book 2, 1860, pp. 74-75 (Abundant in the forests of Washington Territory; habits).

Specimen examined.—One: No. 464 [probably 461], U. S. Nat. Mus.; original label missing; obverse of label attached “464 *Lynx faciatus* [so] Shoalwater Bay, W. T. Dr. J. G. Cooper.” A museum label attached to the specimen bears the date “Sept. 1854.”

Specimen evidently made over into modern study skin after receipt at Museum.

This example and another collected by Dr. Suckley are at the dark extreme of the *Lynx fasciatus* series as represented in the collections in the National Museum.

Lynx ruffus californicus Mearns

“*Lynx rufus*” (part), Cooper, Pac. R. R. Expl. and Surv., 12, book 2, 1860, p. 75 (Abundant in California); Cronise, The Natural Wealth of California, 1868, p. 438 (Abundant throughout California); Amer. Nat., 3, 1869, p. 186.

“*Lynx rufus*, var. *maculatus*” (part), Cooper, Amer. Nat., 8, p. 15 (Cuyamaca Mountains).

Specimen examined.—One: No. 1167, U. S. Nat. Mus., original label missing; obverse of old label attached “1167 *Lynx rufus?* Santa Clara, Cal. Dr. J. G. Cooper”; reverse, four measurements. The typewritten museum label attached bears the date “November 1855.”

Specimen evidently worked over and made up after receipt at Museum. Skin in rather poor condition; large hole on the left side.

The specimen is a trifle darker than the type of *Lynx ruffus californicus*, apparently varying somewhat in the direction of *L. r. oculus*.

***Peromyscus californicus californicus* (Gambel)**

"*H[esperomys] Californicus*," Cooper, Zoology, in Cronise, The Natural Wealth of California, 1868, p. 444 (General note inserted to cover all *Peromyscus* listed).

"*Hesperomys californicus* Gamb.," Cooper, Proc. Cal. Acad. Sci., 4, 1870, pp. 63, 69. (Peculiar to California; not known to occur north of the latitude of San Francisco Bay).

"*Hesperomys Californicus*," Cooper, Amer. Nat., 4, 1871, p. 757. (Monterey).

Specimens examined.—Eight; Nos. 5835, 5836, Univ. Calif. Mus. Vert. Zool.; Nos. 8547-8552, U. S. Nat. Mus. No. 5835: original label missing; labelled *Hesperomys Californicus* ♂ Santa Cruz, Calif., April. No. 5836: original label missing, labelled *Hesperomys Californicus*, from Los Gatos, Calif., April. The specimens in the National Museum all lack original labels; Nos. 8547-8549 are labelled *Hesperomys californicus*, Santa Cruz, Dr. J. G. Cooper, 1861; Nos. 8550-8552 come from the same locality, but are dated 1866.

Specimens prepared in accordance with Cooper's custom; part of skull inside each skin; fore-feet folded back on breast, hind feet either irregularly aligned posteriorly or arranged anteriorly beneath body; tails never skinned out. Some of the skins have very little stuffing within them; one, No. 8552, is represented by a head only.

The condition and coloration of the pelage, the size and especially the thickness of the tail, were principally relied on in the identification of these specimens. The cranium of No. 8552 has been removed, and its characters confirm the identification previously made.

***Peromyscus eremicus fraterculus* (Miller)**

"*H[esperomys] Sonoriensis*" (part), Cooper, Zoology, in Cronise, The Natural Wealth of California, 1868, p. 444.

Specimen examined.—One: No. 145276, U. S. Nat. Mus.; obverse of label "268d *Hesperomys sonoriensis* ♀ San Diego

Cal May 26th '62, J G C"; reverse "from old nest of Cactus Wren 4 ft above ground 2 young on teats, in alcohol."

Prepared as usual, part of skull inside skin; fore feet disposed irregularly on breast, hind feet bent forward beneath body; abdominal slit not sewed up; tail straight out behind, not skinned; body stuffed with cotton; in good condition.

The relatively long tail, which lacks the distinct dorsal and ventral coloration characteristic of *Peromyscus maniculatus gambelii*, demonstrates the identity of this specimen.

***Peromyscus maniculatus clementis* (Mearns)**

"*H[esperomys] Gambelii*" (probably part), Cooper, Zoology, in Cronise, The Natural Wealth of California, 1868, p. 444.

"*Hesperomys* _____?", Cooper, Proc. Cal. Acad. Sci., 4, 1870, p. 77 (Collected on Santa Barbara Island, and evidently observed on San Clemente; record of occurrence on Santa Catalina Island is questioned).

Specimen examined.—One: No. 7184, U. S. Nat. Mus.; obverse of label "*Hesperomys gambelii* S. Barbara I. Cal. May 27th 63 J. G. C."

Prepared as usual; a portion of the skull is inside the skin; fore feet folded on breast, hind feet crossed behind body; tail not skinned. Specimen in good condition, except tail loose.

Although no characters distinguishing this specimen from topotypes of *Peromyscus maniculatus gambelii* are clearly in evidence, it should doubtless be referred to *P. m. clementis* on geographic grounds alone.

***Peromyscus maniculatus sonoriensis* (LeConte)**

"*H[esperomys] Sonoriensis* (LeConte)," Cooper, Proc. Cal. Acad. Nat. Sci., 2, 1863, p. 122 (Mojave River).

"*H[esperomys] Sonoriensis*," Cooper, Zoology, in Cronise, The Natural Wealth of California, 1868, p. 444 (General note covers all the *Peromyscus*).

"*Hesperomys Sonoriensis*," Cooper, Amer. Nat., 3, 1869, p. 183 (Southern part of California).

"*Hesperomys Gambellii*" (part), Cooper, Amer. Nat., 3, 1869, pp. 473, 476 (Fort Mojave).

"*Hesperomys sonoriensis* Lec." (part), Cooper, Proc. Cal. Acad. Sci., 4, 1870, pp. 67, 68 (Range does not so far as known extend north of "Southern Coast Slope").

"*Hesperomys Boylii*? Baird," Cooper, Proc. Cal. Acad. Sci., 4, 1870, p. 74 (Colorado Valley).

"*Hesperomys Gambellii*? Baird," Cooper, Proc. Cal. Acad. Sci., 4, 1870, p. 74 (Colorado Valley).

Specimens examined.—Five: Nos. 5624, 5625, Univ. Calif. Mus. Vert. Zool.; Nos. 7183, 7186, 145275, U. S. Nat. Mus. No. 5624: original label missing; skeleton only; Fort Mojave, Feb. 24, 1861, J. G. Cooper. No. 5625: obverse of label "*Hesperomys sonoriensis*? [the "sonoriensis?" pencilled in] ♀ Mojave R. Camp Cady ¹⁸ June 6, '61, J. G. C."; reverse, ten measurements. No. 7183: original label missing; from two other labels attached we learn that the specimen came from "California"; it is credited to the "Geol. Surv. Cal.," and is said to have been collected by Dr. J. G. Cooper; it has been variously identified as "*Hesperomys*" merely, "*Hesperomys leucopus*," "*Hesperomys leucopus*?" "*gambelli*," and "*Peromyscus m. sonoriensis*." No. 7186: obverse of label "90 *Hesperomys gambelli* ♂ Ft. Mojave Coldo. R. Feb. 14 '61, J. G. C."; reverse, eleven measurements. No. 145275: obverse of label "19 *Hesperomys gambelli* Ft. Mojave, Col'do R. Dec. 24th '60, J. G. C."; reverse, ten measurements.

As usual with Dr. Cooper's material these skins were prepared with the skulls inside, the forelegs folded on breast, the hind legs crossed and tied just posterior to body or disposed beneath body; tail not skinned (end nearly broken off in No. 7183), extended posteriorly; in several of the specimens the abdominal slit is not sewed up.

Nos. 7183 and 7186 are bright examples of *Peromyscus maniculatus sonoriensis* both apparently in full winter pelage. It is not improbable that No. 7183 came from Fort Mojave, as did No. 7186. The other specimens are typical *sonoriensis*, presenting no conspicuous peculiarities.

¹⁸ Camp Cady: San Bernardino County, Cal., on lower course of Mojave River, about lat. 35°, long. 116° 30', a little south of west of the south end of the sink of the Mojave River (see Whitney's Map of California and Nevada, State Geological Survey of California, 2nd ed., 1874). Camp Cady is shown on all the maps of this period which I have examined.

***Peromyscus maniculatus gambelii* (Baird)**

"*H[esperomys] Gambelii*," Cooper, Zoology, in Cronise, The Natural Wealth of California, 1868, p. 444 (A general note is inserted to cover all the *Peromyscus*).

"*Hesperomys Gambelii*," Cooper, Amer. Nat., 3, 1869, p. 473 ("The common woodmouse of California.")

"*Hesperomys sonoriensis* LeC." (part), Cooper, Proc. Cal. Acad. Sci., 4, 1870, pp. 67, 68 (Range does not, so far as known, extend north of "Southern Coast Slope").

Specimens examined.—Four: Nos. 5626, 5627, Univ. Calif. Mus. Vert. Zool.; Nos. 5652, 5653, Mus. Comp. Zool. Harvard Univ. No. 5626: obverse of label "*Hesperomys Gambelii* Wilmington Cal. Oct '65, J. G. C.". No. 5627: obverse of label "*Hesperomys californicus*.—Great-Eared mouse [printed strips pasted on] ♀ Sta Cruz Cal. Apr 8th, '66, J. G. C." Cooper had written "*Hesperomys Californicus*" on the label, the printed strips having been pasted over his written name. No. 5652, obverse of label "*Hesperomys sonoriensis*-juv. Saticoy Cal. May 1873 J. G. C."; No. 5653, obverse of label (erroneously attached here) "*Perognathus parvus* Saticoy Cal. Mch. '73 J. G. C."

Specimens (Nos. 5626-5627) prepared in the usual manner, skulls inside skins, fore legs folded on breast, etc.; abdominal slit in No. 5626 not closely sewed up; hind feet in this specimen disposed at right angles to body in the region of the base of the tail, tails not skinned. In No. 5627 the hind feet are broken so that care must be exercised to avoid separating them from the body completely. Nos. 5652-5653 have been made over into modern museum skins; the skulls have been removed; that of No. 5652 is uncleaned, and its posterior portion has been cut away as was customary with Cooper in preparing his specimens. I have not seen the skull of No. 5653.

The October example of *Peromyscus maniculatus gambelii* from Wilmington, California, is buffy in coloration, with some admixture of black; the April specimen from Santa Cruz is intensely warm buff to ochraceous-buff, likewise with some black intermixed. No. 5652 from Saticoy is a typical juvenal.

Peromyscus maniculatus oreas (Bangs)

"*Hesperomys austerus*" (probably part), Cooper, Pac. R. R. Expl. and Surv., 12, book 2, p. 23 (In western Washington confined to prairies or their borders).

[?] "*Hesperomys austerus* Baird" (probably part), Cooper, Pac. R. R. Expl. and Surv., 12, book 2, pp. 83-84 (One taken August 11 [1853] on top of the Cascade Mountains).

"*Hesperomys boylii* Baird" (part), Cooper, Pac. R. R. Expl. and Surv., 12, book 2, p. 84 (One specimen collected at Shoalwater Bay, Washington Territory).

"*Hesperomys austerus*?" (probably part), Cooper, Amer. Nat., 3, 1869, p. 476 (Incidental reference to this species as occurring in Washington Territory).

Specimen examined.—One: No. 578/1701, U. S. Nat. Mus., original label missing; according to other labels attached the specimen is a female collected at Shoalwater Bay, Washington Territory, by Dr. Cooper.

Skin made over into modern museum specimen, but vertebrae left in tail. In rather poor condition, right ear and fore leg broken off, several patches of hair gone from back, tail loose; skull could not be located in the National Museum collection on February 6, 1918.

Peromyscus truei gilberti (Allen)

"*H[esperomys] Californicus*" (part), Cooper, Zoology, in Cronise, The Natural Wealth of California, 1868, p. 444 (A general note covers all the *Peromyscus*).

"*H[esperomys] Boylii* (part), Cooper, Zoology, in Cronise, The Natural Wealth of California, 1868, p. 444 (A general note covers all the *Peromyscus*).

Specimens examined.—Three: Nos. 5833, 5834, Univ. Calif. Mus. Vert. Zool.; No. 145278, U. S. Nat. Mus. No. 5833: original label missing; label attached reads "*Hesperomys californicus* (young), Santa Cruz, April." No. 5834 also lacks the original label; it is labelled "*Hesperomys californica* Monterey, Calif." No. 145278: obverse of label "494 *Hesperomys boylii* Baird ♂ Monterey Cal. Sept. 4 '61 J. G. C."; reverse, eleven measurements.

Specimens in fair condition; skulls have been removed from Nos. 5833, 5834 for examination; fore legs folded on breast, hind feet extended posteriorly; tail not skinned out, disposed posteriorly. In No. 145278 the tip of tail is broken off.

The long ears, pelage quality, general size, and cranial characters of these specimens all indicate their identity with *Peromyscus truei gilberti*.

Neotoma albigula venusta True

"*N[eotoma] Mexicana*" (part), Cooper, Zoology, in Cronise, The Natural Wealth of California, 1868, p. 444.

"*Neotoma mexicana* Baird" (part), Cooper, Proc. Cal. Acad. Sci., 4, 1870, p. 74 (Colorado Valley).

"*Neotoma Mexicana*" (part), Cooper, Amer. Nat., 3, 1869, p. 477 (Said to be common and very large in the Colorado Valley).

Specimens examined.—Three: Nos. 5608, 5609, 5610, Univ. Calif. Mus. Vert. Zool. No. 5608; obverse of label "91 *Neotoma mexicana*, Baird, Mexican Bush Rat, [printed strips pasted on] ♂ Ft. Mojave Feb. 15 '61 J. G. C."; reverse of label, eleven measurements. No. 5609: obverse of label "92 *Neotoma mexicana* ♂ Ft. Mojave, Col'do R. Feb. 16 '61. J. G. C." No. 5610: obverse of label "104 *Neotoma mexicana* ♂ Ft. Mojave, Col'do R. Feb. 20 '61 J. G. C."; reverse, ten measurements.

Skulls inside; fore feet either extended anteriorly and tied together, or else folded posteriorly on breast, hind feet extended posteriorly, tied together; abdominal slit not always sewed up; tails left unskinned, extended posteriorly.

These specimens were identified by Major E. A. Goldman of the U. S. Biological Survey.

Neotoma intermedia intermedia Rhoads

"*N[eotoma] Mexicana*" (probably part), Cooper, Zoology, in Cronise, The Natural Wealth of California, 1868, p. 444.

"*Neotoma mexicana* Baird" (probably part), Cooper, Proc. Cal. Acad. Sci., 4, 1870, p. 68 (not extending north of the "Southern Coast Slope" of California).

"*Neotoma Mexicana*" (probably part), Cooper, Amer. Nat., 3, 1869, p. 184 (Cajon Pass).

Specimen examined.—One: No. 145270, U. S. Nat. Mus.; obverse of label "*Neotoma* (Bairdii J. G. C. [plus an undecipherable notation]) San Diego Cal. May 1st 62 J. G. C."; reverse, ten measurements.

Specimen stuffed with cotton; skull inside; fore feet folded back on breast; hind feet crossed behind body; bones left in tail, which points straight out posteriorly.

The condition of this specimen is not all that could be desired for purposes of identification; but it is evidently closer to *Neotoma intermedia intermedia* than to *Neotoma fuscipes macrotis*, which is the only other wood rat occurring in the region.

***Neotoma intermedia desertorum* Merriam**

"*N[eotoma] Mexicana*" (part), Cooper, Zoology, in Cronise, The Natural Wealth of California, 1868, p. 444.

"*Neotoma mexicana* Baird" (part), Cooper, Proc. Cal. Acad. Sci., 4, 1870, p. 74 (Colorado Valley).

"*?Neotoma Mexicana*" (part), Cooper, Amer. Nat., 3, 1869, p. 184 (Cajon Pass).

"*Neotoma Mexicana*" (part), Cooper, Amer. Nat., 3, 1869, p. 476 (Colorado Valley).

Specimens examined.—Two: Nos. 5607, 5611, Univ. Calif. Mus. Vert. Zool. No. 5607: obverse of label "217 *Neotoma mexicana* ♂ Ft. Mojave Coldo V Apr 29 '61, J G C"; reverse "About half grown". No. 5611: obverse of label "210 *Neotoma mexicana* ♂ Ft. Mojave Col'do V Apr 27 '61 J. G. C."; reverse "two thirds grown" and eleven measurements.

These skins were identified by Major E. A. Goldman of the U. S. Biological Survey. No. 5607 exemplifies a dark phase of coloration not normal in specimens from the Colorado Valley, though in a series of specimens collected in the vicinity of the Desert of the Little Colorado River in Arizona by Goldman in 1917 the darker phase predominates. The other specimen (No. 5611) exemplifies the normal coloration.

Neotoma fuscipes annectens Elliott

"*Neotoma fuscipes*" (part), Cooper, Zoology, in Cronise, the Natural Wealth of California, 1868, p. 444; Amer. Nat., 2, 1868, p. 534 (California).

"*Neotoma fuscipes* Cp.," Cooper, Proc. Cal. Acad. Sci., 4, 1870, pp. 63, 69. (Believed to be peculiar to California; not known to occur north of San Francisco Bay).

Specimens examined.—Three: Nos. 1185/2040, 2041, U. S. Nat. Mus.; No. 5264, Mus. Comp. Zool. Harvard Univ. No. 1185/2040: obverse of label "Santa Clara Cal. Nov. '55. Head $2\frac{1}{4}$ nose to tail 9 tail $8\frac{1}{2}$ Heel $1-\frac{7}{8}$? Cubit $2\frac{1}{2}$ males J. G. Cooper". No. 2041: skull only; label reads "Smithsonian 2041/1159 Institution Neotoma Santa Clara Cal Dr. Cooper". The original label for No. 5264 is lacking; obverse side of the oldest label attached reads "1159/2041 Neotoma 'fuscipes' Santa Clara, Cal. Nov. 55, J. G. Cooper."

No. 1185 in poor condition, original stuffing removed, except for wads of cotton in the regions of chest and head. Skull removed; hole torn in head near left ear; fore feet disposed irregularly in throat region; hind feet and tail pointing straight out behind; bones left in tail, as usual. Parietal portion of cranium (No. 2040) broken; nasal bones and upper incisor teeth broken off, left lower incisor missing. No. 5624 is not stuffed; skin of abdomen slit up nearly five inches; tail not skinned, broken off from skin and tied to right hind foot; portion of skin about head torn off. The cranium numbered 2041 in the National Museum collection evidently belongs with the skin numbered 1159 now in the collection of the Museum of Comparative Zoology (No. 5624, Mus. Comp. Zool.). The skull (No. 2041) is in fragments.

Neotoma fuscipes macrotis Thomas

"*N[eotoma] fuscipes*" (part), Cooper, Zoology, in Cronise, The Natural Wealth of California, 1868, p. 444.

"*Neotoma fuscipes* Cp." (part), Cooper, Proc. Cal. Acad. Sci., 4, 1870, pp. 63, 69. (Believed to be peculiar to California; listed also as one of the animals not known north of San Francisco Bay).

"*Neotoma fuscipes*" Cooper, Amer. Nat., 2, 1868, p. 534, (Casual mention of the species as occurring in California).

"*Neotoma fuscipes*" (part), Cooper, Amer. Nat., 4, 1871, p. 757, (Monterey).

Specimen examined.—One: No. 5606, Univ. Calif. Mus. Vert. Zool.; obverse of label "326 *Neotoma fuscipes*, Cooper, Brown-Footed Rat [printed strips pasted on] Monterey, Cal. Aug 14th 61 J. G. C." There is a pencilled "♀" sign on this face of the label which was evidently put on at a later date than that on which the rest of the label was written; reverse side of the label, eleven measurements.

Prepared as usual, skull inside skin, fore feet folded onto breast, hind feet extended posteriorly; tail folded anteriorly along side of animal.

Neotoma cinerea occidentalis Baird

"*Neotoma occidentalis*," Cooper, Pac. R. R. Expl. and Surv., 12, book 2, p. 32 (occurs in forests west of Cascade Mountains).

"*Neotoma occidentalis*, Cooper," Cooper, Pac. R. R. Expl. and Surv., 12, book 2, pp. 85-86 (Inhabits the wooded regions west of the Cascade Mountains; discussion of habits).

"*N[eotoma] occidentalis*" Cooper, Amer. Nat. 2, 1868, p. 535 (West of Cascade Range).

Specimens examined.—Two: Nos. 462/1662, 572, U. S. Nat. Mus.; No. 462/1662: original label missing; from other labels attached we learn that the specimen is from Shoalwater Bay, W. T., and that it was collected by J. G. Cooper in June, 1854. No. 572: obverse of a label, apparently in Cooper's handwriting "No. 16 W. T. '54 J. G. C."; reverse, seven measurements and sex, "male."; another label attached reads "N. Pacific R. R. Survey Gov. I. I. Stevens 572 *Neotoma occidentalis* ♂ Shoalwater Bay, W. T. Dr. J. G. Cooper." This specimen is the type of *occidentalis*. For additional details regarding it see Lyon and Osgood (1909, pp. 102-103).

Both these examples of *Neotoma cinerea occidentalis* have been made over into modern study skins. The skull of No. 462/1662 is in good condition, except that the posterior portion of the cranium has been cut off and the angular processes of the mandibles are broken.

Microtus townsendii (Bachman)

"*Arvicola Townsendii*, Bachman" (part), Cooper, Pac. R. R. Expl. and Surv. 12, book 2, 1860, p. 86 (Abundant on the meadows of Shoalwater Bay).

"*Arvicola Townsendii*, Bachm." (part), Cooper, Proc. Cal. Acad. Sci., 4, 1870, p. 70 (Latitude of San Francisco said to be southern limit of distribution.)

Specimen examined.—One: No. 5300, Mus. Comp. Zool. Harvard Univ.; original label lacking; obverse of oldest label attached "N. Pacific R. R. Survey. Gov. I. I. Stevens 464 *Arvicola townsendii* skull 1595 Shoalwater Bay, W. T. Dr. J. G. Cooper."

Skull removed; skin stuffed with cotton, in good condition; fore feet spread, pointing out to sides; hind feet pointing irregularly to rear; tail not skinned out, disposed posteriorly.

Microtus californicus californicus (Peale)

"*A[rvicola] Californica*" (probably part), Cooper, Zoology, in Cronise, The Natural Wealth of California, 1868, p. 445.

"*A[rvicola] montana*" (probably part), Cooper Zoology, in Cronise, The Natural Wealth of California, 1868, p. 445.

"*A[rvicola] edax*" (probably part), Cooper, Zoology, in Cronise, The Natural Wealth of California, 1868, p. 445.

"*Arvicola edax* Lec." (probably part), Cooper, Proc. Cal. Acad. Sci., 4, 1870, pp. 63, 69 (Believed to be peculiar to California; not known to occur north of San Francisco Bay).

"*Arvicola edax*" (probably part), Cooper, Amer. Nat., 4, 1871, p. 757 (Monterey; called the "Monterey Field-mouse").

Specimens examined.—Two: Nos. 145279, 145280, U. S. Nat. Mus.; No. 145279, obverse of label "424 *Arvicola* [*'edax*' pencilled in] Monterey Cal. Aug. 23 '61"; reverse, eleven measurements. No. 145280, obverse of label "*Arvicola montana* ♂ Oakland Cal. Apr. 3 '63, 950 J. G. C."; reverse, eleven measurements.

Specimens prepared as usual; skulls inside skins, fore feet folded back on breast; hind feet disposed irregularly behind body except in No. 145280, in which hind feet are crossed close up to posterior end of body; tail not skinned out.

In coloration these specimens are close to examples of *Microtus californicus californicus* in the Biological Survey Collection from Alameda, Marin and Monterey Counties; the brownish dorsal coloration with the whitish of the under parts very faintly washed with buffy can be easily matched in our series. While it is true that No. 145279 resembles certain pale-colored examples of *edax* from the Sacramento Valley, on the average *edax* is considerably darker. No. 145280, an immature specimen, is paler than are specimens of *edax* of corresponding age.

Lagurus pauperrimus (Cooper)

"*Arvicola pauperrima*" Cooper, Amer. Nat., 2, 1868, pp. 535-536. (Original description, with notes on habits).

Specimen examined.—One: No. 10268/35071 U. S. Nat. Mus.; obverse of label "*Arvicola* ♂ 126 Great Plains, W. T. Oct. 9 60 J. G. C."; reverse, eight measurements.

This specimen, though in very poor condition (see Lyon and Osgood, 1909, p. 90) is nevertheless of importance from the fact that it is the type of *Lagurus pauperrimus*; and the species is of interest because it is one of the earliest known members of the group of short-tailed gray meadow mice of the uplands, now referred to the genus *Lagurus*.

Mus musculus musculus Linnæus

"*Mus musculus*," Cooper, Zoology, in Cronise, The Natural Wealth of California, 1868, p. 444.

Specimen examined.—One: No. 5651, Mus. Comp. Zool. Harvard Univ.; original label missing. Said to have been collected in "California" by "J. G. Cooper."

Specimen has been made over into modern study skin, skull removed but not cleaned; the posterior portion evidently cut away in the original process of preparation.

Rattus rattus (subspecies indet.)

"*M[us] rattus*," Cooper, Zoology, in Cronise, The Natural Wealth of California, 1868, p. 444 (General note on the introduced rats).

Specimen examined.—One: No. 5647, Univ. Calif. Mus. Vert. Zool.; obverse of label "755 *Mus rattus*, L-Black Rat [printed slip pasted on] San Diego Cal ♀ Feb 7th '62 J. G. C."; reverse, eleven measurements.

The specimen is prepared as usual, skull inside, hind feet sticking out behind, fore feet folded back on breast; tail not skinned out, turned so as to lie along back.

This animal is a pure albino; the size of its ears, length of its tail, and character of its teeth shows it to belong to the *rattus* series rather than to *norvegicus*.

Thomomys bottæ bottæ (Eydoux & Gervais)

"*Thomomys bulbivorus*" (part), Cooper, Zoology in Cronise, The Natural Wealth of California, 1868, pp. 445-446 (Middle counties near the coast).

"*T[homomys] umbrinus*" (part), Cooper, same, p. 446 ("found in the southeast quarter [of the state]"); Amer. Nat., 3, 1869, p. 183 (Southern part of California).

"*Thomomys bulbivorus* Rich." (part), Cooper, Proc. Cal. Acad. Sci., 4, 1870, pp. 63, 69 (Peculiar to California; not known to occur north of the Middle and North Coast Ranges).

"*Thomomys umbrinus* Rich." (part), Cooper, same, p. 68 (Does not extend north of the southern coast slope).

Specimens examined.—Seven: Nos. 5613-5617, Univ. Calif. Mus. Vert. Zool.; Nos. 11933, 145271, U. S. Nat. Mus. No. 5613: obverse of label "*Thomomys bulbivorus* San Mateo Cal. Mch 10 '63 J. G. C."; reverse, eight measurements. No. 5614: obverse of label "*Thomomys bulbivorus*—California Gopher— [printed strips pasted on] San Mateo Cal. Mch. 7, '63 J. G. C."; reverse, eleven measurements. No. 5615: obverse of label "*Thomomys talpoides bulbiv* Santa Cruz Mts. Cal. 20th May 1864 J. G. C."; reverse, nine measurements and the word "young?"; the "*talpoides bulbiv*" portion of the scientific name was evidently pencilled in subsequent to the writing of the rest of the label. No. 5616: obverse of label "*Thomomys umbrinus* [printed strip pasted on] Drum Bks. Cal. Oct. '65 Sonora Gopher [printed slip containing name pasted on] J. G. C." No. 5617: obverse of label "*Thomomys umbrinus* Drum Bks. Cal. Nov. '65, J. G. C." No. 11933: original label missing; Saticoy,

Ventura County, no date. No. 145271: obverse of label "679a San Diego Cal Dec 6th '61 J. G. C."

Skins all prepared as was customary by Cooper, skulls inside, fore feet either extended anteriorly or bent back on breast, hind feet folded forward beneath the body posteriorly or extended irregularly backward; tail not skinned, in two specimens (Nos. 11933, 145271, U. S. Nat. Mus.) broken off completely and missing.

Nos. 5615 and 5617 (Univ. Calif. Mus. Vert. Zool.) are young animals. While the pelage appearance of Nos. 5613, 5614 (Univ. Calif. Mus. Vert. Zool.) from San Mateo, California, indicates a condition of molt, close examination of the skin does not disclose the darkened appearance usually so characteristic of the molting process. No. 5616 (Univ. Calif. Mus. Vert. Zool.) is an adult specimen with an unusually intense reddish brown coloration, somewhat resembling *Thomomys bottæ leucodon* in summer pelage. The coloration of No. 11933 (U. S. Nat. Mus.) from Saticoy, California, comes well within the range of variation of *T. b. bottæ*; while a bright-colored example from San Diego (No. 145271, U. S. Nat. Mus.) is very similar to specimens of *bottæ* in the Biological Survey collection from Twin Oaks, California (compare Nos. 100161, 100164). The specimens in the collections of the National Museum were identified by Vernon Bailey of the U. S. Biological Survey.

Thomomys bottæ pallescens Rhoads

"*Thomomys umbrinus*" (part), Cooper, Zoology, in Cronise, The Natural Wealth of California, 1868, p. 446 ("found in the southeast quarter [of the state]"); Amer. Nat., 3, 1869, p. 183 (Southern part of California).

"*Thomomys umbrinus* Rich." (part), Cooper, Proc. Cal. Acad. Sci., 4, 1870, p. 68 (does not extend north of the southern coast slope).

Specimen examined.—One: No. 145273, U. S. Nat. Mus.; obverse of label "273 *Thomomys* ['umbrinus?'] written on in pencil] ♂ Cajon Pass, W. Slope. Cal. June 8 '61, J. G. C."

Skull inside skin; fore feet crossed on breast; hind feet and tail disposed posteriorly; tail not skinned.

This specimen is an immature molting from the soft pelage of the adolescent into a bright summer pelage. Its coloration is well within the range of variation of *Thomomys bottæ pallescens*. Identified by Vernon Bailey of the U. S. Biological Survey.

***Thomomys monticola monticola* Allen**

"*T[homomys] borealis*" (probably part), Cooper, Zoology, in Cronise, The Natural Wealth of California, 1868, p. 446 (Said to be found northward and on the mountains).

Specimen examined.—One: No. 145272, U. S. Nat. Mus.; obverse of label "1125 *Thomomys* Summit Johnson's Pass¹⁷ Sept. 25 '63 J. G. C."; reverse, nine measurements.

Specimen prepared as usual, skull inside skin; fore feet bent back, hind feet folded forward beneath body; tail not skinned out, disposed straight out behind.

The coloration of this specimen is identical with that of a series of topotypes in the collection of the U. S. Biological Survey.

***Thomomys perpallidus mohavensis* Grinnell**

"*Thomomys umbrinus*" (part), Cooper, Proc. Cal. Acad. Nat. Sci., 2, 1861, p. 121 (Said to occur in the "Mojave river bottoms and Cajon Pass"); Amer. Nat., 3, 1869, p. 183 (Southern California).

"*T[homomys] umbrinus*" (part), Cooper, Zoology, in Cronise, The Natural Wealth of California, 1868, p. 446 ("found in the southeast quarter [of the state]").

Specimen examined.—One: No. 5845, Univ. Calif. Mus. Vert. Zool.; original label missing; label from old University collection reads "No. 254, *Thomomys umbrinus*? ♂ Bottom land Mojave R. June."

Skull left within the skin; fore legs crossed on breast, hind feet crossed at base of tail; tail not skinned; abdomen not sewed up; in fairly good condition.

This animal is evidently an immature; it is molting conspicuously from a pale to a much browner pelage.

¹⁷ Johnson's Pass: El Dorado County, California (see Whitney's Map of California and Nevada, State Geological Survey of California, 2nd ed., 1874), about eight miles south of the south end of Lake Tahoe, at the head of the South Fork of the American River between Lake Valley and Phillips (see Pyramid Peak Sheet, U. S. Geological Survey, Topographic Map of the United States, 1905).

Perognathus panamintinus brevinasus Osgood.

"*Perognathus parvus*" (part), Cooper, Zoology, in Cronise, The Natural Wealth of California, 1868, p. 445 (Note on habits); Amer. Nat., 3, 1869, p. 183 (Southern part of California).

"*Perognathus parvus Peale*" (Part), Cooper, Proc. Cal. Acad. Sci., 4, 1870, p. 63 (Believed to be peculiar to California).

Specimens examined.—Four: Nos. 5633-5635, Univ. Calif. Mus. Vert. Zool.; No. 145280, U. S. Nat. Mus. No. 5633: obverse of label "*Perognathus parvus* Wilmington Cal. Oct. '65 J. G. C." No. 5634: obverse of label "136 - *Perognathus parvus* [printed slip bearing number and name pasted on] Wilmington, Cal. Oct '65 J. G. C." No. 5635: obverse of label "*Perognathus parvus* Wilmington Cal., Oct. '65 J. G. C."

Specimens prepared as usual by Dr. Cooper; skulls within skins (except No. 5633); fore feet folded posteriorly on breast, hind feet extended posteriorly or bent forward beneath body, tails not skinned; in No. 145280 the abdominal slit is not sewed up. Condition of specimens fair, except that the tail in No. 5634 has been broken off about one-half inch from the body.

Perognathus penicillatus penicillatus Woodhouse

"*P[erognathus] penicillatus*" Cooper, Zoology, in Cronise, The Natural Wealth of California, 1868, p. 445 (Notes on habits).

"*Perognathus penicillatus* Woodh." Cooper, Proc. Cal. Acad. Sci., 4, 1870, pp. 67, 74 (Not found west of the desert region; occurs Colorado Valley).

"*Perognathus penicillatus*," Cooper, Amer. Nat., 3, 1869, p. 476 (Colorado Valley; said to be quite common in the thatched roofs.)

Specimens examined.—Four: Nos. 5636, 5637, 5825, 5826, Univ. Calif. Mus. Vert. Zool. No. 5636: obverse of label "267 *Perognathus penicillatus* ♀ Ft. Mojave, Col'do V Apr 25 '61 J. G. C."; reverse, eleven measurements. No. 5637: obverse of label "*Perognathus penicillatus* Woodhouse [printed slip pasted on] Ft Mojave, Col'do R. Mch 19 '61 J. G. C. Tuft-

tailed Mouse [printed slip bearing this name is pasted on over Cooper's initials]"; reverse, eleven measurements. No. 5825: original label missing; from label attached we learn that the specimen is from Fort Mojave; that it was taken in February; and that it is a male. No. 5826: original label missing; data identical with that of No. 5825, except that the specimen was taken in March instead of February.

Skulls inside the skins; fore feet folded posteriorly on breast; hind feet variously placed, one pair forward on the belly, the others posteriorly just back of the body; the tails unskinned, extended irregularly posteriorly; abdominal slits rather carelessly sewed up.

In color characters the specimens agree closely with the large series of *Perognathus penicillatus* taken on both sides of the Colorado River by the members of the Colorado River Expedition of the Museum of Vertebrate Zoology in 1910.

Perodipus agilis simulans Merriam

"*Dipodomys agilis*" (part), Cooper, Zoology, in Cronise, The Natural Wealth of California, 1868, p. 445 (Notes on habits); Amer. Nat., 3, 1869, p. 183 (Southern part of California).

Specimens examined.—Two: No. 5847, Univ. Calif. Mus. Vert. Zool.; No. 7181, U. S. Nat. Mus. No. 5847: original label missing; label attached reads "*Dipodomys agilis* ♂ San Diego Calif. Dec." No. 7181: original label missing; old museum label attached reads "Smithsonian Institution Washington, D. C., Geol. Surv. Cal. 7181 *Dipodomys* [crossed out] *Perodipus agilis*? [pencilled in later] California Dr. J. G. Cooper."

No. 5847 in rather poor condition; skull inside skin; fore feet folded back on breast; abdominal slits not sewed up; bones left in tail, which is turned forward beneath body, broken and somewhat loose at base. Specimen No. 7181 is also in poor condition, apparently at one time preserved in alcohol; skull inside skin [until removed for examination], forelegs disposed irregularly forward; hind feet pointing backward; body unevenly stuffed with cotton; abdominal slit not sewed up; tail broken off and lost.

There is little doubt but that No. 5847, collected at San Diego, is referable to *Perodipus agilis simulans*; the case is different with No. 7181, the condition of which makes the precise determination of its status difficult or impossible. In the writer's opinion, so far as its appreciable characters are concerned, the specimen may be referred with equal propriety to *agilis* or *simulans*.

Perodipus panamintinus Merriam

"*D[ipodomys] Philippii*" (part)?, Cooper, Zoology, in Cronise, The Natural Wealth of California, 1868, p. 445 (The reference is somewhat uncertain, but the probabilities point to this allocation.)

Specimen examined.—One: No. 5630, Univ. Calif. Mus. Vert. Zool.; obverse of label "249 *Dipodomys* ♂ Chico spr.¹⁸ Providence Mt. Cal. 1. 35° alt. 5000 ft. May 28'61 J. G. C."; reverse, nine measurements.

Specimen prepared as usual; skull inside; fore feet folded backward along sides, hind feet extended posteriorly. Tail not skinned, extended posteriorly.

In coloration and cranial characters this specimen is nearest *Perodipus panamintinus*, though in color it is a trifle closer to examples from Maturango Spring, Argus Mountains, than to the typical form. It is not improbable that the specimen represents a local variant of *P. panamintinus*, but the answer to this and other questions concerning the status of the kangaroo rats must await a monographic revision of the group.

Dipodomys merriami merriami Mearns

"*D[ipodomys] Philippii*" (part), Cooper, Zoology, in Cronise, The Natural Wealth of California, 1868, p. 445 (General comments only).

"*Dipodomys Philippii* Gray" (part), Cooper, Proc. Cal. Acad. Sci., 4, 1870, p. 74 (Colorado Valley).

¹⁸I have failed to locate "Chico Spring" on any of the maps examined. Cooper's route from Fort Mojave to Los Angeles doubtless traversed the Pah Ute Hills and Providence Mountains almost due west of Fort Mojave (see Whitney's Map of California and Nevada, State Geological Survey of California, 2nd ed., 1874). It is highly probable that "Chico Spring" is an obscure locality in the Pah Ute Hills of this map rather than in the true Providence Range; for Cooper did not leave Fort Mojave until May 28, 1861, and could hardly have reached the Providence Mountains by the evening of the first day out.

"*Dipodomys Phillippii*" (part), Cooper, Amer. Nat., 3, 1869, p. 477 (Colorado Valley, said to be common and an invader of dwellings).

Specimens examined.—Three: Nos. 5631, 5632, Univ. Calif. Mus. Vert. Zool.; No. 7182, U. S. Nat. Mus. No. 5631: obverse of label "129—*Dipodomys philippii*, Gray, [printed slip pasted on] ♂ Ft Mojave Col'do R. Mch. 3'61, J. G. C. Jumping Rat. [printed slip pasted on]"; reverse, eleven measurements. No. 5632: obverse of label "115 *Dipodomys philippii* ♀ Ft. Mojave, Col'do R. Mch 3'61, J. G. C."; reverse, eleven measurements. No. 7182: obverse of label "106 *Dipodomys philippii* ♂ Ft Mojave Col'do R.—Feb. 23 '61, J. G. C."; reverse, eleven measurements.

Specimens prepared as was customary by Dr. Cooper; fore legs extended forward and tied beneath throat; hind feet extended posteriorly and tied or crossed beneath tail; tail not skinned, extended posteriorly, somewhat loose; abdominal incision not sewed up. Specimens in fair condition.

In general characters these examples agree closely with specimens of *Dipodomys merriami merriami* from the Colorado Valley.

Zapus trinotatus trinotatus Rhoads

"*Jaculus hudsonius*" Cooper, Pac. R. R. Expl. and Surv., 12, book 2, 1860, p. 83 (Single specimen collected in Washington Territory).

Specimen examined.—One: No. 587/1710, U. S. Nat. Mus.; original label missing; the catalog entry shows that the skin was taken out of alcohol; a label attached reads as follows "N. Pacific R. R. Survey Gov. I. I. Stevens 587/1710 *Meriones hudsonius* ♂ [sex mark pencilled in] Shoalwater Bay, W. T. [locality crossed out] W. T. [written in later, apparently in same handwriting as name and Museum number] Dr. J. G. Cooper."

Specimen made over, after having been preserved as an alcoholic. Skull in fragments.

Its dark coloration shows the specimen to be referable to *Zapus trinotatus trinotatus* rather than to *Zapus princeps oregonus*, which is the only other jumping mouse known to occur in the State.

Citellus beecheyi beecheyi (Richardson)

"*Spermophilus Beecheyi*" (part), Cooper, Zoology, in Cronise, The Natural Wealth of California, 1868, p. 443 (A serious pest in all parts of the valleys).

"*Spermophilus Beecheyi* Rich." (part), Cooper, Proc. Cal. Acad. Sci., 4, 1870, pp. 63, 77 (Believed to be peculiar to California).

Specimen examined.—One: No. 2384, U. S. Nat. Mus.; original label missing; a very old and greasy label reads "2384 *Spermophilus beecheyi* Santa Clara, Cal. Dr. J. G. Cooper."

Skin with skull inside; fore feet aligned along sides of neck; hind feet folded forward beneath body and tied together; tail skinned, extending irregularly backward.

Citellus beecheyi fisheri (Merriam)

"*Spermophilus Beecheyi*" (part), Cooper, Zoology, in Cronise, The Natural Wealth of California, 1868, p. 443 ("So numerous and destructive in all parts of the valleys that are not annually inundated, as to be one of the most serious pests of the farmer and gardener"); Amer. Nat. 3, 1869, pp. 182-189, (Said to abound in the southern part of California); Amer. Nat., 8, 1874, p. 15 (Said to be scarce in the Cuyamaca Mountains, though common near river beds along the coast).

"*Spermophilus Beecheyi* Rich." (part), Cooper, Proc. Cal. Acad. Sci., 4, 1870, pp. 63, 77 (Believed to be peculiar to California).

Specimen examined.—One: No. 5645, Univ. Calif. Mus. Vert. Zool.; obverse of label "748a California Ground Squirrel [name pasted on] ♂ San Diego Cal Jan 27th '62 J. G. C."; reverse, eleven measurements and a slip, bearing the name "*Spermophilus beecheyi*, Rich."

Specimen prepared as a study skin, stuffed with tow, fixed to lie on back; skull inside skin; fore legs folded onto breast, hind legs crossed at posterior end of body; tail folded along side of body, abdominal incision very roughly sewed together; specimen in good condition.

Citellus beecheyi nesioticus (Elliot)

"*Spermophilus Beecheyi*" (probably part), Cooper, Zoology, in Cronise, The Natural Wealth of California, 1868, p. 443.

"*Spermophilus Beecheyi* Rich." (part), Cooper, Proc. Cal. Acad. Sci., 4, 1870, p. 63 (Believed to be peculiar to California); Proc. Cal. Acad. Sci., 4, 1870, p. 77 (Collected Catalina Island; evidently observed on Santa Barbara Island also).

Specimen examined.—One: No. 145285, U. S. Nat. Mus.; obverse of label "*Spermophilus Catalina I. Cal* ♂ June 16-'63 J. G. C."; reverse, ten measurements.

Specimen prepared as usual, skull inside; a little dry grass has been stuffed into skin; ventral incision not sewed up; fore feet folded posteriorly beneath body; hind feet and tail anteriorly.

The specimen is darker colored than typical *Citellus beecheyi fisheri*, the form of the adjoining mainland.

Citellus beldingi (Merriam)

"*Spermophilus elegans* Kennicott" (part), Cooper, Proc. Cal. Acad. Sci., 4, 1868, p. 6 ("Hab. near Salt Lake, Utah, to Johnson's Pass, Sierra Nevada, where I found it in 1863. Pitt River?").

"*S*[*permophilus*] *elegans*," Cooper, Zoology, in Cronise, The Natural Wealth of California, 1868, p. 443 ("inhabits east of the Sierras.")

Specimen examined.—One: No. 5824, Univ. Calif. Mus. Vert. Zool.; original label missing; label in old University of California collection reads "1124 *Spermophilus elegans* Kenn. ♂ Summit Johnson's Pass Sept."

Skull inside skin; fore feet folded posteriorly beneath body; hind feet forward; tail not skinned.

Eutamias canicaudus Merriam

"*Tamias quadrivattatus*" (part), Cooper, Amer. Nat., 2, 1868, pp. 530-531 (Found east of mountains in Washington Territory).

Specimen examined.—One: No. 145286, U. S. Nat. Mus.; obverse of label "Smithsonian Institution, Washington, D. C. *Tamias 4 vittatus* 145286 125 S of Spokane R. W. T. Oct. 7, 60, J. G. C."

Specimen stuffed with cotton, slit in abdomen not sewed up; part of skull inside of skin; right fore foot folded back on right side of body; left fore foot on left side; hind legs and tail disposed forward beneath body.

Eutamias townsendii townsendii (Bachman)

"*Tamias Townsendii*" (part), Cooper, Pac. R. R. Expl. and Surv., 12, Book 2, 1860, pp. 80-81 (Habits and distribution in Washington Territory).

"*T[amias] Townsendii*," Cooper, Amer. Nat., 2, 1868, p. 531 (Found west of Cascade Mountains in Washington Territory).

Specimens examined.—Two: No. 1381, U. S. Nat. Mus.; No. 4756, Mus. Comp. Zool. Harvard Univ. No. 1381: original label missing; obverse of label attached reads "1381 ♂ *Tamias townsendii* [*asiaticus* written in and later crossed off], Shoalwater Bay, W. T. Dr. Cooper"; reverse, "Aug. 30, 1855." No. 4756: original label "No. 18 W. T. '54 near coast J. G. C."; another label reads "N. Pacific R. R. Survey 2469 Gov. I. I. Stevens, *Tamias townsendii*, Shoalwater Bay, W. T. Dr. J. G. Cooper, 18".

Specimen No. 1381 prepared as usual, skull inside skin; fore and hind feet folded back and forward, respectively, beneath the body; tail curled anteriorly beneath the body; No. 4756 has been made over into a modern museum skin; the skull has suffered several slight injuries, basal and occipital portion, part of the nasal region, and the angular and coronoid processes of the left mandible having been broken away.

Eutamias townsendii cooperi (Baird)

"*Tamias townsendii*" (part), Cooper, Pac. R. R. Expl. and Surv., 12, book 2, 1860, pp. 80-81 (Account of habits and distribution in Washington Territory, *Tamias cooperi* synonymized under *Tamias townsendii*).

"*T[amias] townsendii*," Cooper, Amer. Nat., 2, 1868, p. 531 (nearly intermediate between forms found east and west of Cascade Mountains).

Specimens examined.—Two: Nos. 4754, Mus. Comp. Zool. Harvard Univ.; 212/1183 U. S. Nat. Mus. No. 212/1183: original label missing; specimen collected at Klickitat Pass, 4500 ft., Skamania County, Wash. (see Amer. Nat., 2, p. 531), July, 1853, by Dr. J. G. Cooper. No. 4754: original label missing also; one label attached to the specimen reads "N. Pacific R. R. Survey, Gov. J. J. [so] Stevens, 211 *Tamias cooperi*? [the *cooperi* has been crossed out and *townsendii* written in] W. T. Cascade Mts. Lat 46 1182 Dr. J. G. Cooper."

These specimens are cotypes of *Eutamias townsendii cooperi*, which appears to be worthy of recognition. They have been remade into modern study skins.¹⁹

Specimens of *Eutamias townsendii* from the Cascade Mountains of Washington and Oregon are paler in comparable pelage than those from Astoria, Tillamook, Aberdeen, Quinalt Lake and other localities on the coast. They appear to show a mass difference in cranial characters, also, the mountain form, *E. t. cooperi*, tending to have larger incisors and heavier zygomata than typical *townsendii*.

***Eutamias speciosus frater* (Allen)**

"*T[amias] quadrivittatus*" (part), Cooper, Zoology, in Cronise, The Natural Wealth of California, 1868, p. 444 ("found in the higher Sierras, and eastward to the Rocky Mountains").

Specimen examined.—One: No. 5640, Univ. Calif. Mus. Vert. Zool.; obverse of label "1101 *Tamias quadrivittatus*, Rich.—Missouri Striped Squirrel—[printed strips pasted on] ♂ Lake Tahoe Valley Cal. Sept. 1863 J. G. C."; on the reverse side of the label is the single word "immature."

Prepared with skull inside skin; legs and tail folded beneath body; specimen in good condition.

¹⁹ For note on the condition of No. 212/1183, see Lyon and Osgood (1909, p. 175). The other cotype (No. 211/1183) referred to but not found by these authors is No. 4754 in the collection of the Museum of Comparative Zoology of Harvard University.

Eutamias merriami pricei (Allen)

"*Tamias Townsendii*" (part), Cooper, Zoology, in Cronise, The Natural Wealth of California, 1868, p. 444 ("Inhabits both ranges of mountains, as far south as Santa Cruz.")

Specimen examined.—One: No. 5639, Univ. Calif. Mus. Vert. Zool.; obverse of label "Townsend's Striped Squirrel [printed strip pasted on] ♂ 932 Arroyo Quito,²⁰ Sta Clara Co Mch. 17th 63 J G Cooper"; on the back of the label is a printed slip bearing the words "*Tamias townsendii* Bach." and ten measurements.

Specimen prepared with skull inside; fore feet folded onto breast, hind feet placed forward posteriorly beneath abdomen; tail folded forward on back. Specimen in good condition.

Eutamias senex (Allen)

"*Tamias Townsendii*" (part), Cooper, Zoology, in Cronise, The Natural Wealth of California, 1868, p. 444 ("inhabits both ranges of mountains, as far south as Santa Cruz").

Specimen examined.—One: No. 5823, Univ. Calif. Mus. Vert. Zool.; original label missing; label in old University of California Collection reads "*Tamias Townsendii* ♂ Summit Johnson's Pass Sept."

Prepared with skull inside; fore feet folded back, hind feet forward beneath body; in good condition.

Callospermophilus chrysoideirus chrysoideirus (Merriam)

"*Spermophilus lateralis* Say, (Rich.)" (part), Cooper, Proc. Cal. Acad. Sci., 4, 1868, p. 6 ("Near summits of the Sierra Nevada, lat. 38° common").

"*S[permophilus] lateralis*" (part), Cooper, Zoology, in Cronise, The Natural Wealth of California, 1868, p. 443 ("inhabiting the high Sierras").

²⁰ Arroyo Quito, Santa Clara County. I have been unable to find this locality on any map examined. Possibly it refers to the present San Francisquito Creek, which near Palo Alto constitutes the boundary line between San Mateo and Santa Clara Counties, California. The Santa Cruz sheet (1906), U. S. Geological Survey Topographic Map of the United States, shows a large tract of land labelled Rinconada del Arroyo de San Francisquito in the vicinity of Stanford University, Palo Alto and Mayfield.

Specimens examined.—Two: Nos. 5618, 5619, Univ. Calif. Mus. Vert. Zool. No. 5618: obverse of label "Say's Striped Squirrel, [printed strip pasted on over Cooper's handwritten name *Spermophilus lateralis*] ♀ 1104 Tahoe valley, Cal. Sept. 14 '63 J. G. C."; on reverse side of label appear eleven measurements and another printed slip bearing the name "*Spermophilus lateralis*, Rich." No. 5619: obverse of label "*Spermophilus lateralis* ♂ Taho Valley Cal Sept. 15 '63 J. G. C."; reverse, ten measurements.

Specimens prepared with skulls inside, fore feet folded back on breast, hind feet forward beneath body, tail not skinned, disposed straight out behind, skins in good condition.

***Ammospermophilus leucurus leucurus* (Merriam)**

"*S[permophilus] Harrisii*" Cooper, Zoology, in Cronise, The Natural Wealth of California, 1868, p. 443 (" . . . found only in the desert plains of the southeast part of the State").

"*Spermophilus Harrisii* Aud.," Cooper, Proc. Cal. Acad. Sci., 4, 1870, pp. 63, 67 (Peculiar to California, and said not to occur west of the "Desert Region").

"*Spermophilus Harrisii*," Cooper, Amer. Nat., 3, 1869, p. 188 (Mentioned as occurring on the desert between Cajon Pass and Fort Mojave).

Specimens examined.—Two: Nos. 5638, Univ. Calif. Mus. Vert. Zool.; No. 145284, U. S. Nat. Mus. No. 5638: obverse of label "248 *Spermophilus harrisii*, Aud. and Bach. [printed slip pasted on] ♀ Mts. W. side Col'do V. 1. 35° Cal. May 27 '61—Harris's Spermophile [printed strip bearing vernacular name pasted on]"; reverse, eleven measurements. No. 145284: obverse of label "247 *Spermophilus harrisii* ♂ Mts W. side Col'do Val. 35° Cal. May 27—'61 J. G. C."; reverse, eleven measurements.

Specimens prepared with skulls inside, fore feet bent back along side or beneath body, hind feet extended posteriorly; tail with bones inside, extended backward; abdominal slits not sewed up.

No. 5638 is apparently a young animal, as it is undersized. Both specimens are clearly referable to *Ammospermophilus leucurus leucurus*.

Sciurus douglasii albolimbatus Allen

"*Sciurus Douglassii*" (part), Cooper, Zoology, in Cronise, The Natural Wealth of California, 1868, p. 444 ("It is found north of San Francisco bay and in the Sierras. . .").

Specimens examined.—Three: Nos. 5641, 5642, 5643, Univ. Calif. Mus. Vert. Zool. No. 5641: obverse of label "*Sciurus douglassii* ♀ Strawberry Flat,²¹ Cal.—Sept. 18–63, J. G. C."; reverse, eleven measurements. No. 5642: obverse of label "Oregon Red Squirrel [pasted on] ♂ Summit Johnson's Pass Sept 24—'63 J. G. C."; reverse, eleven measurements, a number "1128a," and the name "*Sciurus douglassii*, Bach." pasted on. No. 5643: obverse of label "Summit, Placer Co Cal. July 26 '70"; reverse "*Sciurus Douglassii*, Bach. J. G. C."

The specimens are prepared with skulls inside, fore feet folded on breast, hind feet either folded beneath abdomen or crossed behind body; tails disposed variously posteriorly; abdominal slits sewed up in two specimens, left gaping open in the other; specimens in very good condition.

Sciurus griseus nigripes Bryant

"*Sciurus leporinus*," Cooper, Zoology, in Cronise, The Natural Wealth of California, 1868, p. 443 (" . . . common in the mountains from Santa Cruz north"); Amer. Nat., 3, 1869, p. 186 ("Southern coast slope" of California).

Specimens examined.—Two: No. 5644, Univ. Calif. Mus. Vert. Zool.; No. 5647, Mus. Comp. Zool. Harvard Univ. No. 5644: obverse of label "*Sciurus leporinus*, Aud. & Bach. [name pasted on] ♂ Sta Cruz Mts Cal May 27 '64 J. G. C."; reverse, eleven measurements. No. 5647: original label missing; "Near San Francisco, Dr. J. G. Cooper."

No. 5644 prepared as usual by Dr. Cooper; skull inside skin, fore feet folded on breast, hind feet extended backward. Specimen in excellent condition. The skin of No. 5647 has been made over into a modern museum specimen.

²¹ Strawberry Flat: Tuolumne County, California, South Fork of the Stanislaus River, on main wagon road across Sonora Pass, about 25 miles distant (straight line) from Sonora in a general northeasterly direction (see Whitney's Map of California and Nevada, State Geological Survey of California, 2nd ed., 1874).

Ochotona schisticeps schisticeps (Merriam)

"*Lagomys princeps*," Cooper, Proc. Cal. Acad. Nat. Sci., 3, 1863, p. 69 (Record in minutes of meeting of Academy for October 19, 1863, of exhibition by Dr. Cooper of specimens from the summits of the Sierra Nevada); the same, 4, 1868, p. 6 ("I obtained specimens near the snow line, above Johnson's Pass, Sierra Nevada . . .").

"*Lagomys princeps?*" Cooper, Zoology, in Cronise, The Natural Wealth of California, 1868, p. 446 ("It inhabits the Alpine summits of the Sierra Nevada, among enormous granite boulders and banks of perpetual snow . . .").

"*Lagomys princeps*," Cooper, Amer. Nat., 8, 1874, p. 15 (Footnote reference to Gabb's record of *Ochotona* in Lower California. Cope, in Proc. Acad. Nat. Sci. Phil., 1868, p. 2, erroneously records Gabb as having noted a specimen at 10,000 feet in the Sierra Nevada at 32° latitude).

Specimens examined.—Three: Nos. 5612, 5628, Univ. Calif. Mus. Vert. Zool.; No. 145282, U. S. Nat. Mus. No. 5612: obverse of label "*Lagomys princeps*, Rich.—[printed strip pasted on] ♂ Summit Sierras Lat. 39°, Sept 26–63 J. G. C."; reverse, eight measurements and a printed strip bearing the name "Little Chief Hare". No. 5628: obverse of label "1120 *Lagomys princeps* ♀ juv. Summit Sierras, Lat., 39° Sept. 22-'63, J. G. C."; on the reverse side of the label appear the words "immature 4/5 grown". No. 145282: obverse of label "*Lagomys princeps* ♀ Summit Sierras Lat. 39°, Sept. 26 '63, J. G. C."; reverse, eight measurements.

Specimens prepared with skulls inside; fore and hind feet folded posteriorly and anteriorly, respectively, beneath body; the hind feet in No. 145282 are somewhat torn and loosened.

The locality where these examples were secured is probably not far from the type locality of the species (Donner, Placer Co., Calif.). The two specimens in the Museum of Vertebrate Zoology (Nos. 5612, 5628) are in very different pelage condition in spite of the fact that they were collected within four days of each other. The female, No. 5628, taken September 22, is in worn summer pelage, and in spite of its being marked "juv.," may have been a breeding animal. In such an event, a delayed molt would not be unexpected. The male

specimen (No. 5612), taken September 26, has acquired most of the full fresh pelage of winter.

***Sylvilagus audubonii sanctidiégi* (Miller)**

"*L[epus] Audubonii*," Cooper, Zoology in Cronise, The Natural Wealth of California, 1868, p. 446. (" . . . the two latter [*Lepus Audubonii* and *Lepus Trowbridgii*] occur together throughout most of the western slope of the State").

"*Lepus Audubonii*" (part), Cooper, Amer. Nat., 3, 1869, p. 183 (Southern part of California.)

"*L[epus] Audubonii*" (part) Cooper, Amer. Nat., 8, 1874, p. 15 (Seen once about 2000 feet up in the Cuyamaca Mountains).

Specimen examined.—One: No. 5623, Univ. Calif. Mus. Vert. Zool.; obverse of label "33c *Lepus audubonii*, Baird, Audubon's Hare [printed strips pasted on] ♂ San Diego Cal. Nov. 6th, '61 J. G. C."; reverse, eleven measurements.

Prepared with skull inside; fore feet folded back beneath body; hind feet forward; specimen in good condition.

***Sylvilagus audubonii arizonæ* (Allen)**

"*L[epus] Audubonii*" (part), Cooper, Zoology in Cronise, The Natural Wealth of California, 1868, p. 446 (Refers to occurrence of this form in the western part of the state only).

"Audubon's Hare (fur finer than near the coast, approaching *Lepus artemisiæ*)", Cooper, Amer. Nat., 3, 1869, p. 476 (Colorado Valley).

"*Lepus Audubonii?* Baird", Cooper, Proc. Cal. Acad. Sci., 4, 1870, p. 74 (Colorado Valley).

Specimen examined.—One: No. 145283, U. S. Nat. Mus.; obverse of label "95 *Lepus audubonii* Ft. Mojave, Col'do R. Feb. 19 '61 J. G. C."; reverse, eleven measurements.

Skin in fairly good condition; stuffed flat, the skull inside the skin; legs folded, the fore feet backward, the hind feet forward beneath the body.

In general coloration agrees closely with *Sylvilagus audubonii arizonæ* in the collection of the National Museum, being distinctly paler than either *S. a. audubonii* or *S. a. sanctidiégi*.

Lepus californicus bennettii Gray

"*L[epus] Californicus*" (part), Cooper, Zoology, in Cro-nise, The Natural Wealth of California, 1868, p. 446 ("most numerous west of the Sierra Nevada").

"*Lepus californicus* Gray" (part), Cooper, Proc. Cal. Acad. Sci., 4, 1870, p. 63 (Believed to be peculiar to California).

"*Lepus Californicus*" (part), Cooper, Amer. Nat., 3, 1869, p. 183 (Southern part of California); Amer. Nat., 3, 1869, p. 470 (Only large species westward of Fort Mojave).

"*Lepus Californicus*," Cooper, Amer. Nat., 8, 1874, p. 15 (Seen in the foothills of the Cuyamaca Mts.).

Specimens examined.—Two: Nos. 5621, 5622, Univ. Calif. Mus. Vert. Zool. No. 5621: obverse of label "719 *Lepus californicus* ♂ San Diego Cal. Dec 20th '61 J. G. C."; reverse, ten measurements, and a notation "Iris brown". No. 5622: obverse of label "810 *Lepus californicus*, Gray.—California Hare.—[printed slips pasted on] San Diego Cal Apr 25th '62 J. G. C."

Specimens prepared with skulls inside skins, fore feet folded backward, hind feet forward beneath body.

No. 5622 is in very dark pelage, being darker, in fact, than any specimens in the series of *Lepus californicus bennettii* in the collection at the Museum of Vertebrate Zoology.

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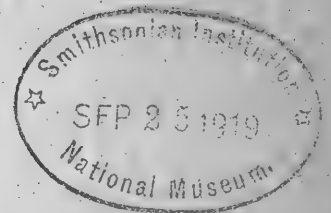
JULY 12, 1919

IV

Climatic Relations of the Tertiary and
Quaternary Faunas of the
California Region

BY
JAMES PERRIN SMITH
Stanford University

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IV
CLIMATIC RELATIONS OF THE TERTIARY AND
QUATERNARY FAUNAS OF THE
CALIFORNIA REGION

BY JAMES PERRIN SMITH, STANFORD UNIVERSITY

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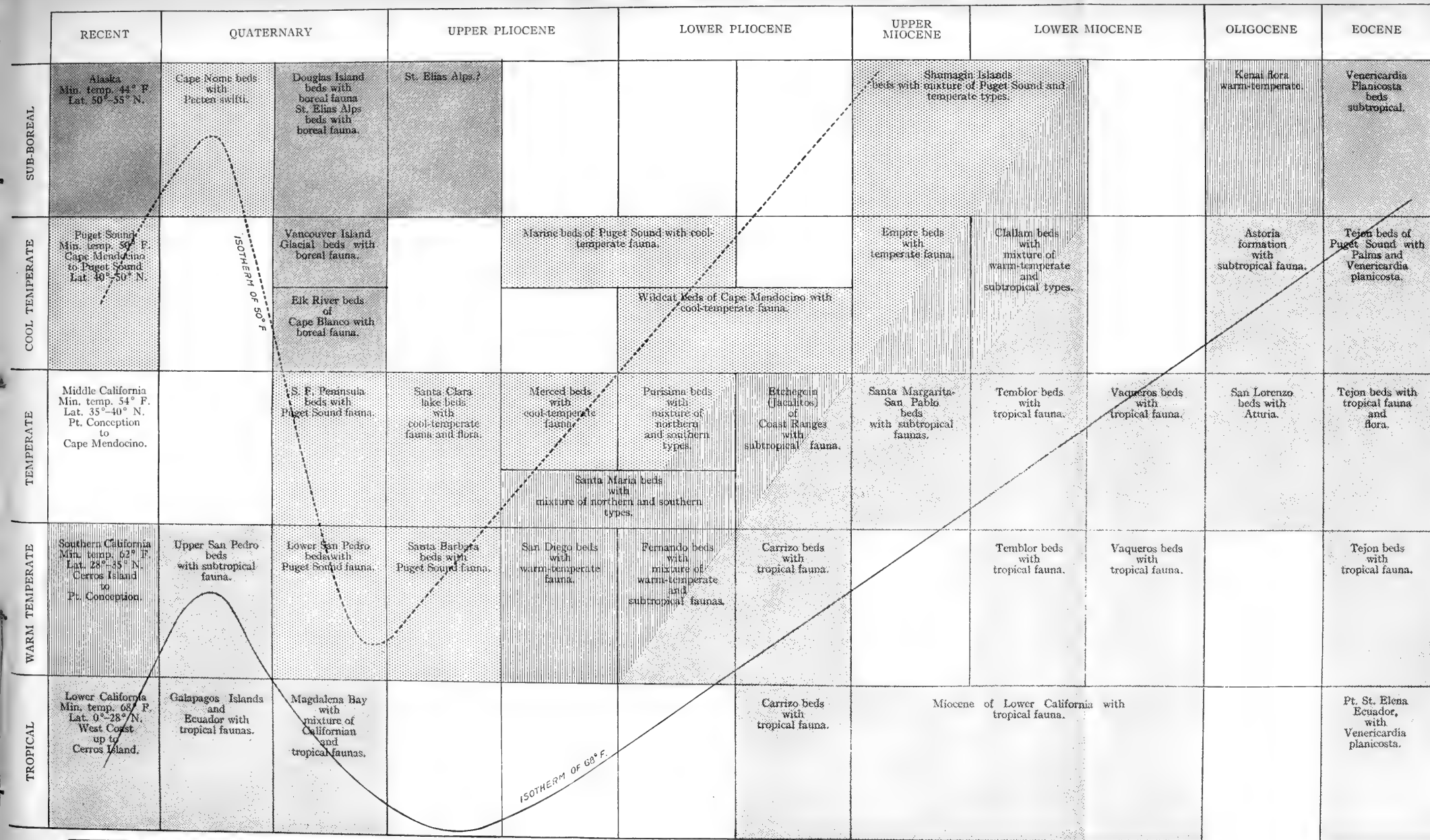
INTRODUCTION.

The Tertiary and Quaternary formations of the West Coast of North America offer peculiar advantages for the study of climatic relations, for they are strung out along the coast from the equator to the boreal regions, and their faunas and floras may be compared with Recent faunas and floras in the same latitudes.

The Recent faunas of the West Coast, from the Galapagos Islands and Panama northward to Alaska, are well known, in publications and collections. The climatic conditions under which they live are known, and the range of species with reference to temperature of the water has been determined. By comparison with Recent faunas of the same region the climatic conditions (temperature) of a fossil fauna may be estimated, and the position of the isotherms plotted, with considerable accuracy. This accuracy naturally decreases as we go back in time, and the number of Recent species in the fossil fauna decreases to little or nothing. There are nearly 400 Recent species in the Quaternary faunas of the West Coast; of these nearly 100 range down into Pliocene, and over 50 into Miocene. No Recent species ranges back to Eocene, but most of the genera of that age are still represented somewhere in the world, and make possible accurate conclusions concerning the physical conditions of that time.

The writer has arranged at Stanford University an exhibition set of the marine faunas of the West Coast, from Eocene to the present, and from the equator to the Gulf of Alaska. This set corresponds to the accompanying correlation and climatic chart, the successive faunas being placed in parallel columns, so that each fossil fauna is in line with the corresponding Recent fauna of the same latitude.

The major geographic divisions used were as follows, from south to north: (1) Lower California and the Gulf of California; (2) Southern California; (3) Middle California; (4) Puget Sound; (5) Alaskan Gulf. The material in the exhibition set is necessarily not so detailed as that in the lists given below. And in these lists no attempt at completeness is made. Only those forms are listed that are really characteristic, that tell a definite story as to geographic range or geologic age.



Sub-boreal

Cool Temperate

Warm Temperate

Tropical

We have thus a series of columnar sections from Eocene to the present, strung out from the equator to the Gulf of Alaska, at intervals of from 5° to 15° , giving good representatives of the Tertiary and Quaternary faunas of the tropical, subtropical, warm temperate, cold temperate, and sub-boreal zones; also for comparison, the Recent faunas of the same latitudes. We have also fossil floras of Eocene, Oligocene, Miocene and Pliocene, to check the results obtained from the faunas.

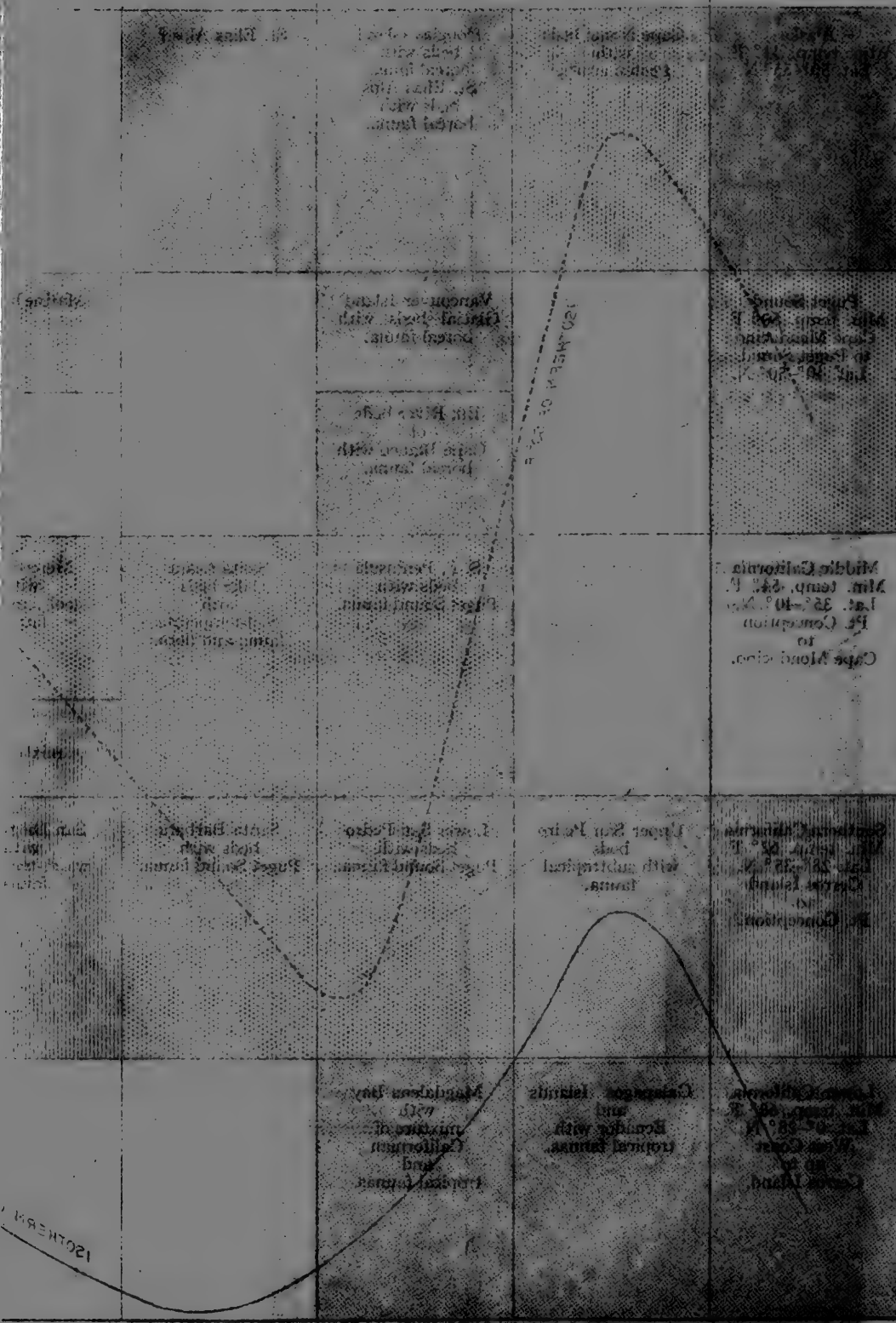
Quaternary faunas, as should be expected, are better represented than Tertiary, though this is true only on the West Coast. We have Quaternary faunas from Manta, Ecuador, and the Galapagos Islands under the equator; Magdalena Bay, Lower California, lat. $24^{\circ} 30'$ N.; San Ignacio Lagoon, lat. 27° N.; Cerros Island, lat. 28° N.; San Diego to Santa Barbara, southern California, lat. 33° to $34^{\circ} 30'$ N.; San Francisco Peninsula, lat. $37^{\circ} 30'$ N.; Cape Blanco, Oregon, lat. 43° N.; Victoria, Vancouver Island, lat. 48° N.; Douglas Island, Alaska, lat. 58° N.; and Cape Nome, lat. 64° N. These Quaternary faunas range from tropical to boreal, as they should, keeping pace with the Recent faunas, but showing in many cases great displacement of the isotherms, as compared with the present.

The Pliocene faunas, stretched out in the same way, show still greater displacement of the isotherms in some cases, which becomes more strongly marked in the Miocene. The extreme is reached in the Eocene, when a tropical temperature extended from the equator to Alaska, strongly contrasted with lower Quaternary, when a sub-boreal temperature extended down nearly to San Diego.

The constant fall of temperature from Eocene to lower Quaternary, and the temporary rise in the upper San Pedro, were not confined to the West Coast, being apparent also in the Atlantic and the Mediterranean regions. But the evidence of its great regularity is almost peculiar to western America.

It is important to know upon what basis a given fauna is assigned to a certain horizon, and also what genera or species are used as climatic criteria. Not all genera or species are equally characteristic, nor are they equally characteristic in different geographic zones. *Cucullæa* is an Eocene genus in

		MIOCENE	OLIGOCENE	EOCENE
SUB-BOREAL	MI E		Kenai flora warm-temperate.	Venericardia Planicosta beds subtropical.
COOL TEMPERATE	MI C P		Astoria formation with subtropical fauna.	Tejon beds of Puget Sound with Palms and Venericardia planicosta.
TEMPERATE	MI MI L P C	Vaqueros beds with tropical fauna.	San Lorenzo beds with Aturia.	Tejon beds with tropical fauna and flora.
WARM TEMPERATE	SOV MI L E	Vaqueros beds with tropical fauna.		Tejon beds with tropical fauna.
TROPICAL	Lia with MI E			Pt. St. Elena Ecuador, with Venericardia planicosta.



150 MILES OF DISTANCE

150 MILES OF DISTANCE

Middle California
 Min. temp. 44° F.
 Max. temp. 70° F.
 1st. 32°-40° F.
 2d. 40°-50° F.
 to
 Cape Mendocino.

Lower Sonoran
 with sub-tropical
 forests.

Lower Sonoran
 with
 tropical forests.

Lower Sonoran
 with
 tropical forests.

Lower Sonoran
 with
 tropical forests.

Lower Sonoran
 with
 tropical forests.

Lower Sonoran
 with
 tropical forests.

Lower Sonoran
 with
 tropical forests.

Lower Sonoran
 with
 tropical forests.

Lower Sonoran
 with
 tropical forests.

California, but is still living in the Indian Ocean region. *Lyropecten* is a Miocene group in middle California, survives into lower Pliocene in southern California, and is still living in Lower California. *Mioleionia* is an Oligocene genus in the Puget Sound region, but in middle California is characteristic of lower Pliocene.

The writer has prepared a table of diagnostic forms used as criteria in determining the age of West Coast formations. This table is given below. But since an important genus or species may be common in one geographic region and lacking in another, or may be characteristic of a certain horizon in one and of a different horizon in another region, still another table has been prepared, showing the climatic as well as geologic range of the important forms. This brings out especially well the differences in geologic range of the same species in different latitudes. In this table the occurrence of a form is registered with (+), and the absence of a form from a horizon in one province is registered with (0).

DIAGNOSTIC FORMS IN WEST COAST NEOZOIC FAUNAS.

EOCENE.

Many extinct genera: *Strepsidura*, *Ficopsis*, *Perissolax*; many genera now confined to the tropics: *Avicula*, *Crassatellites*, *Cucullæa*, giant *Lima*, *Meretrix*, giant *Venericardia*, *Ancillaria*, giant *Conus*, *Cassis*, *Murex*, *Rimella*, *Strombus*, *Terebellum*, *Turbinella*, *Volutilithes*, true *Nautilus*, spatangoid sea-urchins, and cidaroids (absence of all ammonites, *Inoceramus*, belemnites, *Exogyra* and *Trigonia*). No climatic zones, and faunas not yet provincial.

OLIGOCENE.

Survival of many Eocene genera, but appearance of more modern types; modern groups of *Pecten*, especially *Chlamys*; *Spisula*, *Panopæa*, *Phacoides*; modern groups of *Veneridæ*, especially *Chione* and *Macrocallista*; *Agasoma*, *Dolium*, *Mioleionia*, *Priscofusius*, *Molopophorus*, *Strepsidura*, *Turcicula*, *Aturia*. First appearance of modern species of Mollusca: *Panopæa generosa*, *Macoma nasuta*, *Thracia trapezoidea*,

Thyasira bisecta. Fewer tropical genera than in Eocene. Faunas already provincial, but climatic zones not yet definitely established.

MIOCENE.

Numerous *Pecten*: *Lyropecten*, *Amusium*, *Patinopecten*, *Janira*, *Spondylus*; *Veneridæ* abundant: *Chione* ancestral to modern groups, *Amiantis*, *Dosinia*, *Tivela*; giant *Ostrea*; giant *Cardium*; *Pinna*; *Avicula*; *Agasoma*, *Astræa*, giant *Conus*, *Ficus*, *Mitra*, *Molopophorus*, *Mioleionia*, *Nassa*, *Oliva*, *Priscofusus*, *Purpura*, *Trophon*, *Turritella*, *Rapana*, *Astroedapsis*, *Clypeaster*, *Dendraster*, *Scutella*. Disappearance in later Miocene of most of the tropical genera, and reduction in size of most of the remaining ones. Notable exception to this is the great increase in the size of the pectens and oysters, which are veritable giants. Few extinct genera: *Molopophorus*, *Agasoma*, *Mioleionia*, *Astroedapsis*. Climatic zones developed, but not sharply defined. Faunas distinctly provincial. Many modern species.

PLIOCENE.

Dwarf *Venericardia*, *Arca*, *Cardium*, *Chione*, *Spisula*, *Patinopecten*, *Chlamys*, *Janira*, *Paphia*; *Fusus*, *Chrysodomus*, *Purpura*, *Nassa*, *Dendraster*. Climatic zones already sharply defined in lower Pliocene, with *Mioleionia*, giant *Chrysodomus*, *Buccinum*, *Volutopsius*, and *Patinopecten* in northern California; and *Lyropecten*, *Janira*, abundant *Chione*, *Dosinia*, *Ficus*, *Murex*, and giant *Conus* in southern California. The Wildcat fauna of Humboldt County, California, was cold temperate, the Purisima of middle California was warm temperate, while the Fernando of southern California was subtropical, all contemporaneous.

Mioleionia and *Astroedapsis* are the only extinct genera, but there are many now extinct in the Californian province. More than half of the Pliocene species are still living.

QUATERNARY.

Fauna like the Recent, but with rapidly shifting climatic zones, northern species ranging southward in lower Pleistocene, and southern species ranging northward in upper Pleistocene. Few extinct species, but many extinct locally.

DERIVATION OF TERTIARY MARINE FAUNAS OF CALIFORNIA.

The marine faunas of Tertiary and Recent time on the coast of California must be either endemic or immigrants. There are certain persistent stocks that appear to give us a continuous line from Eocene time, but the great majority are unmistakably immigrants. The regions from which they may have come are so limited in number and so characteristic in their faunas that it is comparatively easy to determine the kinship and probable origin of the successive faunas in the California province.

The Martinez Eocene has strong Oriental affinities, shown in: *Ovula*, *Xenophora*, and the *Tudicla* group. The Tejon Eocene, while having some Oriental survivors, such as *Rimella*, *Terebellum* and the *Tudicla* group, is clearly Caribbean in kinship, in proof of which may be cited the *Venericardia planicosta* fauna, which came in from the Atlantic region through the Panama portal.

The Oligocene is decidedly Oriental, as shown by the incoming of *Voluta (Miopleionia)*, *Dolium*, and Japanese types of *Nucula*. The incoming of these forms is accompanied by the advent of northern species: *Thyasira bisecta*, *Phacoides acutilineatus*, *Solemya*, and *Turcicula*.

The lower Miocene Vaqueros fauna retains some Oriental survivors, such as *Rapana*, but is, in the main, Caribbean in kinship. The *Lyropecten* group is the most characteristic Caribbean element, having been present in that region already in Oligocene, and wholly lacking on the Pacific coast in that epoch.

R. E. Dickerson* has shown that in lower Miocene time there was probably a connection between the Caribbean and the Pacific. This is borne out not only by the occurrence of *Lyropecten*, but also by *Dosinia* and the giant oysters.

In the Temblor epoch of the lower Miocene there is no further suggestion of Caribbean immigration, although *Lyropecten* is still exceedingly abundant. There is, however, a suggestion of renewed Oriental immigration in the Pecten groups, *Pallium* and *Amusium*.

The upper Miocene faunas appear to be endemic, or descendants of those that preceded them, the only outside increments

* Proc. Calif. Acad. Sci., 4th ser., vol. 7, p. 197, et seq.

being gradually increasing numbers of northern types such as *Chrysodomus*.

In the lower Pliocene there is a great influx of northern forms such as *Chrysodomus* and *Patinopecten*, accompanied by some Oriental elements such as *Haliotis*, and *Pallium*. These mingled in southern California with northward-moving species from the Panama fauna.

In upper Pliocene the tropical species are nearly all gone, and the fauna of Puget Sound has extended its sway southward to San Diego. The relationships of the lower San Pedro Pleistocene fauna are the same as those of the upper Pliocene, with the northern facies still more distinct.

The upper San Pedro fauna is southern in kinship, with many species now living only in the Panama region.

CLIMATIC RANGE OF WEST COAST TERTIARY FORMS

		Lower Miocene	Upper Miocene	Lower Pliocene	Upper Pliocene	Quaternary	Recent
PUGET SOUND Cape Mendocino to Vancouver Island.	<i>Pecten caurinus</i>.....	..	..	+	..	+	+
	Dwarf <i>Venericardia</i>.....	..	++	..	..	+	+
	Giant <i>Chrysodomus</i>.....	..	++	+	..	+	+
	<i>Mioleionia</i>.....	..	++	+	..	..	..
	<i>Argobuccinum</i>.....	..	++	+	..	+	+
	<i>Phacoides annulatus</i>.....	..	++	+	..	+	+
	<i>Arca trilineata</i>.....	..	++	..	..	..	..
	<i>Gyrineum</i>.....	+	++	..	..	..	..
	Giant <i>Turritella</i>	OO	OO	OO	..	OO	OO
	<i>Lyropecten</i>	OO	OO	OO	..	OO	OO
	<i>Janira</i>	OO	OO	OO	..	OO	OO
	<i>Dosinia</i>	O	O	O	..	O	O
MIDDLE CALIFORNIA Pt. Conception to Cape Mendocino.	<i>Dendraster gibbsi</i>.....	..	+	+	..	..	..
	<i>Pecten caurinus</i>.....	..	..	++	..	..	..
	<i>Argobuccinum</i>.....	..	..	++	..	..	..
	Giant <i>Chrysodomus</i>.....	..	..	++	+	..	..
	Dwarf <i>Venericardia</i>.....	..	..	++	+	..	..
	<i>Phacoides annulatus</i>.....	..	+	++	++	..	..
	<i>Lyropecten</i>	+	++	OO	OO	OO	OO
	<i>Janira</i>	++	++	OO	OO	OO	OO
	<i>Ficus</i>	+	+	OO	O	O	O
	<i>Mioleionia</i>.....	..	..	+	..	..	..
	<i>Pecten healeyi</i>.....	..	..	+	O	..	..
	<i>Arca trilineata</i>.....	+	++	+	..	..	..
	<i>Astroedapsis</i>.....	..	++	OO	OO	OO	OO
	<i>Chione (gnidia group)</i>	+	++	+	OO	OO	OO
	Giant <i>Turritella</i>	++	OO	OO	OO	OO	OO
<i>Dosinia</i>	++	++	+	..	O	O	
<i>Trophon</i>	+	+	+	..	O	O	

		Lower Miocene	Upper Miocene	Lower Pliocene	Upper Pliocene	Quaternary	Recent
SOUTHERN CALIFORNIA	<i>Pecten caurinus</i> . . . . .	..	..	O	+	+	O
	<i>Argobuccinum</i> . . . . .	..	..	..	+	+	O
	<i>Mioleleionia</i>	O	..	O	+	+	O
	<i>Phacoides annulatus</i> . . . . .	..	..	+	+	+	O
	Dwarf <i>Venericardia</i> . . . . .	..	..	+	+	+	O
	<i>Ficus</i>	+	..	+	+	O	O
	Giant <i>Arca</i> . . . . .	..	..	+	+	+	O
	<i>Lyropecten</i>	+	..	+	+	+	O
	<i>Janira</i>	+	..	+	+	+	+
	<i>Pecten healeyi</i> . . . . .	..	..	+	+	..	..
	<i>Trophon</i> . . . . .	+	..	..	..	..	+
	Giant <i>Turritella</i>	+	..	O	O	O	+
	<i>Chione (gnidia group)</i>	+	..	+	+	+	O
	<i>Trachycardium</i>	+	..	+	O	+	+
	<i>Dosinia</i>	+	..	+	O	+	O
<i>Astrodapsis</i> . . . . .	..	..	+	..	..	..
<i>Dendraster gibbsi</i> . . . . .	..	..	+	+	..	..
<i>Clypeaster</i> . . . . .	..	..	+	O	O	O	
<i>Mellita</i> . . . . .	..	..	..	..	+	O	
LOWER CALIFORNIA	<i>Lyropecten</i>	+	+	+	..	+	+
	<i>Janira</i> . . . . .	..	+	+	..	+	+
	Giant <i>Arca</i> . . . . .	..	..	+	..	+	+
	<i>Dosinia</i> . . . . .	..	..	..	..	+	+
	Giant <i>Turritella</i> . . . . .	+	..	..	..	+	+
	<i>Ficus</i> . . . . .	..	..	..	..	..	+
	<i>Dendraster gibbsi</i> . . . . .	..	..	..	..	?	..
	<i>Chione (gnidia group)</i> . . . . .	..	..	..	..	+	+
	<i>Clypeaster</i> . . . . .	..	..	+	..	..	+
	<i>Mellita</i> . . . . .	..	..	..	..	..	+
<i>Encope</i> . . . . .	..	..	+	..	+	+
<i>Astræidæ</i> . . . . .	..	..	+	..	..	..

It will be seen from the table, and the lists included in this paper, that *Patinopecten* (*Pecten caurinus*), dwarf *Venericardia*, giant *Chrysodomus*, *Phacoides annulatus*, and *Mioleleionia* are northern types, appearing first in the northern region, making their way southward as the temperature was lowered, all reaching southern California in the lower Pliocene. *Mioleleionia* perished there, but the others continued to live on until the present, holding out in their northern home, where the proper temperature for them still prevails.

On the other hand, giant *Venericardia*, giant *Conus*, giant *Turritella*, *Chione* of the *gnidia* group, *Dosinia*, *Lyropecten* and *Ficus* are southern, tropical, types. They doubtless appeared first in the south, but ranged far to the north in early Tertiary times. Giant *Venericardia* has found no dwelling place north of the tropics since Eocene; giant *Turritella* has

been confined to the torrid zone since lower Miocene; *Ficus*, *Lyropecten*, *Janira* and *Astrodapsis* retreated southward, and are found in southern California in the lower Pliocene, Fernando, where *Astrodapsis* became extinct. *Ficus* and *Lyropecten* retreated still further south, but the latter, along with *Janira* and *Dosinia*, reappears in the warm water upper San Pedro epoch. All these forms, with the exception of *Astrodapsis*, are still abundantly represented in the Gulf or Panama fauna, and *Astrodapsis* has there a very near relative in *Clypeaster*. These are only a few out of the many examples that might be brought up.

CLIMATIC DISTRIBUTION OF RECENT MARINE FAUNAS OF THE WEST COAST.

I. *Alaskan Gulf* (Gulf of Alaska to Vancouver Island, lat. 60°–50° N., min. temp. 44° F.). *Astarte borealis* Schum., *Astarte alaskensis* Dall, *Cardium californiense* Desh., *Glycimeris septentrionalis* Midd., *Macoma middendorffi* Dall, *Mya truncata* L., *Pecten hastatus* Sby., *Pecten islandicus* Sby., *Peronidea lutea* Gray, *Serripes grænelandicus* Gmel., *Saxicava arctica* L., *Siliqua patula* Dixon, *Spisula alaskana* Dall, *Thyasira bisecta* Con., *Venericardia alaskana* Dall, *Venericardia crassidens* B. & S., *Bela harpa* Dall, *Beringius morchianus* Dall, *Beringius kennicotti* Dall, *Beringius crebricostatus* Dall, *Buccinum aleuticum* Dall, *Buccinum morchianum* Fisch., *Buccinum glaciale* L., *Chrysodomus amiantus* Dall, *Chrysodomus liratus* Martyn, *Chrysodomus magnus* Dall, *Natica pallida* B. & S., *Sipho halibrectus* Dall, *Tritonofusus halli* Dall, *Tritonofusus rectirostris* Carp., *Turris circinata* Dall, *Volutoptus castaneus* Morch., *Volutoptus kobelti* Dall, *Volutoharpa ampullacea* Midd., *Scutella parma* Lam., *Strongylocentrotus dræbachiensis* Say.

The Alaskan Gulf fauna contains a large number of circum-boreal species, some of which are also common to the North Atlantic.

II. *Puget Sound* (Vancouver Island to Cape Mendocino, lat. 50°–40° N., min. temp. 50° F.). *Astarte compacta* Carp., *Glycimeris septentrionalis* Midd., *Kennerleya grandis* Rv., *Leda fossa* Baird, *Marcia kennerleyi* Rv., *Marcia subdiaphana* Carp.,

Panomya ampla Dall, *Panopea generosa* Gld., *Pecten caurinus* Gld., *Pecten hericeus* Gould, *Phacoides annulatus* Rv., *Saxidomus giganteus* Desh., *Siliqua nuttalli* Con., *Thracia trapezoides* Con., *Thyasira bisecta* Con., *Venericardia ventricosa* Gld., *Amphissa corrugata* Rv., *Boreotrophon gracilis* Perry, *Boreotrophon stuarti* Smith, *Chrysodomus phœniceus* Dall, *Chrysodomus tabulatus* Baird, *Haliotis gigantea* Chem., *Natica clausa* B. & S., *Purpura foliata* Martyn, *Tritonofusus jordani* Dall, *Trichotropis cancellata* Hds., *Turris perversa* Gabb.

The Puget Sound fauna contains a considerable number of circumboreal species, also several inhabitants of the Japanese coast that are not circumboreal. The influx of circumpolar species is probably going on now, but that from Japan certainly is not. All the species on the northwest coast that are common to Japan date back to Pliocene time, when the configuration of the coast-line, and the climate permitted free intermigration between the two regions.

III. *Middle California* (Cape Mendocino to Point Conception, lat. 40°–34° 30' N., min temp. 54° F.). *Cardium corbis* Martyn, *Pandora punctata* Carp., *Paphia staminea* Con., *Paphia tenerrima* Carp., *Macoma bodegensis* Hds., *Modiolus flabellatus* Gld., *Schizothærus nuttalli* Con., *Tivela crassatelloides* Con., *Yoldia cooperi* Gabb, *Bathytoma carpenteriana* Gabb, *Calliostoma canaliculatum* Martyn, *Cancellaria crawfordiana* Dall, *Chlorostoma montereyi* Kien., *Gyrineum californicum* Hds., *Lucapina crenulata* Sby., *Nassa fossata* Gld., *Nassa perpinguis* Gld., *Polinices lewisii* Gld., *Haliotis rufescens* Swain, *Dendraster excentricus* Esch., *Strongylocentrotus purpuratus* Stimp.

There are few characteristic species confined to this province. The fauna is chiefly composed of northern species ranging southward, and southern species ranging northward.

IV. *Southern California* (Point Conception, California, to Cerros Island, Lower California, lat. 34° 30' to 28° N., min. temp. 62° F.). *Amiantis callosa* Con., *Arca multicosata* Sby., *Atrina oldroydi* Dall, *Cardium elatum* Sby., *Cardium quadrigenarium* Sby., *Chione succincta* Val., *Chione fluctifraga* Sby., *Metis alta* Con., *Pecten æquisulcatus* Carp., *Pecten diegensis* Dall, *Pecten hastatus* Sby., *Phacoides richthofeni* Gabb, *Spisula*

hemphilli Dall, *Semele decisa* Con., *Astræa undosa* Wood, *Conus californicus* Hds., *Crucibulum spinosum* Sby., *Cypræa spadicea* Gray, *Murex carpenteri* Dall, *Fusus barbarensis* Trask, *Gyrineum californicum* Hds., *Siphonalia kellettii* Fbs., *Trophon belcheri* Hds., *Trophon triangulatus* Carp., *Polinices recluzianus* Desh., *Strongylocentrotus franciscanus* Ag.

V. *Gulf of California* (Cerros Island, Lower California, to Panama, lat. 28° to 8° 30' N., min temp. 68° F.). *Arca grandis* Sby., *Arca multicostata* Sby., *Arca pacifica* Sby., *Arca tuberculosa* Sby., *Avicula peruviana* Rv., *Chione gnidia* Sby., *Chione neglecta* Carp., *Cardium procerum* Sby., *Codokia distinguenda* Tryon, *Crassatellites gibbosus* Sby., *Dosinia dunkeri* Phil., *Dosinia ponderosa* Gray, *Macrocallista aurantiaca* Sby., *Macrocallista squalida* Sby., *Mactra exoleta* Gray, *Margaritiphora fimbriata* Dkr., *Miltha childreni* Gray, *Mulinia pallida* B. & S., *Ostrea palmula* Carp., *Pecten circularis* Sby., *Pecten dentatus* Sby., *Pecten subnodosus* Sby., *Spondylus crassisquama* Lam., *Cassis tenuis* Gray, *Cassis abbreviata* Lam., *Cerithium gemmatum* Hds., *Conus fergusonii* Sby., *Conus princeps* L., *Conus purpurascens* Brod., *Cuma kiosquiformis* Duclos, *Cypræa exanthema* L., *Dolium (Malea) ringens* Swain., *Eupleura muriciformis* Brod., *Fusus dupetithouarsi* Kien., *Ficus decussatus* Wood, *Macron æthiops* Rv., *Macron kellettii* Hds., *Mitra tristis* Brod., *Murex radix* Lam., *Oliva araneosa* Lam., *Oliva porphyria* L., *Oliva splendidula* Sby., *Purpura hæmostoma* L., *Strombus gracilior* Sby., *strombus granulatus* Gray, *Strombina lanceolata* Sby., *Terebra robusta* Hds., *Turritella goniostroma* Val., *Turbo fluctuosus* Wood, *Arbacia stellata* Gray, *Cidaris thouarsii* Ag. & Desot., *Encope californica* Verrill, *Encope grandis* Ag., *Encope micropora* A. Ag., *Mellita longifissa* Mich., *Clypeaster rotundus* A. Ag., *Hipponoe depressa* Ag., *Lovenia cordiformis* Lutken, *Pocillopora capitata* Verrill, *Porites compressa* Verrill.

FOSSIL FAUNAS.

QUATERNARY.

Manta, Ecuador, lat. 1° S., collected by B. Bryan. *Arca pacifica* Sby., *Arca reversa* Rv., *Cardium consors* B. & S., *Cardium magnificum* Desh., *Cytherea multicostata* Sby.,

Chama frondosa Brod., *Carditamera affinis* Brod., *Chione amalthusia* Phil., *Dosinia ponderosa* Gray, *Dosinia dunkeri* Phil., *Glycimeris giganteus* Rv., *Glycimeris inequalis* Sby., *Macrocallista auriantica* Sby., *Margaritiphora fimbriata* Dkr., *Mulinia pallida* B. & S., *Ostrea chilensis* Phil., *Pecten circularis* Sby., *Spondylus crassisquama* Lam., *Venericardia cuvieri* Brod., *Bullaria adamsi* Menke, *Cerithium adustum* Kien., *Conus princeps* L., *Conus purpurascens* Brod., *Conus virgatus* Rv., *Cymia tectum* Wood, *Latirus castaneus* Rv., *Latirus ceratus* Wood, *Latirus varicosus* Rv., *Murex multicrispatus* Dkr., *Murex radix* Gmel., *Oliva peruviana* Lam., *Strombus gracilior* Sby., *Strombus granulatus* Gray, *Terebra robusta* Hds., *Thais crassa* Bl., *Turritella goniostoma* Val., *Turbo saxosus* Wood, *Uvanilla olivacea* Wood, *Vasum muricatum* Born, *Vitularia salebrosa* King.

These species are all living now in the same region. The fauna is thoroughly tropical, and is probably very late Quaternary.

Galapagos Islands. This fauna evidently belongs to the older Quaternary, since it contains a number of extinct species. The fossils collected several years ago by Mr. W. H. Ochsner for the California Academy of Sciences are now under investigation by Dr. Dall. No displacement of the isotherms is indicated, and none could be expected under the equator.

Magdalena Bay, Lower California, lat. 24° 30' N. Collected by R. G. McGregor and E. Call Brown. *Arca tuberculosa* Sby., *Cardium elatum* Sby., *Cardium consors* B. & S., *Chione neglecta* Carp., *Macrocallista squalida* Sby., *Metis alta* Con., *Mulinia pallida* B. & S., *Pecten circularis* Sby., *Pecten subnodosus* Sby., *Tapes grata* Say, *Tellina punica* Born, *Astræa undosa* Wood, *Cerithium adustum* Kien, *Cerithium gemmatum* Hds., *Cerithium ocellatum* Hds., *Cuma kiosquiformis* Duclos, *Conus princeps* L., *Conus purpurascens* Brod., *Eupleura muriciformis* Brod., *Macron æthiops* Rv., *Macron kellestii* Hds., *Murex festivus* Hds., *Oliva angulata* Lam., *Oliva araneosa* Lam., *Oliva porphyria* L., *Olivella buplicata* Sby., *Pleurotoma carpenteriana* Gabb, *Purpura hæmostoma* L., *Ranella californica* Hds., *Strombus gracilior* Sby., *Strombus granulatus* Gray, *Terebra robusta* Hds., *Terebra specillata* Hds., *Terebra var-*

iegata Gray, *Turbo fluctuosus* Wood, *Turritella goniostoma* Val., *Dendraster excentricus* Esch., *Encope micropora* A. Ag.

This fauna is probably lower Quaternary, for while the species are all living, several are not known so far south, some not south of California. This probably shows a slight southward displacement of the isotherm; but the temperature was probably not lowered below 68° F.

The Quaternary fauna of San Ignacio Lagoon, lat. 27° N., collected by Henry Hemphill, is practically the same as that of Magdalena Bay. This is also true of that of Cerros Island, off Lower California, lat. 28° N., which is now the meeting place of the warm temperate fauna of California with that of the tropical Gulf of California.

Southern California (San Diego to Santa Barbara, lat. 33°–34° N.). The Quaternary of southern California is well known through the work of Ralph Arnold¹, under the name of the San Pedro formation. This formation has furnished a rich fauna of beautifully preserved forms, and the study of it has thrown much light upon the Quaternary history of the West Coast. Arnold divides the formation into two divisions: upper San Pedro and lower San Pedro.

Lower San Pedro. This phase is best developed at San Pedro, near Los Angeles, but is also found at Ventura and Santa Barbara. Important members of the fauna are: *Macoma calcarea* Gmel., *Marcia subdiaphana* Carp., *Pecten caurinus* Gld., *Pecten hastatus* Sby., *Panopea generosa* Gld., *Phacoides annulatus* Rv., *Venericardia babarensis* Stearns, *Amphissa corrugata* Hds., *Argobuccinum oregonense* Redf., *Boreotrophon gracilis* Perry, *Boreotrophon stuarti* Smith, *Chrysodomus tabulatus* Baird, *Natica clausa* B. & S., *Tritonofusus rectirostris* Carp., *Turris perversa* Gabb, (all Recent species in the cold water of the Puget Sound region); and *Pecten jordani* Arnold, *Crepidula princeps* Con., *Pisania fortis* Carp., extinct species. Of the whole fauna about 90 per cent are living, though mostly not in the southern California waters. The fauna indicates a temperature of about 50° F., a displacement southward of the isotherms of 1500 miles, and a lowering of temperature of about 12° F., as com-

¹ Paleont. and Stratig. Marine Pliocene and Pleistocene of San Pedro, California. <Mem. Calif. Acad. Sci., Vol. 3, 1903.

pared with the present. This epoch probably corresponds to the time of maximum glaciation of the continent. R. A. Daly² has estimated that the general lowering of temperature at the maximum glaciation was about 14° F., which agrees with the figure given.

Upper San Pedro. This fauna is best known at San Pedro, Dead Man Island, and Santa Barbara; the beds in which it occurs lie unconformably above the lower San Pedro, and consist of unconsolidated sands, gently tilted. The time interval between the two formations is not long, but long enough for the climate to have changed entirely, for the temperature to have risen from 12° F. below the present to about 4° F. above the present; long enough for the isotherm of 50° F. to have been pushed far to the north, and for that of about 66° F. to have invaded southern California. Among the important species of the upper San Pedro are: *Amiantis callosa* Con., *Cardium elatum* Sby., *Chione succincta* Val., *Metis alta* Con., *Pecten æquisulcatus* Carp., *Pitaria newcombiana* Dall, *Astræa undosa* Wood, *Chorus belcheri* Hds., *Gyrineum californicum* Hds., *Siphonalia kelletii* Hds., (all Recent species in southern California); and *Cardium procerum* Sby., *Chione gnidia* Sby., *Chione neglecta* Sby., *Dosinia ponderosa* Gray, *Miltha childreni* Gray, *Maetra exoleta* Gray, *Mulinia grayi* Dall, *Pecten dentatus* Sby., *Pecten subnodosus* Sby., *Eupleura muriciformis* Brod., *Macron kelletii* Hds., *Nassa versicolor* Adams, *Mellita longifissa* Mich. (all tropical species in Lower California or the Gulf of California); and *Cancellaria tritonidea* Gabb, *Crepidula princeps* Con. and *Pisania fortis* Carp., which are extinct.

The upper San Pedro is not post-Glacial, the number of extinct mollusca, about five per cent in a large fauna, being too great for that to be possible. It is probably interglacial. There was in Europe, after the second glaciation, a warm epoch in which the temperature of southern Europe was higher than that of the present. It may be that the upper San Pedro epoch corresponds to this. The cause of the rise was not local.

We have no way of measuring the time that has elapsed since the upper San Pedro, but it was long enough for about

² Glacial control theory of coral reefs. <Proc. Amer. Acad. Arts and Sci. Vol. 51, No. 4, (1915) p. 168.

five per cent of the fauna to have become extinct entirely, for all the tropical Mexican and Panama species to die out locally, and for the general temperature to be lowered by about 4° F.; also long enough for a considerable amount of deformation, terracing, and erosion to have taken place.

San Francisco Peninsula, lat. 37° 30' N. The Pleistocene deposits of Seven Mile Beach, near San Francisco, contain a fauna very like that now living in the same region, with the exception of *Natica clausa*, which is not known south of Puget Sound. Further collecting would probably yield more northern species.

Elk River, Cape Blanco (southwest Oregon, lat. 42° 50' N.). In the raised beach are found: *Kennerleya grandis* Midd., *Macoma middendorffi* Dall, *Mya truncata* L., *Pecten caurinus* Gld., *Saxidomus giganteus* Desh., *Spisula voyi* Gabb, *Venericardia ventricosa* Gld., *Amphissa corrugata* Hds., *Argobuccinum oregonense* Redf., *Bela harpa* Dall, *Bela tabulata* Carp., *Boreotrophon gracilis* Perry, *Boreotrophon stuarti* Smith, *Buccinum strigillatum* Dall, *Chrysodomus phæniceus* Dall, *Chrysodomus tabulatus* Baird, *Epitonium hindsi* Carp., *Natica clausa* B. & S., *Purpura foliata* Gmel., *Sipho halibrectus* Dall, *Solarirella cidaris* Adams, *Trichotropis cancellata* Hds., *Tritonofusus rectirostris* Dall, *Turris perversa* Gabb, (all northern or Puget Sound species), along with a considerable number of forms now living on the Oregon coast. This fauna indicates a temperature considerably lower than that now prevailing at Cape Blanco, and thus probably belongs to the lower San Pedro.

Arnold and Hannibal³ assign the Cape Blanco beds to the upper Pliocene, but the fauna listed by them is a mixture of Pliocene and Quaternary. Dall's interpretation of the geology of Cape Blanco⁴ was partly correct.

Vancouver Island (near Victoria, lat. 48° 30' N.). *Astarte alaskensis* Dall, *Cardium comoxense* Dall, *Cardium decoratum* Grew., *Leda fossa* Baird, *Macoma calcarea* Gmel., *Macoma krausei* Dall, *Mya truncata* L., *Pecten islandicus* Müller, *Saxicava arctica* L., *Serripes grænlandicus* Gmel., *Natica clausa* B. & S., *Natica pallida* B. & S.

³ Marine Tertiary Stratigraphy of the North Pacific Coast of America. <Proc. Amer. Phil. Soc. Vol. 52, No. 212, 1913, p. 595.

⁴ Bull. 196, U. S. Geol. Survey, (1902), p. 31.

This is a boreal fauna, indicating a temperature lower by several degrees than the present, and is probably Glacial in age.

Douglas Island (southern Alaska, lat. 58° N.). *Astarte borealis* Sch., *Cardium ciliatum* Fab., *Cardium decoratum* Grew., *Leda fossa* Baird, *Macoma balthica* L., *Macoma calcarea* Gmel., *Mya truncata* L., *Pecten hericeus* Gld. var. *navarchus* Dall, *Saxicava arctica* L., *Venericardia stearnsi* Dall, *Chryso-domus liratus* Martyn, *Natica pallida* B. & S., *Hemithyris psittacea* Gmel.

W. H. Dall⁵, who described this fauna, says that it indicates a temperature considerably colder than the present.

Cape Nome, lat. 64° N. In unconsolidated sands on intermediate beach, Center Creek, Cape Nome, Alaska. *Macoma middendorffi* Dall, *Monia macroschisma* Desh., *Pecten swifti* Bernh. This small fauna is interesting as well as important. Dall⁶ assigns it to Pliocene, but the material seen by the writer can only belong to the Quaternary. Also all Pliocene, north of middle California, indicates a lower temperature than the present. *Pecten swifti* now lives in the Japanese waters 1200 miles south, and eight degrees warmer than that of Cape Nome.

This is the only case where the warm water phase of the Quaternary is known in the far north, but farther search should yield many localities on both sides of the Pacific. It is to be expected that the Japan current would carry the warm water fauna farther to the north on the Siberian coast than it has been able to go on the American shore.

Mt. St. Elias. I. C. Russell⁷ mentions the occurrence of marine beds of Pliocene age uplifted to the height of 5000 feet on the slopes of Mt. St. Elias. The fauna is said to consist of Recent species. No lists of this fauna have been given, but in a later paper A. H. Brooks⁸ says that these beds probably belong to the Quaternary.

PLIOCENE.

There is at present much confusion in the correlation and nomenclature of the Pliocene formations on the West Coast. This comes from the disconnected occurrence of the beds, their

⁵ Harriman Expedition. Neozoic invertebrate fossils, p. 120, Vol. 4, 1904.

⁶ On climatic conditions at Cape Nome, etc. Amer. Jour. Sci. Vol. 173 (1907) p.

457.

⁷ Expedition to Mt. St. Elias. <Nat. Geograph. Mag. Vol. 3, 1891, pp. 170-175.

⁸ Geog. and Geol. of Alaska, Prof. Paper No. 45, U. S. Geol. Survey. 1906, p. 295.

varying lithology, and the great variety of rapidly changing climatic conditions under which they were laid down.

Equal confusion has existed concerning the climatic relations of the Pliocene of the West Coast, some having regarded it as indicating a cold climate and others treating it as uniformly warm. W. H. Dall⁹ makes a statement that the Pliocene on the West Coast was warmer than the Miocene. The Pliocene of San Diego was certainly warmer than the upper Miocene of Oregon and Washington; but if the Pliocene is compared with the Miocene of its own latitude it will be seen, without exception, to have been cooler.

There is much need of revision of the data concerning the Pliocene of California, where the greater part of the work has been done. The writer has therefore prepared detailed tables of this region, showing the present state of our knowledge, and giving the results of researches carried on in the last few years. These results are not final, for this is, at present, the fringing line in West Coast stratigraphy.

The Pliocene appears to have been a time of considerable intermigration between Japan and western America, but all the Oriental types that came over were northern forms. No species characteristic of warm water came from the southern Orient since lower Miocene time.

⁹ On climatic conditions at Cape Nome, etc. <Amer. Jour. Sci. Vol. 173, (1907), p. 457.

MARINE Pliocene Formations of the West Coast of North America

		Lower California	Southern California	Point Conception	Middle California	Northern California	Oregon	Puget Sound	Alaska
UPPER	Santa Barbara		Beds of Santa Barbara and Dead Man Island		Santa Clara lake beds				Mt. St. Elias beds? (Probably Quaternary)
	San Diego		Beds of San Diego, Pacific Beach, Carnulos Ranch and Los Angeles		Merced beds of San Francisco Peninsula	Crescent City beds	Beds of Cape Blanco and Fossil Rock		
LOWER	Fernando		Fernando of Elsmere Canyon, Puente Hills, and 3d St. tunnel, Los Angeles	Santa Maria beds of Fugler's Point in Santa Maria oil fields	Purisima formation of San Francisco Peninsula	Wildcat formation of Bel River with cold water fauna		Pliocene beds of Olympic Peninsula with Purisima fauna	
	Carrizo	Carrizo beds of Cerros Island	Carrizo beds of Imperia and San Diego Counties	"Lower Fernando" beds of Santa Maria	Jacalitos-Etchequin beds of San Joaquin Valley and Coast Ranges				

INTERREGIONAL CORRELATION TABLE OF PLIOCENE FAUNAS

	ITALY	NORTHERN EUROPE	CALIFORNIA
UPPER	Sicilian- (Villafranchian) appearance of Boreal species	Weyburn Crag of Norfolk. Norwich Crag. Boreal faunas.	Santa Barbara zone of southern California, with cold temperate fauna.
	Astian warm temperate fauna, with some tropical left-overs, and the beginning of the influx of northern types.	Red Crag of England, and Scaldesian of Belgium. Coralline Crag of England.	San Diego Beds of southern California and Merced of northern California.
LOWER	Plaisancian with subtropical species, left over from the Indian Ocean fauna.	Diestian beds of Antwerp, and Lenhamian of England.	Fernando beds of southern California, and Purisima beds of northern California.
	Messenian- (Zanclean), with fauna largely tropical. (Miocene?)	Wanting.	Carrizo of southern California and Jacalitos- Etchegoin of middle California.

The Messenian has 83% extinct and the fauna is largely tropical. The Plaisancian still has Indian Ocean species, and many remnants of the tropical fauna, like the Fernando. The Astian is more temperate, and the Coralline Crag, like the Purisima, begins to show influx of northern types. In the Sicilian, and Norfolk Crag, the boreal types have completely replaced the southern.

PLIOCENE FAUNAS OF THE WEST COAST.

Olympic Peninsula (coast of Washington, lat. 48° N.). Collections made by R. Arnold, A. B. Reagan, and H. Hannibal, have yielded: *Cardium meekianum* Gabb, *Chione securis* Shum, *Macoma calcarea* Gmel., *Marcia oregonensis* Con., *Panopea generosa* Gld., *Pecten caurinus* Gld., *Phacoides annulatus* Rv., *Spisula voyi* Gabb, *Thyasira bisecta* Con., *Argobuccinum oregonense* Redf., *Astræa inequalis* Martyn, *Chrysodomus imperialis* Dall, *Chrysodomus tabulatus* Baird, *Gyrineum marshalli* Reagan, *Natica clausa* B. & S., *Purpura foliata* Martyn, *Turris perversa* Gabb.

This is a Puget Sound fauna, indicating a temperature of about 50° F., the same as at present, showing no displacement of the isotherms. The age of this fauna is probably the same as that of the Purisima of middle California, upper part of lower Pliocene. About half of the species are extinct, and those still living are confined to cold water.

Cape Blanco (mouth of Elk River, southern Oregon, lat. 42° 50' N.). *Macoma astori* Dall, *Marcia gibbosa* Gabb, *Mya truncata* L., *Macoma nasuta* Con., *Paphia staminea* Con., *Pecten caurinus* Gld., *Spisula albaria* Con., *Thyasira bisecta* Con., *Yoldia strigata* Dall, *Polinices lewisii* Gld., *Dendraster interlineatus* Stimp. This fauna is probably of Merced age, lower part of upper Pliocene.

Wildcat Fauna (Eel River, Humboldt Co., California, north of Cape Mendocino, lat. 40° 30' N.). Collections made by W. M. Gabb, W. S. Monroe, W. G. Cooper, B. Martin, and H. Hannibal have yielded: *Arca trilineata* Con., *Cardium meek-anum* Gabb, *Chione securis* Shum., *Glycimeris coalingensis* Sen., *Macoma calcarea* Gmel., *Marcia oregonensis* Con., *Panomya ampla* Dall, *Paphia staleyii* Gabb, *Pecten caurinus* Gld., *Pecten dilleri* Dall, *Phacoides annulatus* Rv., *Serripes grænländicus* Gmel., *Spisula albaria* Con., *Spisula voyi* Gabb, *Schizothærus pajaroanus* Con., *Thracia trapezoidea* Con., *Thyasira bisecta* Con., *Venericardia castor* Dall, *Zirphæa gabbi* Tryon, *Boreotrophon fleernerensis* Martin, *Buccinum saundersi* Martin, *Chrysodomus eurekaensis* Martin, *Chrysodomus imperialis* Dall, *Chrysodomus liratus* Martyn, *Chrysodomus lawsoni* Martin, *Chrysodomus purisimaensis* Martin, *Chrysodomus scotiaensis* Martin, *Chrysodomus postplanatus* Dall, *Gyrineum marshalli* Reagan, *Haliotis rufescens* Swains., *Linatella pacifica* Dall, *Miopeleonia oregonensis* Dall, *Nassa moraniana* Martin, *Natica clausa* B. & S., *Polinices galianoii* Dall, *Tritonofusus fortunensis* Martin, *Dendraster interlineatus* Stimp., *Dendraster oregonensis* Clark.

This fauna has been variously assigned, to upper Miocene, and to the Merced horizon of the Pliocene. Its real age is that of the Purisima of middle California, and the true Fernando of southern California, upper part of lower Pliocene. It is probable, however, that in the thick section of the Wildcat formation the uppermost beds may overlap with the Merced, and the low-

est beds may belong to the age of the Etchegoin-Jacalitos fauna of middle California.

The Wildcat fauna belongs to the Puget Sound province, which then extended southward to Cape Mendocino, as it does now, and indicates a temperature of about 50° F. min. It lacks all the southern, warm-water, types, such as giant *Arca*, *Dosinia*, *Chione gnidia* group, *Janira*, *Pecten healeyi*, *Pecten oweni*, *Lyropecten*. It was the southern limit of the northern forms: *Macoma calcarea*, *Pecten caurinus*, *Pecten dilleri*, *Natica clausa*, *Buccinum*, *Haliotis* and *Volutopsis*. It is especially characterized by the large number of giant *Chryso-domus*, and by the first appearance of the oriental *Haliotis* in the California waters.

Cape Mendocino played the part, which now falls to Pt. Conception, as the dividing line between the warm-water and the cold-water faunas. This was the time of greatest differentiation of climatic zones on the Californian coast. The cold-water zone extended down to Cape Mendocino, and the warm-temperate zone pressed northward nearly to the same place. There was thus some telescoping of the isotherms, with the middle Californian province obliterated. This fact has made difficult the correlation of the Pliocene of northern California with that of the southern part of the state, and has resulted in faunas of the same age having been assigned to very different parts of the geologic column.

Merced (San Francisco Peninsula, south of San Francisco, lat. 37° 30' N.).

Collections by W. M. Gabb, G. H. Ashley, B. Martin, H. Hannibal, and many others have yielded: *Arca trilineata* Con., *Cardium meekannum* Gabb, *Cardium quadragenarium* Con., *Chione securis* Shum., *Marcia gibbosa* Gabb, *Mya japonica* Jay, *Pandora grandis* Dall, *Paphia staley* Gabb, *Phacoides annulatus* Rv., *Saxidomus giganteus* Desh., *Schizothærus pajaroanus* Con., *Spisula albaria* Con., *Zirphæa gabbi* Tryon, *Chryso-domus stantoni* Arn., *Chryso-domus (tabulatus) var. colmaensis* Martin, *Crepidula princeps* Con., *Nassa moraniana* Martin, *Natica clausa* B. & S., *Pisania fortis* Carp., *Dendraster interlineatus* Stimp.

This fauna is more northern in character than the underlying Purisima, agreeing more nearly in character with the older and

more northerly Wildcat formation. Of the entire fauna about 35% are extinct and 65% living. It is commonly regarded as upper Pliocene, but belongs to the older horizon of that division. The temperature of the sea in which the Merced beds were laid down was probably about 50° F., instead of 55° F. at present.

Purissima (Half Moon Bay, on the San Francisco Peninsula, lat. 37° N.). *Arca trilineata* Con., *Cardium meekianum* Gabb, *Chione securis* Shum., *Glycimeris coalingensis* Arn., *Macoma calcarea* Gmel., *Macoma middendorffi* Dall, *Marcia oregonensis* Con., *Mya truncata* L., *Panomya ampla* Dall, *Panopea generosa* Gld., *Paphia staleyi* Gabb, *Pecten purissimaensis* Arn., *Peronidea lutea* Gray, *Phacoides annulatus* Rv., *Schizothærus pajaronus* Con., *Spisula albaria* Con., *Spisula voyi* Gabb, *Thracia trapezoidea* Con., *Yoldia cooperi* Gabb, *Zirphea gabbi* Tryon, *Argobuccinum oregonense* Redf., *Bathytoma carpenteriana* Gabb, *Chrysodomus colmaensis* Martin, *Chrysodomus imperialis* Dall, *Chrysodomus liratus* Martyn, *Chrysodomus portolansis* Arn., *Chrysodomus purissimaensis* Martyn, *Chrysodomus stantoni* Arn., *Chrysodomus tabulatus* Baird, *Crepidula princeps* Con., *Gyrineum marshalli* Reagan, *Mioleptonia oregonensis* Dall, *Nassa moraniana* Martin, *Natica clausa* B. & S., *Natica draconis* Dall, *Natica lewisii* Gld., *Dendraster interlineatus* Stimp. (all northern types, or characteristic of this latitude); and: *Arca canalis* Con., *Chione elsmerensis* Eng., *Dosinia ponderosa* Gray, *Pecten healeyi* Arn., *Pecten nutteri* Arn., *Pecten purissimaensis* Arn., *Pecten oweni* Arn., *Dendraster ashleyi* Arn., *Dendraster perrini* Weaver, (all southern types).

This fauna shows a mixture of southern and northern types, with the latter predominating, the giant *Chrysodomus*, especially, indicating cooler water. *Dosinia ponderosa*, *Arca canalis*, and *Chione elsmerensis* indicate warm water. The temperature was probably a little warmer than the present, approximately 60° F., since northern forms can and do range southward by increasing their depth, while southern forms can not range north of their normal temperature.

Of the whole fauna 46% are extinct, and 54% living.

Santa Clara lake beds. These freshwater beds are known at many localities around the Santa Clara Valley, south of San Francisco. They contain a small fauna of bivalves and gastro-

Pods mostly living now in the Klamath Lakes in southern Oregon; also a small flora of species now living in the Klamath Mountains of northern California. This region is more than 300 miles to the north, and about 4000 feet higher than the ancient Santa Clara lakes. It is safe to assume that the temperature of the land and the sea during the Santa Clara epoch was as cool as it now is in the latitude of Cape Mendocino.

The Santa Clara beds overlie the Merced, and are the probable equivalent of the marine Santa Barbara formation of southern California.

Santa Maria faunal zone (north of Point Conception, in the Santa Maria embayment, Santa Barbara County, lat. 35° N.). *Arca trilineata* Con., *Cardium meekianum* Gabb, *Clidiphora punctata* Carp., *Dosinia ponderosa* Gray, *Glycimeris coalingensis* Arn., *Modiolus rectus* Gld., *Mya truncata* L., *Ostrea veatchi* Gabb, *Panomya ampla* Dall, *Pecten* cf. *cerrosensis* Gabb, *Pecten etchegoini* And., *Pecten hastatus* Sby., *Pecten healeyi* Arn., *Pecten hemphilli* Dall, *Pecten lawsoni* Arn., *Pecten oweni* Arn., *Pecten stearnsi* Dall, *Pecten wattsi* Arn., *Paphia staleyi* Gabb, *Paphia tenerrima* Carp., *Phacoides annulatus* Rv., *Thracia trapezoidea* Con., *Venericardia californica* Dall, *Argobuccinum oregonense* Redf., *Bathytoma carpenteriana* Gabb, *Cancellaria rapa* Nomland, *Cancellaria tritonidea* Gabb, *Chrysodomus portolaensis* Arn., *Crepidula princeps* Con., *Gyrineum elsmerense* Eng., *Mioleionia oregonensis* Dall, *Nassa californiana* Con., *Nassa moraniana* Martin, *Trochita radians* Lam., *Terebratalia occidentalis* Dall, *Dendraster ashleyi* Arn.

This fauna contains a mixture of Fernando (southern) and Purisima-Wildcat (northern) species. It was the northern limit of *Ostrea veatchi*, *Janira*, *Cancellaria tritonidea*, and *Gyrineum elsmerense*. It was the southern limit of *Cardium meekianum*, *Glycimeris coalingensis*, *Paphia staleyi*, *Nassa californiana*, *Nassa moraniana*, and *Mioleionia oregonensis*.

It lacks: *Ficus*, *Lyropecten*, and *Astrodapsis*, which are characteristic of the more southerly contemporaneous Fernando. The temperature was probably a little warmer than that of the present Santa Barbara Channel (62° F. min.), and a little cooler than the present temperature south of Cerros Island (68° F. min.), which would make it approximately 64° F. Of the whole fauna 44% are extinct, and 56% living.

The age is that of the Fernando and the Purisima, upper part of lower Pliocene. At the base of the Santa Maria beds there occurs an horizon with the Etchegoin-Jacalitos fauna, including *Pecten estrellanus*, and *Pecten coalingensis*.

Etchegoin-Jacalitos. This fauna is found in the San Benito Valley, and on the west side of the San Joaquin Valley, south of San Francisco Bay, also at the bottom of the Fernando section of the Santa Maria embayment in Santa Barbara County. F. M. Anderson¹⁰, who first described the Etchegoin, assigned it to Pliocene, while R. Arnold¹¹, who later published an account of both Etchegoin and Jacalitos, placed them in the upper Miocene. Dr. J. C. Merriam¹², correlates both Jacalitos and Etchegoin with Pliocene, basing his determination upon the relations of their vertebrate faunas with those of the continental Pliocene.

The recent study of the Etchegoin fauna by J. M. Nomland* places it beyond doubt that the Etchegoin and Jacalitos are practically identical, and that the joint fauna is Pliocene. There can also be little doubt that a portion of the Etchegoin overlaps with the Purisima. Collections by F. M. Anderson, R. Arnold, W. H. Ochsner, J. M. Nomland, and many others, have yielded the following fauna, along with many others not listed: *Dendraster gibbsi* Gabb, *Dendraster perrini* Weaver, *Astrodapsis peltoides* And. & Mart., *Arca trilineata* Con., *Cardium coosense* Dall, *Cardium quadrigenarium* Con., *Chione elsmerensis* Eng., *Chione securis* Shum., *Cryptomya ovalis* Con., *Dosinia jacalitosana* Arn., *Glycimeris coalingensis* Arn., *Modiolus directus* Dall, *Mulinia densata* Con., *Mytilus coalingensis* Arn., *Ostrea atwoodi* Gabb, *Ostrea veatchi* Gabb, *Ostrea vespertina* Con., *Panopea generosa* Gld., *Paphia staminea* Con., *Paphia tenerima* Carp., *Pecten cerrosensis* Gabb, *Pecten coalingensis* Arn., *Pecten estrellanus* Con., *Pecten etchegoini* And., *Pecten healeyi* Arn., *Pecten nutteri* Arn., *Pecten oweni* Arn., *Pecten proteus* Nomland, *Phacoides annulatus* Rv., *Placunanomia californica* Arn., *Schizothærus pajaroanus* Con., *Spisula albaria* Con., *Spisula coalingensis* Arn., *Thracia trapezoidea* Con., *Zirphæa dentata* Gabb, *Cancellaria rapa* Nomland, *Bathytoma carpenteriana* Gabb, *Bathytoma coalingaensis* Arn., *Callistoma coa-*

¹⁰ A Stratigraphic Study in the Mount Diablo Range of California. <Proc. Calif. Acad. Sci. 3d Ser. Geol. Vol. 2, No. 2 (1905).

¹¹ Paleont. Coalinga District. Bull. 396, U. S. Geol. Survey (1909).

¹² Tertiary Vertebrate Faunas of the North Coalinga Region of California. <Trans. Amer. Phil. Soc. n. s. Vol. 22, Pt. 3 (1915), p. 29.

lingense Arn., *Cancellaria tritonidea* Gabb, *Cancellaria rapa* Nomland, *Chrysodomus imperialis* Dall, *Chrysodomus portolaensis* Arn., *Ficus nodiferus* Gabb, *Miopleionia oregonensis* Dall, *Nassa californiana* Con., *Thais ethegoiensis* Arn., *Thais kettlemansensis* Arn., *Trophon coalingense* Arn., *Trophon ponderosus* Gabb, *Turritella vanvlecki* Arn.

Of the entire fauna about 40% are living, and 60% extinct. The temperature was probably subtropical, as indicated by *Lyropecten*, *Ficus*, *Janira*, *Chione* of the *gnidia* group, and fluted *Ostrea*.

One good reason for placing the Etchegoin below the greater part of the Purisima zone is the fact that the Etchegoin fauna still preserves more of the warm water elements and has fewer of the boreal, Puget Sound, forms than the Fernando, although it lies 200 miles to the north. The isotherm of subtropical warmth had not yet moved to the south of Point Conception, as it had in the Fernando-Purisima epoch.

Near relationship between the Etchegoin-Jacalitos and the Purisima-Fernando is shown by the following species which range from Etchegoin into Purisima or Fernando, and are not known to occur higher in the section: *Cardium meekorum*, *Chione elsmereensis*, *Chione securis*, *Cryptomya ovalis*, *Glycymeris coalingensis*, *Marcia oregonensis*, *Mulinia densata*, *Mytilus coalingensis*, *Paphia staleyi*, *Pecten healeyi*, *Pecten nutteri*, *Pecten wattsi*, *Pecten oweni*, *Spisula albaria*, *Venus pertenuis*, *Zirphea dentata*, *Cancellaria rapa*, *Chrysodomus imperialis*, *Chrysodomus portolaensis*, *Nassa moraniana*, *Polinices galianoi*, *Ficus nodiferus*, *Miopleionia oregonensis*, *Sinum scopulosum*. In addition to these, the following are known to occur below the Etchegoin, and in the Purisima or Fernando horizon, but not yet known in the Etchegoin: *Cardium coosense*, *Macoma astori*, *Miltha sanctæcruis*, *Chrysodomus postplanatus*, *Trochita inornata*. These are nearly all Miocene species ranging upward.

The Oriental group, *Pallium*, group of *Pecten swifti*, is especially abundant and characteristic in the Etchegoin fauna. The relationship of the American to the Japanese fauna becomes even more marked in the Purisima epoch, as it should, since the latter is more northern in position, and cooler in temperature than the Etchegoin.

TABLE OF PLOCIENE AND PLEISTOCENE OF SOUTHERN CALIFORNIA.

PLEISTOCENE	UPPER	<i>Upper San Pedro</i> , of San Pedro, San Diego, and many other points in the southern California embayment. Unconsolidated sands, several hundred feet thick, and gently tilted. Fauna with many tropical species.
	LOWER	<i>Lower San Pedro</i> , of San Pedro, Ventura and Santa Barbara, unconsolidated sands, somewhat more disturbed, with cold-temperate (Puget Sound) fauna.
PLIOCENE	UPPER	<i>Santa Barbara</i> , of Santa Barbara, Dead Man Island, and many other places in the San Pedro region. Sands and clays slightly more disturbed, with cold-temperate (Puget Sound) fauna. These are the equivalent of the Santa Clara beds in middle California.
		<i>San Diego</i> , of San Diego, Los Angeles, Santa Susanna, Camulos Ranch, etc., with mixture of southern (predominating) and northern types. This is the equivalent of the Merced of middle California.
	LOWER	<i>Fernando</i> , of Elsmere Canyon, Fernando Pass, Temescal Canyon, Third St. Tunnel in Los Angeles, Puente Hills, and the older beds in old San Diego, underlying the San Diego formation. The fauna is characterized by <i>Ficus nodiferus</i> , <i>Lyropecten ashleyi</i> , giant <i>Conus</i> , and <i>Astrodapsis fernandoensis</i> .
		<i>Carrizo</i> , of Carrizo Creek in Imperial County, and Cerros Island, Lower California. Fauna with <i>Pecten veatchi</i> , <i>Pecten ashleyi</i> , <i>Pecten cerrosensis</i> , <i>Clypeaster bowersi</i> , <i>Encope tenuis</i> , <i>Dolium</i> , giant <i>Conus</i> , <i>Olivia porphyria</i> , and reef-forming <i>Astræidæ</i> . This is the tropical equivalent of the Jacalitos-Etchegoin of middle California.

DIAGNOSTIC PLOCIENE SPECIES IN SOUTHERN CALIFORNIA

	Carrizo	Fernando	San Diego	Santa Barbara	Lower San Pedro	Upper San Pedro	Recent
<i>Dendraster excentricus</i> Esch.....	+	+	+	+	+
" <i>ashleyi</i> Arnold.....	..	+	+
<i>Astrodapsis fernandoensis</i> Eng.....	..	+
<i>Clypeaster bowersi</i> Weaver.....	+
<i>Encope tenuis</i> Kew.....	+
<i>Terebratalia hemphilli</i> Dall.....	..	+	+	+
" <i>smithi</i> Arnold.....	..	+	+	+
<i>Arca trilineata</i> Con.....	..	+	+
" <i>canalis</i> Con.....	..	?	+
" <i>camuloensis</i> Osmont.....	..	+
<i>Ostrea veatchi</i> Gabb.....	+	+	+
<i>Pecten ashleyi</i> Arnold.....	+	+
" <i>bellus</i> Con.....	..	+	+	+
" <i>caurinus</i> Gld.....	+	+	+	..	Puget Sound +
" <i>cerrosensis</i> Gabb.....	+	+	+
" <i>healeyi</i> Arnold.....	..	+	+
" <i>hemphilli</i> Dall.....	..	+	+
" <i>jordani</i> Arnold.....	+	+
" <i>keepi</i> Arnold.....	+
" <i>oweni</i> Arnold.....	..	+
" <i>opuntia</i> Dall.....	..	+	+	+
" <i>parmaleei</i> Dall.....	+
" <i>stearnsi</i> Dall.....	..	+	+	+
" <i>subnodosus</i> Sby.....	+	+	Lower Calif. +
<i>Phacoides sanctæcrucis</i> Arnold.....	..	+
<i>Cancellaria rapa</i> Nomland.....	..	+
<i>Conus</i> (giant).....	+	+
<i>Ficus nodiferus</i> Gabb.....	..	+
" <i>pyriformis</i> Gabb.....	..	+
<i>Fusus barborensis</i> Trask.....	+	+	+	+
<i>Pisania fortis</i> Carp.....	..	+	+	+	+
<i>Turritella jewetti</i> Carp.....	+	+	+

Santa Barbara. The uppermost Pliocene in southern California, in the old Santa Barbara embayment from Point Conception to San Diego, has been called by various names, Merced, Fernando, and San Diego, but it is different in age and in fauna from all three. J. P. Smith¹³ proposed to call it the Santa Barbara zone, which term seems to be acceptable. The fauna of this horizon, from the beds at Santa Barbara, and Dead Man Island (San Pedro), chiefly collected and described

¹³ Geol. range of Miocene Invertebrate Fossils of California. <Proc. Calif. Acad. Sci. 4th Ser. Vol. 3, (1912), p. 169.

by Ralph Arnold¹⁴, is as follows: *Dendraster excentricus* Esch., *Terebratalia hemphilli* Dall, *Terebratalia smithi* Arn., *Marcia subdiaphana* Con., *Panopea generosa* Gld., *Pecten caurinus* Gld., *Pecten bellus* Con., *Pecten hastatus* Sby., *Pecten hericeus* Gould, *Pecten jordani* Arn., *Pecten opuntia* Dall, *Pecten stearnsi* Dall, *Thracia trapezoidea* Con., *Thyasira bisecta* Con., *Venericardia barbarendis* Con., *Venericardia ventricosa* Gld., *Argobuccinum oregonense* Redf., *Chrysodomus tabulatus* Baird, *Crepidula princeps* Con., *Fusus barbarendis* Trask, *Natica clausa* B. & S., *Pisania fortis* Carp., *Solariella peramabilis* Carp., *Tritonofusus rectirostris* Carp., *Trophon (Boreotrophon) gracilis* Perry, *Trophon (B.) stuarti* Smith, *Turris smithi* Arn., *Turritella jewetti* Carp.

A census of the entire fauna shows about 15% extinct, and 85% living. The character is decidedly northern, with many Puget Sound types such as *Pecten caurinus*, *Tritonofusus*, and *Chrysodomus*, but with the southern *Janira* still persisting. The temperature was cooler than the present, and probably about the same as that of Puget Sound.

San Diego. This faunal zone, too, has been variously named, San Diego, Merced, and Fernando; but while it is the equivalent of the Merced, it is not synonymous with Fernando, and the name given by W. H. Dall¹⁵ antedates the others. The formation is especially well developed at San Diego, Pacific Beach, San Pedro, Los Angeles, and Todos Santos Bay, Lower California. Collections by Henry Hemphill, R. Arnold, and many others, have yielded, among others: *Dendraster ashleyi* Arn., *Terebratalia hemphilli* Dall, *Terebratalia smithi* Arn., *Arca canalis* Con., *Arca trilineata* Con., *Metis alta* Con., *Modiolus rectus* Gld., *Monia macroschisma* Desh., *Ostrea veatchi* Gabb, *Pecten bellus* Con., *Pecten caurinus* Gld., *Pecten cerrosensis* Gabb, *Pecten cooperi* Arn., *Pecten hastatus* Sby., *Pecten healeyi* Arn., *Pecten hemphilli* Dall, *Pecten opuntia* Dall, *Pecten parmaleei* Dall, *Pecten stearnsi* Dall, *Venericardia californica* Dall, *Chrysodomus tabulatus* Baird, *Tritonofusus rectirostris* Carp.

¹⁴ Pal. and Stratig. Pliocene and Pleistocene of San Pedro, California, Mem. Calif. Acad. Sci. Vol. 3, (1903); The Tertiary and Quaternary Pectens of California, Prof. Paper No. 47, U. S. Geol. Survey, (1906); and New and characteristic species of fossil mollusks . . . Santa Barbara, etc. Smithsonian Misc. Coll. Vol. 50, (1907); and New and characteristic species of fossil mollusks . . . Southern California. Proc. U. S. Nat. Mus. Vol. 32, (1907), pp. 525-546.

¹⁵ Proc. Calif. Acad. Sci. Vol. 6, (1874), p. 227 et seq.; and A Table of North American Tertiary Horizons, etc., Eighteenth An. Rept. U. S. Geol. Survey, part 2, (1898), p. 337.

The most recent discussion of this fauna by C. L. Moody¹⁶, adds greatly to the list of known species.

This horizon is the same as that of the Merced of middle California, but has more southern types, such as giant *Arca*, and *Janira*, and fewer northern forms. Of the whole fauna 30% are extinct, and 70% living. It is upper Pliocene, but not uppermost Pliocene. Moody correlates the Los Angeles fauna with the San Diego, but calls it Fernando, following the usage of Arnold.

Fernando. This name has been greatly misused, having come to be applied to all the Pliocene in southern California, and even the marine Pleistocene. G. H. Ashley¹⁷ first listed the fauna, but merely called it the "beds at Fernando," without formally naming the geologic formation. Homer Hamlin first used the term, on unpublished maps, for the same beds from which came the fauna listed by Ashley. R. Arnold¹⁸ first published the name Fernando, but included in the formation the San Diego beds of the Los Angeles region, the Santa Barbara horizon of San Pedro and Santa Barbara, and some of the marine San Pedro Pleistocene of southern California.

W. A. English¹⁹ has used the term in its original significance, and described the true Fernando fauna.

Fernando fauna of southern California. The true Fernando, of Fernando Pass, Elsmere Canyon, Third St. Tunnel (Los Angeles), Temesal Canyon, and the Puente Hills, contains the following characteristic species: *Astrodapsis fernandoensis* Pack, *Dendraster ashleyi* Arn., *Amiantis callosa* Con., *Arca canalis* Con., *Arca camuloensis* Osmont, *Arca grandis* B. & S., *Arca multicostata* Sby., *Arca trilineata* Con., *Cardium quadrigenarium* Con., *Chione elsmereensis* Eng., *Dosinia ponderosa* Gray, *Metis alta* Con., *Marcia subdiaphana* Carp., *Mya truncata* L., *Ostrea veatchi* Gabb, *Paphia tenerima* Carp., *Pecten ashleyi* Arn., *Pecten bellus* Con., *Pecten cerrosensis* Gabb, *Pecten healeyi* Arn., *Pecten hemphilli* Dall, *Pecten oweni* Arn., *Pecten stearnsi* Dall, *Panopea generosa* Gld., *Phacoides sanctæcrucis* Arn., *Thyasira bisecta* Con., *Astræa undosa* Wood,

¹⁶ Fauna of the Fernando of Los Angeles, Univ. of Calif. Pub. Bull. Dept. Geol. Vol. 10, No. 4, (1916), pp. 39-62.

¹⁷ The Neocene Stratigraphy of the Santa Cruz Mountains of Calif. Proc. Calif. Acad. Sci. 2d Ser. Vol. 5, (1895), pp. 273-367.

¹⁸ Bull. 309, U. S. Geol. Survey, p. 22.

¹⁹ The Fernando Group near Newhall, California, Univ. of Calif. Pub. Bull. Dept. Geol. Vol. 8, No. 8, (1914), pp. 203-218.

Calyptræa radians Lam., *Cancellaria rapa* Nomland, *Cancellaria tritonidea* Gabb, *Conus* species, *Cypræa fernandoensis* Arn., *Ficus nodiferus* Gabb, *Ficus pyriformis* Gabb, *Murex eldridgei* Arn., *Pisania fortis* Carp., *Terebra martini* Eng., *Terebratalia occidentalis* Dall, *Terebratalia smithi* Arn.

This decidedly indicates warm water, of a temperature not much below 68° F. min., not strictly tropical, for reef-forming corals are lacking, and there are several northern types that would hardly have lived in tropical waters. The abundant *Lyropecten*, *Janira*, *Ficus*, giant *Arca* and *Miltha* and the rarer *Astrodapsis*, *Chione*, *Dosinia*, *Murex*, and *Cypræa*, all speak for a temperature considerably higher than that now prevailing in the Santa Barbara Channel, or about 66° F. min. This fauna was the northern limit of *Astrodapsis*, *Cypræa*, giant *Arca*, *Lyropecten*, and *Ficus*, in the lower Pliocene. Of the whole fauna, as now known, about 50% are extinct, which agrees with that of the Santa Maria, the Purisima, and the Wildcat faunas.

Point Conception then played the part, now given to Cerros Island (Lower California), as the dividing line between the subtropical and the warm temperate zones. There was then considerable telescoping of the isotherms, since the cold-water belt came down to Cape Mendocino, and the warm temperate met the subtropical belt at Point Conception, with much more sharply defined climatic zones than now exist on the coast of California.

Carrizo (Imperial Co., Calif., and Cerros Island, Lower California, lat. 33° N.—28° N.). This fauna was first described by R. Arnold²⁰, who correlated it with the Etchegoin of middle California, a correlation which still stands. W. S. Kew²¹ has more recently described the fauna more fully, assigning it definitely to the Pliocene. The following forms are known to belong to the Carrizo: *Arca* (giant), *Cardium quadrigenarium* Con., *Codakia* cf. *distinguenda* Tryon, *Metis alta* Con., *Ostrea palmula* Carp., *Ostrea veatchi* Gabb, *Ostrea heermanni* Con., *Ostrea vespertina* Con., *Pecten carrizoensis* Arn., *Pecten ashleyi* Arn., *Pecten cerrosensis* Arn., *Pecten deserti* Con., *Pec-*

²⁰ Science (n. s.), vol. 19, p. 503 (1904); and U. S. Geol. Survey, Prof. Paper No. 47, (1906).

²¹ Tertiary Echinoids of the Carrizo Creek region in the Colorado Desert. Univ. of Calif. Pub. Bull. Dept. Geol. vol. 8, No. 5, (1914).

ten keepi Arn., *Pecten lecontei* Arn., *Pecten veatchi* Gabb, *Pinna* species, *Cassis* species, *Conus* (giant), *Cypræa* species, *Dolium* (*Malea*) cf. *ringens* Swain., *Oliva* cf. *porphyria* L., *Solarium* species, *Strombus* cf. *granulatus* Gray, *Turritella* (giant), *Cidaris* species, *Clypeaster bowersi* Weaver, *Clypeaster carriænsis* Kew, *Clypeaster deserti* Kew, *Encope tenuis* Kew, *Mæandra bowersi* Vaughan, *Dichocænia merriami* Vaughan, *Plesiastræa californica* Vaughan, *Siderastræa californica* Vaughan, *Siderastræa mendenhalli* Vaughan, *Solenastræa fairbanksi* Vaughan, *Porites carrizensis* Vaughan.

This is a thoroughly tropical fauna, all the species being nearly related to members of the Gulf or Panama fauna, with the exception of the *Astræidæ*, which indicate still warmer water than that of Panama. The *Astræidæ* are most nearly related to Caribbean forms, and suggest the possibility of a late Miocene connection between the Atlantic and the Pacific. There is nothing else in the fauna, however, to make this probable, T. W. Vaughan*, who has described the coral fauna of the Carrizo, leaves the question in abeyance. Further study by R. E. Dickerson has cast doubt upon the Pliocene age of the Carrizo fauna, and it may yet be placed in the Miocene, to which Arnold first assigned it.

It is clear that the real tropical belt extended up to Imperial County, California, lat. 33° N., the head of the ancient Gulf of California. The corals have not been found in the Carrizo formation on Cerros Island; it is probable that then, as now, the ocean side of Lower California was cooler than the Gulf in the same latitudes. The Carrizo beds of the Gulf were deposited in water that was probably considerably warmer than 68° F. min. temperature.

CLIMATIC DISTRIBUTION OF FAUNAS IN FERNANDO-PURISIMA EPOCH OF THE LOWER PLIOCENE.

I. *Oregonian* (Eel River, California, to Puget Sound, lat. 40°–49° N.). *Cardium grænlandicum*, *Chione securis*, *Arca tri-lineata*, *Cardium meekaanum*, *Pecten dilleri*, *Pecten caurinus*, *Spisula albaria*, *Spisula voyi*, *Saxidomus giganteus*, *Thyasira bisecta*, *Dendraster oregonensis* Clark. The present temperature

* The reef-coral fauna of Carrizo Creek, etc. U. S. Geol. Survey, Prof. Paper No. 98-T, pp. 353-395, 1917.

of the sea is 50° F. min., and the fossil fauna indicates about the same temperature.

II. *Franciscan or Middle Californian* (Cape Mendocino to Pt. Conception, 40°–34° 30' N.). *Chione securis*, *Cardium meekianum*, *Peronidea lutea* Gray, *Spisula albaria*, *Chrysodomus imperialis*, *C. purissimaensis*, *C. stantoni*, *C. tabulatus*, *Priene pacifica*, *Argobuccinum oregonense*, *Gyrineum marshalli*, *Miopleionia oregonensis*, *Scutella interlineata*, (all northern species); *Dosinia ponderosa*, *Arca trilineata*, *Arca canalis*, *Chione elsmereensis*, *Pecten healeyi*, *Pecten nutteri*, *Pecten oweni*, *Dendraster ashleyi*, (all southern species). This fauna lacks: *Ficus*, *Janira*, *Lyropecten*, *Astrodapsis*, *Trachycardium*, giant *Conus*, *Amiantis*, and the *Arca multicostata* group. The temperature was about 60° F.

III. *Fernandan, or Southern Californian* (Pt. Conception to San Diego, 34° 30'–33° N.). *Ficus nodiferus*, *Dosinia ponderosa*, *Arca camulosensis*, *Arca multicostata*, *Arca grandis*, *Chione*, *Lyropecten*, *Trachycardium*, *Amiantis*, *Pecten healeyi*, *Janira*; *Pecten hemphilli*, *P. stearnsi*; giant *Conus*, *Cypræa*, *Cancellaria*, *Dendraster ashleyi*, *Astrodapsis fernandoensis*, (all southern species, indicating a minimum temperature of at least 65° F., several degrees warmer than the present, which has a minimum of about 62° F.).

IV. *Gulf of California*. The equivalent of the Fernando fauna is not yet known in Lower California, but the next lower fauna, the Carrizo, is decidedly tropical, and indicates a minimum temperature of not less than 68° F.

MIOCENE

Shumagin Islands (off the Alaskan Peninsula, lat. 55° N.). This is the most northerly Miocene known on the American coast; it has been described by W. H. Dall²², who assigns it to lower Miocene, on the basis of identity of a few species with those of the lower Miocene of Oregon. The species listed by Dall are: *Cardium ciliatum* Fab., *Cardium decoratum* Gren., *Glycimeris kochevarofi* Gren., *Mytilus middendorffi* Gren., *Paphia grewingki* Dall, *Papyridea harrimani* Dall, *Mya aren-*

²² Harriman Alaska Exped. vol. 4, (1904). Neozoic invertebrate fossils, pp. 111-120.

aria L., *Mya crassa* Gren., *Mya truncata* L., *Pecten fucanus* Dall, *Saxicava unguana* Gren., *Buccinum* sp., *Chrysodomus* cf., *liratus* Martyn, *Tritonofusus* sp.

This fauna is decidedly northern, very like that of the Alaskan Gulf and Puget Sound region. It seems to the writer more likely to be the boreal equivalent of the Puget Sound Empire fauna. There are too many Recent species in it for it to be equivalent to either the Astoria (Oligocene), or the Clallam (lower Miocene) of Oregon and Washington.

Empire. On the shores of Oregon and Washington, from Cape Blanco (lat. 42° 50' N.) to the Olympic Peninsula, (lat. 48° N.), occurs the Empire formation. It was described by W. H. Dall ²³, as upper Miocene, his fossils having been collected at Coos Bay, Oregon, by B. H. Camman, from the entire section exposed there. This fauna has since been collected and described by R. Arnold and H. Hannibal ²⁴ at Coos Bay, and numerous other localities up to the Olympic Peninsula. Collections by B. H. Camman and H. Hannibal have yielded: *Arca trilineata* Con., *Cardium coosense* Dall, *Cardium meek-anum* Gabb, *Chione securis* Shum., *Glycimeris grewingki* Dall, *Macoma astori* Dall, *Macoma calcarea* Gmel., *Marcia oregonensis* Con., *Mulinia densata* Con., *Mya truncata* L., *Mytilus middendorffi* Gren., *Nucula conradi* Meek, *Panomya ampla* Dall, *Paphia staleyi* Gabb, *Pecten coosensis* Dall, *Phacoides acutilineatus* Con., *Schizothærus pajaroanus* Con., *Spisula albaria* Con., *Tellina aragonia* Dall, *Argobuccinum cammani* Dall, *Argobuccinum coosense* Dall, *Bathytoma gabbiana* Dall, *Boreotrophon stuarti* Smith, *Bullia bogachielii* Rgn., *Calyptrea bairdi* Dall, *Cancellaria oregonensis* Dall, *Chrysodomus bairdi* Dall, *Chrysodomus imperialis* Dall, *Crepidula princeps* Con., *Cymatium pacificum* Dall, *Fusus coosensis* Dall, *Miopleionia oregonensis* Dall, *Natica clausa* B. & S., *Phalium æquisulcatum* Dall, *Phalium turricula* Dall, *Polinices galianoi* Dall, *Turris coli* Dall, *Turris perversa* Gabb, *Discinisca oregonensis* Dall, *Dendraster gabbi* Rémond. Dall also lists *Eudolium oregonense* Dall, but it seems more likely that this, possibly along with *Phalium æquisulcatum*, and *P. turricula* came out of the older Astoria or Clallam beds, since the fossils were collected on

²³ U. S. Geol. Survey, Prof. Papers No. 59, (1909).

²⁴ The marine Tertiary stratigraphy of the north Pacific Coast of America. Proc. Amer. Phil. Soc. vol. 52, No. 212, (1913), pp. 559-605.

the beach, without discrimination. The Empire fauna, as here listed, seems to be an incongruous mixture of the Purissima-Wildcat fauna with a few adventitious forms out of either the Astoria (Oligocene), or the Clallam (lower Miocene). If the Empire does represent an independent horizon, it can correspond only to the lost interval between the Monterey and the Santa Margarita-San Pablo of the California section.

Clallam. (Olympic Peninsula, Washington, lat. 48° N.). The Clallam formation was first described by R. Arnold,²⁵ as the equivalent of the Monterey of the Californian section, and this correlation still stands. A portion of this fauna has since been described by W. H. Dall,²⁶ and fuller lists have been given by Arnold and Hannibal,²⁷ but with the inclusion of some Oligocene elements. C. E. Weaver,²⁸ has also described a portion of this fauna. Other species have been added by F. M. Anderson and Bruce Martin.²⁹ All these writers agree in correlating the Clallam with the Monterey. Characteristic species, collected by these various workers are: *Arca devincta* Con., *Arca trilineata* Con., *Dosinia mathewsoni* Gabb, *Leda penita* Con., *Marcia oregonensis* Con., *Panopea generosa* Gld., *Pecten fucanus* Dall, *Pecten propatulus* Con., *Phacoides acutilineatus* Con., *Spisula albaria* Con., *Tellina arctata* Con., *Tellina obruta* Con., *Tellina oregonensis* Con., *Thracia trapezoidea* Con., *Thyasira bisecta* Con., *Venus clallamensis* Rgn., *Yoldia impressa* Con., *Yoldia oregona* Shum., *Ampullina oregonensis* Dall, *Chrysodomus nodiferus* Con., *Crepidula prærupta* Con., *Cylichnella petrosa* Con., *Ficus clallamensis* Weaver, *Fusus devinctus* Con., *Fusus corpulentus* Con., *Fusus geniculus* Con., *Mioleptonia indurata* Con., *Natica oregonensis* Con., *Polinices saxea* Con., *Sinum scopulosum* Con., *Turritella oregonensis* Con.

Most of these forms are also found in the Monterey-Temblor of California; but the Clallam fauna lacks *Lyropecten*, *Conus*, giant *Turritella*, and *Scutella* (southern types). It indicates warm temperate conditions, but cooler than the contemporary Monterey-Temblor of California.

²⁵ A geological reconnaissance of the Olympic Peninsula. Bull. Geol. Soc. Amer. vol. 17, (1906), pp. 451-468.

²⁶ Prof. Paper No. 59, U. S. Geol. Survey, (1909).

²⁷ Proc. Amer. Phil. Soc. vol. 52, No. 212, (1913), pp. 586-588.

²⁸ A preliminary report on the Tertiary paleontology, Washington Geol. Survey, Bull. No. 15, (1912), pp. 1-80.

²⁹ Neocene record in the Temblor basin, California, etc. Proc. Calif. Acad. Sci. 4th ser. vol. 4, 1914), pp. 15-112.

Santa Margarita-San Pablo. This fauna is found throughout the inner Coast Ranges of middle California, from Mt. Diablo southward to the Coalinga region. Since the classic works of Conrad and Gabb, it has been described by R. Arnold,³⁰ from the Salinas Valley and the Coalinga region of the San Joaquin Valley; and by numerous writers upon the region of Mt. Diablo, especially B. L. Clark,³¹ who has published a monograph on the entire San Pablo fauna.

The most important species in the Santa Margarita-San Pablo fauna are: *Asterias remondi* Gabb, *Astrodapsis antiselli* Con., *Astrodapsis tumidus* Rémond, *Astrodapsis whitneyi* Rémond, *Clypeaster breverianus* Gabb, *Dendraster gibbsi* Gabb, *Dendraster gabbi* Rémond, *Disciniscia oregonensis* Dall, *Tamiosoma gregaria* Con., *Amiantis dalli* Clark, *Arca microdonta* Con., *Arca trilineata* Con., *Cardium californiense* Desh., *Cardium meekianum* Gabb, *Cardium quadrigenarium* Con., *Chione diabloensis* Clark, *Chione pabloensis* Clark, *Chione securis* Shum., *Dosinia arnoldi* Clark, *Dosinia merriami* Clark, *Dosinia ponderosa* Gray, *Glycimeris coalingensis* Arn., *Macoma andersoni* Clark, *Macoma pabloensis* Clark, *Marcia oregonensis* Con., *Modiolus gabbi* Clark, *Mulinia densata* Con., *Mytilus coalingensis* Arn., *Ostrea attwoodi* Gabb, *Ostrea titan* Con., *Panopea estrellana* Con., *Paphia tenerrima* Carp., *Pecten crassicardo* Con., *Pecten estrellanus* Con., *Pecten holwayi* Clark, *Pecten pabloensis* Con., *Pecten raymondi* Clark, *Pecten sancti-ludovici* And., *Pecten weaveri* Clark, *Phacoides annulatus* Rv., *Pinna alamedensis* Yates, *Pitaria stalderi* Clark, *Spisula albaria* Con., *Spisula lenticularis* Gabb, *Tellina diabloensis* Clark, *Tivela gabbi* Clark, *Agasoma sinuatum* Gabb, *Astrarium raymondi* Clark, *Cancellaria pabloensis* Clark, *Calyptrea filosa* Gabb, *Calyptrea inornata* Gabb, *Chrysodomus diabloensis* Clark, *Chrysodomus imperialis* Dall, *Gyrineum trampasense* Clark, *Ficus nodiferus* Gabb, *Hemifusus dalli* Clark, *Neverita reclusiana* Petit, *Siphonalia kellestii* Fbs., *Trophon carisaenses* And., *Trophon ponderosus* Gabb, *Turritella vanvlecki* Arn.

³⁰ The Tertiary and Quaternary Pectens of California. Prof. Paper No. 47, U. S. Geol. Survey, (1906); and Paleontology of the Coalinga District, etc. Bull. 396, U. S. Geol. Survey, (1909).

³¹ Fauna of the San Pablo group of middle California. Univ. of Calif. Pub. Bull., Dept. Geol., vol. 8, No. 22, (1915), pp. 385-570.

This fauna is of upper Miocene age, and probably represents the whole of that epoch. It has about 25 per cent of Recent species, and 75 per cent extinct. The abundant *Lyropecten*, giant *Ostrea*, *Astrodapsis*, *Trophon*, *Ficus*, and *Dosinia* indicate subtropical conditions as far north as Mt. Diablo in middle California. North of that locality the fauna is unknown.

Monterey-Temblor. Since the work of Conrad in the Pacific Railroad Reports, and of Gabb in the Palæontology of California, vol. 2, many workers have contributed to the knowledge of the Monterey fauna. Among them have been: Frank M. Anderson,³² who has devoted himself especially to the study of the Temblor phase of the Miocene of the middle Coast Ranges and The Kern River deposits near Bakersfield; R. Arnold,³³ who has given special attention to the fauna in the oil fields of the southwestern part of the San Joaquin Valley, and of southern California. Anderson, in his various papers, has called this fauna the Temblor, while Arnold has called it Vaqueros. Most workers in West Coast stratigraphy are now agreed that the Temblor fauna is not synchronous with the Vaqueros, but does agree with the Monterey, upper part of, lower Miocene.

The most important species of the Monterey-Temblor are: *Scutaster andersoni* Pack, *Scutella fairbanksi* Arnold, *Scutella merriami* Anderson, *Scutella norrisi* Pack, *Linthia californica* Weaver, *Arca devincta* Con., *Arca microdonta* Con., *Arca obispoana* Con., *Arca trilineata* Con., *Amiantis conradiana* And., *Amiantis diabloensis* And., *Cardium quadrigenarium* Con., *Cardium vaquerosense* Arn., *Chione mathewsoni* Gabb, *Chione panzana* And., *Corbicula dumblei* And., *Dosinia conradi* Gabb, *Dosinia mathewsoni* Gabb, *Dosinia ponderosa* Gray, *Glycimeris branneri* Arn., *Macoma ocoyana* Con., *Macoma arctata* Con., *Marcia oregonensis* Con., *Metis alta* Con., *Modiolus multiradiatus* Gabb, *Mulinia densata* Con., *Mytilus expansus* Arn., *Nucula conradi* Meek, *Ostrea eldridgei* Arn., *Ostrea titan* Con., *Panopea estrellana* Con., *Panopea generosa*

³² A stratigraphic study in the Mount Diablo Range of California, Proc. Calif. Acad. Sci., Third Ser. Geol., vol. 2, No. 2, 1905, pp. 156-248; The Neocene deposits of Kern River, etc. Proc. Calif. Acad. Sci., 4th Ser., vol. 3, (1911), pp. 73-148; and Anderson and Martin, Neocene record in the Temblor basin, etc., Proc. Calif. Acad. Sci., 4th Ser. Vol. 4, pp. 15-112 (1914).

³³ Bull. 309, U. S. Geol. Survey, (1907); Prof. Paper No. 47, U. S. Geol. Survey, (1906) Bull. 322, U. S. Geol. Survey (1907); Bull. 396, U. S. Geol. Survey (1909); and Descr. New Cretaceous and Tertiary fossils, etc., Proc. U. S. Nat. Mus., vol. 34, No. 1617, (1908), pp. 343-389.

Gld., *Pecten andersoni* Arn., *Pecten crassicardo* Con., *Pecten discus* Con., *Pecten estrellanus* Con., *Pecten hamlini* Arn., *Pecten lomdocensis* Arn., *Pecten miguelensis* Arn., *Pecten nevadanus* Con., *Pecten peckhami* Gabb, *Pecten perrini* Arn., *Pecten propatulus* Con., *Phacoides acutilineatus* Con., *Phacoides richthofeni* Gabb, *Phacoides sanctæcrucis* Arn., *Pinna alamedensis* Yates, *Septifer coalingensis* Arn., *Tellina idæ* Dall, *Thracia trapezoidea* Con., *Tivela inezana* Con., *Yoldia impressa* Con., *Yoldia oregona* Shum., *Yoldia submontereyensis* Arn., *Zirphea dentata* Gabb, *Agasoma barkerianum* Cooper, *Bathytoma keepi* Arn., *Cancellaria condoni* And., *Cancellaria dalliana* And., *Cancellaria vetusta* Gabb, *Chrysodomus nodiferus* Con., *Conus hayesi* Arn., *Conus owenianus* And., *Crepidula princeps* Con., *Ficus kernianus* Cooper, *Ficus nodiferus* Gabb, *Ficus pyriformis* Gabb, *Hemifusus wilkeseanus* And., *Macron merriami* Arn., *Molopophorus anglonana* And., *Nassa arnoldi* And., *Neverita callosa* Gabb, *Ranella mathewsoni* Gabb, *Sinum scopulosum* Con., *Terebra cooperi* And., *Thais præcursor* Dall, *Trochita costellata* Con., *Trophon carisaensis* And., *Trophon gabbianus* And., *Trophon kernensis* And., *Turritella ocoyana* Con.

This faunal horizon has been called by Dr. J. C. Merriam the *Agasoma* zone, but this name is given up, since the genus *Agasoma* is not confined to the zone; and the original *Agasoma* beds have been shown by Dr. B. L. Clark to be Oligocene.

This fauna is tropical or subtropical, and indicates a temperature considerably warmer than that of southern California at present, as shown by the presence of *Chione*, *Dosinia*, *Lyropecten*, giant *Arca*, *Ficus*, *Trophon*, *Conus*, *Pinna*, and giant *Turritella*, all tropical types.

Vaqueros. This formation was first named by H. W. Fairbanks,³⁴ from the outer Coast Ranges, in the region of San Luis Obispo, California. It was afterwards recognized by R. Arnold³⁵ at numerous localities in the outer Coast Ranges of middle California, and in the Santa Ynez Mountains of southern California.

³⁴ U. S. Geol. Survey, San Luis Folio (1904), No. 101.

³⁵ Prof. Paper 47, U. S. Geol. Survey, (1906); Bull. 309, U. S. Geol. Survey, (1907); Proc. U. S. Nat. Mus., vol. 34, No. 1617, (1908), pp. 343-389; and Environment of the Tertiary faunas of the Pacific Coast of the United States, Jour. Geol., vol. 17, (1909), pp. 509-533.

The most important species, so far as known, are: *Scutella fairbanksi* Arn., *Scutella norrisi* Pack, *Terebratalia kennedyi* Dall, *Astræa biangulata* Gabb, *Dosinia conradi* Gabb, *Dosinia whitneyi* Gabb, *Glycimeris branneri* Arn., *Modiolus ynezanus* Arn., *Mytilus expansus* Arn., *Panopea generosa* Gld., *Pecten branneri* Arn., *Pecten lompocensis* Arn., *Pecten magnolia* Con., *Pecten nevadanus* Con., *Pecten perrini* Arn., *Pecten sanctæ-cruzensis* Arn., *Pecten sespeensis* Arn., *Pecten vanvlecki* Arn., *Tivela inezana* Con., *Natica inezana* Con., *Rapana vaquerosensis* Arn., *Trochita costellata* Con., *Turritella inezana* Con.

This fauna is lower Miocene, and represents the very bottom of that series. The abundant *Lyropecten*, giant *Turritella*, *Dosinia*, *Chione*, and *Rapana* indicate tropical or subtropical conditions. The Vaqueros has not been found to the north of middle California.

Of this fauna, *Lyropecten*, *Dosinia*, and *Chione* are immigrants from the Caribbean; the *Turritella* group is a little modified descendant of the Eocene giants; *Rapana* can only have come from the southern Orient, from the same source as *Mioleionia*, and *Amusium*.

What appears to be a Vaqueros fauna has been collected by Mr. E. C. Brown on the Pacific coast of Lower California, near San Gregorio Lagoon, lat. 26° N. It contained *Lyropecten*, giant *Turritella*, and *Rapana*.

OLIGOCENE.

Astoria. The Astoria, Oligocene, fauna has been collected at various places on the Pacific Coast, from the Santa Cruz Mountains, lat. 37° N., to the Olympic Peninsula, lat. 48° N. It has been described from Oregon by W. H. Dall,³⁶ and from both Washington and Oregon by Arnold and Hannibal.³⁷ C. E. Weaver³⁸ has also described species of this fauna from the coast of Washington; and R. Arnold³⁹ has described the species known to occur in the equivalent San Lorenzo formation in the Santa Cruz Mountains of middle California.

³⁶ Prof. Paper No. 59, U. S. Geol. Survey (1909).

³⁷ Proc. Amer. Phil. Soc., vol. 52, No. 212 (1913), pp. 559-605.

³⁸ Washington Geol. Survey, Bull. No. 15, (1912); and Univ. of Washington Pub. in Geol., vol. 1, No. 1, pp. 1-67 (1916).

³⁹ Proc. U. S. Nat. Mus., vol. 34, pp. 345-390, (1908).

The most important species thus far known are: *Cardium lorenzoanum* Arn., *Crenella porterensis* Weaver, *Dosinia mathewsoni* Gabb, *Macrocallista mathewsoni* Gabb, *Macrocallista vespertina* Con., *Macoma nasuta* Con., *Marcia oregonensis* Con., *Mytilus mathewsoni* Gabb, *Mytilus ynezianus* Arn., *Nucula gettysburgensis* Rgn., *Nucula townsendi* Dall, *Panopea generosa* Gld., *Pecten branneri* Arn., *Pecten waylandi* Arn., *Phacoides acutilineatus* Con., *Solemya ventricosa* Con., *Spisula albaria* Con., *Tellina lorenzoensis* Arn., *Thracia trapezoidea* Con., *Thyasira bisecta* Con., *Yoldia impressa* Con., *Yoldia oregona* Shum., *Agasoma gravidum* Gabb, *Crepidula prærupta* Con., *Eudolium petrosum* Con., *Fusus hecoxi* Arn., *Miopleionia indurata* Con., *Molopophorus gabbi* Dall, *Strepsidura oregonensis* Dall, *Turricula washingtoniana* Dall, *Turritella newcombei* Merriam, *Turritella oregonensis* Con., *Aturia angustata* Con.

These forms indicate tropical or subtropical waters, which extended up at least as far north as Puget Sound. Noteworthy is the appearance of the first Recent species: *Panopea generosa* Gld., *Macoma nasuta* Con., *Thracia trapezoidea*, and *Thyasira bisecta* Con. The others are all extinct, but many have living relatives in warm latitudes, especially *Aturia* and *Eudolium*. There are no apparent relations with the Caribbean Oligocene, the Panama portal having probably been closed at this time. An immigration from the Orient is shown by the presence of *Dolium*, *Voluta* (*Miopleionia*), and other forms with near relatives still living in that region.

EOCENE.

Tejon. The upper Eocene, Tejon, fauna of California has recently been described in monographic form by R. E. Dickerson,⁴⁰ so that it is unnecessary to give further references. This same fauna extended unchanged to Puget Sound, and *Venericardia planicosta*, the "finger-post of the Eocene", reached up to Alaska.⁴¹

The most characteristic species of this horizon are: *Balano-phyllia striata* Gabb, *Flabellum remondianum* Gabb, *Trocho-*

⁴⁰ Stratigraphy and fauna of the Tejon Eocene of California Univ. of Calif. Pub. Bull., Dept. of Geol. vol. 9, No. 17, (1916), pp. 363-524.

⁴¹ W. H. Dall, Harriman Alaska Exped. Neozoic Invert. fossils, p. 103.

cyathus stantoni Vaughan, *Cassidulus californicus* And., *Schizaster lecontei* Merriam, *Avicula pellucida* Gabb, *Arca morsei* Gabb, *Crassatellites collina* Con., *Crassatellites grandis* Con., *Crassatellites wasana* Con., *Cucullæa morani* Waring, *Cardium breweri* Gabb, *Cardium cooperi* Gabb, *Dosinia elevata* Gabb, *Glycimeris sagittata* Gabb, *Macrocallista californica* Con., *Macrocallista horni* Gabb, *Macrocallista wasana* Con., *Ostrea idriaensis* Gabb, *Spisula merriami* Packard, *Tellina remondi* Gabb, *Venericardia merriami* Dickerson, *Venericardia planicosta* Lam., *Amauropsis alveata* Con., *Architectonica cognata* Gabb, *Conus californiana* Con., *Conus horni* Gabb, *Ficopsis cowlitzensis* Weaver, *Ficopsis horni* Gabb, *Ficus mamillatus* Gabb, *Galeodea sutterensis* Dickerson, *Galeodea tuberculata* Gabb, *Gyrineum washingtonianum* Weaver, *Loxotrema turrata* Gabb, *Lunatia horni* Gabb, *Lyria andersoni* Waring, *Murex sopenahensis* Weaver, *Natica hannibali* Dickerson, *Olivella mathewsoni* Gabb, *Perissolax blakei* Gabb, *Rimella canalifera* Gabb, *Rimella simplex* Gabb, *Siphonalia sutterensis* Dickerson, *Terebellum erraticum* Cooper, *Terebra californica* Gabb, *Tritonium californicum* Gabb, *Turris fresnoensis* Arn., *Turritella merriami* Dickerson, *Turritella wasana* Con. *Nautilus* sp.

This is a decidedly tropical fauna, with *Nautilus*, *Macrocallista*, giant *Venericardia*, *Crassatellites*, *Conus*, *Ficus*, *Fusus*, giant *Turritella*, *Rimella*, and *Galeodea* all represented in the tropics by kindred forms. This tropical belt extended up to Puget Sound, and the Alaskan waters were probably cooler.

The Tejon fauna is of Caribbean origin, and the zone of *Venericardia planicosta* represents the last great migration from the Atlantic to the Pacific. Many Tejon species are identical with, or closely related to, forms in the Eocene of the Gulf states.

Kenai flora (Unga Island, Shumagin Islands, Alaskan Peninsula, lat. 55° N.). This flora was listed by W. H. Dall⁴² as Oligocene, while A. H. Brooks⁴³ considers it as Eocene. The forms known are: *Taxodium distichum miocenicum* Hr., *Glyptostrobus europæus* Hr., *Sequoia nordenskioldi* Hr., *Quercus pseudocastanea* Gpt., *Castanea ungeri* Hr., *Populus glandifer* Al. Br., *Liquidambar europæum* Al. Br., *Betula*, *Alnus*,

⁴² Seventeenth An. Rept., U. S. Geol. Survey, Part 1, (1896), p. 836.

⁴³ Prof. Paper No. 45, U. S. Geol. Survey, (1906), p. 238.

Carpinus, *Corylus*, *Fagus*, *Ulmus*, *Planera*, *Nyssa*, *Viburnum*, *Diospyros*, *Vaccinium*, *Vitis*, *Cornus*, *Magnolia*, *Acer*, *Juglans*.

This flora indicates warm temperate conditions, about the same as the South Atlantic states.

Ione Flora (middle California, in the inner Coast Ranges, and in the Auriferous Gravels, Sierra Nevada). *Acer æquidentatum* Lx., *Aralia angustiloba* Lx., *Aralia whitneyi* Lx., *Castanea castaneæfolia* Ung., *Castaniopsis chrysophyloides* Lx., *Cornus hyperborea* Hr., *Ficus tiliæfolia* Al. Br., *Juglans californica* Lx., *Juglans laurinea* Lx., *Geonomites schimperi* Lx., *Liquidambar californicum* Lx., *Magnolia californica* Lx., *Magnolia lanceolata* Lx., *Persea pseudocarolinensis* Lx., *Platanus appendiculata* Lx., *Quercus nevadensis* Lx., *Quercus distincta* Lx., *Rhus myricæfolia* Lx., *Sabalites californica* Lx., *Ulmus affinis* Lx., *Ulmus californica* Lx., *Zizyphinus piperoides* Lx.

This flora is certainly tropical, or subtropical, and extends with little change up to Puget Sound, where palms are more abundant than they are in the Ione flora.

The flora of the Auriferous Gravels (Ione) was listed by F. H. Knowlton⁴⁴ as Miocene. This does not agree with the results of various workers on the West Coast, and R. E. Dickerson⁴⁵ has proved conclusively that the Ione portion of the Auriferous Gravels is Eocene. This flora has been found interbedded with marine Eocene forms in the Mt. Diablo region in the Coast Ranges, in the foothills of the Sierra Nevada, of California, and in the Arago Eocene of Oregon.

Martinez fauna. The Martinez is the oldest Eocene known on the Pacific Coast; its fauna has been described in monographic form by R. E. Dickerson.⁴⁶ Species are: *Terebratalia tejonensis* Stanton, *Flabellum remondianum* Gabb, *Trochocyathus zitteli* Merriam, *Cucullæa mathewsoni* Gabb, *Crassatellites unioides* Stanton, *Glycimeris veatchi* Gabb, var. *major* Stanton, *Leda alæformis* Gabb, *Leda packardi* Dickerson, *Lima multiradiata* Gabb, *Lima haseltinei* Dickerson, *Lima perrini* Waring, *Pecten interradiatus* Gabb, *Phacoides turneri* Stanton, *Pholadomya nasuta* Gabb, *Tellina undulifera* Gabb, *Venericardia planicosta* var. *venturensis* Waring, *Architectonica tabulata*

⁴⁴ Prof. Paper No. 73, U. S. Geol. Survey, (1911), pp. 57-64.

⁴⁵ Univ. of Calif. Pub. Bull. Dept. Geol., vol. 9, No. 17, (1916), pp. 409 *et seq.*

⁴⁶ Fauna of the Martinez Eocene of California. Univ. of Calif. Pub. Bull. Dept. Geol., vol. 8, No. 6, (1914), pp. 61-180.

Weaver, *Brachysphingus liratus* Gabb, *Heteroterma gabbi* Stanton, *Neptunea mucronata* Gabb, *Ovula martini* Dickerson, *Perissolax blakei* Con., *Turbinella crassitesta* Gabb, *Turritella maccreadyi* Waring, *Turritella martinezensis* Gabb, *Turritella pachecoensis* Stanton, *Turritella simiensis* Waring, *Urosyca caudata* Gabb, *Urosyca robusta* Weaver, *Xenophora zitteli* Weaver, *Hercoglossa merriami* Dickerson, *Nautilus stephensoni* Dickerson, *Nautilus hallidayi* Waring.

The Martinez horizon is not yet known north of California, but it is certain that tropical conditions extended at least that far north at this time, and probably much further. No flora of this age is known, but one is not needed to tell us the climatic conditions.

SUMMARY.

In the Eocene there is no suggestion of climatic zones, the marine faunas being nearly the same from the equator to Alaska. The fossil floras of California, Oregon, and Washington indicate tropical conditions on the land.

In the Oligocene, tropical types, *Aturia* and *Dolium*, ranged up to Puget Sound. Marine beds of this age are not yet known in Alaska, but the Kenai flora belongs to the warm temperate zone.

In the lower Miocene the Californian faunas are tropical, and *Ficus*, a tropical genus, occurs in the Clallam fauna of Washington. It is not known whether the warm belt extended up to Alaska, for lower Miocene faunas and floras are not yet described from there.

In the middle Miocene, (Empire), *Phalium*, a tropical genus, is found in the region of Puget Sound, but there is a great increase in the number of giant *Chrysodomus*, suggesting a lowering temperature.

The Santa Margarita-San Pablo, upper Miocene, with giant *Ostrea*, numerous *Trophon*, *Lyropecten* and *Astrodapsis*, shows that the climate was still subtropical in California. Faunas of this age are not known in the Puget Sound region, while those of the Alaskan Gulf indicate cooler water. On the Asiatic side of the Pacific the warm belt extended to northern Siberia, for Dall⁴⁷ has described from there a subtropical fauna.

⁴⁷ A subtropical Miocene fauna in arctic Siberia. Proc. U. S. Nat. Mus., vol. 16, (1893), pp. 471-478.

The Jacalitos-Etchegoin, upper Miocene or lower Pliocene, in middle California, still retains *Ficus*, *Lyropecten*, *Janira*, and tropical types of *Ostrea*. The contemporary Carrizo fauna of the head of the old Gulf of California is much more decidedly tropical, with *Clypeaster*, *Dolium*, and *Astræidæ*.

In the Fernando-Purisima epoch of the lower Pliocene climatic zones are already definitely established. The faunas of this age from near Cape Mendocino, (Wild cat), and Puget Sound, contain *Pecten caurinus*, numerous giant *Chrysodomus*, *Buccinum*, *Volutopsis*, and indicate a temperature colder than the present in those latitudes.

The Purisima of middle California contains a few of the giant *Chrysodomus*, and other northern types, but has also many southern forms, such as *Dosinia*, *Chione elsmereensis*, *Pecten healeyi*. Cape Mendocino was then the dividing line between the northern and the southern faunas, just as Pt. Conception is now.

The Fernando of southern California has *Ficus*, *Janira*, *Lyropecten*, giant *Conus* and *Astrodapsis*, tropical forms lacking in the Purisima, indicating a milder temperature than that of the present Santa Barbara Channel.

In the Merced epoch the Puget Sound climatic zone has shifted south of Cape Mendocino, and some of the northern forms range down to the San Diego formation of Los Angeles and San Diego (*Pecten caurinus*), although the large numbers of *Janira* and *Ostrea veatchi* in the San Diego indicate a temperature nearly as warm as the present.

In the upper Pliocene Santa Barbara fauna, of Santa Barbara and San Pedro, the almost total extinction of southern types, and the prevalence of a Puget Sound fauna, indicate a sea temperature not higher than 50° F. min. Whether this chilling by the oncoming Glacial Epoch was felt south of California is not known.

The lower Pleistocene (lower San Pedro) shows the entire coast, from Alaska to San Diego, in the grip of the cold northern climate, a southward shifting of the isotherms of at least a thousand miles, and a general lowering of temperature by about 12° F., as far south as Los Angeles.

This shifting of the isotherms was felt as far southward as Magdalena Bay, Lower California, in the edge of the tropics, for the Quaternary fauna of that locality, while still tropical, contains many Californian species not known to occur there now.

This was the time of greatest southward shifting of the isotherms and greatest lowering of temperature on the West Coast. It probably corresponds to the maximum glaciation on the continents of the northern hemisphere.

A very decided rebound from the cold temperate conditions of the lower Pleistocene is seen in the fauna of the upper San Pedro formation in the Los Angeles embayment of southern California. This fauna shows a displacement of all the northern types, and the incoming of tropical forms from Lower California; among them are: *Dosinia ponderosa*, *Pecten sub-nodosus*, *Chione gnidia*, *Chione neglecta*, *Cardium procerum*, *Miltha childreni*. This would indicate a minimum temperature of nearly 68° F., a rise of about 18° F. from the lower San Pedro.

This amelioration of the climate extended up to Cape Nome, for there the fossil fauna contains *Pecten swifti*, which now lives 1200 miles to the southwest in the Japanese waters, warmer by 8° F. than the present temperature of Bering Sea.

The two extremes of climatic conditions are seen in the Eocene and in the lower Pleistocene. In the former a tropical climate extended up to Alaska, and in the latter a Puget Sound climate stretched southward to San Diego.

The fall and the rise were probably oscillatory rather than regular, but the marine faunas do not furnish a sufficiently sensitive thermometer to register the minor fluctuations.

BASIS OF THE WORK.

The conclusions given in this paper are based upon a critical study of collections of Recent, Quaternary, and Tertiary fossils made on the Pacific Coast, from Ecuador to Alaska. Material was studied by the writer, or by workers assisting him, in the U. S. National Museum, Philadelphia Academy of Science, California Academy of Sciences, University of California,

Stanford University, University of Oregon, and University of Washington.

The most important works used in this study are given in the appended bibliography, though many others, not cited, were consulted.

The classic writings of Carpenter, Gould, and Cooper on the Recent Mollusa gave the groundwork for the investigation. The pioneer works of Conrad and Gabb on Tertiary fossils gave the basis for comparison of Recent and Tertiary faunas. This was amplified by detailed study of the later literature, especially of Dall on the Recent and Tertiary faunas, and of Arnold on the Tertiary of California. Also the papers of Weaver on the Tertiary faunas of Washington have been invaluable, in determining the horizons of the Puget Sound region, and comparing them with those of California.

The writings of Dall, Arnold, Anderson, Hannibal, Dickerson, B. L. Clark, C. A. Waring, J. M. Nomland, and many others, on Tertiary geographic conditions on the West Coast, have changed many of our old ideas on the subject, and necessitated much revision.

It has been the aim of the writer to bring the information on the subject up to date, and to formulate results of his own studies as well as those of the other workers in the stratigraphy and paleontology of California.

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V

Contribution to the Optics of the Microscope

BY

C. W. WOODWORTH

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V

**CONTRIBUTION TO THE OPTICS OF THE
MICROSCOPE**

BY
C. W. WOODWORTH

INTRODUCTION

A subject which has received as much attention as the optics of the microscope is not liable to offer much that is new except to the delver into the intricacies of its details.

That which follows is not concerned with matters of detail, but instead, is based on a re-examination of some of the fundamental facts from a somewhat different angle than those by which they have usually been approached. This has resulted in the finding of some relationships which appear to have been overlooked and in the perception of the practical importance of some well known relationships in the calculation of lens aberrations.

As a result of these studies a very great simplification of the methods of lens calculation has been evolved, which should prove useful in the design of optical instruments and in the further study of the theory of aberrations by relieving the investigators of these subjects of much of the tedium of the elaborate computations heretofore necessary.

July 12, 1919

I. SPHERICAL ABERRATIONS

Nearly every treatise on lenses illustrates the characteristic appearance of one of the five spherical aberrations, namely distortion, but the remaining four are referred to if at all only by rather vague, indefinite descriptions. As a consequence very few have any definite conception of the distinctions between them.

All of these are shown in the accompanying figure which represents eight sections of the field as seen in a microscope or telescope, each one of these sections illustrating an instrument with a different correction or adjustment. The two sections illustrating positive and negative distortion show the two familiar effects when this aberration is under or over corrected.

Curvature is shown in the two phases dependent on the adjustment of the instrument. It is the effect so familiar to users of the microscope, because a certain amount of curvature is uncorrected in some of the best and most expensive instruments. In such a case, when the edge of the field is in focus the center shows as out of focus, lines and points becoming broad and vague, and when the fine adjustment is turned the central portion of the field becomes sharp and clear while the edge is indistinct.

Axial aberration is rarely seen because this is the distortion to which first attention is given in designing an instrument and is perhaps the easiest aberration to correct. When it is present, due to the use of an instrument under conditions for which it was not designed, it is usually associated with one of the lateral aberrations, coma or astigmatism.

Astigmatism resembles in some particulars the appearance of curvature, when the focus is made sharp on the center of the field, but differs most strikingly by the fact that radial lines remain sharp as shown at three parts of the letter S in the figure. This aberration is due to the fact that the portions of the image produced by the different zones of the lens are displaced radially and shifting of this kind would not increase the width nor therefore decrease the sharpness of a radial line. This kind of aberration is entirely different in character from the out of focus effect due to curvature.



Fig. 1. Chart illustrating the appearance under the microscope of the five spherical aberrations.

Coma is also due to a radial shifting of images, but is distinguished by the fact that one edge of the image is sharp and distinct instead of fading off in both directions as is true of astigmatism. Like distortion positive and negative coma, representing under and over correction, are strikingly different in appearance.

In the calculation of aberrations, a series of rather complicated formulæ have been developed which are supposed to be measures of these aberrations, and in some cases faulty definitions of the aberration have sprung from these mathematical formulæ. Among these is a prevailing conception of the nature of astigmatism, not conforming to anything that can be verified experimentally, as has been pointed out by the writer in another place ("Science", vol. XLVII, pp. 459-460).

These effects shown in the figure are the things visible to the eye that the systems of calculation have been devised to measure in order that lenses can be so designed as to eliminate them.

As has been already intimated, it is not usual to find these aberrations present singly as here drawn, but they are all distinct enough so that they can be distinguished even when simultaneously present. Thus the distortion of an image would not prevent the recognition of any of the other aberrations that might be present.

When curvature is involved, a manipulation of the fine adjustment might be necessary to make the distinction, and between coma and astigmatism the distinction might require changes in the method of illumination.

II. LAWS OF FOCUS FORMATION

The study of the behavior of rays of light from a point source when refracted at a spherical surface presents no special difficulties, but the laws of focus formation under these conditions do not seem to have been formulated, though they lie at the foundation of all practical optics. The attempt made below to formulate these laws presents nothing new and nothing not thoroughly accepted by physicists.

The need of the definite statement of these laws will be evident when it is appreciated that the prevailing theory of

astigmatism is contrary to these fundamental conceptions. It is perhaps one of the most remarkable facts in the whole history of optics that the hypothetical conoids of Sturm should have been accepted by physicists and used by all practical computers of optical instruments in the face of the recognized fact that nothing corresponding to them can be obtained experimentally. When it is fully realized that the theory based on this conception also violates the fundamental laws of focus formation, the study of these interesting mathematical forms will be removed from optics to their proper place in geometry and in their place rational methods of measuring the astigmatism will prevail.

The laws of focus formation as regards object points on the optical axis are correctly interpreted even in elementary treatises, but it is not so well understood that precisely the same laws apply to oblique refraction. It is not difficult to state them in such general terms that their universal applicability is at once evident.

Law I. All possible foci of an object point lie on the line through that point normal to the spherical refracting surface.

This law has often been stated in the form "the focus of a point is a line" without defining the position of the line. The law is true of all refractions of a point source of light through a single spherical surface. The equation of this line may be given in either of the following forms:

$$(1) \quad \frac{n'}{c} - \frac{n}{c'} = \frac{n'-n}{r} \cdot \frac{\cos \frac{\theta + \theta'}{2}}{\cos \frac{\alpha + \alpha'}{2}}$$

$$(2) \quad \frac{n}{c'} - \frac{n}{r} = \left(\frac{n'}{c} - \frac{n'}{r} \right) \cdot \frac{\cos \frac{\alpha' + \theta'}{2}}{\cos \frac{\alpha + \theta}{2}}$$

the angles θ and θ' in each case being measured from the normal to the surface.

The pair of aplanatic points are those in which $c=r \frac{n'}{n}$, $c'=r \frac{n}{n'}$, $\theta = \alpha'$ and $\theta' = \alpha$ in which case the ratios of cosines become equal to unity. The common aplanatic point is where c , c' , α and α' are all zero and $\theta = \theta'$. These are the only finite

values of these angles which will eliminate the variable factor in the equation.

Law II. All rays from an object point to points on a spherical refracting surface equidistant from the line from the object point normal to the surface focus at a common point.

This law is the definition of a focus, the concentration of a very large number of rays to a point. A focus, according to this definition, is always a point. The line referred to in the discussion of the first law is in fact a train of foci. There should be separate words to designate these two conceptions. Perhaps the line should be called the locus of the object point, as will be done below.

Law III. The location of the foci of rays through successive zones depend on the relation of the angles θ and α or θ' and α' .

That which is called positive spherical aberration where the focus of the outer zones is nearer the center of curvature than of the rays of the inner zone is the condition where α increases more rapidly than θ .

The above laws refer to refraction at a single surface. The first law holds for all subsequent refractions through a centered optical system for object points on the optical axis. It is not true of the second or subsequent refractions of an object point away from the optical axis though the locus of that point may remain approximately linear. It is always more or less curved.

On the optical axis, while the locus remains linear and fulfills the conditions of Law I and all foci conform to Law II, they may fail to conform to Law III because the successive relative values of angles α and θ contribute to the final locations of the foci. The locus of an object point thus comes to be a very complicated thing even in the simple case of an axial object. Instead of attempting to study the subject exhaustively it is enough for practical purposes to determine the limits which for an axial point requires the calculation of at least two rays and for a point away from the axis at least three or four rays.

The usual discussion of the loci in oblique refraction illustrates the errors in not recognizing these laws of focus forma-

tion. For instance Figure 27 on p. 64 of Southall's "Geometrical Optics" illustrates the loci of the meridional and sagittal planes as a pair of lines intersecting, at two points, a line passing through the central point of the ray bundle at the surface of refraction. A plane surface is only the special case of a spherical surface with an infinite radius. According to Law I all possible foci lie on the normal from the object point S which is represented by the line AS . The two edge rays on the sagittal plane $\overline{JS'}$ & $\underline{J S'}$ being equidistant from the normal should meet on this plane precisely as drawn according to Law II, but this point should be slightly further from the object point than the intersection of the median line BS' with the normal, according to Law III. According to the same law the edge rays of the meridional plane would intersect this normal or focus line as shown but at unequal distances. These two rays should also intersect the median or chief ray at different points and intersect each other at a third point. The most cursory examination of a figure showing the nature of a locus of a point produced by a refracting surface will convince one that on a meridional plane rays on the same side of the normal invariably intersect each other at some distance before they come to their respective foci in the case of positive aberrations or beyond in the case of negative aberrations as seen in this case. These intersections are not foci but only individual crossings of rays. Foci result from the simultaneous convergence of many rays. In the case of a single refracting surface a focus is the convergence of all the rays intersecting the lens on a zone equidistant from the normal from the object point. Perhaps the failure to make the distinction between individual ray crossings and ray concentrations is accountable for the prevalent misconceptions. No one makes this mistake in reference to the foci from axial objects, and if an oblique focus were conceived of as the lateral half of an axial focus one would retain the true understanding of the nature of the focus.

Such a figure as this is thus seen to be inaccurate in all its details and to give a completely erroneous picture of the nature of oblique refraction. Apparently from a knowledge that this view of the nature of oblique refraction does not accord to experimental observations it is usual to contend that this

represents only the behavior of a very narrow bundle of rays, so narrow that it cannot be studied experimentally because of defraction phenomena. This begging of the question does not avail, however, since there is no room for argument in this case for the reason that the laws here formulated are the direct consequences of the fundamental laws of refraction upon which the whole superstructure of Geometrical Optics rests, and apply with equal force to all refractions including those for narrow bundles.

Again in the case of curved surfaces the construction usually presented (See, for instance, Southall's "Geometrical Optics," pp. 49-50, fig. 15a and 15b) one can readily conceive what the nature of the surface must be to produce the conoid of Sturm. It would not be difficult to calculate nor would it be impossible to grind such a lens, though it would not by any means be a spherical lens:

As applied to a spherical lens it could be shown by calculations that every detail of the construction shown in these figures fails to conform to the laws above enunciated in the same definite way explained above in the case of refraction at a plane surface. The writer has calculated the rays and constructed models and verified them in every particular experimentally, and has proven beyond controversy that the transformation of a beam of light while passing through a locus behaves as the laws indicated and not at all according to Sturm's theory.

Here again the assumption is made that the construction illustrated in these figures applies only to very narrow bundles, an assumption as will be shown below necessary to give the theory any standing at all because all the observable facts contradict it and it has no more basis in sound theory than in the previous case.

The final consequence of any focus is that all rays concerned are completely reversed in relation to each other and in case lateral aberrations and a section of a beam of light beyond a locus assumes a different and characteristic shape.

A very simple and effective way of showing how the reversal is accomplished when a beam of light passes through an oblique locus is by pasting strips of paper on a common reading glass, leaving four equal windows, thus conforming

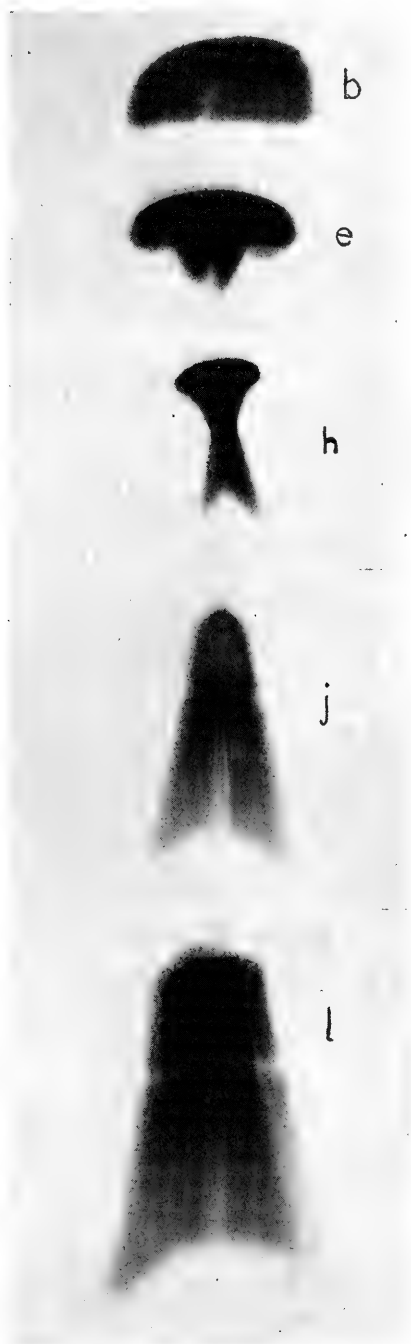


Fig. 2. Photographs showing the distribution of light at different planes in a beam of light passing through a focal region. The lettering is the same as in fig. 3.



to the diagram used to illustrate Sturm's theory. Supporting the lens obliquely in the sunlight and laying a piece of solio paper in the refracted beam thus making a permanent record of the distribution of the light at that plane. Repeating this at different planes will enable one to secure a very complete record of the transformation. A few of such records are shown in the accompanying figure.

To contrast the generally accepted hypothetical changes with those actually formed in the beam of light we may designate the following phases of the rectangular pencil forming the conoid by Roman numerals and of the actual pencil by letters: (Fig. 3).

I. *The initial phase* is the shape of the unaberrated image. We have chosen the four-celled grating commonly employed to illustrate this aberration with the intersections of the lines numbered so that the transformations may be readily followed.

II. *The first oblong phase* with a much more rapid decrease in the direction of the meridional plane represented by the numbers 4, 5 and 6.

III. *The meridional locus* at which the points 4, 5 and 6 are assumed to coincide. The shape of the pencil at this region is a line at right angles to the meridional plane.

IV. *The second oblong phase* of the same general character as the first oblong phase but with the lines reversed so that the numbers read 6, 5 and 4.

V. *The second orthographic phase* in which the pencil has the same proportions as in the initial phase but with the same reversal of numbers seen in the previous phase.

VI. *The third oblong phase* where the numbers on the meridional plane are further apart than those at right angles to this plane.

VII. *The sagittal locus* where the light all concentrates on the meridional plane as a line along this plane which intersects the sagittal plane at a point at which 2, 5 and 8 are supposed to coincide.

VIII. *The fourth oblong phase* of the same shape as the third phase but with the position of the points 2, 5 and 8 inverted.

This is the final shape of the spreading pencil according to Sturm's theory.

The actual focal transformations are much more complicated as will be comprehensible from a study of the second set of diagrams.

(a) *The initial phase* precisely like that used in the preceding series of diagrams.

(b) *The first conjunction*, the plane where points 1 and 2 are nearest. There is a point in line between 2 and 5 which does coincide with 1 on a plane not far above this.

(c) *The first crossing*, the plane where 4 coincides with 5. The point 4 has been travelling along the line 4 and 5 and when it reaches that point the remainder of the line stretches out a short distance behind.

(d) *The second conjunction* being the plane showing the nearest approach of 1 and 3. This phase is probably in general shape more nearly comparable with phase II, according to the Sturm theory.

(e) *The second crossing*, in which plane points 4 and 6 coincide. This phase probably could be chosen as the nearest approximation to the third phase of the old theory.

(f) *The first marginal focus* at which the points 1 and 7 coincide. It is only the beginning of the coincidence of the line 1, 4, 7.

(g) *The third conjunction* at which points 2 and 3 are nearest. This diagram also represents the completion of the reversal of line 1, 4, 7.

In this and the following diagram the constriction between the erect and inverted portion of the image is by no means as sharp as here shown where the lines indicate the edges only of the infolded image, and the whole image at the point of crossing has a very appreciable width, still the general shape of the pencil section conforms very closely with these diagrams.

(h) *The third crossing* where points 5 and 6 coincide but it is not the conclusion of the reversal of the line, because the points on the line 5, 6 are spread out behind this point. This and the preceding five phases include the region in which the reversal of the rays is brought about as is supposed to occur in the meridional locus.

(i) *The median focus* being the coincidence of points 2 and 8. This point is probably the nearest to the sagittal locus of Sturm's system, and here also the shape of the pencil most nearly suggests the fourth oblong phase.

(j) *The optical focus* where the reversal is complete except for the last line 3, 6, 9. This is approximately the plane which will be chosen by the eye as the focus.

(k) *The second marginal focus* at which 3 and 9 coincide. This and the preceding five phases intersect the locus obliquely.

(l) *The final phase*, showing the complete transformation and approximate form of the pencil.

A striking and significant difference between these two sets of diagrams is that in the first rays 3 and 9 intersect nearest the set of refracting points and in the other diagram this intersection is furthest from that surface. The further fact that the loci of which these intersections are one limit, are nearly at right angles with one another emphasizes the irreconcilable differences between these conceptions.

The oblique locus in the case of a reading glass is not a line but a very narrow linear figure, appreciably curved at the ends, oblique relative to the optical axis and approximately normal to an equivalent single lens surface.

These diagrams exhibit only two of the five aberrations. *Distortion* and *curvature* are concerned with differences between the foci of the different portions of the field. *Axial aberration* is that which appears when the lens is normal to the beam of light. The aberrations here exhibited are *astigmatism* and *coma*. Considering point 5 the middle of the light pencil then, the 1, 4, 7 region represents astigmatism and the 3, 6, 9 region represents coma. The optical focus is on the plane at which the phenomenon known as coma is most pronounced, which occurs where there is the greatest difference between the numerical values of these two aberrations.

While there is just enough similarity between these two sets of diagrams to explain how the geometrically simpler conception of Sturm was suggested and enough correspondence of the focal lines of that theory with the mean of the focal values when correctly determined to make the calculations of some practical value, the whole theory should certainly be replaced by one conforming to physical observations.

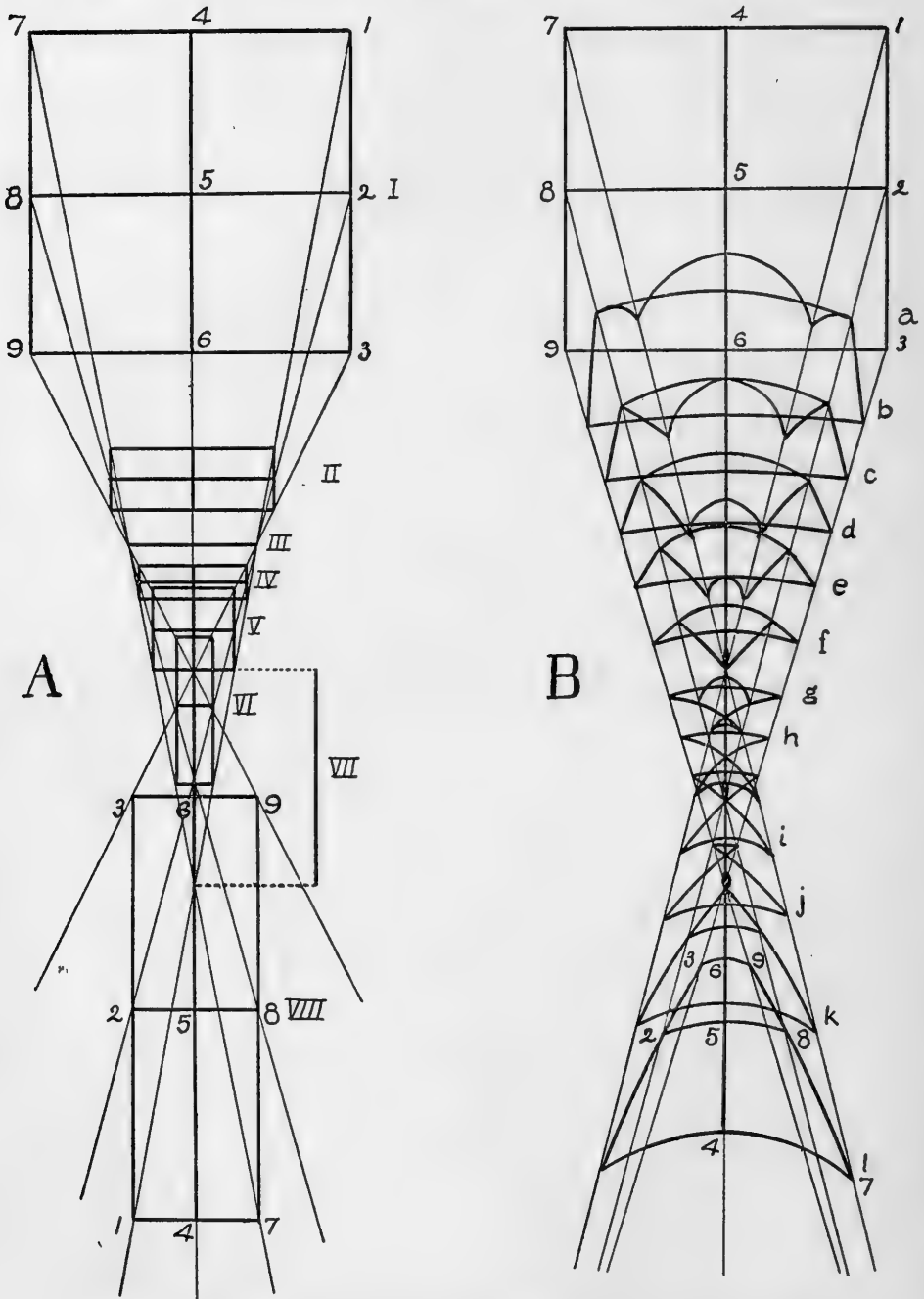


Fig. 3. Diagrams contrasting the inversions of the rays in a beam of light rays on passing through their foci. (A) According to Sturm's theory, (B) according to observed changes (See fig. 2), (I-VIII) successive hypothetical phases, (a-1) successive actual phases, (1-9 rays) whose positions are traced through each plane.

The differences just pointed out have not been wholly unknown to physicists by any means, but apparently it has not been made clear that the differences are due to fundamental laws of focus formation equally applicable to narrow as well as wide bundles of rays.

III. OBLIQUE AXIS CALCULATIONS

The system of lens calculation proposed by the writer consists of the calculation of a definite series of rays through an optical system, either graphically or mathematically, and in the latter case the plotting of these rays on an enlarged drawing of the lenses. When this is done a simple inspection of the drawing will enable one to estimate the simultaneous effect upon the aberrations of any possible variation in the construction data.

The rays that need be calculated are as follows:

1. The *Zone* ray, commonly called the edge ray, the extreme ray from the point of intersection of the optical axis and the object. This ray determines the *aperture* of the instrument.

2. The *Field* ray from the extreme edge of the field midway between the extreme rays of the pencil. This ray determines the *magnification* of the instrument.

3. The *Paraxial* ray from the object along the optical axis. The difference between this and the *Zone* ray, measured on the X axis, determines the *axial aberration*, that between this and the field ray also measured on the X axis determines the *curvature*.

4. The *Distortion* ray similar to the *Field* ray but from a point midway between the center and the edge of the field. The difference between this ray and half the *Field* ray, measured on the Y axis, determines the *distortion*.

5. The *Comatic* ray, similar to the *Field* ray but through the nearest marginal point of the lens system. The difference between this and the *Field* ray measured on the Y axis or with the *Zone* ray measured on the X axis determines the *coma*.

6. The *Astigmatic* ray, similar to the *Comatic* ray, but through the most distant marginal point of the lens system.

Measured the same way as the Comatic ray. This ray determines *astigmatism*.

The focus of the Zone and Paraxial rays is determined by the intersection with the optical axis. The Distortion ray does not require the determination of a focal point. The three oblique rays require, for the three values of the X coordinates, the determination of the oblique focus of each, which can be most easily accomplished by the new oblique axis method described below. There is no true focus in the strict sense of the word after a number of refractions, but if each successive focus were considered the source of a radiant pencil of light then all would be true foci. The theoretical foci secured by assuming this character of each focus lie within the loci of the point and this is the best if not the only method available for determining the position of an element of the locus of a point away from the optical axis after numerous refractions.

The oblique axis method is based on the first law of focus formation, that all possible foci lie on a line from the object normal to the refracting surface. Having calculated the path of a ray in any of the usual ways, the determination of the focus after the first refraction is accomplished according to this method by locating the normal on which the focus must lie and finding the intersection this normal makes with the refracted ray which is accomplished by running a line from the object point towards or through the center of curvature. After thus locating the focus on the ray path after the first refraction, this point is considered as an object and the focus conjugate with it after the second refraction is determined in the same manner.

The accompanying figure (4) illustrates the calculation of the foci of a ray in both directions through a doublet, assuming the object to be first on one side of the lens and then on the other at the two points marked Focus 0. The graphic calculation of these rays is shown above.

The foci 0 and 1 are on Axis 1 normal to the first surface, foci 1 and 2 are on axis 2 normal to the second surface and foci 2 and 3 are on axis 3 normal to the third surface.

The application of this method to the study of aberrations is seen in figure 5 where the successive foci of two points

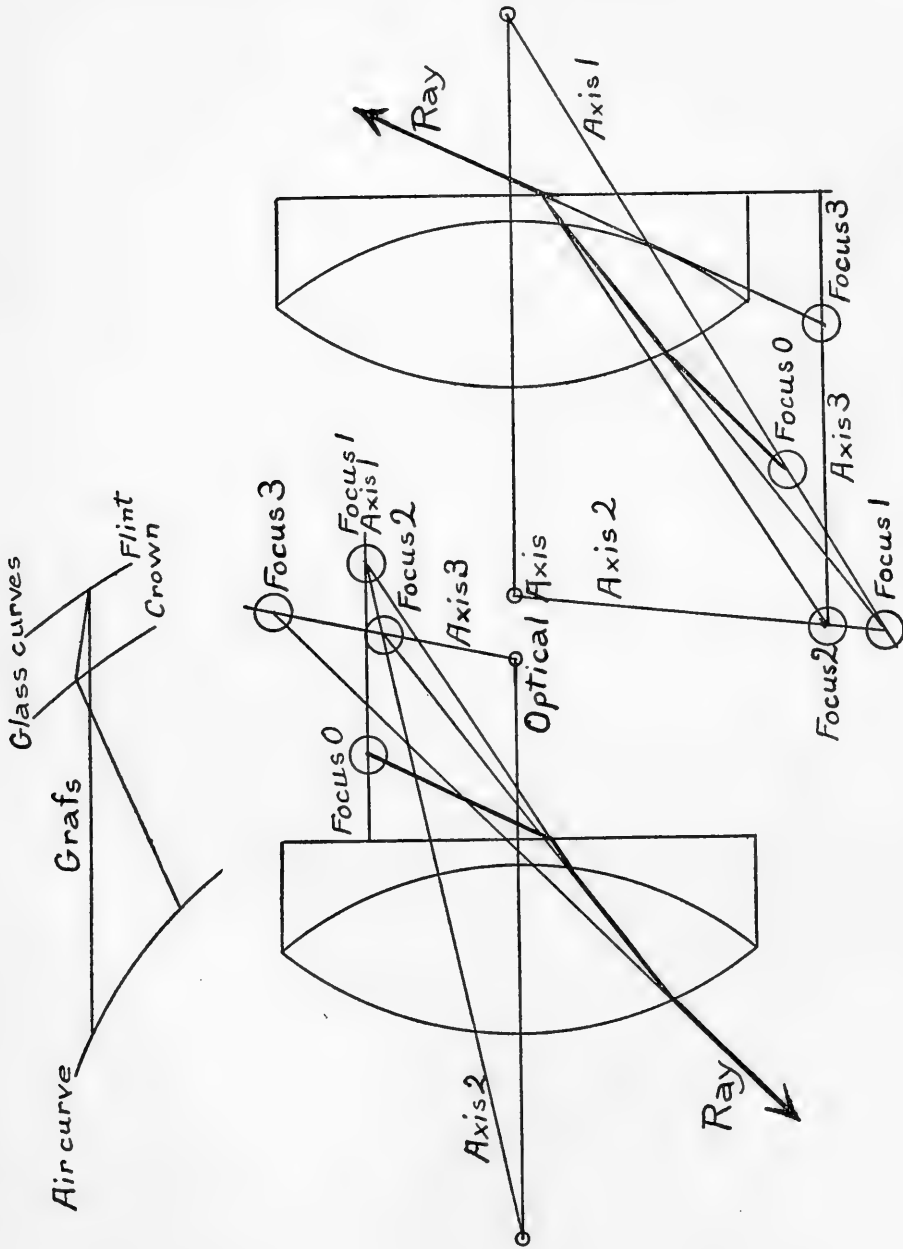


Fig. 4. Graphic calculation of consecutive foci through a doublet.

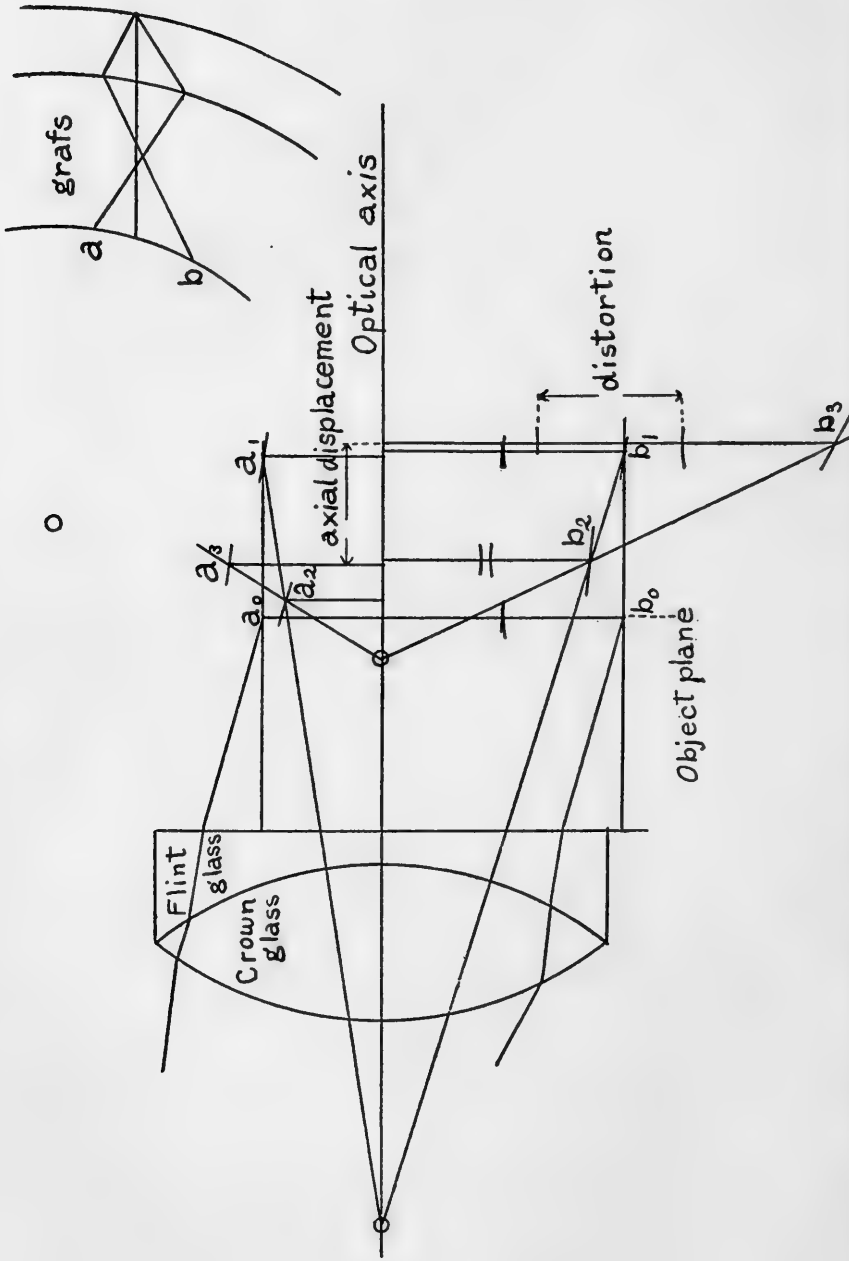


Fig. 5. Graphic calculation of two rays and successive foci to illustrate distortion and lateral aberration.

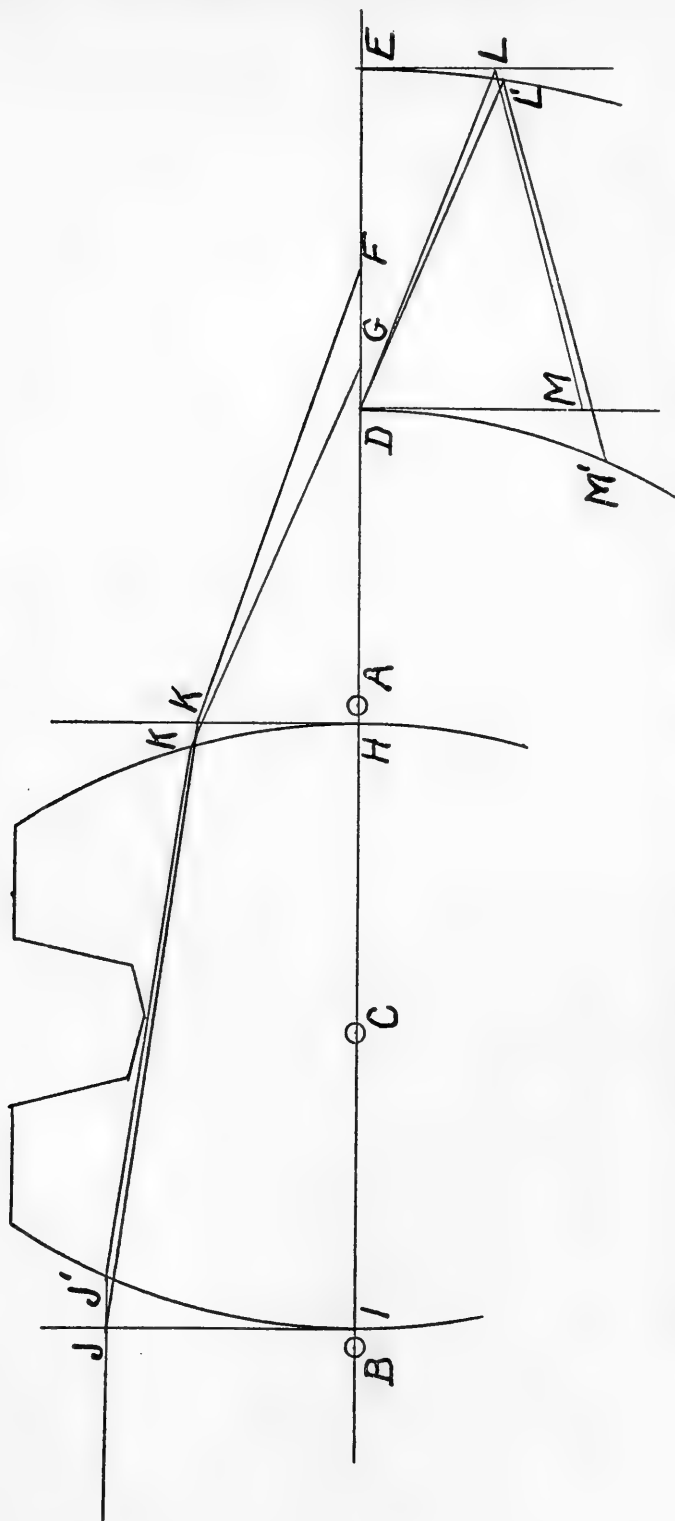


Fig. 6. Graphic calculation of edge and paraxial rays through a Coddington lens showing axial spherical aberration.

a and b through a doublet objective is studied. One of these points is twice as far from the optical axis as the other. Parallel rays from these two points to the lens are selected to show at the same time distortion and oblique aberrations. The graphic calculation of the two rays is given to the right above and all the oblique axes are drawn, the successive foci being represented by letters with subnumbers. Each image plane is also drawn and on the longer the length of the shorter is laid off by short curves. The distance between these curves is the amount of the distortion which is not serious till at the third refraction. Because of the lateral aberrations, the axial displacement is quite large at the second refraction and very serious at the third.

A simple inspection will show that both axial displacement and distortion will be most greatly improved by a slight increase in the length of the radius of the third surface, and that this would have a very much more profound effect than a change in the curvature of the second surface, and that if these two are changed in the proper degrees the aberration could be greatly improved without changing the magnification of the lens as a whole.

The great advantage of this system of lens calculation is the facility with which the manner of correcting aberrations can be located by inspection of the drawings.

The graphic calculation, which is preliminary to the oblique axis calculation in these examples, is described below.

The method of calculation is illustrated in Figure 6, which shows the calculation of the axial spherical aberration at the principal focus of a Coddington lens. A is the center of curvature of the first surface, B of the second. C is the Graph Center, D and E are so located that $CD/CE = n/n'$.

The method of calculation of a ray parallel with the optical axis is as follows:

1. Draw DL' parallel with $J'A$
2. Draw $J'K'$ parallel with CL'
3. Draw $L'M'$ parallel with $K'B$
4. Draw $K'G$ parallel with CM'

The point G is the principal focus for the zone J' of the lens.

Exactly the same method applies to the calculation of paraxial rays except that straight lines perpendicular with the axis replace all the curves. The steps in the process are

the same as those given above, omitting the primes and ending at F, which is the principal focus for paraxial rays. The distance FG is therefore the spherical aberration.

The correctness of this method of calculation is proven as follows: In the triangle CDL', L'DE is by construction = α and since $CD/CL' = n/n'$ the angle $DL'C = \alpha'$. Since θ equals zero and the external angle $L'DE = CL'D + DCL'$ we have from the equation $\alpha - \theta = \alpha' - \theta'$; $DCL = \theta'$ and therefore CL is parallel with J'K'. In the same way, in the next refraction CM' can be shown to be parallel with K'G.

In the calculation of the paraxial ray it is at once evident that a ray half way between I and J would by this method of construction proceed to a point half way between H and K and then exactly to F. The same would be true of a ray $\frac{1}{4}$ or $\frac{1}{8}$ above I and H, that is the distance from the optical axis does not affect the focal distance F; therefore a paraxial ray comes to a focus at this point.

The methods above described constitute a complete scheme for lens calculation which can be carried out grafically with as much accuracy as is required for practical purposes, since it is well within the limits of the accuracy of the physical data and mathematically to any degree required for theoretical investigation.

IV. ON THE ABERRATION OF DEPTH

The aberrations due to the thickness or depth of objects have received very scant attention though it is well known through observation, as well as from the theoretical considerations, that there are such aberrations.

The figure accompanying this article (Fig. 7) illustrates the amount and character of such aberrations in the simple case of a single lens surface, and of an object limited to a single axial plane.

It illustrates at the same time an application of the methods of graphic calculation and the new oblique axis method of calculation, which is available either for graphic or mathematical computations. The "air curve" and "glass curve" are drawn in the manner already described about the "graph center" with radii proportional to the index of air and of

glass, respectively, and the graphs, three series of which are shown, are drawn parallel with three radii of the lens from the three points of refraction being studied.

The object whose images are studied is the letter A standing edgewise to the lens and at some distance above the optical axis. The "chief image" is the one produced by the central portion of the lens and the incident pencil is indicated by lines from the principal points of the image to the middle point of the lens.

Lines from the graph center to the air curve parallel with three lines of the incident pencil, but which are omitted in the drawing, locate the air ends of the chief graphs. Similar lines, also not shown, from the graph center to the glass ends of these graphs give the directions of the corresponding rays of the refracted pencil.

In precisely the same manner the pencils to the extreme edges of the lens which produce images showing extreme aberrations are indicated by lines, and likewise parallels to the rays of these pencils from the graph center to the air curve locate the positions of the other graphs shown. Likewise also the directions of the rays of the refracted pencil are indicated by lines connecting the glass ends of these graphs with the graph center. None of these lines from the graph center are drawn nor need they be drawn when making graphic calculations since the graphs themselves are the only record that need be made of the process of calculation.

The "oblique axis" method of calculation is as stated above based on the fundamental fact of refraction at spherical surfaces that the focus conjugate with any image point must lie on a line through that point and the center of curvature of the lens. Thus all points on the optical axis have their conjugate foci also on the optical axis. In the same manner all conjugate foci away from the optical axis lie on oblique axes. The oblique axes of the principal points of the object A are shown in the figure. These axes are drawn away from the lens because the object A is so located that virtual images will be formed in that direction.

Knowing the direction of each ray of the refracted chief pencil as explained above, it is only necessary to find the intersection of a line from the vertex of the lens, which is

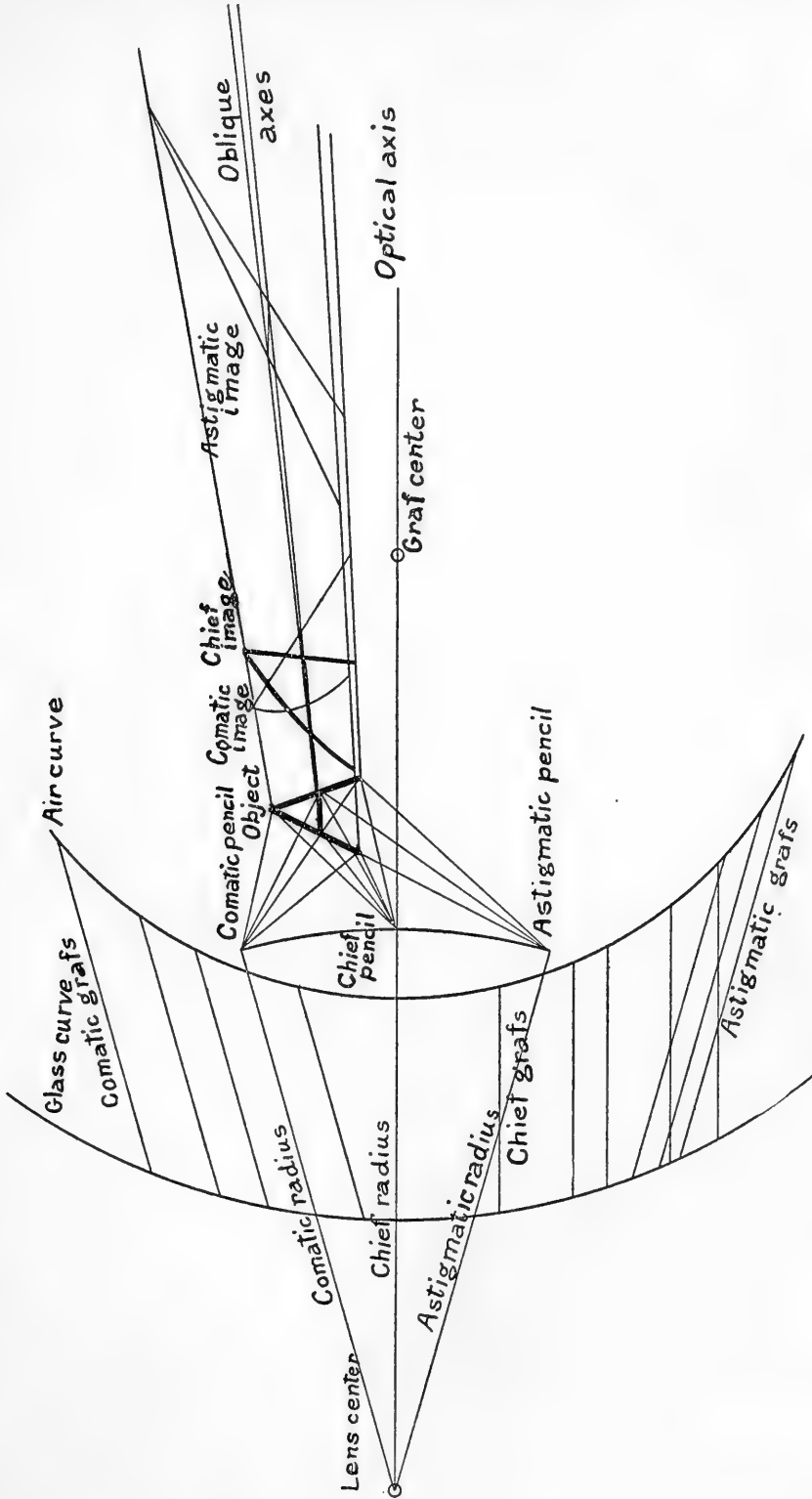


Fig. 7. Graphic calculation of depth aberration.

the point of refraction of this pencil, with the corresponding oblique axis to locate the principal points of the image and connecting these principal points produces the distorted shape of the chief image shown in the figure.

In the same way the comatic and astigmatic image can be located. These two extreme images represent the extreme aberration. The same method would enable one to locate the images produced at any point along the lens surface and they would all be intermediate between the extreme images and the chief image.

The reasons for designating these two extreme images "comatic" and "astigmatic" is given in "Science", vol. XLVIII, pp. 459-460.

The distorted shape of the chief image is due not to distortion but to curvature, the former aberration not appearing at all in the simple case of refraction at a single surface.

Axial aberration can be appreciated by conceiving the legs of the A extending to the optical axis when the corresponding legs of the astigmatic and comatic images will coincide at points considerably further from the lens than the legs of the chief image, the amount of difference being the longitudinal axial aberration.

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VI

The Gopher-Snakes of Western North America

BY

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VI
THE GOPHER-SNAKES OF WESTERN NORTH
AMERICA

BY

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AND

JOSEPH R. SLEVIN

Assistant Curator, Department of Herpetology

The snakes of the genus *Pituophis*, commonly are called gopher or bull snakes. They occur in the United States from the Atlantic to the Pacific coasts. In the region lying west of the Rocky Mountains they are widely distributed, and have been taken in Idaho, Utah, Nevada, Arizona, Washington, Oregon and California. Their range also includes Lower California and certain of the coastal islands.

Although herpetologists now generally agree that three kinds of *Pituophis* occur in this western territory, the differential characters and the distribution of these forms never have been clearly set forth. Further study of these snakes,

August 21, 1919



therefore, seems well worth while. In undertaking this study we have again made use of material in the collections of Stanford University and the University of California, and, for this privilege, we are again indebted to Professors Charles H. Gilbert and John O. Snyder of Stanford University, and Dr. Joseph Grinnell of the University of California. The snakes in the collection of the University of California are distinguished by the letter C prefixed to their numbers in the lists of specimens; those from Stanford University, by the letter S. When no letter is attached to its number the specimen is in the collection of the California Academy of Sciences.

Several names have, in the past, been based upon, or applied to, gopher-snakes from the area under consideration.

In 1835, Blainville described two kinds of gopher-snakes from specimens collected by M. Botta in "California", a term which, as then used, included Lower California. These he called *Coluber catenifer* and *Coluber vertebralis*. In 1842, Holbrook established the genus *Pituophis* for the eastern bull-snake, which Daudin had described, in 1803, as *Coluber melanoleucus*. In 1853, Baird and Girard placed Blainville's *Coluber catenifer* in this genus *Pituophis*, and the following year Duméril and Bibron made the same disposition of his *Coluber vertebralis*.

Cope, in 1860, described the gopher-snake of the Cape Region of Lower California under the name *Pityophis hæmatois*, from specimens collected by John Xantus at Cape San Lucas. In more recent publications, however, Cope (1875) and other authors have recognized Blainville's description of *Coluber vertebralis* as referring to this Lower California species and, therefore, have called it *Pituophis vertebralis*.

Blainville's description of *Coluber catenifer* is so meager that one is left uncertain as to which kind of snake he had. His plate indicates that he may have had the less brightly colored coast race. Baird and Girard, in 1853, may be considered to have determined the subsequent use of the term by using the name *Pituophis catenifer* for a specimen from San Francisco. It would seem that this restriction of the name, in the first general review of the genus, should be followed, unless subsequent examination of the original type specimen shows that it did not belong to this race.

In the same publication (p. 71) Baird and Girard, in 1853, proposed the name *Pituophis wilkesii* for two specimens from "Puget Sound, Or.," with gastrosteges numbering 215 and 209, and two from "Oregon", with counts of 209 and 213. This name evidently is based upon specimens of the coast race and has been regarded as a synonym of *Pituophis catenifer*.

Baird and Girard, in 1853 (p. 72), proposed still another name for a western gopher-snake. This was *Pituophis annectens*, based upon one specimen, with 243 gastrosteges, collected at San Diego, California, by Dr. J. L. Leconte.

In 1853, also, Hallowell described *Pityophis heermannii* from a specimen collected on the Cosumnes River, California. His description does not state the number of gastrosteges. The locality is one where specimens more or less intermediate in character but most like the coast race are to be expected. The name may, therefore, be treated as a synonym of *Pituophis catenifer*. The original specimen may perhaps still be preserved in the collection of the Philadelphia Academy of Natural Sciences.

In 1852, Baird and Girard described as *Churchillia bellona* a gopher-snake collected by General Churchill on the left bank of the Rio Grande, at the crossing near Presidio del Norte. The following year, they placed this species in the genus *Pituophis*. Later, the name *Pituophis bellona* or *Pityophis sayi bellona* was used by Cope and other authors for gopher-snakes from parts of California, Arizona and the Great Basin. Stejneger, however, in 1893, called attention to the fact that this name is really a synonym of *Pituophis sayi*, and cannot properly be applied to another race. Stejneger proposed a new name, *Pituophis catenifer deserticola*, for this western race to which the name *bellona* had been misapplied. Stejneger mentions no type specimen, names no type locality and gives no characterization of *Pituophis catenifer deserticola* other than that it is the "richly-colored form from the Great Basin and the southwestern deserts" which must be distinguished from *Pituophis catenifer* by "the totality of the characters," as the number of smooth rows of lateral scales will not serve for this purpose. He merely proposed a substitute name.

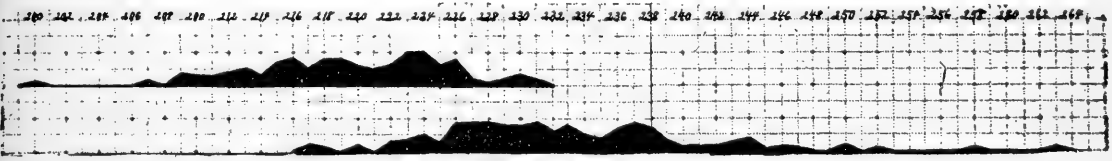
So far as we have been able to learn no one, either before or since, has stated any more definite means of distinguishing these more "richly-colored" snakes from those which have been called *Pituophis catenifer*.

The present study is based upon nearly 300 specimens of the western races of *Pituophis*, all but eight of which represent *Pituophis catenifer* and its subspecies. This material should be large enough to demonstrate any differences in squamation which exists between the two subspecies. Great individual variation is evident in both, but in only one series of scales is there apparent any geographical variation. Only in the counts of the gastrosteges do we find any scale-character which is of value in the classification of these snakes. While this, in one sense, is disappointing, we nevertheless, must be glad to have found even one character which will aid in the separation of these snakes, since reliance upon color differences, which are subject to so much individual variation, and are so difficult to estimate, has resulted in most unsatisfactory determinations.

In the series at hand the differences in the number of gastrosteges in specimens from the northwestern coast counties of California and in others from Arizona, Nevada and Utah is very easily appreciated. If we had specimens only from these localities they might almost be regarded as distinct species, with only an occasional individual of each overlapping the limit of say 230 gastrosteges. Gopher-snakes, however, occur throughout most of the intervening territory and offer gastrostege counts which completely bridge over this difference. We, therefore, must continue to regard these coast and interior races merely as subspecies.

The number of gastrosteges increases from a minimum of 200 in the coast subspecies to a maximum of 263 in the desert subspecies. While individual variation is great in any one locality, it may be said that, in a general way, the warmer and dryer the climate of a given locality the greater the number of gastrosteges. As one proceeds south and east from the cool coast regions toward the interior desert valleys, the average counts gradually increase.

The transition from the number characteristic of the coast snakes to that of the desert snakes is complete and more or less gradual. Nevertheless, these counts are of great use in the separation of the two subspecies.



The specimens which we have studied show gastrostege counts ranging from 200 to 263. No sexual difference is apparent in the counts. We believe that specimens having fewer than 220 gastrosteges may, on that basis alone, be referred to *Pituophis catenifer catenifer*, and that any specimen with more than 231 gastrosteges may be considered to belong to the other subspecies, which has been called *Pituophis sayi bellona* or *Pituophis catenifer deserticola*, properly to be known as *Pituophis catenifer annectens* (Baird & Girard).

The typical specimens of *Pituophis catenifer catenifer* with fewer than 220 gastrosteges are from northern California and western Oregon. Specimens of *Pituophis catenifer annectens* with more than 231 gastrosteges have been found only in southern California, northern Lower California, Arizona, Nevada, and Utah.

A large number of specimens have gastrostege counts varying from 220 to 231. Most of these are from central California and the San Diegan Fauna. They represent geographic intergradation and, to some extent, the extremes of individual variation. A majority of the specimens with 220 to 225 gastrosteges are from the more northern localities and may be referred to *Pituophis catenifer catenifer*. Most of those having counts of 226 to 231 gastrosteges are from the range of *Pituophis catenifer annectens*, and may be so called.

On the accompanying map specimens having from 200 to 220 gastrosteges are indicated by round spots; those having from 231 to 263 by square spots; those with 221 to 225 by half-round spots; and those with from 226 to 230 gastrosteges

by half squares. This serves to bring out quite clearly the fact that the variation is largely geographic.

The localities arranged according to the number of gastrosteges in specimens which represent them are as follows:

200 *Gastrosteges*

Santa Cruz Island, Santa Barbara County¹
Corralitos, Santa Cruz County

209

Inverness, Marin County
San Juan, San Benito County
Callahan, Siskiyou County
Roseburg, Douglas County, Oregon

210

Goose Lake Meadows, Modoc County
Napa, Napa County
Pismo, San Luis Obispo County

211

Lagunitas, Marin County
Edna, San Luis Obispo County
Camas Mountains, Douglas County, Oregon
Santa Cruz Island, Santa Barbara County

212

Santa Cruz Island, Santa Barbara County
Palo Alto, Santa Clara County
Palo Alto, Santa Clara County
Palo Alto, Santa Clara County

213

Berkeley, Alameda County
Berkeley, Alameda County
Berkeley, Alameda County
Palo Alto, Santa Clara County
Duncan Mills, Sonoma County

¹ All localities in California unless otherwise stated.

214

Carmel, Monterey County
San Francisco
Palo Alto, Santa Clara County

215

Point Reyes Station, Marin County
Mailliard, Marin County
Manzanita, Marin County
Sugar Hill, Modoc County
Palo Alto, Santa Clara County
Palo Alto, Santa Clara County
Palo Alto, Santa Clara County
Tehama, Tehama County

216

Berkeley, Alameda County
Mt. Diablo, Contra Costa County
San Pablo Valley, Contra Costa County
San Anselmo, Marin County.
Carmel, Monterey County
San Juan, San Benito County
Fort Jones, Siskiyou County

217

Madera, Madera County
San Anselmo, Marin County
Palo Alto, Santa Clara County
Palo Alto, Santa Clara County
Monte Rio, Sonoma County
Charter Oak, Los Angeles County
Cold Water Canyon, Los Angeles County

218

Walnut Creek, Contra Costa County
Coulterville, Mariposa County
Carmel, Monterey County
Coburn, Monterey County

Coyote, Santa Clara County
Palo Alto, Santa Clara County
Palo Alto, Santa Clara County
San Jose, Santa Clara County
San Diego County

219

Berkeley, Alameda County
Winslow, Glen County
Middletown, Lake County
Los Baños, Merced County
Carmel, Monterey County
Welby, Monterey County
Lander, Placer County
Soquel, Santa Cruz County
Grand Island Landing, Yolo County

220

Fyffe, El Dorado County
Vicinity of Alturas, Modoc County
Warner Mountains, Modoc County
Bradley, Monterey County
Tracy, San Joaquin County
Palo Alto, Santa Clara County
San Jacinto, Riverside County
San Jacinto, Riverside County

221

Mt. Diablo, Contra Costa County
Clovis, Fresno County
Tracy, San Joaquin County
Coyote Creek, Santa Clara County
Buddha Canyon, Solano County

222

Fyffe, El Dorado County
Indian Creek, San Luis Obispo County
San Juan River, San Luis Obispo County

Palo Alto, Santa Clara County
Palo Alto, Santa Clara County
Palo Alto, Santa Clara County
San Jacinto, Riverside County
Ontario, San Bernardino County
Cuyamaca Mountains, San Diego County

223

Butte Creek, Butte County
Garberville, Humboldt County
Pleasant Valley, Mariposa County
Canby, Modoc County
Carmel, Monterey County
Salinas River, San Luis Obispo County
Palo Alto, Santa Clara County
Palo Alto, Santa Clara County
Sunnyvale, Santa Clara County
Yolla Bolly Mountain, Trinity County
Tehachapi Mountains, Kern County
Sierra Madre, Los Angeles County
Cahuilla Valley, San Diego County
Fort Douglas, Salt Lake County, Utah

224

Fruto, Glen County
Winslow, Glen County
Kelseyville, Lake County
Willits, Mendocino County
Tracy, San Joaquin County
Indian Creek, San Luis Obispo County
Pismo, San Luis Obispo County
Alma, Santa Clara County
Los Gatos, Santa Clara County
Palo Alto, Santa Clara County
Buttonwillow, Kern County
San Jacinto, Riverside County
Agua Caliente, San Diego County
Campo, San Diego County
Campo, San Diego County

225

Near Gridley, Butte County
Contra Costa, Contra Costa County
Welby, Monterey County
Palo Alto, Santa Clara County
Palo Alto, Santa Clara County
Palo Alto, Santa Clara County
Soquel, Santa Cruz County
Colton, Riverside County
San Jacinto, Riverside County
Campo, San Diego County

226

Mt. Diablo, Contra Costa County
Mt. Diablo, Contra Costa County
Kelseyville, Lake County
Snelling, Merced County
Carmel, Monterey County
Coburn, Monterey County
Metz, Monterey County
Palo Alto, Santa Clara County
Santa Cruz River, Pima County, Arizona
Tehachapi Mountains, Kern County
San Jacinto Mountains, Riverside County
San Jacinto Mountains, Riverside County
San Bernardino Mountains, Riverside County
Campo, San Diego County
Campo, San Diego County
Campo, San Diego County
Pine Creek, Ventura County

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Dunlaps, Fresno County
Vicinity of Kinsley, Mariposa County
Sierra Madre, Los Angeles County
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Campo, San Diego County
Campo, San Diego County

Julian, San Diego County
———, San Diego County
Warner Pass, San Diego County
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Fort Douglas, Salt Lake County, Utah

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San Miguel, San Luis Obispo County
Pasadena, Los Angeles County
San Jacinto, Riverside County
San Jacinto Mountains, Riverside County
Shandon, San Luis Obispo County
Simmler, San Luis Obispo County
Campo, San Diego County
Fort Douglas, Salt Lake County, Utah
Fort Douglas, Salt Lake County, Utah
Fort Douglas, Salt Lake County, Utah

229

Coulterville, Mariposa County
Palo Alto, Santa Clara County
Ensenada, Lower California
South Coronado Island, Lower California
Bakersfield, Kern County
Sierra Madre, Los Angeles County
Sierra Madre, Los Angeles County
Campo, San Diego County
Campo, San Diego County
———, San Diego County

230

Antioch, Contra Costa County
Soledad, Monterey County
Palo Alto, Santa Clara County
Middletown, Lake County
Pasadena, Los Angeles County
San Jacinto, Riverside County

Poso, San Luis Obispo County
 Campo, San Diego County
 Campo, San Diego County
 Campo, San Diego County
 Fort Douglas, Salt Lake County, Utah
 Fort Douglas, Salt Lake County, Utah

231

Riverton, El Dorado County
 Los Baños, Merced County
 South Coronado Island, Lower California
 San Jacinto, Riverside County
 San Jacinto, Riverside County
 Simmler, San Luis Obispo County
 Campo, San Diego County
 Campo, San Diego County
 Fort Douglas, Salt Lake County, Utah
 Fort Douglas, Salt Lake County, Utah
 Wallula, Walla Walla County, Washington

232

Fort Lowell, Pima County, Arizona
 Delano, Kern County
 Hesperia, San Bernardino County
 Carson, Ormsby County, Nevada
 Fort Douglas, Salt Lake County, Utah
 Fort Douglas, Salt Lake County, Utah

233

Huachuca Mountains, Cochise County, Arizona
 La Crescenta, Los Angeles County
 Mt. Wilson, Los Angeles County
 Benton, Mono County
 Campo, San Diego County
 Fort Douglas, Salt Lake County, Utah
 Fort Douglas, Salt Lake County, Utah
 Boise, Ada County, Idaho

234

Ontario, San Bernardino County
Virgin Valley, Humboldt County, Nevada
Fort Douglas, Salt Lake County, Utah
Fort Douglas, Salt Lake County, Utah
Fort Douglas, Salt Lake County, Utah

235

Cave Creek, Maricopa County, Arizona
Agua Caliente, San Diego County
Campo, San Diego County
Campo, San Diego County

236

San Martin Island, Lower California
Isabella, Kern County
Campo, San Diego County
———, San Diego County
Fort Douglas, Salt Lake County, Utah
Fort Douglas, Salt Lake County, Utah
Boise, Ada County, Idaho

237

Cave Creek, Maricopa County, Arizona
Santa Cruz River, Pima County, Arizona
Bakersfield, Kern County
Sierra Madre, Los Angeles County
Palo Prieto Canyon, San Luis Obispo County
Campo, San Diego County
Campo, San Diego County
Fort Douglas, Salt Lake County, Utah
Wasatch Mountains, Wasatch County, Utah

238

Fort Lowell, Pima County, Arizona
Santa Barbara, Santa Barbara County
Fort Douglas, Salt Lake County, Utah

Fort Douglas, Salt Lake County, Utah
Fort Douglas, Salt Lake County, Utah
Fort Douglas, Salt Lake County, Utah
Fort Douglas, Salt Lake County, Utah

239

Campo, San Diego County
Carlin, Elko County, Nevada
Fort Douglas, Salt Lake County, Utah

240

Campo, San Diego County
Fort Douglas, Salt Lake County, Utah

241

Victorville, San Bernardino County
Thompson, Grand County, Utah

242

Thousand Creek Flat, Humboldt County, Nevada
Pyramid Lake, Washoe County, Nevada

243

San Jacinto Mountains, Riverside County
Mecca, Riverside County
Pine Forest Mountains, Humboldt County, Nevada

244

Walker Pass, Kern County
Blue Lakes, Twin Falls County, Idaho
Nixon, Washoe County, Nevada
Pyramid Lake, Washoe County, Nevada

245

Cave Creek, Maricopa County, Arizona

246

Palmetto Mountains, Esmeralda County, Nevada
Pine Forest Mountains, Humboldt County, Nevada

247

Silsbee, Imperial County

250

Colorado River, Mojave County, Arizona
Benton, Mono County

252

Mecca, Riverside County

258

Yuma, Yuma County, Arizona

263

Mecca, Riverside County

The complete scale-counts together with the lists of localities where the specimens examined by us were secured are given below under the names of the subspecies to which we have referred the specimens. As we already have said, many of these specimens are from the region of geographical intergradation and some are so intermediate in character that their reference to one or the other subspecies is largely a matter of convenience.

***Pituophis catenifer catenifer* (Blainville)**

Specimens from 78 localities have been studied by us. They represent 29 counties of northern and central California and two of southwestern Oregon.

1. Berkeley, Alameda County, California
2. Butte Creek, Butte County, California
3. Antioch, Contra Costa County, California
4. Contra Costa, Contra Costa County, California
5. Moraga Valley, Contra Costa County, California
6. S. W. Side Mt. Diablo, Contra Costa County, California
7. San Pablo Valley, Contra Costa County, California
8. Two miles east of Walnut Creek, Contra Costa County, California

9. Fyffe, El Dorado County, California
10. Riverton, El Dorado County, California
11. Clovis, Fresno County, California
12. Dunlaps, Fresno County, California
13. Fruto, Glen County California
14. Winslow, Glen County, California
15. Garberville, Humboldt County, California
16. Kelseyville, Lake County, California
17. Lower Lake, Lake County, California
18. Madera, Madera County, California
19. Inverness, Marin County, California
20. Lagunitas, Marin County, California
21. Mailliard, Marin County, California
22. Manzanita, Marin County, California
23. San Anselmo, Marin County, California
24. Coulterville, Mariposa County, California
25. Between Kinsley and Maculey's Stage Station, Mariposa County, California
26. Pleasant Valley, Mariposa County, California
27. Los Baños, Merced County, California
28. Snelling, Merced County, California
29. Between Alturas and Davis Creek, Modoc County, California
30. Goose Lake Meadows, Modoc County, California
31. Sugar Hill, Modoc County, California
32. Dry Creek, Warner Mountains, Modoc County, California
33. Bradley, Monterey County, California
34. Carmel, Monterey County, California
35. Coburn, Monterey County, California
36. Metz, Monterey County, California
37. Soledad, Monterey County, California
38. Welby, Monterey County, California
39. Napa, Napa County, California
40. Lander, near Colfax, Placer County, California
41. San Juan, San Benito County, California
42. San Francisco, San Francisco County, California
43. Tracy, San Joaquin County, California (four mi. west)
44. Edna, San Luis Obispo County, California
45. Indian Creek, San Luis Obispo County, California

46. Pizmo, San Luis Obispo County, California
47. Source of Salinas River, San Luis Obispo County, California
48. San Juan River, San Luis Obispo County, California
49. San Miguel, San Luis Obispo County California
50. Santa Cruz Island, Santa Barbara County, California
51. Alma, Santa Clara County, California
52. Coyote, Santa Clara County, California
53. Coyote Creek, Santa Clara County, California
54. Los Gatos, Santa Clara County, California
55. Palo Alto, Santa Clara County, California
56. San Jose, Santa Clara County, California
57. Stanford University, Santa Clara County, California
58. Sunnyvale, Santa Clara County, California
59. Corralitos, Santa Cruz County, California
60. Soquel, Santa Cruz County, California
61. Callahan, Siskiyou County, California
62. Ft. Jones, Siskiyou County, California
63. Buddha Canyon, Solano County, California (N. W. Corner).
64. Duncan Mills, Sonoma County, California
65. Guerneville, Sonoma County, California
66. Monte Rio, Sonoma County, California
67. Tehama, Tehama County, California
68. Yolla Bolly Mountain, Trinity County, California
69. Grand Island Landing, Yolo County, California
70. Camas Mountains, Douglas County, Oregon
71. Roseburg, Douglas County, Oregon
72. Klamath Falls, Klamath County, Oregon
73. East side Mt. Diablo, Contra Costa County, California
74. Between Live Oak and Gridley, Butte County, California
75. Canby, Modoc County, California
76. Ten miles south from Willits, Mendocino County, California
77. Middletown, Lake County, California
78. Point Reyes Station, Marin County, California

The full scale-counts are as follows:

Scale counts in *Pituophis catenifer catenifer*

Number	Sex	Scale Rows	Gastro-steges	Uro-steges	Supra-labials	Infra-labials	Pre-oculars	Post-oculars	Loreals	Temporals	Locality
C1589		29	213	71c	X-8	X-X	1-1	3-3	1-1	X-4	1
C2314		31	216	55c	9-8	12-13	1-2	3-3	1-1	4-3	1
C2434		31	219	66c	8-8	12-12	1-1	3-4	1-1	3-3	1
C1626		31	213	71c	8-8	13-13	2-2	3-4	1-1	5-4	1
C848		31	213	71c	8-8	12-12	1-1	3-3	1-1	3-3	1
C4012		29	223	68c	9-8	14-11	2-2	3-3	1-1	3-4	2
43452		31	230	66c	8-8	13-13	2-2	3-3	1-1	3-3	3
C849		31	225	60c	9-9	12-12	1-2	2-2	1-1	2-3	4
43519		31	216	66c	8-8	14-13	2-2	4-4	1-1	4-4	5
C4019		31	226	62c	8-8	14-14	2-2	3-3	1-1	4-3	6
C4018		31	221	68c	8-8	12-12	2-2	3-3	1-1	3-2	6
C5614		29	216	64c	8-8	13-13	2-2	3-3	1-1	3-3	7
C4017		31	218	75c	9-8	13-13	2-2	4-4	1-1	4-4	8
S5631		35	220	64c	8-8	12-12	2-2	3-3	1-1	4-4	9
S5633		29	222	66c	8-9	13-11	2-2	3-3	1-1	3-4	9
39637		31	231	62c	8-9	13-13	2-2	3-3	1-1	4-4	10
27333		31	221	64c	9-8	13-13	2-2	3-3	1-1	4-4	11
C6264		33	227	38+	8-8	14-14	2-2	3-3	1-1	4-4	12
C4016		31	224	66c	8-8	12-13	2-2	3-3	1-1	4-5	13
C4015		31	219	53+	8-9	13-14	2-2	4-4	1-1	4-4	14
C4014		29	224	74c	8-8	13-13	2-2	3-3	1-1	4-5	14
S4220		33	223	74c	9-9	12-11	2-2	3-3	1-1	3-4	15
S1697		31	226	67c	8-9	12-12	2-2	3-3	1-1	4-4	16
S1741		31	224	65c	8-8	12-12	1-1	2-3	1-1	4-4	16
30888		31	X	74c	9-8	13-12	2-2	3-3	1-1	3-3	17
41670		31	217	63c	9-9	13-13	2-2	3-3	1-1	3-4	18
C5285		31	209	70c	9-8	13-13	2-2	3-3	1-1	4-4	19
27326		31	211	68c	8-8	11-11	1-1	3-3	1-1	3-4	20
C975		29	215	64c	8-8	13-13	1-1	3-3	1-1	3-4	21
C4845		29	215	68c	8-8	10-11	2-2	3-3	1-1	2-2	22
C5283		29	216	68c	9-8	12-12	1-1	3-3	1-1	3-3	23
C5282		31	217	70c	8-8	12-12	1-1	3-3	1-1	4-4	23
C5883		33	218	60+	10-10	14-14	2-2	3-3	1-1	3-2	24
C5884		29	229	58c	X-8	X-13	X-2	X-3	X-1	X-X	24
C5885		33	227	55c	10-9	13-13	1-1	4-4	1-1	3-4	25
C5886		31	223	67c	8-8	13-13	2-2	4-4	1-1	4-4	26
41699		31	219	61c	8-8	13-13	2-2	3-3	1-1	4-4	27
C3608		33	231	56c	8-8	13-13	2-2	3-3	1-1	5-5	27
C5595		33	226	58c	8-8	13-13	2-2	3-3	1-1	4-4	28
C2080		31	220	74c	9-X	X-X	2-2	3-3	1-1	4-X	29
C2081		31	210	67c	8-7	12-12	2-2	3-3	1-1	3-4	30
C2082		29	215	67c	7-7	12-12	1-1	3-3	1-1	3-3	31
C2083		31	220	72c	8-8	12-13	2-2	3-3	1-1	5-5	32
43377		31	220	63c	8-8	13-13	2-2	4-3	1-1	2-2	33
13766		31	219	64c	8-8	11-11	2-2	3-3	1-1	3-4	34
13767		31	218	65c	8-8	11-13	2-2	3-3	1-1	3-3	34
13768		33	223	62c	9-8	13-12	2-2	4-4	1-1	4-5	34
13769		31	216	66c	9-9	13-13	2-2	4-4	1-1	4-4	34
13770		31	226	68c	8-9	11-12	2-2	4-5	1-1	3-4	34
17858		31	214	79c	10-9	13-12	2-2	3-4	1-1	4-4	34
43375		29	218	67c	8-8	13-13	2-2	3-4	1-1	4-4	35
43376		31	226	68c	8-8	12-12	2-2	4-3	1-1	4-4	35
43321		31	X	61c	8-8	13-13	2-2	3-3	1-1	5-5	36
43322		31	226	67c	8-8	12-12	1-1	3-3	1-1	4-4	36
43379		33	230	71c	8-9	12-13	2-2	3-3	1-1	3-3	37
43373		31	225	67c	8-8	12-12	2-2	4-3	1-1	4-4	38
43374		31	219	74c	9-8	13-13	2-2	3-4	1-1	5-4	38
C4312		31	210	67c	9-9	13-13	2-2	3-3	1-1	4-4	39
S6500		33	219	62c	9-9	12-12	2-2	3-3	1-1	X-4	40
43412		31	209	70c	8-9	13-13	2-2	4-4	1-1	4-3	41
39261		31	214	58c	8-9	12-13	2-2	3-3	1-1	4-5	42
43521		29	220	64c	8-8	12-12	2-2	3-3	1-1	3-4	43
43522		31	221	55c	8-8	12-14	2-2	3-3	1-1	4-4	43
C2759		33	224	48+	9-8	13-13	2-2	3-3	1-1	3-3	43
43274		29	211	71c	8-8	11-12	1-1	3-3	0-0	3-3	44
43418		33	224	78c	9-10	13-13	2-2	3-3	1-1	4-5	45
43419		33	222	67c	9-8	12-12	2-2	3-3	1-1	3-3	45
43364		31	224	X	8-9	13-12	2-2	3-3	1-1	3-3	46
43365		31	210	71c	8-8	11-11	2-2	3-3	1-1	3-3	46
43413		33	223	67c	8-8	12-13	2-2	3-3	1-1	4-4	47
43414		31	222	66c	8-8	13-13	2-2	3-4	1-1	3-4	48
43382		31	228	69+	8-9	11-12	2-2	3-3	1-1	4-4	49

Scale counts in *Pituophis catenifer catenifer*—Continued

Number	Sex	Scale Rows	Gastro-steges	Uro-steges	Supra-labials	Infra-labials	Pre-oculars	Post-oculars	Loreals	Temporals	Locality
36120	♂	29	212	70e	8-8	13-13	1-1	4-4	1-1	3-3	50
36121		29	200	54c	9-9	10-10	1-1	3-3	1-1	3-4	50
45131		31	211	71c	9-10	12-12	1-1	4-4	1-1	3-4	51
C6166		33	224	62c	8-8	12-12	1-1	3-3	1-1	2-2	52
43434		31	218	75c	8-8	13-13	1-1	3-3	1-1	4-4	52
S1165		31	221	69c	8-8	14-13	2-2	3-3	1-1	3-4	53
40413		33	224	63c	9-8	13-13	2-2	3-3	1-1	3-3	54
S4026		33	215	68c	8-8	13-14	2-2	4-3	1-1	3-3	55
S1799		31	216	69c	8-8	13-13	2-2	4-3	1-1	4-3	55
S1798		31	218	70c	9-9	12-13	2-2	4-4	1-1	4-4	55
S1808		31	215	61c	8-9	13-13	2-2	3-3	1-1	4-4	55
S4017		31	212	59c	8-8	11-12	1-1	3-3	1-1	3-3	55
S1150		33	214	71c	8-9	12-12	2-2	3-3	1-1	3-3	55
41667		33	218	73c	9-8	13-14	2-2	3-3	1-1	3-3	56
S1119		31	229	60c	9-9	12-13	2-2	4-3	1-1	3-4	57
S1118		31	215	73c	8-8	12-12	2-2	3-3	1-1	3-4	57
S1773		33	224	53c	8-9	11-11	2-2	3-3	1-1	3-3	57
S1168		33	225	61c	8-8	13-13	2-2	3-3	1-1	4-4	57
S1117		33	226	61c	8-8	12-11	2-2	3-4	1-1	3-3	57
S5806		33	230	56c	8-8	12-12	2-2	3-3	1-1	4-5	57
S1749		33	223	63c	9-9	14-13	2-2	3-3	1-1	4-4	57
S1748		31	220	66c	8-8	13-11	2-2	3-3	1-1	3-2	57
S1752		31	217	74c	8-8	12-12	2-2	3-3	1-1	4-5	57
S7195		33	225	60c	10-10	13-12	2-2	3-3	1-1	4-5	57
S1167		31	222	58c	9-9	13-12	2-2	3-3	1-1	3-4	57
S4042		31	223	72c	8-8	12-13	2-1	3-3	1-1	3-3	57
S4047		33	217	68c	8-8	13-13	1-1	3-3	1-1	3-3	57
S4044		31	225	69c	8-8	13-13	2-2	3-3	1-1	4-4	57
S4045		31	218	59c	8-8	12-13	2-2	3-3	1-1	3-4	57
S4043		31	222	64c	8-8	11-12	2-1	3-3	1-1	3-4	57
S1747		31	222	62c	8-8	13-12	2-2	4-4	1-1	4-4	57
S1171		31	220	67c	8-8	13-13	2-2	3-3	1-1	3-3	57
S1169		33	212	71c	8-9	13-13	2-2	4-4	1-1	4-4	57
S1751		31	213	56c	9-9	12-11	2-2	3-3	1-1	4-4	57
41671		31	212	72c	8-9	12-11	2-2	3-3	1-1	3-4	57
43440		31	223	67c	8-8	13-12	1-2	3-3	1-1	4-4	58
S4092		33	207	69c	8-8	12-12	2-2	3-3	1-1	4-4	59
S1681		31	225	73c	9-9	12-12	2-2	3-3	1-1	3-3	60
S1772		31	219	67c	8-8	12-13	2-2	3-3	1-1	3-3	60
36061		31	209	76c	8-8	10-10	2-2	3-3	1-1	4-4	61
S1740		31	216	62c	9-8	12-13	2-2	3-3	1-1	4-4	62
43523		31	221	65c	8-9	13-13	2-2	3-4	1-1	3-3	63
27942		29	213	74c	9-9	11-11	2-2	3-3	1-1	4-4	64
C4911		31	212	72c	9-8	12-12	1-2	3-3	1-1	5-4	65
C4131		31	217	62c	8-9	12-12	2-2	3-3	1-1	4-4	66
C4013		29	215	71c	9-8	13-13	2-2	3-3	1-1	4-4	67
C5284		31	223	68c	8-9	14-13	2-2	3-3	1-1	4-4	68
C4011		29	219	73c	8-8	12-12	2-2	4-5	1-1	4-6	69
29492		31	211	75c	8-8	11-11	2-2	3-4	1-1	4-4	70
S4062		29	209	70c	8-7	11-11	2-2	3-3	1-1	4-4	71
20413		31	210+	56c	8-8	12-X	2-2	3-3	1-1	4-4	72
44194		31	226	58c	9-9	13-13	2-2	4-3	1-1	4-4	73
44161		31	225	60c	8-8	13-13	2-2	3-3	1-1	5-5	74
44241		31	223	65c	9-8	13-13	2-2	3-3	1-1	3-3	75
44943		33	224	65c	8-8	13-13	2-2	3-3	1-1	4-4	76
45119		31	216	33	8-7	13-13	2-2	3-3	1-1	3-3	41
45120		31	230	64c	8-8	13-13	2-2	3-3	1-1	4-4	77
45121		31	219	62c	9-8	13-14	2-2	3-4	1-1	4-4	77
45127		31	215	72c	8-8	13-13	2-2	3-3	1-1	4-4	78

***Pituophis catenifer annectens* (Baird & Girard)**

To this name we refer specimens from 60 localities in Mexico, Arizona, Nevada, Utah, Idaho, eastern Washington, and ten counties in southern California

1. Ensenada, Lower California, Mexico
2. San Martin Island, Lower California, Mexico
3. South Coronado Island, Lower California, Mexico
4. Huachuca Mountains, Cochise County, Arizona
5. Cave Creek, Maricopa County, Arizona
6. Colorado River, above Bill Williams River, Mohave County, Arizona
7. Ft. Lowell, Pima County, Arizona
8. Santa Cruz River, Pima County, Arizona
9. Yuma, Yuma County, Arizona
10. Silsbee, Imperial County, California
11. Bakersfield, Kern County, California (eight mi. N. E.).
12. Buttonwillow, Kern County, California
13. Delano, Kern County, California
14. Isabella, Kern County, California
15. Tehachapi Mountains, Kern County, California
16. Walker Pass, Kern County, California
17. Charter Oak, Los Angeles County, California
18. Cold Water Canyon, Los Angeles County, California
19. La Crescenta, Los Angeles County, California
20. Mt. Wilson, Los Angeles County, California
21. Pasadena, Los Angeles County, California
22. Sierra Madre, Los Angeles County, California
23. Benton, Mono County, California
24. Colton, Riverside County, California
25. San Jacinto, Riverside County, California
26. San Jacinto Mountains, Riverside County, California
27. Mecca, Riverside County, California
28. Riverside, Riverside County, California
29. San Bernardino Mts., Riverside County, California
30. Hesperia, San Bernardino County, California
31. Ontario, San Bernardino County, California
32. Victorville, San Bernardino County, California
33. Palo Prieto Canyon, San Luis Obispo County, California

34. Pozo, San Luis Obispo County, California
35. Shandon, San Luis Obispo County, California
36. Simmler, San Luis Obispo County, California
37. Agua Caliente, San Diego County, California
38. Cahuilla Valley, San Diego County, California
39. Campo, San Diego County, California
40. Cuyamaca Mountains, San Diego County, California
41. Julian, San Diego County, California
42. San Diego County, California
43. Warner Pass, San Diego County, California
44. Santa Barbara, Santa Barbara County, California
45. Pine Creek, Ventura County, California
46. Blue Lakes, Twin Falls County, Idaho
47. Carlin, Elko County, Nevada
48. Palmetto Mountains, Esmeralda County, Nevada
49. Big Creek, Pine Forest Mountains, Humboldt County,
Nevada
50. Thousand Creek Flat, Humboldt County, Nevada
51. Virgin Valley, Humboldt County, Nevada
52. Austin, Lander County, Nevada
53. Carson, Ormsby County, Nevada
54. Nixon, Washoe County, Nevada
55. Pyramid Lake, Washoe County, Nevada
56. Thompson, Grand County, Utah
57. Fort Douglas, Salt Lake County, Utah
58. Wasatch Mountains, Wasatch County, Utah
59. Wallula, Walla Walla County, Washington
60. Boise, Ada County, Idaho

The full scale-counts are as follows:

Scale counts in *Pituophis catenifer annectens*

Number	Sex	Scale Rows	Gastro-steges	Uro-steges	Supra-labials	Infra-labials	Pre-oculars	Post-oculars	Loreals	Temporals	Locality
8575	♂	31	229	76c	8-9	13-14	2-2	4-3	1-1	3-4	1
8678	♂	31	236	76c	8-9	13-13	1-1	3-3	1-1	4-4	2
13588	♂	31	231	65c	8-8	12-12	2-2	3-3	1-1	4-4	3
13589	♂	35	229	71c	8-9	13-13	2-2	3-3	1-1	3-3	3
34755	♂	33	233	57c	8-8	13-14	1-1	3-4	1-1	4-4	4
17541	♂	31	237	64c	9-9	14-14	2-2	4-4	1-1	3-3	5
17546	♂	35	245	60c	8-8	12-12	1-1	3-3	1-1	4-4	5
17547	♂	31	235	57c	8-8	12-12	1-1	3-3	1-1	4-4	5
1824	♂	33	250	60c	8-10	12-12	2-2	3-3	1-1	4-5	6
S1131	♂	31	238	56c	8-8	X-12	1-1	3-3	1-1	4-4	7
S1705	♂	33	X	68c	8-9	13-13	2-2	3-3	1-1	4-4	7
S1714	♂	33	232	52c	8-8	13-13	1-1	4-3	1-1	5-4	7
33869	♂	33	237	52c	9-10	12-12	1-1	3-4	1-1	2-3	8
33870	♂	33	226	64c	8-8	13-13	1-1	3-3	1-1	3-3	8
33447	♂	33	258	59c	8-8	12-12	1-1	4-5	1-1	3-3	9
C1003	♂	33	249	50c	9-8	13-13	2-2	3-3	1-1	5-5	10
C2761	♂	35	227	57c	8-8	13-13	2-2	3-3	1-1	3-4	11
C2760	♂	31	237	59c	9-8	12-12	2-2	3-3	1-1	4-4	11
39553	♂	33	224	60c	8-8	13-13	2-2	3-3	1-1	3-4	12
43381	♂	33	232	60c	9-9	13-13	2-2	3-3	1-1	5-5	13
39595	♂	31	236	65c	8-8	13-12	2-2	3-3	1-1	3-4	14
38958	♂	33	226	72c	8-8	13-13	2-2	3-3	1-1	3-4	15
38959	♂	35	223	62c	8-10	13-12	2-2	3-3	1-1	3-4	15
C2798	♂	33	244	58c	8-8	13-12	2-2	3-3	1-1	3-2	16
S5163	♂	33	217	73c	8-8	14-13	1-1	3-3	1-1	3-4	17
38918	♂	31	217	75c	8-8	11-11	1-1	3-3	1-1	4-4	18
40003	♂	33	233	67c	9-8	13-13	2-2	3-4	1-1	4-6	19
C4311	♂	31	233	69c	8-9	11-13	2-2	3-3	1-1	4-4	20
C749	♂	33	228	73c	8-8	13-13	2-2	3-3	1-1	3-3	21
C750	♂	33	230	63c	8-8	13-11	1-1	3-3	1-1	4-4	21
C4313	♂	31	229	64c	9-9	13-13	2-2	3-3	1-1	5-5	22
C4310	♂	31	227	73c	9-9	13-13	1-1	3-3	1-1	5-5	22
27534	♂	33	237	70c	8-9	13-13	2-2	4-4	1-1	4-4	22
27774	♂	31	223	71c	9-9	12-13	2-2	3-3	1-1	3-3	22
27806	♂	33	229	70c	9-8	13-13	2-2	3-3	1-1	4-4	22
C3716	♂	31	233	56c	8-9	13-13	2-2	3-3	1-1	5-5	23
C3715	♂	31	250	59c	8-8	12-12	2-2	3-3	1-1	4-4	23
C75	♂	33	225	65c	9-9	13-13	2-2	3-3	1-1	3-4	24
S1197	♂	31	228	78c	9-9	13-13	2-2	4-4	1-1	5-5	25
S1164	♂	33	230	78c	9-8	12-12	2-2	3-4	1-1	3-3	25
S1784	♂	29	231	77c	9-9	13-13	2-2	4-3	1-1	3-4	25
S1166	♂	33	231	66c	9-8	13-13	2-2	3-3	1-1	3-3	25
S1122	♂	31	220	75c	8-8	13-13	1-1	3-3	1-1	3-3	25
S4008	♂	31	220	73c	8-8	11-10	1-1	3-3	1-1	4-4	25
S1146	♂	33	224	73c	9-9	13-13	2-2	4-4	1-1	5-5	25
S1135	♂	33	225	85c	8-8	12-12	1-1	4-4	1-1	4-4	25
S1750	♂	33	222	75c	9-9	14-13	1-2	4-4	1-1	4-4	25
C104	♂	31	243	78c	9-8	12-14	2-1	3-3	1-1	3-3	26
C553	♂	33	226	62c	8-9	13-13	2-2	3-3	1-1	4-5	26
C343	♂	31	227	81c	8-8	13-12	2-2	3-3	1-1	4-3	26
C551	♂	31	226	71c	9-9	12-13	2-2	3-3	1-1	4-4	26
C552	♂	33	228	73c	8-8	13-13	2-2	3-3	1-1	3-4	26
C469	♂	35	263	58c	8-8	12-12	1-1	3-3	1-1	4-3	27
C470	♂	31	252	65c	9-8	12-12	2-2	3-3	1-1	4-5	27
C471	♂	33	243	55c	8-8	12-12	1-2	3-3	1-1	3-4	27
S5240	♂	33	X	69c	8-8	13-13	2-2	4-4	1-1	4-4	28
S6464	♂	33	226	77c	8-8	13-13	1-1	3-3	1-1	3-3	29
36285	♂	33	232	49+	8-8	13-13	2-2	4-4	1-1	4-5	30
S4291	♂	33	222	63+	9-9	14-13	2-2	4-4	1-1	4-4	31
S4268	♂	31	234	68c	8-8	13-13	2-2	4-4	1-1	4-3	31
C5365	♂	31	241	61c	9-9	12-12	2-2	4-4	1-1	4-4	32
43383	♂	31	237	59c	8-8	13-13	2-2	3-3	1-1	3-4	33
43347	♂	31	230	64c	8-9	13-14	2-1	4-4	1-1	5-3	34
43429	♂	37	228	67c	9-8	14-14	2-2	4-4	1-1	4-5	35
C2763	♂	31	228	63c	8-8	13-13	2-2	3-3	1-1	3-4	36
C2764	♂	33	231	67c	8-8	14-12	2-2	3-3	1-1	4-5	36
S1163	♂	33	224	62c	8-8	12-12	2-1	3-3	1-1	3-3	37
S1162	♂	31	235	74c	9-9	12-12	2-2	3-3	1-1	3-3	37
S4050	♂	31	223	73c	8-8	12-13	1-1	3-X	1-1	4-X	38
40060	♂	31	229	77c	8-8	13-14	2-2	3-4	1-1	4-4	39
40061	♂	31	233	74c	8-8	11-12	2-2	3-3	1-1	3-4	39
40062	♂	33	226	79c	9-9	14-14	2-2	5-5	1-1	5-5	39

Scale counts in *Pituophis catenifer amnectens*—Continued

Number	Sex	Scale Rows	Gastro-steges	Uro-steges	Supra-labials	Infra-labials	Pre-oculars	Post-oculars	Loreals	Temporals	Local-ity
40063	♂	33	231	77c	9-9	14-14	2-2	4-3	1-1	3-5	39
40064	♀	35	239	71c	9-9	13-13	2-2	3-3	1-1	3-4	39
40065	♀	33	237	70c	9-8	14-13	2-2	3-3	1-1	4-4	39
40066	♀	33	224	71c	8-8	12-12	1-1	4-3	1-1	3-4	39
40067	♀	33	240	66+	8-8	13-13	1-1	3-3	1-1	4-5	39
40068	♀	31	231	78c	8-8	13-13	1-1	3-3	1-1	3-4	39
40069	♀	31	236	78c	8-8	12-13	1-1	3-3	1-1	4-5	39
40070	♀	33	227	77c	8-8	14-13	1-1	3-3	1-1	2-3	39
40071	♀	31	229	69+	9-8	14-15	2-2	5-4	1-1	4-4	39
40072	♀	33	226	74c	8-8	12-13	1-1	3-3	1-1	2-4	39
40073	♀	33	225	76c	8-8	13-13	2-2	3-3	1-1	4-4	39
40074	♀	33	230	72c	8-8	12-12	2-2	4-4	1-1	4-4	39
40075	♀	35	237	71c	8-8	13-13	2-2	4-4	1-1	4-4	39
40076	♀	33	230	78c	9-8	13-13	1-2	4-4	1-1	4-5	39
40077	♀	35	227	83c	8-9	13-13	2-2	3-3	1-1	4-5	39
40078	♀	33	235	68c	8-8	13-14	2-2	3-3	1-1	3-5	39
40079	♀	33	228	38+	8-8	14-14	1-1	3-4	1-1	3-3	39
40080	♀	31	230	73c	8-8	12-13	1-1	3-3	1-1	3-4	39
40081	♀	35	224	77c	8-8	14-13	2-2	4-3	1-1	4-4	39
40082	♀	35	235	65c	9-9	13-13	2-2	4-4	1-1	5-6	39
C623	♀	31	222	76c	9-9	13-13	1-1	3-4	1-1	4-4	40
C622	♀	33	227	66+	9-9	13-13	2-1	3-2	1-1	3-3	41
S1160	♀	33	229	84c	8-8	13-14	2-2	3-3	1-1	3-3	42
S1149	♀	33	227	69c	9-8	13-13	2-2	3-4	1-1	3-3	42
S1155	♀	31	236	73c	9-9	12-12	1-1	2-4	1-1	2-2	42
S1170	♀	33	218	64c	8-9	13-13	2-2	4-4	1-1	3-3	42
C1040	♀	33	227	77c	9-8	13-13	2-2	3-3	1-1	4-4	43
C3819	♀	33	238	44+	8-8	13-13	2-2	3-3	1-1	4-4	44
43520	♀	33	226	78c	8-8	13-13	2-2	3-3	1-1	4-4	45
S4064	♀	31	244	59c	8-8	12-12	1-1	4-3	1-1	4-2	46
40925	♀	33	239	57c	8-8	13-13	2-2	3-3	1-1	5-5	47
S5649	♀	31	246	64c	9-9	14-13	2-2	3-3	1-1	4-4	48
C1529	♀	29	243	59c	8-8	11-12	2-2	3-3	1-1	3-3	49
C1528	♀	31	246	63c	8-8	12-12	2-2	3-3	1-1	4-4	49
C1274	♀	33	242	58c	8-8	13-13	2-2	3-4	1-1	6-3	50
C1275	♀	31	227	66c	9-9	13-13	2-2	4-4	1-1	6-6	51
C1276	♀	29	234	62c	8-8	13-13	2-2	3-3	1-1	3-4	51
37808	♀	29	226	66c	8-8	13-13	1-1	2-2	1-1	4-4	52
S....	♀	29	232	58c	8-8	12-13	2-2	3-3	1-1	4-4	53
S....	♀	33	244	58c	9-9	14-13	2-2	3-3	1-1	4-4	54
S6406	♀	33	244	63c	8-8	13-13	2-2	3-3	1-1	3-4	55
40504	♀	31	242	66c	8-8	14-12	1-1	3-3	1-1	3-3	55
40961	♀	31	241	65c	8-8	12-12	2-2	4-4	1-1	4-4	56
14207	♀	29	233	60c	8-8	13-14	1-1	3-3	1-1	4-5	57
27198	♀	31	232	68c	8-8	13-13	1-1	3-3	1-1	3-5	57
27199	♀	29	230	63c	8-8	13-12	1-1	3-3	1-1	3-4	57
30913	♀	29	228	66c	8-8	X-12	1-1	3-3	1-1	4-4	57
30914	♀	29	236	60c	9-8	12-12	1-1	3-3	1-1	4-X	57
30915	♀	29	238	67c	9-9	13-13	1-1	2-2	1-1	3-4	57
30916	♀	31	240	61c	9-9	13-13	1-1	2-2	1-1	4-4	57
30917	♀	29	227	65c	8-8	12-13	1-1	2-3	1-1	4-4	57
30918	♀	29	233	58c	9-8	12-12	1-1	2-2	1-1	4-4	57
30919	♀	27	228	66c	8-8	12-13	1-1	3-3	1-1	3-4	57
30920	♀	29	223	55c	8-9	11-12	2-2	3-3	1-1	3-4	57
38756	♀	29	230	71c	9-9	13-13	1-1	2-2	1-1	3-4	57
38757	♀	29	232	62c	8-8	13-13	1-1	2-2	1-1	4-5	57
14193	♀	31	238	67c	8-8	12-X	1-1	2-2	1-1	4-5	57
14194	♀	29	239	59c	X-X	X-X	X-X	X-X	X-X	X-X	57
14195	♀	31	238	66c	8-8	11-11	1-1	2-2	1-1	3-3	57
14196	♀	29	231	68c	X-X	X-X	X-X	X-X	X-X	X-X	57
14197	♀	X	228	66c	X-X	X-X	X-X	X-X	X-X	X-X	57
14198	♀	29	238	61c	8-8	13-13	1-1	3-3	1-1	4-4	57
14199	♀	27	234	70c	9-X	13-X	1-1	3-3	1-1	2-3	57
14200	♀	27	231	70c	8-9	12-13	1-1	2-2	1-1	3-4	57
14201	♀	25	234	66c	8-8	13-13	1-1	3-3	1-1	3-4	57
14202	♀	31	234	70c	9-9	13-13	1-1	3-3	1-1	3-4	57
14203	♀	29	238	66c	9-9	12-12	1-1	2-2	1-1	4-4	57
14204	♀	27	237	62c	8-8	13-12	1-1	2-2	1-1	3-4	57
14205	♀	X	X	67c	X-X	X-X	X-X	X-X	X-X	X-X	57
14206	♀	29	236	66c	X-X	X-X	X-X	X-X	X-X	X-X	57
38755	♀	31	237	70c	8-9	11-11	2-2	3-3	1-1	3-3	58
C5577	♀	29	231	61c	8-8	11-11	2-2	3-3	1-1	3-3	59
45129	♀	31	233	63c	8-8	12-11	2-1	4-3	1-1	4-4	60
45130	♀	29	236	64c	8-8	12-12	1-2	3-3	1-1	4-5	60

Pituophis vertebralis (Blainville)

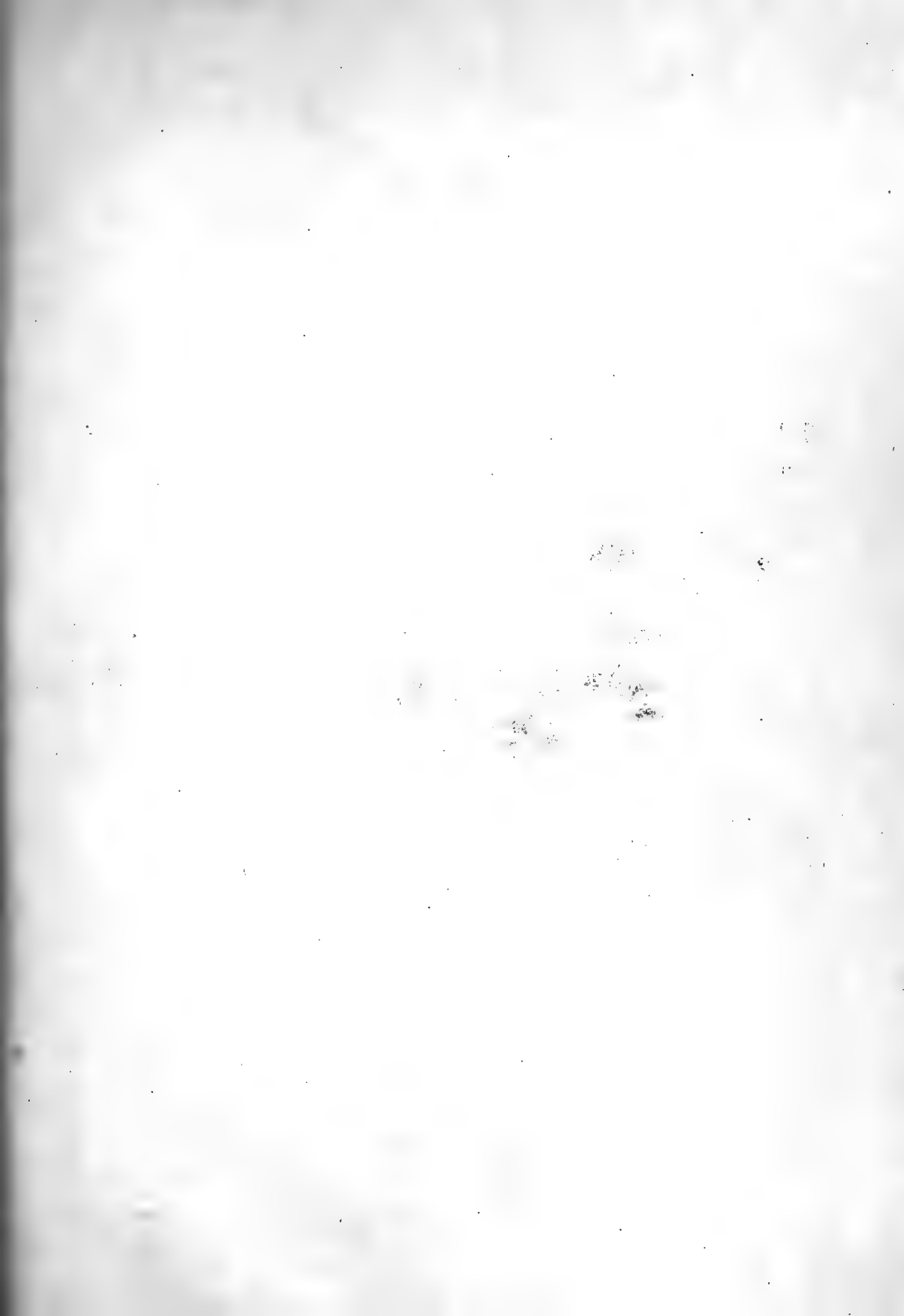
We now have at hand no specimens of this gopher-snake. Its range seems to be restricted to the Cape Region of Lower California. It agrees with *Pituophis catenifer annectens* in the number of its gastrosteges. The large amount of red in its coloration enables one to distinguish it readily from both subspecies of *Pituophis catenifer*. That it also seems to have a larger number of scale-rows is shown by the counts reprinted below.

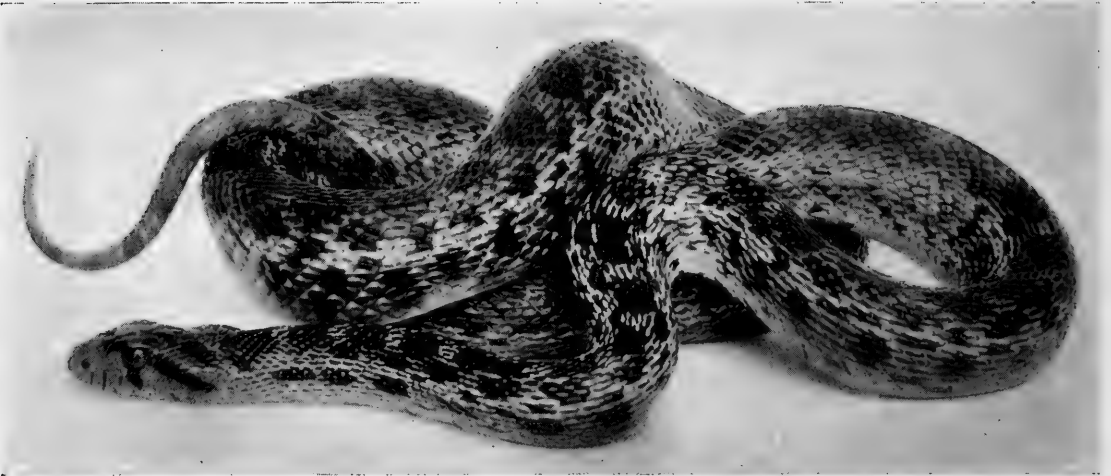
Scale counts in *Pituophis vertebralis*

Specimen	Scale Rows	Gastrosteges	Urosteges	Supralabials	Infra-labials	Pre-oculars	Post-oculars	Loreals
Type.....	..	245	64	...	.....	2	3	2
Cal. Acad. Sci....	35	239	64	8-9	13-13	2-2	3-3	....
" " ".....	35	243	67	9-9	12-12	2-2	3-3	....
" " ".....	33	234	65	9-9	12-12	2-2	3-3	....
" " ".....	34	251	60	9-9	13-13	2-2	3-3	....
" " ".....	35	245	61	9-10	13-13	2-2	3-3
" " ".....	35	233	63	9-9	12-12	2-2	3-3
" " ".....	35	243	62	10-9	12-12	1-1	3-3
Cope.....	..	247	61	9-9	12-12	2-2	3-3

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Pituophis catenifer catenifer (Blainville). Coast Gopher-Snake. Photograph of living adult male, C. A. S. No. 36061, from Wild Cat Creek, South Fork of Scott River, near Callahan, Siskiyou County, California, taken May 21, 1913.

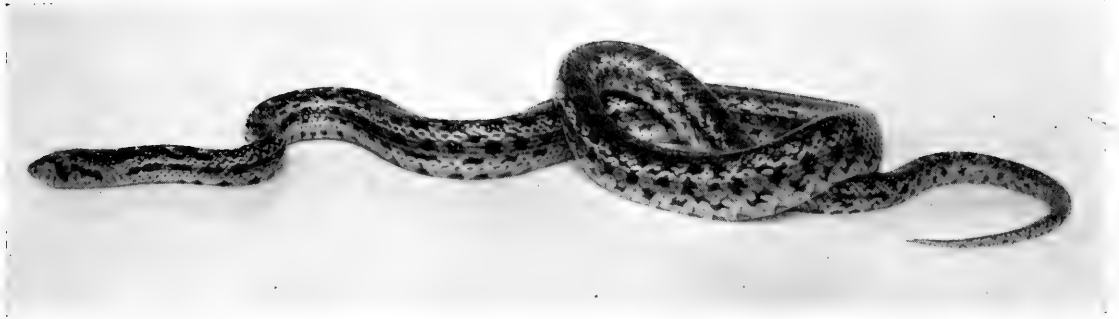


Figure 1.—*Pituophis catenifer catenifer* (Blainville). Coast Gopher-Snake. Photograph of living young specimen from Santa Cruz Island, California.

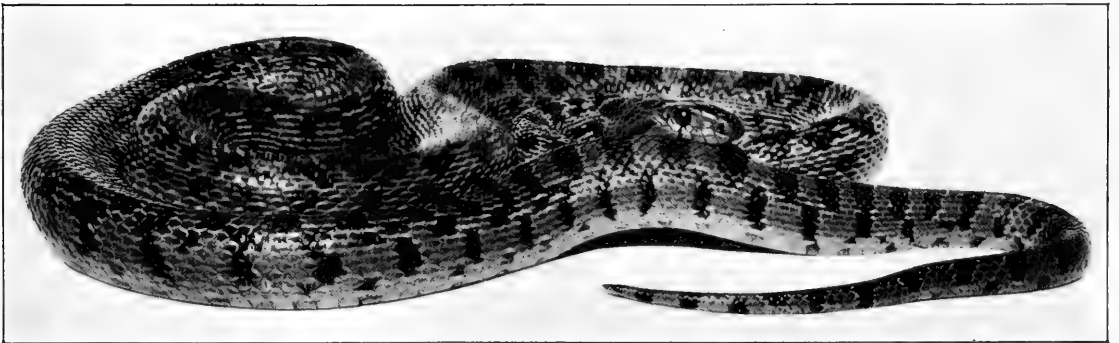
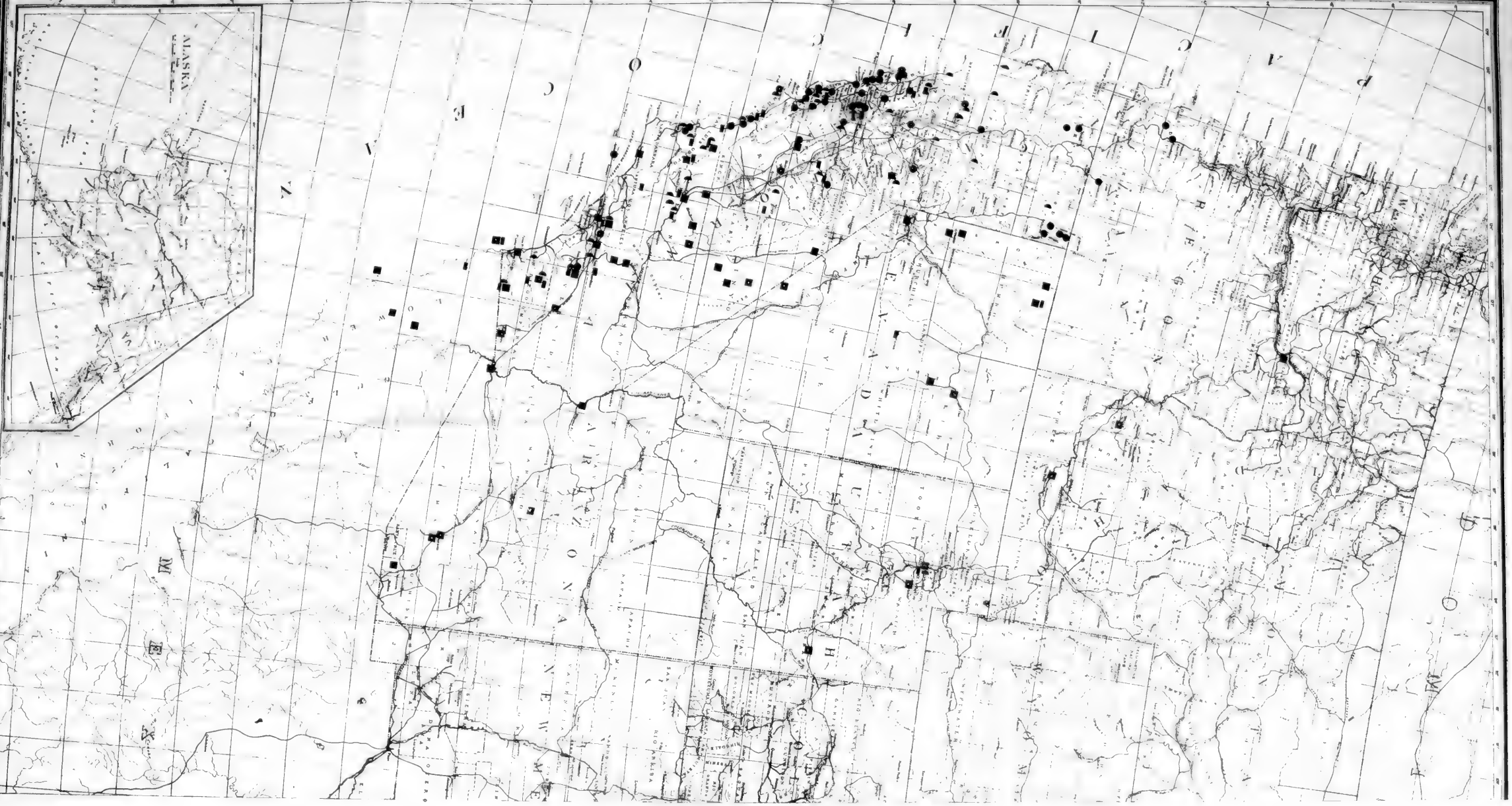
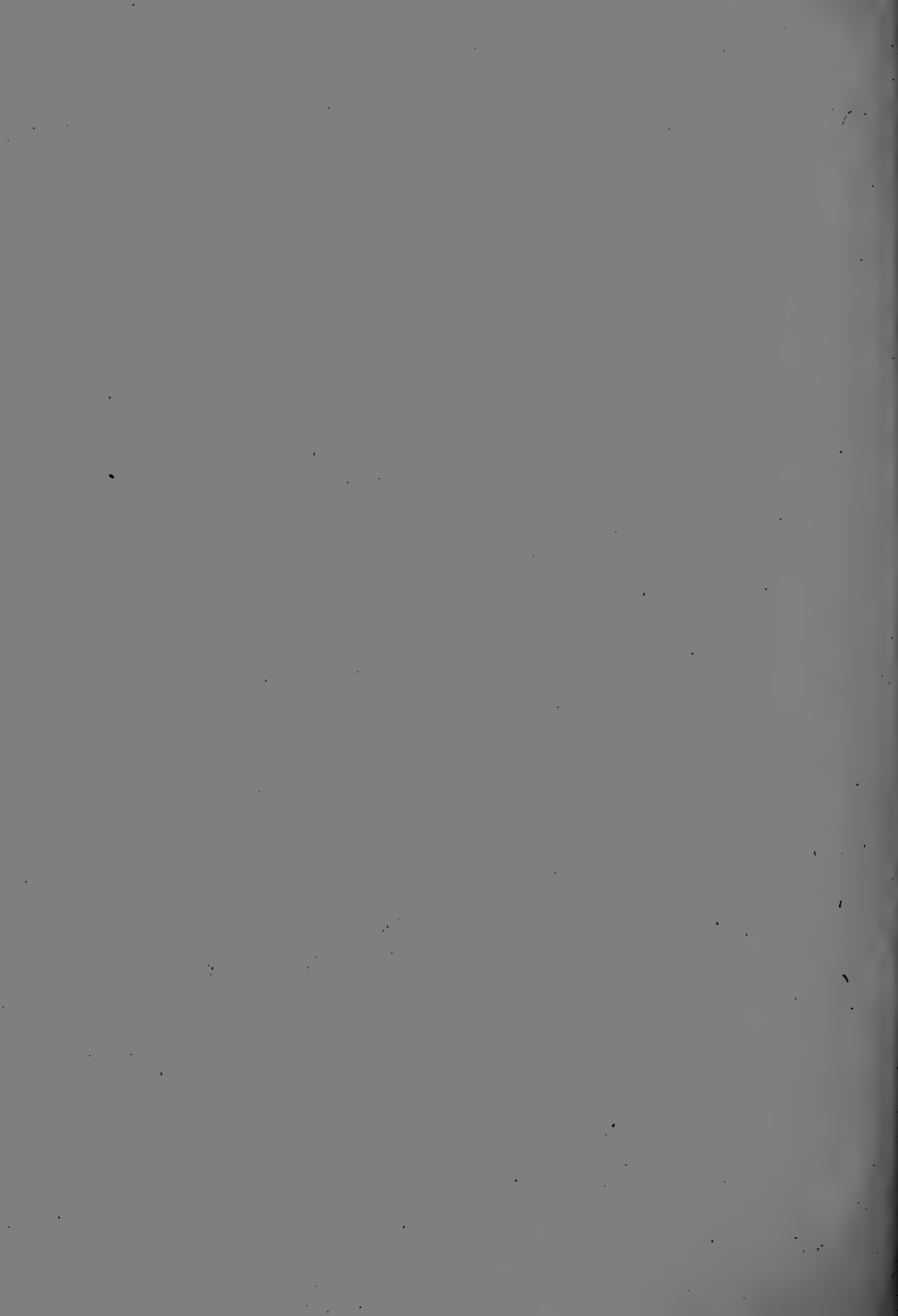


Figure 2.—*Pituophis catenifer annectens* (Baird & Girard). Desert Gopher-Snake. Photograph of living adult male from Provo Canyon, Wasatch Mountains, Wasatch County, Utah.

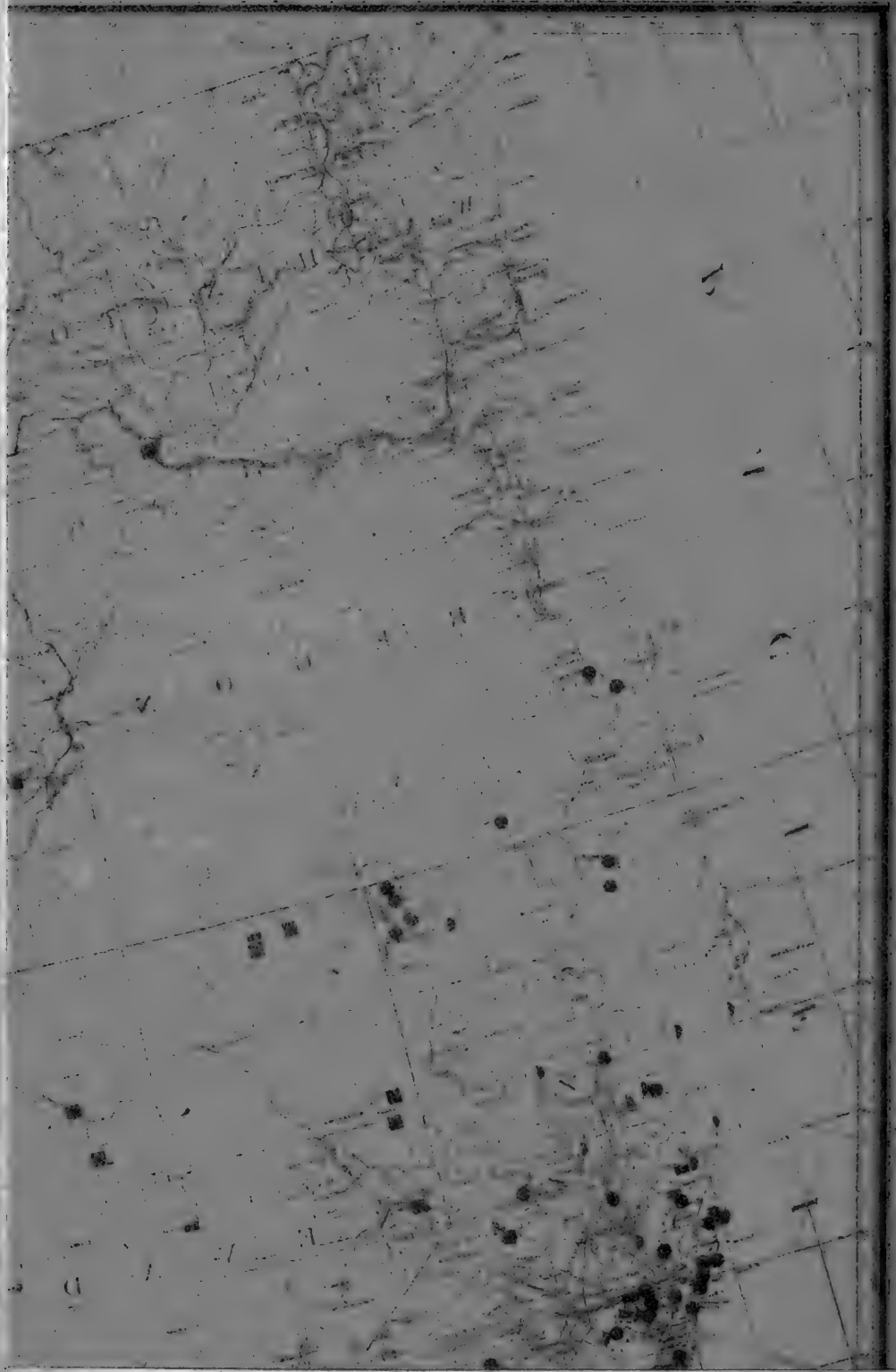


Map showing distribution of gopher snakes. Specimens having from 200 to 220 gastrosteges (typical *P. c. catenifer*) are indicated by round spots; those having from 231 to 253 gastrosteges (typical *P. c. omissus*) by square spots; those with 221 to 225 gastrosteges by half-round spots; and those with 226 to 230 gastrosteges by half-squares.



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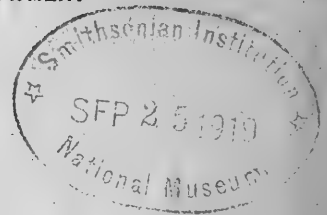
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VII
NEW OREGON DIPTERA

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The authors have a List of the Diptera of Oregon about completed and the following descriptions are published in order that the names of the species may be included in the List. Many other species new to science were collected in Oregon, some of which will be described by specialists in various groups. In many cases there was insufficient material on which to base a species with certainty, a large part of the collecting having been done in the past two years. We have included in this paper the descriptions of three new anthomyiids and a new chironomid for which Mr. J. R. Malloch has furnished the manuscript.

Two of the new syrphids described by Prof. Lovett were collected in the state of Washington but will no doubt be found south of its boundaries. One syrphid is redescribed.

It often happens that a species is described from one sex and if the other sex is found later by some other collector there may

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be some confusion as to its identity. The sexes are in some cases quite different and the allotype is almost as important as the type. In this paper four allotypes are described in order to establish the species more firmly. One merely adds to the confusion by describing a new species from female specimens only in such a group as the asilid genus *Cyrtopogon*, and there are many such groups in the diptera.

1. *Platyura nigra* Cole, new species

(Plate 14, fig. 1)

Male: Length 5.5 mm. Head, antennæ and palpi black; pile black; thorax and pleura black with black pile; scutellum black; abdomen entirely black with short reclinate black pile; genitalia black, with black pile; halteres black.

Coxæ black with black pile; femora and tibiæ yellowish, the tarsi blackish brown; costal region yellowish, the center of wing grayish hyaline, the posterior margin and apical fourth pale-infuscated; veins of wing brown; subcostal vein ending in costa proximad of base of radial sector; R_3+4 ending in costa distad of end of R_2 , and almost perpendicular to other radial vein. The coalesced part of the media is slightly greater than the petiole. Subcostal cross-vein absent.

Holotype (No. 463), female, collected at Forest Grove, Oregon, May 20, 1918 (F. R. Cole), in the Museum of the California Academy of Sciences.

This species will run to *melasoma* Loew in Johannsen's table of species in "Mycetophilidæ of North America." The wing differs, however, and there is no yellow color on the thorax.

2. *Dziedzickia immaculata* Cole, new species

(Plate 14, fig. 2)

Male: Length 4 mm. Head black. Antennæ blackish, the first two segments yellowish; mesonotum black with yellowish pile; humeri yellowish; scutellum black; pleura black; halteres yellow.

Abdomen blackish with pale yellowish pile; posterior margins of second, third and fourth ventral segments yellowish, the color extending up on dorsum but faintly; genitalia black with blackish pile.

Coxæ yellow, the two hind pair faintly infuscated; femora yellow; tibiæ brownish yellow, the tarsi darker; tibial spurs yellowish; wings grayish hyaline; radial veins blackish and heavier than others. Subcosta ending in the first radial vein slightly beyond middle of small cell. Petiole of cell M_1 about twice as long as R-M cross-vein. Cubitus forks shortly before the R-M cross-vein.

Holotype (No. 464), collected at Forest Grove, Oregon, May 2, 1918 (F. R. Cole), in museum of the California Academy of Sciences.

Paratype in the author's collection, taken at the same time.

This species would run to *Dziedzickia*, new species, in Johannsen's table of species. It is very probably a different form, however, as that species was from New Hampshire.

3. *Dziedzickia oregona* Cole, new species

(Plate 14, fig. 3)

Male: Length 4.5 mm. General color blackish; head black, the palpi black; antennæ blackish brown, the second joint short and yellow; thorax black, faintly gray pollinose; pile along sides of mesonotum long and yellow; three lines of pile on dorsum; some long black pile above wings and on scutellum, together with yellow pile; pleura black; halteres yellow, the knobs black.

Abdomen black with pale yellow pile; venter black; genitalia black; front coxæ yellow, the two hind pair infuscated; femora yellow, the tibiæ brownish yellow; tarsi blackish; tibial spurs bright yellow.

Wings grayish hyaline, slightly darker in the costal region; radial veins heavier and blackish; subcostal vein ending in first radial vein a little before middle of small cell, which is twice as long as wide; petiole of media about twice as long as R-M cross-vein; cubitus forked far before R-M cross-vein.

Holotype (No. 465), collected at Forest Grove, February 10, 1919 (F. R. Cole), in Museum of the California Academy of Sciences.

Paratype in author's collection, taken at the same time. Differs from *immaculata* in the longer cell R_1 and in the black knob of the halteres, etc.

4. *Stratiomyia atra* Cole, new species

(Plate 14, fig. 4)

Male: Length 12 mm. A black, rather thickly pilose species of medium size. Antennæ of normal length and black. Face black; frontal and vertical triangle black; black pile around base of antennæ; occiput reddish yellow on sides, black above and below with black pile; a yellow mark on each side of facial prominence (Pl. 14, fig. 4a) on which is some yellow pile.

Thorax black, rather thickly black pilose, the pile having a deceptive yellowish appearance in strong light; pleura and pectus black and black pilose; knobs of halteres greenish white; scutellum black, the margin broadly reddish yellow with reddish, blunt spines (Pl. 14, fig. 4b).

Abdomen black and black pilose; flat above with dorsal yellow marks narrow and confined to lateral margins much as in *S. meigenii*. The marks

on the fourth segment greatly reduced; fifth segment with a rather narrow yellow triangle (Pl. 14, fig. 4); venter black, thickly black pilose with rather narrow clay yellow posterior borders.

Femora black; tibiae and tarsi reddish, the tibiae darkened near middle above; pile of femora black, that on tibiae and tarsi short and reddish; wings infuscated, the veins brown.

Holotype (No. 466), male, collected at Empire, Oregon, June 27, 1916, in Museum of the California Academy of Sciences.

Specimens from Empire and South Inlet, Coos County, June 27, 1916. (Miss Rhodes, collector.) Several specimens were bred from barnyard manure. Some of the pupæ are in vials of alcohol in the Corvallis Agricultural College Collection.

This species is very near *barbata* Lw. but the yellow abdominal markings are very much smaller, wings more deeply infuscated, occiput black above, etc.

5. *Eclimus celer* Cole, new species

Male: Length 12 mm. Body entirely black; face shining black with black pile; pile of occiput white, that beneath head black; third antennal joint narrow, slightly longer than first; the first two joints black pilose; proboscis scarcely twice the length of the head; palpi slender, shorter than the antennæ.

Thorax and scutellum shining black; dorsum of thorax muricate and covered with short, rather curly white pile which gives the thorax a marked gray appearance to the naked eye; pleura shining, sparsely black pilose; knob of halteres black, the stem paler.

Abdomen dull black, with peculiar little dents on the dorsum; a pair on each side and a widely separated pair anterior to these, one on each side; these little line-like impressions absent on the first and last segments; the pile on the first five segments white, on the last segments black; venter with black pile. On the posterior margins of the first five segments there is a fringe of more reclinate white pile.

Legs black, the anterior four femora with sparse black pile below; hind femora with four small bristles below on the outer half; wings infuscated, blackish along the costal margin, the anal cell paler, the axillary cell almost hyaline; wing very similar to that of *E. magnus*, the darkened indentation above the anterior cross-vein being present; wing glossy and shining as in *E. magnus*.

Holotype (No. 467), male, collected at Parkdale, Ore., June 18, 1917 (F. R. Cole), in the Museum of the California Academy of Sciences.

Paratype in the author's collection, taken at the same time. The head of this species is very similar to that of *E. magnus* (Fig. 5a).

6. *Eclimus magnus* O. S.

(Plate 14, figs. 5, 5a)

Male: Length 15 mm. Very similar to the female. Pile of the occiput black, as is the pile on antennæ and beneath the head.

Thorax black and muricate; the pile on dorsum and on pleura black; scutellum with longer black pile on surface.

Abdomen rather long and slender and clothed with short black pile; posterior margin of the first segment with a conspicuous fringe of white pile; a very narrow fringe on segments two, three, four and five; rest of abdomen, including genitalia, black pilose.

The black pile on the coxæ is longer and thicker than on the femora. The wings are as in the female, except for the strong denticulations on the costa (Fig. 5). Above the anterior cross-vein the membrane appears to be bent inward; this hollow is darkened.

Allotype (No. 468), male, collected at Joseph, Oregon, in Museum of the California Academy of Sciences.

The female was described by Osten Sacken in "Western Diptera," from a specimen taken on Vancouver Island.

There are five males in the author's collection, taken at Forest Grove, from June 3 to June 18, 1918. One is only 8 mm. in length. A female was taken at Parkdale, Ore., June 18, 1917 (Cole).

7. *Bombylius silvus* Cole, new species

(Plate 14, fig. 6)

Female: Length 8.5 mm. Frons and occiput gray black, face obscure brown; mystax thin and mixed black and yellowish; antennæ black, the first two joints with black pile and together scarcely more than one-half as long as third; a black stripe from antenna to eye (Fig. 6); frons with sparse golden tomentum; occiput with yellow tomentum and an unusual fringe of black bristly pile on the line of the ocellar bristles, present in some other diptera; head below with white pile; proboscis a little more than three times the length of the head.

Thorax and scutellum black, semi-shining, with a metallic blue lustre, and clothed rather densely with a fur-like blackish brown pile which in certain lights appears yellowish; thorax and scutellum with some golden tomentum above; the gray black pleura obscured by white pile; some brown pile under the wing; stem of halteres brown, the knob whitish.

Abdomen black with black pile most of which is longer and more bristly than that on the thorax; sides of second, third and fourth segments with finer brownish black pile; a median dorsal line of white tomentose spots on segments two to six, quite noticeable on the dark background; on each side of these spots there is some short yellowish pile; last abdominal segment with some yellow tomentum above; venter black, clothed mostly with white pile.

Femora and tibiæ reddish, with whitish tomentum; tarsi blackish, knees black; wings gray, the costal region darker from base to tip of costal cell, this darker region with a brownish tinge. Wings rather long and narrow.

A single female specimen collected at Parkdale June 18, 1917, by the author, at an altitude of about 3500 feet in a pine forest.

We know of no species which could be easily confused with this one; it appears to be quite distinct. It is nearer to *B. lancifer* than to any other species.

Holotype (No. 518), female, in Museum of the California Academy of Sciences.

8. *Bombylius aurifer pendens* Cole, new subspecies

(Plate 14, fig. 7)

Male: Length 5 to 8 mm. Body black, covered with long dense pile which varies from golden yellow to a silvery white; face and frontal triangle gray; epistoma with long white pile reaching down over the oral margin; frontal triangle with short appressed white pile; beard and pile of occiput white; antennæ black, third joint about twice the length of the first two (Fig. 7); proboscis about $2\frac{1}{2}$ times the length of the head.

Thorax deep black with sparse yellow tomentum; pile of anterior part a silvery white, on the sides golden yellow; scutellum with long golden yellow pile and sparse yellow tomentum; pleura gray with white pile; halteres yellow.

Abdomen gray-black with long yellow pile, darker near the base; a small tuft of black pile on the anterior lateral margins of the third and fourth segments.

Middle and front femora black with fine hairs below, the hind pair black at base with a double row of spines below and a number above on the outer third; tibiæ reddish, the tarsi darker, blackish toward the tip; femora and tibiæ thickly covered with whitish scales; proximal part of wings reddish brown, the color reaching a little beyond the tip of the first vein and the anterior cross-vein; the remainder of the wing gray hyaline.

Female: Very nearly like male. Pile paler and the occiput densely clothed with white tomentum; third antennal joint slightly thicker. Some black pile above on mystax; frons covered with shining yellow tomentum and with some erect yellow pile; pile of occiput more yellowish; brown of proximal part of wings paler and not defined as in the ♂. There is some variation in the pile and coloring.

Holotype (No. 469), male, and allotype (No. 470), female, in Museum of California Academy of Sciences, collected at Hood River, Oregon, June 18, 1917 (F. R. Cole).

Described from 6 ♂♂ and 3 ♀♀ collected by the senior author in June at Parkdale, Dee and Hood River, all in the Hood River Valley, Oregon.

9. *Anthrax macula* Cole, new species

(Plate 15, fig. 8)

Frons black semi-shining, with a dent in the center; face reddish with silvery tomentum and white pile; occiput black; frons with yellow and

silvery tomentum; occiput with silvery tomentum; oral margin narrowly black; basal joints of antennæ red with black pile, the third joint black and evenly pointed.

Thorax shining brownish-black with white and some yellow tomentum; yellow pile in front and white on sides and on scutellum; scutellum except base brownish red; spines whitish; pile of pleura and pectus white; halteres brown with a yellow knob.

Abdomen black with black and white tomentum; white pile on sides of first and second segments; reddish spot on sides of second segment; black pile on lateral margins of third segment, posterior margin of second, lateral margin of fourth and fifth and most of sixth; base of third and fourth segments with band of white tomentum broadly interrupted in the middle, the second segment with a narrower cross-band; all of the segments with black tomentum; some tomentum on fifth and sixth segments appearing brassy yellow in certain lights; seventh segment thickly covered with white tomentum and with long black pile; venter black with white tomentum, posterior margins of segments narrowly reddish.

Legs with femora above, apex of tibiæ and the tarsi blackish; tomentum of legs silvery white, the spines black; front claws minute, the tibiæ without spines; wings hyaline and blackish brown, the color not quite reaching end of first vein and running from there in a jagged line back to apex of the anal cell; hyaline spots on cross-veins and elsewhere as shown in Fig. 8. This species runs in Coquillett's table to *fenestratooides* Coq. and is close to that species.

Holotype, male (No. 519), and allotype, female (No. 520), Dallas, Ore., July (Moznette, coll.), in the Museum of the California Academy of Sciences. Paratypes in author's collection, from Hemiston, Ore., Sept. 14, 1918 (Reeher, coll.).

10. *Spogostylum argentatum* Cole, new species

(Plate 15, fig. 9)

Male: Face, frons and occiput dull black with a grayish tinge, clothed with short black pile; the antennæ black with a short styliform portion (Fig. 9a).

Thorax dull gray-black with black pile and tomentum; pleura of like color and black pilose; halteres brown, the tips paler or whitish; squamæ whitish with a white fringe; scutellum blackish gray with black tomentum and pile.

Abdomen black, semi-shining, with black pile and tomentum; sides of first segment with white pile, which runs up on dorsum for some distance, and a spot of silvery tomentum at the incisure; second and third segments with a corresponding silvery spot and an additional pair each side of median line with perhaps a few scales between; last two abdominal segments of male, except a median stripe, clothed with appressed silvery scales which are smooth and catch the light like burnished silver.

Legs black with fine short black bristles; coxæ with some whitish tomentum; basal half of wing opaque brownish black, the color reaching to the end of costal cell and from there in a jagged line through the end of the anal and axillary cells (Fig. 9).

Female: Resembles the male. Frons broader; lacking the silvery tip to the abdomen; anterior lateral margin of last segment with a few silvery scales; tip of abdomen with fringe of dense pale brown pile which curves inward around the ovipositor.

Holotype (No. 471), male, and allotype (No. 472), female, collected at Hood River, Oregon, July 5, 1917, and June 20, 1917 (F. R. Cole), in the Museum of the California Academy of Sciences.

Paratypes in the author's collection, from Hood River.

11. *Leptomidas pantherinus* Gerst.

(Plate 15, fig. 10)

The male of this species has never been described. Osten Sacken described the female in "Western Diptera" and a number of specimens taken at Hood River seem to agree very well with the description. The species is variable in color and extent of the markings.

Male: Length 11 mm. Head black. Frons excavated, sides of frons, occiput, face and cheeks with bushy bright yellow pile. Antennæ varied in color, in some specimens almost all black, usually first two joints reddish. First joint about twice the length of the second, the third more than three times the length of the first two; terminal club about equal to rest of antennæ and coarctate on first third of its length; proboscis brown.

Thorax jet black, shining on sides and in front of scutellum; scutellum very small and shining black; a fan-shaped tuft of yellow pile on sides of thorax; two longitudinal stripes of short yellow pile on dorsum, a yellow tuft in front of scutellum and on each side (Fig. 10); pleura shining black; a yellow tuft of pile beneath wings and on each side of halteres; halteres black.

Abdomen yellow with anterior margin of segments black; the markings vary somewhat, lateral margin black in varying degrees; pile of abdomen short and sparse, longer on first segment; some short black pile on the black abdominal markings; genitalia reddish yellow.

Legs yellow with short yellow spines and pile; hind femora broadly blackish above almost to apex; middle and front coxæ mostly yellow, the hind ones black; four strong spines beneath apical half of hind femora; wings mostly hyaline, yellowish along veins and anterior margin; veins yellowish; venation normal (Fig. 10); twelve specimens collected at Hood River, Ore., July 7, 1917 (F. R. Cole).

Female: Basal joints of antennæ with yellow pile; facial callosity yellowish; thorax reddish in ground color, an indistinct black mark on each side on dorsum, and one in front of scutellum; upper pleura, humeral calli and margin of scutellum yellow; prothorax yellowish; venter yellow, the base of segments 2, 3 and 4 narrowly black; first segment of abdomen with a yellow spot on the posterior lateral margin. Length 21.5 mm.

Osten Sacken's description in "Western Diptera," translated from the original, is a very good one.

Allotype (No. 473), male, in Museum of the California Academy of Sciences.

12. *Leptogaster aridus* Cole, new species

Male: Length 9 mm. Face and mystax white; frons and occiput gray pollinose; bristles of upper occiput black, below with sparse white hairs; proboscis black; first antennal joint black, second yellowish, third brown with an arista longer than the joint itself.

Thorax gray pollinose, the ground color black; two rather obscure brownish dorsal lines, and a brown spot on either side; humeri yellow, bristles of thorax black; scutellum black, gray pollinose; the pre-scutellar callosities yellowish; stem of halteres pale yellow, knob blackish.

Ground color of abdomen dark brown; abdomen very slender, second segment longest; the second, third and fourth segments cylindrical; posterior margins of second to fifth yellow; legs yellow; the swollen part of the hind femora, distal half of hind tibiae and last four joints of tarsi brown; hind tarsi much darker than others; claws black; empodia present; wings hyaline, the anal and posterior cells all wide open. Wings reach to middle of fifth segment of abdomen.

Female: Similar to male. Marks on dorsum of thorax more distinct; the two median stripes not reaching the scutellum; abdomen darker, a little heavier, the yellow posterior margins obscured by gray pollen; small, distinct black dots near the anterior margin of the abdominal segments; no yellow on fifth segment.

Holotype (No. 474), male, from Hood River, Ore., July, 1917 (L. Childs), and allotype (No. 475), female, from Forest Grove, Oregon, July 12, 1918 (F. R. Cole), in the Museum of the California Academy of Sciences.

Paratypes in the author's collection, taken at Forest Grove in July.

This species would run to *flavipes* in Back's table of species, in his Monograph. The bristles of the occiput are black, however, only the second antennal joint is yellow and the abdomen is marked differently.

13. *Lasiopogon cinereus* Cole, new species

(Plate 15, fig. 11)

Male: Length 8 mm. Head black, gray pollinose, except a faint yellowish tinge on upper occiput; mystax, and hairs of frons, antennae and upper occiput black; a few white hairs on side of mouth opening; pile of lower occiput and proboscis white; antennae black, the third joint slightly longer than first two; pointed style about as long as first joint.

Thorax black, gray pollinose, with a faint yellowish, narrow median stripe and a heavy brown stripe on either side, diverging anteriorly and expanded at the end; scutellum with black upcurved hairs; pile and bristles of thoracic dorsum black; bristles in front of wings and halteres black; pile of pleura white; halteres yellowish, the knob brown.

Abdomen black, densely gray-pollinose, except on the genitalia; a large blackish brown, semi-shining spot on base of each segment, leaving only the lateral and posterior margins gray-pollinose; these spots rounded posteriorly; first four segments with rather long white pile; the pile of the other segments black and shorter, that on the genitalia black and heavier; a conspicuous tuft of black hair on the dorsum of the genitalia just behind the seventh segment (Fig. 11a).

Legs black, gray-pollinose, with black bristles; coxæ and femora with white pile; wings very faintly infuscated; anterior cross-vein slightly before the middle of the discal cell.

Female: Very similar to the male. There is a faint brown line above the dorso-pleural suture and some black pile on the posterior margin of the second, third and fourth abdominal segments; eighth segment black with some red on the genitalia; the circlet of blunt bristles black. Genitalia peculiar in shape (Fig. 11b).

Holotype (No. 476), male, collected at Hood River, Ore., Sept. 24, 1918 (F. R. Cole), and allotype (No. 477), female, taken at Hood River, Oregon, July 28, 1917 (F. R. Cole), in the Museum of the California Academy of Sciences.

Paratypes from Corvallis and Parkdale, Oregon, in the author's collection.

This species is very near *opaculus* but differs in having distinct thoracic stripes and also in the abdominal markings.

14. *Dioctria vertebrata* Cole, new species

(Plate 16, fig. 12)

Female: Length 5.5 mm. Head, antennæ, proboscis and palpi black; pile of antennæ brown; face densely pollinose, golden above, silvery below; mystax consisting of a few whitish hairs; occiput and frons shining black; antennal protuberance prominent; antennæ quite long as in some of the European species; third joint flattened.

Thorax and pleura shining black; the metanotum, a line from root of wing to humeral callosity, and dividing line between meso- and pteropleura silvery pollinose; scutellum black with short golden pile; two lines of thin golden pile on dorsum of thorax; halteres yellow.

Abdomen black and yellow banded, almost bare; first segment black, second black at base and on posterior margin; third and fourth yellow with a broad black band across the middle; fifth, sixth and seventh black with narrow yellow posterior margins; venter yellowish.

Legs including coxæ yellow, with yellow bristles and pile; coxæ silvery-pollinose; claws except base, black; last tarsal joint brown; wings rather long and slender as shown in figure; veins black; membrane hyaline; costal margin with fine, short pile.

Holotype (No. 478), female, collected at Parkdale, Ore., July 12, 1917 (Cole), in the Museum of the California Academy of Sciences.

This species is nearest *rubida* Coq., but differs in having yellow coxæ and tarsi, hyaline wings, etc.

15. *Cyrtopogon auratus* Cole, new species

(Plate 16, fig. 13)

Male: Length 11 mm. Black; face gray-pollinose, the frons yellowish gray; oral margin with black hairs, the mystax above it thick and golden

yellow; beard and pile of lower occiput white; upper occiput and frons with black pile, long on the frons; third antennal joint orange-yellow, the style black and about one-fourth as long as the third joint; first two antennal segments with black pile.

Thorax gray-pollinose with a median geminate stripe; a round black spot on each side at about the middle; a spot over the humeri that shows dark in certain lights; scutellum rounded and polished black, with long black pile; thorax quite thickly covered with black pile about as long as the first two antennal joints; pleura, front coxæ and the outside of the two hind pair thickly gray-white pollinose; pile in front of halteres mostly black; halteres yellow; pre-scutellar callosities and a small space before the scutellum shining black.

Abdomen shining black with tufts of golden pile on the segments (Fig. 13); second, third and fourth segments with posterior silvery pollinose bands, wider in the middle; the silvery posterior margin wider on the second segment, and the golden pile on the dorsum shorter than on third and fourth; fifth and sixth segments short, polished blue-black as are the genitalia, with short black pile; venter black, thinly covered with rather long golden pile.

Femora black; front tibiæ and tarsi yellow, paler than others, with a few white spines; legs with black bristles, very dense on the hind tibiæ. Front tibiæ and tarsi short golden pilose behind. Wings grayish hyaline, the cross veins faintly infuscated.

Holotype (No. 479), male, Joseph, Ore., no other data, in Museum of California Academy of Sciences.

This species is near *aurifex* and *pulcher* and the male will run to this group in Back's table of species (Trans. Am. Ent. Soc. xxxv, p. 261).

16. *Cyrtopogon anomalus* Cole, new species

(Plate 16, fig. 14)

Male: Length 11 mm. Head black in ground color, concealed by dense gray pollen, silvery in certain lights. Face not projecting (Fig. 14c); antennæ black; third joint pointed, arista two-jointed; hair and bristles of head white; some blackish hairs on oral margin; pile of face very thick and quite long.

Thorax black, the ground color concealed by pollen; dorsum with brown pollen above, gray around margins; a median dark double stripe reaching beyond suture; dark indistinct marks on each side; dorsum with mixed brown and black pile and bristles, whitish posteriorly; scutellum gray-pollinose with long white bristles, mostly on border; hair on dorsum; all the pile of pleura white; knob of halteres yellow, the stem blackish; pleura silvery gray-pollinose.

Abdomen very broad for this genus, narrowed somewhat at the base and apex; gray-pollinose; dorsum of abdomen largely shining black; a basal mark on all segments, reaching nearly to lateral margin on segments 4, 5 and 6, and leaving only a narrow posterior margin of pollen on 4 and 5; genitalia black, shining; pile on first three abdominal segments white, on remaining segments, and genitalia golden yellow; venter gray pollinose; white pile on basal half, golden on apical half.

Femora black except extreme base, which is yellow. Base of front tibiæ and basal half of two hind pair yellow; tarsi blackish except base; bristles

of legs reddish; femora white pilose, which is long below; four anterior tibiae with white pile and long white hairs; all tarsi, front tibiae and apex of hind tibiae with short golden pile; wings gray-hyaline with black veins.

Female: Length 12 mm. Pile of face and frons sparse and shorter; ocellar bristles brown; pollen of thoracic dorsum more golden brown; two median dorsal gray lines; a bare brown spot near humeri, more noticeable than in male; abdomen much longer and more slender; pile much shorter and entirely white; segments beyond fifth shining black; a narrow brown posterior margin to sixth and seventh segments; a cirlet of stub-like spines at tip of ovipositor.

Holotype (No. 480), male, and allotype (No. 481), female, collected at Hood River, Ore., June 13, 1917 (F. R. Cole), in Museum of California Academy of Sciences.

Paratypes in the author's collection taken at Forest Grove in July and August. This species is near the genus *Heteropogon* in general appearance. All specimens were taken near water, those at Forest Grove alighting on drift wood and sticks along a small creek.

17. *Cyrtopogon nebulo* O. S.

(Plate 16, fig. 15)

The male of this species has never been described and some of the characters are given below.

Male: Differs in a few respects from the female. Besides the spines, some of the hairs are brown at the base and white at the tips, as they are in the female; pile of the abdomen longer, white on the first, second, and base of third segment; rest of abdominal pile brownish black with white tips in certain lights; short golden pile on apical half of front and hind tibiae and inner side of front and hind tarsi, a character some other species have. The genitalia are not of the typical form in this genus, quite densely covered with brown and black bristly hairs and pile.

Wings infuscated but there are several hyaline spots and streaks in addition to the brown clouds; costa armed with short, thickly set, curved bristles or hairs; this costal fringe very noticeable, that part on the basal two-thirds of the wing being about as long as the second antennal joint.

Allotype (No. 482), male, in the Museum of the California Academy of Sciences, obtained in the subalpine regions on Mt. Jefferson, July 25, 1909 (J. C. Bridwell).

A female collected at Horse Lake, July 25, 1909 (J. C. Bridwell), has the antennal style a trifle shorter than the third segment. The second vein in one wing has an adventitious anterior branch near the tip and a stump of a vein just before it. Inner side of the hind tibiae and tarsi with short golden pile. The margin of scutellum golden pollinose.

This species is better placed in *Cyrtopogon*, with which it has several characters in common, but it might well be made the type of a new genus. Osten Sacken noticed that the female was not typical and the male has characters that separate it more definitely. The fringe on the costa of the wing is not found on any of the other species of *Cyrtopogon* known to us, and the antennæ are more like those of *Heteropogon*.

18. *Cyrtopogon infuscatus* Cole, new species

(Plate 17, fig. 16)

Male: Length 10 mm. Head, antennæ, proboscis and palpi black; head silvery gray-pollinose; frons with long erect black pile; facial callosity very large, bulging from oral margin to base of antennæ; clothed with long white pile; pile of occiput mostly white, that on lower corners of face and lower occiput black.

Thorax and scutellum black, thickly gray-pollinose; some black pile in front of wings; pile of pleura white, including metapleural tuft; dorsum with sparse black pile and black bristles; scutellum with long fine black bristles, hair-like and up-curving; halteres with black stem and yellow knob.

Abdomen blue-black with white pile, much longer on sides of first three segments; sides of first segment and posterior lateral margins of second to fifth white pollinose; sixth and seventh pollinose except a dorsal triangle; genitalia black, gray-pollinose and short black pilose.

Legs entirely black; femora and tibiæ with rather long white pile and black bristles; short golden pile beneath tarsi, on tips of hind tibiæ and on all but base of front tibiæ; a large part of the wing infuscated (Fig. 16a).

Holotype (No. 483), male, collected at Pamelia Lake on Mt. Jefferson, altitude 3,000 feet, July 12, 1907 (J. C. Bridwell), in the Museum of the California Academy of Sciences.

This species is very near *evidens* and *rejectus*, differing from the former in the white pile of the face and in the extent of the pollinose crossbands on the abdomen. It may prove to be the male of *rejectus* O. S.

19. *Cyrtopogon perspicax* Cole, new species

Male: Length 10 mm. Black, thickly pilose species; third antennal joint red; scutellum convex and shining.

Head black, thinly grayish yellow pollinose; mystax thick and black, the pile reaching to base of antennæ; pile in middle of frons whitish, that of upper occiput black; first two antennal joints black, the second yellow at tip, third reddish yellow except extreme apex; style about one-third length of third joint; beard and pile on proboscis white.

Thorax black, brown pollinose, lighter in some places than others and forming a peculiar cross-shaped design on the dorsum, outlined behind by whitish pollen; scutellum and pre-scutellar callosities shining black, the

scutellar pile long and up-curved; thorax with long, black erect pile; pleura light brownish pollinose, the three long tufts of black pile curled at the tip; halteres brown with a yellowish knob.

Abdomen shining black, almost bare of pile above; long black pile on the sides of the abdomen arranged in tufts; pile of venter long and black; the white pollinose fasciæ on the posterior margins of the second, third, fourth and fifth segments widely interrupted in the middle; genitalia much larger than the last segment, black, with black pile.

Femora and knees black; coxæ and basal half of femora beneath long golden yellow pilose; tibiæ and tarsi brownish red, the last tarsal segment and most of the preceding one black; pulvilli white, the claws black; pile of apical half of femora, pile and spines of tibiæ and tarsi black; tarsi not ornamented except for short silvery pile beneath on hind pair; front tarsi much longer than the others, the first two joints as long as the entire middle tarsi. Wings grayish hyaline; a narrow brown cloud runs from end of first vein along base of third to anterior cross-vein and along cross-veins closing discal, fourth and fifth posterior cells; a pale cloud on veins at distal end of discal cell; anterior cross-vein a little distad of end of first vein, near base of discal cell.

Female: Very similar to male. There is some white pile on face beneath antennæ and some, mixed with black pile, on femora; front tarsi much shorter and heavier than in male, about same length as others; no silvery pile beneath on hind tarsi; pile of the hind tibiæ white above and black below; some white pile above on middle tibiæ; the interrupted pollinose fasciæ much wider and with white pile on them; rest of pile on abdomen black, except at posterior angles of first segment, and much shorter and thinner than in male, decreasing in length toward the tip.

Holotype (No. 484), male, collected at Hood River, Oregon, May 15, 1917 (F. R. Cole), and allotype (No. 485), female, taken by the senior author at the same place May 29, 1917, in the Museum of the California Academy of Sciences.

Paratypes in the author's collection, taken at Hood River, Oregon, in June.

This species is in the group having the third antennal joint red and with a convex, shining scutellum. It would run to *aurifex* in Back's table of species, given in his Monograph, but has no fulvous hair on the abdomen; the tibiæ are all red, etc.

20. *Cyrtopogon princeps* O. S.

The holotype is a single male from Webber Lake, Sierra Nevada Mts., California. Back, in his Monograph, mentions no other specimens. The description of the female is therefore given.

Female: Length about 12.5 mm. The frons and face with gray bloom, the pile as in male; thorax mostly brownish, the markings not distinct but outlined posteriorly with whitish bloom.

Abdomen polished black but the pollinose cross-bands differ. Segments two to five with the usual posterior cross-bands of gray-white pollen. Scarcely any pile on abdomen except on the basal two segments.

Legs all black; front tarsi normal in length and with short black pile; hind tibiae with the silvery white pile as in male, but no such pile on the tarsi; claws and pulvilli as in male.

Allotype (No. 486), female, collected at Mackenzie Ridge, Ore., altitude 6,000 feet, August 1, 1909, in the Museum of the California Academy of Sciences.

There are several males from the sub-alpine region on Mt. Jefferson, collected by J. C. Bridwell, and now in the Oregon Agricultural College Collection. One female from Horse Lake, altitude 6,000 feet, July 25, 1909.

21. *Metapogon setigerum* Cole, new species

(Plate 17, fig. 17)

Male: Length 8.5 mm. Black, largely covered with gray and silvery pollen; base of wings white, the apical half brown; face and frons gray pollinose with a peculiar olive tinge, especially on the frons; four strong ocellar bristles. A few weak small bristles in center of frons, stronger along sides; face with numerous strong black bristles in place of the usual pile, reaching from oral margin almost to base of antennae; antennae black, the second joint slightly larger than first, the third a little longer than the first two taken together; one bristle beneath second antennal joint, two strong bristles beneath first; bristles of upper occiput strong, and black, the pile of occiput and beard white; occiput gray-pollinose, yellowish above.

Thorax and pleura almost entirely pruinose, with a yellowish tinge in places; median geminate stripe gray, more or less well defined; inside of the humeri, on each side of the median stripe, is a faint brown spot; four strong dorsocentrals, two small humerals, and three bristles above the pleural suture in a triangle; most of the metapleural tuft black; scutellum pruinose above with two strong apical bristles; knob of halteres yellow, the base pale brown; dorsum of thorax destitute of pile; with only a few scattered minute bristles; in front of the scutellum is a spot appearing black in certain lights; spines and pile on coxae whitish; sternopleura with a large spot destitute of pollen.

Abdomen black, semi-shining; the posterior margins of segments two to six widely pruinose; sides of first segment pruinose; posterior half of fifth segment pruinose with a median wedge running to anterior margin. Sixth segment pruinose except base. Posterior margin of seventh segment brownish pruinose; the pollen on five and six with a brownish tinge; dorsum of abdomen with sparse, short black pile; genitalia black with black pile; white bristles and pile on sides of first segment; venter black with pruinose posterior margins on segments.

Legs black with black spines and claws; pulvilli dark gray; pile of legs sparse, short and black, that beneath tips of hind tibiae golden brown and reclinate. In certain lights this same type of pile can be seen beneath the fore tibiae and metatarsi. Basal half of wings milk white, the veins yellow on basal third; apical portion of wing infuscated, with black veins; anterior cross-vein in middle of discal cell.

Female: Similar to above. Dorsum of thorax marked with brown; median geminate stripe brown; a long brown spot on either side of this, merging more or less anteriorly; pruinose posterior margin of segments interrupted in the middle; seventh segment with no pruinose marks, those

on sixth small; wings hyaline, the apical third faintly infuscated; the veins pale at wing-base but no striking white color in this section of the wing membrane.

Holotype (No. 487), male, and allotype (No. 488), female, in the Museum of the California Academy of Sciences, both taken at Dee, in the Hood River Valley, Oregon, August 1, 1917, by L. Childs.

Paratypes in the collections of L. Childs, Corvallis Agricultural College, and in the author's collection. A series of nine females and three males were taken by L. Childs at Dee, Oregon. Other specimens from Joseph, Ore.; Mt. Jefferson, July 15, 1907 (Bridwell); Sherwood, Ore., July 29.

This species might be made the type of a new genus. The mystax is composed of strong bristles, and in the typical *Metapogon* it is composed chiefly of fine pile. The head is hardly as wide as the typical form, and the face more widened below. The thorax is not highly arched, but more like that of *Lestomyia*.

22. *Cophura cyrtopogona* Cole, new species

(Plate 18, fig. 19)

Male: Length 6 mm. Wholly black; most of pile and spines white; frons thinly gray-pollinose and with sparse white pile; ocellar tubercle with white pile and several slender white bristles; face white-pollinose and with long white pile reaching to base of antennæ; a few black hairs on oral margin; face gently and evenly convex, the oral margin retreating; occiput white pollinose and pilose; very little pollen on vertex; pile under the head white; proboscis and palpi rather small; antennæ black, the basal segments with white hairs and spines below; third segment not much longer than basal ones, the style about as long as the second segment and terminating in a fine bristle (Fig. 19).

Thorax, pleura and coxæ silvery gray-pollinose; thoracic dorsum mostly covered with a brown design, resembling that on some species of *Cyrtopogon*; posterior portion of dorsum and thin median line semi-shining; pile brown in the middle, white in front and behind; pile of pleura white, including tuft in front of the yellow halteres; scutellum thinly white-pollinose above, with the apical margin shining and a marginal row of hair-like, white, upcurving bristles; some white pile on dorsum of scutellum.

Abdomen polished blue-black, almost bare above and sparsely pilose on sides, except the longer white pile on segments one and two; sides of first segment silvery pollinose; a silvery pollinose spot on posterior angles of segments two to six, very small on the sixth; genitalia polished black with sparse white pile.

Legs black, with white pile; underside of front two pair of tibiæ short golden pilose; spines of legs mixed white and yellow, those beneath fore tarsi deep yellow; fore tibiæ with a terminal claw-like spur; claws black except at extreme base; femora with long but sparse white pile below;

wings hyaline, in certain lights with strong prismatic colors on the membrane; anterior cross-vein near the middle of the discal cell, slightly proximad.

Female: Similar to male. Pollen on frons and face more brown in color, the pile and spines blackish and brown instead of white; spines and pile beneath basal joints of antennæ black; thorax almost all brown pollinose the brownish tinge reaching down on pleura; silvery pollinose spots on the posterior angles of the abdominal segments larger than in male. Segments six and seven wholly polished black.

Holotype (No. 489), male, and allotype (No. 490), female, in Museum of California Academy of Sciences, both collected at Dee, in the Hood River Valley, Oregon, August 1, 1917, by Leroy Childs.

This species is placed in *Cophura* because there is no other genus to which it can better be referred. It differs from any of the varied species that make up this group.

23. *Chrysoceria pollenia* Cole, new species

(Plate 17, fig. 18)

Male: Length 11.5 mm. Antennæ, palpi and proboscis black; head golden yellow pollinose, dense on frons and face; mystax golden, ocellar bristles yellow; hair and bristles on occiput yellowish white; hair on antennæ brown.

Thorax shining black, densely covered with golden yellow pollen; median dorsal black stripe reaching to scutellum, divided by a narrow yellow line (Fig. 18); pile and bristles of thorax yellow; two large black spots on either side of median stripe, divided at suture; a smaller black spot outside these, back of humeral callosities; scutellum densely golden pollinose; metanotum polished black below scutellum, golden at sides; halteres yellow.

Abdomen black in ground color, golden pollinose, with pale yellow hair; base of segments black; genitalia black, with yellow pile.

Femora shining black; tibiæ yellow with black tips; tarsal segments, except base, black; coxæ golden tomentose with yellow pile; most of the bristles and spines on the legs yellow, the heavier spines at tips of tarsal segments black; wings yellowish hyaline; costal cell and base of marginal yellow.

Female: Length 15 mm. Similar to the male. Basal black bands on abdominal segments broader; last two segments shining, the sixth black, the seventh brown; antennæ black; the golden hair on face reaching almost to antennæ.

Holotype (No. 491), male, collected at Hood River, Sept. 24, 1917 (F. R. Cole), and allotype (No. 492), female, from Mackenzie Ridge, 6,000 feet, August 1, 1909 (Bridwell), in Museum of the California Academy of Sciences.

This species is very near *C. pictitarsis* Bigot, but the femora are black and the median thoracic stripe is scarcely separated.

Dr. Back in his Monograph mentions a female from Wyoming in the Williston Collection which has black femora, and the last two abdominal segments black. "Were several more specimens taken like the Wyoming one, and showed no variation, I should be inclined to believe them a new species."

24. *Agathomyia lutea* Cole, new species

(Plate 18, fig. 20)

Female: Length about 3.75 mm. General body color dull yellow; head black, the frons and occiput thickly gray-pollinose; bristles black; first two antennal joints yellow, the third brown, with an apical, hair-like arista, about as long as rest of antenna; palpi and proboscis yellow; face black dusted with gray.

Thorax dull yellow, with black bristles which are quite conspicuous; last three bristles in dorsocentral row much longer than others; center row of bristles running to a little beyond middle; the row on each side curving out and down to the humeri. Just above the notopleural suture are five strong bristles; scutellum yellow; halteres yellow.

Abdomen yellow; pile of first two segments longer and yellowish; some black pile on dorsum of second segment; rest of pile on abdomen short and black; tip of abdomen brownish yellow.

Legs pale yellow, with short black hairs; wings hyaline and rather long (Fig. 20).

Holotype (No. 493), female, from Parkdale, Ore., Sept. 5, 1917 (F. R. Cole), in Museum of California Academy of Sciences.

This species will run to *fulva* Johns. in Johnson's table (in Psyche, Vol. XXIII, p. 27). We have a specimen of *fulva* which is bright orange in color, occiput more velvety black, thinly pruinose, and bristling of the thorax slightly different. This specimen is only 2.5 mm. in length.

25. *Chilosia ferruginea* Lovett, new species

Eyes elongate black pilose; face but slightly concave, produced, tubercle reduced; body and legs with long dense brown pile. Length 11 mm.

Male: Face black sub-shining with rather sparse almost microscopic reddish brown (brown-ochre) pile; eye-margins with mixed brown and black moderately elongate pile; brown pile extending down to the black, sub-opaque cheeks and around occiput to vertex; at base of eye a small triangular reddish brown spot; frontal triangle swollen, with median groove, sub-shining, black with elongate brown pile; vertical triangle opaque black, ocelli red, pile moderately sparse, elongate brown; antennal prom-

inence produced, face practically straight, considerably produced, tubercle small, obtuse, located about three-fifths of distance from base of antennæ to oral margin, in profile below base of eye. At base of antennæ below, at margin of eye and at base of antennal prominence are small triangular spots of greyish pollen; antennæ short, first two joints shining brownish black, third rounded, reddish brown, lighter at base and covered with sparse greyish pollen; arista black, practically bare, thickened for one-third its length; basal joint distinct.

Thorax and scutellum shining black with brassy reflections; covered throughout with elongate, moderately dense, brown pile, longer at margin of scutellum, on pleura mixed with black; entirely free of bristle-like hairs.

Abdomen blue-black with cobalt reflections, opaque black on disc; covered throughout with elongate pile similar to thorax.

Legs black, knees and proximal third of tibiæ brown or yellow, base of all femora with elongate brown pile, apical two-thirds of front, half of middle and tip of hind femora with elongate coarse black pile; under surface of hind femur with moderately dense, elongate spine-like black hairs; tibiæ and tarsi with golden pile; wings smoky throughout; veins dark, brown at base; squamæ smoky white with margin of dense golden pile; halteres with dark knobs.

Holotype (No. 494), male, in Museum of California Academy of Sciences, collected at Corvallis, Ore., April 14, 1917, by W. J. Chamberlin.

Twelve specimens of this species, collected from Hoquiam and Satsop, Wash., April 29 to May 20, 1914, by Burke, were observed in the National Museum.

This species is near *C. lasiophthalma*, but is markedly different. It more nearly approaches *C. grossa* but varies in the pile and legs. The elongate brown pile of the head and body and elongate black pile of the eyes are characteristic.

26. *Chilosia nigrovittata* Lovett, new species

Eyes moderately elongate, brown pilose; face but slightly concave, tubercle reduced; body covered with moderately long brown and yellow pile; across dorsum of thorax with well defined band of black pile. Length 10.5 mm.

Male: Face not produced, very slightly concave to the small obtuse tubercle, with a short shallow concavity before oral margin; cheeks shining black with sparse yellowish brown pile extending around occiput to vertex; frontal and vertical triangles black, swollen, with coarse black pile; frontal triangle with median groove and with fine yellow pile about margin; antennæ brownish black, third joint orbicular, greyish shading to dull reddish below; arista black almost to base, thickened on basal fifth; face shining black, bare; eye margins sparsely yellow pilose; greyish pollen below the antennal prominence connected briefly with similar triangular areas at eye margins.

Thorax and scutellum black, subshining; extreme front of humeral angle with spot of grey pollen; a triangle on dorsum of thorax in front and the

hind margin and scutellum with elongate yellow pile; across middle of dorsum, as a black band, and extending forward to the humeral angle the pile is moderately elongate, black, blending into the yellow by a margin of brown; post-alar callosities with black bristly pile.

Abdomen black, subopaque on disc of first three segments; fourth segment and margin of fifth subshining blue-black; pile throughout moderately long, brown; legs black, knees and proximal third of tibiae brown; pile black, mixed slightly with yellow on front and middle tibia; wings smoky throughout; veins black.

Holotype (No. 495), male, in Museum of the California Academy of Sciences, collected at Corvallis, April 22, 1917, by C. Neilson.

Two specimens from Hoquiam, Wash., May 1, 1904, Burke, collector, observed in National Museum collection.

27. *Chilosia pacifica* Lovett, new species

Eyes bare; arista moderately plumose; scutellum and thorax with bristles on margin; pile of dorsum, short, bristle-like, black throughout; third antennal joint sub-quadrate, corners rounded, a little longer than broad, bright reddish yellow; legs black. Length 7 to 7.5 mm.

Female: Shining blue-black; front same, punctate, coarsely black pilose; face shining, bare, with indistinct greyish pollen, deeply concave below the antennae; tubercle rounded, obtuse; below tubercle almost straight; cheeks shining black, pollinose at base of eye; first and second joints of antennae brownish black, second yellowish at apex; third slightly larger than medium, longer than wide, subquadrate, conspicuously reddish yellow, very indistinctly pollinose; arista at base of segment, black, moderately plumose.

Dorsum of thorax and scutellum blue-black, shining, with short bristle-like pile more abundant forward; margins of thorax and scutellum with black elongate bristles; pile of pleura black, bristle-like.

Abdomen shining blue-black throughout, broadly oval, widest at apex of second segment; first, second and third segments practically bare on disc; fourth segment and margin of third with sparse, moderately long whitish pile; triangular area on anterior margin of second with longer mixed white and black pile.

Legs black, the knees briefly brown, wings smoky throughout, veins black, stigma yellow. Posterior cross-vein approximately straight with outward stump at base.

Holotype (No. 496), female, in Museum of the California Academy of Sciences, from Lava Lake, Ore., July 25, 1915, A. L. Lovett, collector.

Near *cyanea* Hunter; varies in pile of thorax which is short, coarse, bristle-like, black, including scutellum.

Six specimens, all females, three from Mt. Jefferson, Ore., July, 1907, by Bridwell, one from Corvallis, Ore., May, 1917,

by Sweeney; two from Lava Lake, July, 1915, by Lovett. The specimen from Corvallis is decidedly more blue in color than the alpine forms, otherwise similar.

28. *Bachypalpus pigra* Lovett, new species

Length 10 mm. Black; face, front and antennæ black; legs black, white pilose; front and middle knees briefly brown; abdomen shining; second segment with opaque posterior cross-band.

Female: Face shining black, bare, briefly white pilose along eye margins; cheeks shining black with moderately elongate white pile below, extending around on margin to occiput; front black, briefly white pilose; shining at base of antennæ, opaque above; vertex subshining; pile white, moderately elongate; antennæ black; third joint brownish, as broad as long, rounded, briefly silvery pollinose; arista dark reddish brown, lighter at tip.

Thorax shining brassy black with two median, moderately broad, opaque greyish pollinose stripes, meeting behind to form a spot in front of the scutellum; a similar outer pair of stripes sub-interrupted at suture; pile of thorax light yellow, black on dorsum in middle; scutellum of same color as thorax, pile on margin elongate white.

Abdomen shining black; first and second segments with greenish reflections; first with median opaque black spot; second with opaque black band on posterior margin, convex in front and not reaching the lateral margins; succeeding segments shining black with blue reflections; pile of abdomen white or grey, sparse and short on disc, short and black on opaque band of second segment.

Legs black with white pile, knees briefly brown; hind femur distinctly thickened, tibia arcuate. Wings: Veins brownish, yellowish at base; stigma brown and a well defined brown cloud on all cross-veins. Halteres white at margin, brown at base.

Holotype (No. 497), female, in Museum of the California Academy of Sciences, collected at Mt. Jefferson, August, 15 (A. L. Lovett).

Near *rileyii*, but distinct in antennæ, pile, abdominal markings and legs.

29. *Xylota scutellarmata* Lovett, new species

Length 8 mm. Shining black; thorax with short golden pile; margin of scutellum with four elongate black bristles; abdomen opaque black, segments two and three with small yellow triangular spots; pile white on the lateral margins of first and second segment; on the yellow spots and small triangular areas and on anterior margin of fourth segment with elongate white pile; fourth segment shining black.

Female: Front and vertex shining black; moderately wide and but little narrowed above, with short sparse white pile, longer and yellowish at the vertex; a white pollinose band across the front extending down along the eyes to meet with similar pollen of face; face short, moderately concave, subshining, brownish, lighter about the oral margin, lightly whitish pollinose; cheeks dull black, sparsely grey pilose; antennæ brown; third segment dark brown at tip, reddish at base, moderately broad, rounding; arista basal, dark brown, reddish at base, twice as long as antennæ.

Thorax black with coppery reflections; scutellum blue-black with four conspicuous black bristles on the margin; thorax with usual whitish sericeous spots inside of humeri.

Abdomen: first segment dull shining brown, sparsely short white pilose on disc, elongate pilose on margin; second and third segments of same color, small sub-triangular yellow spots on side not reaching margin; fourth segment more shining, black with triangular areas of elongate whitish pile on sides.

Legs brown with white pile, hind femora dark, with double row of short strong spines below. The base of all and the tip of the middle and front tibiæ and the basal segments of tarsi of the front and middle legs light yellow; hind tibiæ moderately arcuate, dark brown, except the base, as are the hind tarsi and the distal segments of middle and front tarsi; wings hyaline, stigma light yellow.

Holotype (No. 498), female, in Museum of the California Academy of Sciences, collected at Hood River, Ore., June 6, 1917, by F. R. Cole.

Near *nemorum*; varies in bristles on margin of scutellum, etc.

30. *Xylota stigmatipennis* Lovett, new species

Length 7 mm. Face and front shining black; a very heavy silvery white pollinose cross-band below the antennæ, extending narrowly upward along margin of eyes two-thirds of way to vertex and downward along eye margins a short distance then out as a distinct line to oral margin; thorax and scutellum shining black with short light golden pile; abdomen blackish, opaque on the disc, with a pair of yellow quadrangular spots on the anterior margin of second segment.

Female: Front and vertex broad, shining black, short white pilose, but little narrowed at vertex; a median depressed line from lower ocelli to near base of antennæ; the crescentic pollinose spots on front eye-margin connect narrowly with a broad heavy silvery pollinose band below the antennæ; face and cheeks shining black; a pollinose line extending obliquely from oral margin to eye-margin, separating face and cheeks, and extending upward along eye-margin to connect with cross-band; sparsely white pilose along eye margin; antennal prominence produced; antennæ brown-black, short; third joint broadly rounded, a little longer than broad; arista black.

Thorax shining black with obscure coppery reflections; whitish sericeous spots on inside of humeri produced inward almost to median line; scutellum shining black with coarse shallow punctures.

Abdomen: first segment opaque greyish on the disc, narrowly yellow on lateral and posterior margins; second segment narrowly yellow on the anterior margin, the yellow expanding on the anterior lateral margins to form a large quadrangular spot, connecting with the lateral margin narrowly in front and with the yellow of first segment; remainder of second segment opaque brownish black, posterior margin with narrow line of white; succeeding segments shining brownish black with sparse light golden pile throughout.

Legs black, tibiæ and tarsi dark brown, the middle tarsus of hind pairs of legs lighter brown, briefly white pilose; wings hyaline; a dark smoky indefinite area extending from the basal tip of the stigma downward to the discal cell; stigma light yellow; basal portion of wing veins yellow, apical portion brown.

Holotype (No. 499), female, in Museum of the California Academy of Sciences, collected at Hood River, Ore., June 4, 1917, by Frank R. Cole.

Characterized by smoky spots in wing and elongate quadrate yellow spot on second abdominal segment.

31. *Brachyopa gigas* Lovett, new species

(Plate 18, fig. 21)

Face, cheeks, and antennæ uniformly yellow; arista moderately plumose; thorax with four brown lines, wings of a brownish tinge, without spots or markings. Length 9.5 mm.

Male: Face, front, cheeks and antennæ light yellow, briefly white pilinose; cheeks with hint of brown; antennæ with hint of reddish; arista somewhat thickened and light yellow on basal fourth, remainder brown, plumose, pile short at tip; vertical triangle brown, ocelli reddish, occiput briefly short brown pilose.

Thorax and scutellum brown subshining covered with short, bristle-like, golden pile; dorsum of thorax with greyish pollen and four longitudinal brown lines, brown dashes above base of wings and narrow upper margin of meso-pleura dark brown.

Abdomen brown, shining, posterior margin of all segments with cross-band of darker brown connecting with similar lateral margin; disc of first segment, and a median line on second and third segments which may or may not reach the posterior margin dark brown. Pile of abdomen similar to that on thorax, somewhat less coarse.

Legs dark brown, apical tarsi of front and middle legs and all tarsi of hind legs blackish. Pile of legs as that of thorax. Posterior to attachment of front legs and anterior to attachment of hind legs the pectus is black.

Wings brown, veins dark brown, stigma yellow; fourth longitudinal bent sharply downward at apex of discal cell, the flexure straight, with a short spur and forming an obtuse angle with the straight marginal cross-vein (See fig. 21).

Holotype (No. 500), male, in Museum of the California Academy of Sciences, collected at Blue Mts., Washington, July 15, 1896.

Several specimens observed in collection of Washington State College (Cole).

Near *media*; distinguished by large size, plumose antennæ and lines on thorax.

32. *Syrphus bimaculata* Lovett, new species

(Plate 18, fig. 23)

Face yellow, with brown median stripe not reaching base of antennæ; cheeks black; eyes bare; thorax with golden pile; scutellum light yellow; abdomen black subshining; second segment on anterior third with moderately narrow, interrupted band which reaches the lateral margins; posterior margins of fourth and fifth segments yellow, this color not reaching lateral margin. Length 7 mm.

Female: Face shining yellow with black pile; a narrow brown median line from just below, but not reaching, the antennæ to oral margin; oral margin and cheeks dull brown, greyish pruinose below; pile on cheeks and occiput light golden; front and vertex black, shining above antennæ, a broad golden pollinose band across front and extending along eyes to base of antennæ; vertex opaque black; front and vertex with black pile. The prominence just at base of antennæ with a conspicuous honey yellow crescent; antennæ brown; first joint, second below, and third basally and along lower margin sparingly, light yellowish brown, elsewhere dark; arista basal, brown, lighter on basal third, dark brown terminally.

Thorax shining bronze-black with light golden pile; scutellum honey yellow, pile longer and lighter.

Abdomen subshining black; second segment opaque black with elongate narrow yellow spots, rather broadly interrupted, arcuate and reaching the lateral margins for their full width near the anterior lateral angle; segments three, four and five black, subshining; posterior margin of fourth and fifth, broadly yellow, but the yellow not extending to lateral margin; pile moderately elongate, golden, on first segment and on yellow portions of second, elsewhere short, black.

Legs: Front and middle pair yellow throughout, hind pair brown, under surface of femur light brown; wings hyaline; stigma brown; halteres honey yellow.

Holotype (No. 501), female, in Museum of the California Academy of Sciences, collected at Mt. Jefferson, Ore., July 15, 1907, by Bridwell.

Another female, Mary's Peak, Ore., June 6, 1915 (Lovett, collector).

This species is distinct from any *Syrphus* known to us in that it has but one band, or two spots, on the abdomen. It is similar in some ways to *S. bifasciata*, but appears distinct even from the many unusual varieties of this characteristic form.

Also in certain lights there is a hint of a broad uninterrupted fascia on the third and fourth segments. This offers the surmise that it might be a melanic form of some common species, as occurs in *L. pyrastris*. An attempt so to classify it was fruitless; also, were this the case, one might expect the pile over these obscured bands to remain light. It is throughout, however, a coarse short black pile warranting the assumption that the bands are actually obsolete.

33. *Syrphus pacifica* Lovett, new species

Length 7 to 8.5 mm. Eyes moderately white pilose; face greenish yellow with blackish pile; a broad median shining black stripe from oral margin to near base of antennæ; oral margin and cheeks shining black; front and vertex shining greenish black with elongate black pile; dorsum of thorax deep shining black with greenish reflections and moderately elongate black pile; scutellum translucent brown with black pile; abdomen shining black with three interrupted arcuate cross-bands not reaching the lateral margins; legs brown; basal two-thirds of femora and coxæ black; wings smoky; stigma light brown.

Male: Antennæ small, brownish; all three segments black above, brown below; third segment small, rounded; arista black, basal, bare; frontal triangle moderately swollen, shining greenish black with elongate black pile; face almost vertical from slightly raised antennal prominence to obtuse tubercle, not projecting; the median stripe moderately broad with tinge of brown; occiput below with golden pile, on upper two-thirds with coarse black pile.

Abdomen shining black with three interrupted greenish yellow cross-bands, one near middle of second segment, approximating in form an elongate triangle with a straight outer edge not reaching the lateral margin; on third and fourth segments the cross-bands are arcuate, convex in front, almost straight behind, their outer ends crescentic, the inner broadly separated and rounded; posterior margins of fourth and fifth segments greenish yellow, not reaching lateral margin; pile of abdomen coarse, moderately elongate, black, light golden on cross-bands.

Legs brown, basal half of front and middle and basal two-thirds of hind femora and all coxæ shining black; wings smoky brown, veins blackish, stigma brown.

Female: Similar to male. Front with broad pruinose cross-band, pile of face light yellow; pile on margin of cheeks and occiput light yellow to white; without tufts of black bristly pile on post-alar callosities; scutellum dark with deep brown reflections, pile except at margin color of that on thorax; abdominal markings similar, the yellow bands slightly narrower; pile shorter and more sparse than on male, elongate white on lateral margins of second segment; wings hyaline.

Holotype (No. 502), male, in Museum of the California Academy of Sciences, collected at Corvallis, Ore., May 17, by A. L. Lovett.

Five males, May to June, Corvallis, Ore., A. L. Lovett, collector. One male and one female, Hood River, May (Cole, collector).

This species is near *S. pauxillus* but face not projecting and cross-bands differ.

34. *Didea pacifica* Lovett, new species

Eyes bare, third longitudinal vein deeply sinuous, abdominal bands except first not reaching lateral margins; cheeks, legs and scutellum black. Length 10 mm.

Male: Face light yellow with silvery pile; tubercle brown; stripe extending broadly to oral margin and along upper third; cheeks green-black, slate-grey below eyes; front brownish with sparse moderately elongate black pile; two dark brown shining spots at base of antennæ connected with inverted V-shaped, slatey, sub-opaque stripe; ocelli red; pile short, black; orbits fringed with yellowish white pile. Antennæ: First two joints black; third deep brownish, elongate oval, obtusely pointed; arista brown.

Thorax and scutellum shining blue-black with gray pile, showing golden reflections in certain lights; meso, ptero and sternoplura blue black; margins brownish, with white pile.

Abdomen black with three greenish yellow cross-bands, the first consisting of two large spots on second segment moderately separated and reaching the lateral margins; second and third cross-bands broad, entire, separated from lateral margins by a narrow black border, front margin straight, touching anterior margin of segments; black posterior band dilated somewhat in middle; fifth and sixth segments shining black, fifth with hint of cross-band on anterior lateral corners.

Legs black; knees and distal tip of tibiæ brownish. Wings hyaline; stigma greyish; third vein strongly curved into first posterior cell.

Holotype (No. 503), male, in Museum of the California Academy of Sciences, collected at Parkdale, Ore., July 12, 1917, by F. R. Cole.

Varies from *D. fusiceps* in black cheeks, black scutellum, darker legs, wholly hyaline wings and in size.

35. *Pipiza oregona* Lovett, new species

(Plate 18, fig. 22)

Length 9 mm. Black throughout, with bluish reflections; antennæ black; legs black; thorax with fine silvery white moderately elongate pile.

Male: Eyes with elongate white pile, with yellow reflections in certain lights; vertex black with elongate white pile mixed with black, produced along margin of occiput; front shining, somewhat swollen; pile elongate, black on antennal prominence, light above; antennæ short, segments approximately of equal length, third rounded; arista stout, basal, about as long as antennæ; antennal prominence produced, face and front slope straight away from this point; face elongate, light pilose.

Thorax and scutellum with elongate silvery pile with yellowish reflections.

Abdomen where shining has bluish reflection; second segment with opaque band on anterior and posterior margin, produced in middle to meet narrowly, leaving shining portions as quadrangular areas with rounded corners; segment narrowly shining on posterior margin; third segment with opaque bands anteriorly and posteriorly, not reaching margin and but slightly produced in middle; fourth segment with opaque band near front margin not reaching lateral margins, otherwise shining; sparse white pile except on opaque portions where pile is black; legs black, white pilose; pile on tarsi with golden reflection; wings smoky; halteres with white knob.

Holotype (No. 504), male, in Museum of the California Academy of Sciences, collected at Hood River, Ore., May 8, 1917, by F. R. Cole.

Two male specimens taken, vary from 7.5–9 mm.

Near *californica*, differs in size, shape of antennæ, wing venation and color of legs.

36. *Platychirus frontosus* Lovett, new species

Head, thorax and scutellum shiny black with black hairs; legs black, front femur with large tuft of black elongate spine-like hairs on proximal third. Length 8 mm.

Male: Face broad, greenish black, shining, with hint of brownish pollen; frontal triangle same color without pollen, unusually broad and decidedly swollen; vertical triangle black, shining, considerably swollen; ocelli brown; face, front and vertex with moderately long black pile; on lower occiput pile whitish; antennæ black, third joint nearly twice as long as wide, dark brown, lighter basally below; arista black.

Thorax and scutellum green-black, shining; no pruinose spots on sternum or pleura, pile black.

Abdomen opaque black; first segment subshining, outer angles with bronze reflections; second, third, and fourth with pruinose bronze spots. On second segment the bronze spots on lateral margins extend from anterior margin back for distance of two-thirds of segment. On third and fourth segments the spots are deeper, shorter, on anterior third of segment, reach lateral margin but do not touch anterior margin of segment. Fifth segment as first. Pile black on opaque areas, white on bronze areas and along lateral margins.

Legs: Fore legs light brown, tibiæ yellow, darker at tip; front tibiæ gradually dilated, convex on outer angle below, gently concave on inner side; tarsi strongly dilated, gradually narrowed from base to tip; femur with three white hairs at extreme base, then a heavy brush of black pile, most conspicuous at base but extending over proximal third of segment; middle

and hind legs black; knees brown, middle tarsi brownish; hind metatarsi not dilated; pile on hind legs white; wings smoky throughout, stigma greyish brown.

Holotype (No. 505), male, in Museum of the California Academy of Sciences, collected at Corvallis, Ore., May 5, 1917, by F. H. Nichols.

Near *P. aratus* but differs in shape of face, in pile of thorax, in wings and legs.

37. *Criorhina aurea* Lovett, new species

Length 15 mm. Robust; pile elongate; face black; abdomen shining black, fourth segment entirely gray pruinose; pile of second and third abdominal segments elongate, orange; of fourth segment elongate, yellow; of fifth black; legs black, coarse brown and black pilose; tarsi lighter brown; wings dark brown, veins black and heavily shaded.

Male: Antennal process moderately projecting; face concave below, prominence only slightly projecting; heavily white pollinose including front; cheeks shining, usual elongate light yellow pile from antennal prominence out along eye margins to cheeks; cheeks below with elongate brown and black pile; vertical triangle shining black and including occiput with elongate heavy light yellow pile; similar pile at base of antennal prominence; ocelli red; antennæ dark brown, red on basal half of third segment; third segment comparatively small, not thinned except on margin, rounding, not produced on outer angle, much produced to an obtuse point on inner angle; arista at middle of outer angle, moderately elongate, black, lighter toward tip; rim of antennal prominence shining brown.

Thorax subshining, grey pollinose on anterior half, posterior half and scutellum shining black; pile elongate yellow; black on transverse band at base of wings, on scutellum more golden; pteropleura with coarse black pile.

Abdomen shining black; first segment opaque black on disc, subshining on posterior margin; second subshining on disc; fourth forms a characteristic transverse band of grey pollen across abdomen; pile elongate, golden, thinned on disc of first and second segments, yellow on fourth and black on fifth.

Legs black, the knees and tips of tibiæ dark brown, the tarsi very light straw brown; pile of all femora black; on basal third of front femur mixed with brown; on basal half of middle femur mixed with yellow and brown; hind femur below on apical third thickly set with short heavy spines; pile of tibiæ coarse, short, very dark brown; tarsi rounded, darker on distal segments; rather deeply incised and with tufts of short black conspicuous spines on marginal angles.

Wings with brown tinge, the veins conspicuously black, tinging the adjacent membrane to an unusual degree; halteres and squamæ brown black, the latter with a heavy fringe of elongate brown pile.

Female: Similar to male in appearance and coloring. More robust, the pollen of the face and front brown; more black pile on cheeks; pile on legs darker; tarsi darker; spines not so conspicuous; spines on hind femur less noticeable.

Holotype (No. 506), male, in Museum of the California Academy of Sciences.

Allotype, a female in collection of A. L. Melander, Pullman, Wash.

Paratypes, Moscow Mt., Idaho, June 1, 1907, A. L. Melander, collector.

Near *kincaidi* and *luna*, characterized by pollinose band on fourth segment of abdomen and dark legs with black pile.

38. *Criorhina luna* Lovett, new species

(Plate 18, fig. 24)

Length 17–19 mm. Pile elongate; antennæ brownish black; general ground color black; hind femur with spines below; all tarsi broadly flattened and deeply incised; wings smoky brown, veins dark.

Male: 19 mm. Antennal prominence produced; face concave below antennæ then straight to oral margin, considerably produced; face and front black, covered with dense golden brown pollen; cheeks shining black; above and occiput as face; at base of antennæ below, along eye margins, at oral margin and about occiput, elongate golden pilose; at base of antennæ above with elongate black pile; vertical triangle with mixed black and golden pile; first two joints of antennæ brownish black, second reddish at tip; third segment brown, reddish at base, broader than long, outer angles rounded, narrowed toward the base, the margin decidedly thinned, concave on outer side, convex on inner side; arista near outer angle, elongate, dark brown; margin of antennal prominence above shining reddish brown.

Thorax and scutellum sub-opaque greyish pollinose; a transverse shining black cross-band at base of wings; two median lines extending dorsalward from front margin of thorax to shining cross-band; on the dorsum laterally are two sub-shining circular areas produced forward from the cross-band into the pollinose field; pile elongate yellow, longest on scutellum, black on shining cross-band.

Abdomen narrow, elongate; the fifth segment large and produced, adapted for sex organ; black shining, first two segments greyish sub-opaque; pile elongate yellow, reddish on disc, black on fifth segment.

Legs dark brown, the pile golden yellow; knees and tibiæ lighter brown, the tips of tibiæ and tarsi yellow; hind femur not particularly thickened, arcuate; sparsely elongate yellow pilose on proximal two-thirds; thickly beset with spines below and on distal third above; the tarsi flattened, broad, deeply incised and with tufts of heavy brown spines on the inner distal angles of the segments; tuft of coarse black pile at base of fore leg, similar but more luxuriant pile at base of hind legs; wings smoky brown, the veins dark brown; squamæ and halteres brown-black, the former with fringe of golden pile.

Female: Length 17 mm. Abdomen robust. In general similar to male, the front broad, and darker brown pollinose; pruinose triangular areas on second abdominal segment narrowly divided at center, reaching lateral margin; on fourth segment near base with lunule-shaped opaque grey

pruinose areas midway between lateral margin and median line and not reaching any margin; pile more luxuriant but similar to male, orange more conspicuous on disc; black on fifth segment mixed with brown, inconspicuous. Tarsi darker than male; veins of wings black.

Holotype (No. 507), male, and allotype (No. 508), female, in Museum of the California Academy of Sciences, ♂, collected at Mary's Peak, Ore., May 14, 1916, Lovett, collector; ♀ Alsea, Ore., April 15, 1916.

Two females and five males, April and May. Subalpine. A large showy orange and black form occurring about fallen decaying logs. It flies swiftly, and is a very early form.

Similar to *kincaidi* (fig. 26); distinguishing character is the legs, particularly the tarsi. See Fig. 24.

39. *Criorhina quadriboscis* Lovett, new species

(Plate 18, figs. 25, 25a, and pl. 19, fig. 25b)

Female: Length 12 mm. Face unusually produced, heavy, blunt, square at proboscis; lower eye margins but little more than one-half distance to tip; slightly concave below antennæ; tubercle reduced; concave from tubercle to margin; golden pollinose with elongate golden pile along eye margins and a tuft at oral margin; front and vertex dark brown with golden pollen and dark brown pile; a deep median suture about ocelli extending down to antennal prominence; cheeks shining black, bare, below and along occiput golden pruinose with light yellow pile; antennæ small, dark brown; first two segments equal; third broad, rounded, flattened, lighter at base. Arista dark brown.

Thorax black, golden pruinose, on anterior half with light pile, a shining black transverse band dorsally with black pile; post-alar callosities with elongate white pile; scutellum black with conspicuously elongate white pile.

Abdomen black, sub-opaque on first two segments; light yellow pilose, thin and short on disc; third segment shining black, orange pilose on disc, outer angles black pilose; fourth segment shining black, conspicuously elongate orange pilose; on anterior lateral angles, but not reaching the lateral margins, are two pruinose crescentic spots; the lateral margins with elongate whitish pile; fifth segment shining black, elongate black pilose.

Legs brown; femora dark, lighter proximally and apically, tibiæ similar, but lighter throughout; tarsi dark at tip. Pile on front and middle femur light at base, black at tip; on hind femur mostly coarse black with scattering lighter hairs, tibiæ and tarsi with short golden pile; wings appear twice length of abdomen, smoky, veins dark brown throughout; stigma yellow.

Holotype (No. 509), female, in Museum of the California Academy of Sciences, collected at Mt. Jefferson, Oregon, April 16, by Hartley.

Characterized by projecting blunt proboscis, and elongate, black, light and golden pile.

40. *Criorhina tricolor* Coq. (Lovett)

Mt. Jefferson, July-August, 1907 (Bridwell) and August 15 (Lovett); Hood River, June 17 (Cole). I find the description as given by Coquillett faulty and from a total of 25 specimens would redescribe as follows:

Female: Face shining black; base with hint of golden pollen; light yellow pile along eye margins; front and face form practically a straight line to obtuse tubercle, the antennal prominence rising rather abruptly, only moderately produced; from tip of tubercle to oral margin a straight retracted line, oral margin in line with front; cheeks, occiput, front and vertex with light golden yellow pile; across vertex just back of ocelli with transverse row of black pile; front and vertex shining black, with brassy reflections; antennæ brown; first segment shining, twice as long as second; second dull; third light brown, darker on outer angle, thinned, nearly as long as first and twice as broad as long, obtusely rounded on inner angle, prolonged on outer angle to form an obtuse point; arista dark brown located near point of projecting outer angle.

Thorax shining black, grey pruinose and yellow pilose anteriorly, black pilose posteriorly; on grey pruinose field are two median lines joining the shining posterior portion and two side spots projecting forward into pruinose field but not reaching anterior margin; often these side spots are circular and surrounded by the pruinose field; scutellum black with brassy reflections, pile elongate, light yellow.

Abdomen: First segment black with brassy reflections and rendered sub-opaque by grey pollen; second segment similar on disc; subshining on lateral angles, pile here elongate light yellow; hind margin of second and succeeding segments shining black; pile moderately elongate and extremely variable in color; generally bright brick-red on disc of third, black laterally, fourth segment with light yellow pile.

Legs black, knees and middle tibiæ light brown, front and hind tibiæ and all tarsi dark brown; middle and hind coxæ with heavy tuft of black bristly hairs; pile on front femur light yellow, on middle femur mixed with black, on hind femur all black; tibiæ and tarsi with short golden pile.

Wings smoky; a distinct cloud at base of stigma extending to spurious vein; veins dark brown, lighter on proximal third; squamæ grey, margin black, with black bristly hairs; halteres dark brown.

Male: Face opaque black, densely covered with silvery pollen, more deeply convex below antennæ; front and vertex shining, with dark brown and black pile. Abdomen: First segment and second on proximal two-thirds sub-opaque black with brassy reflections, the grey pollen so dense as to give appearance of yellow; pile on second segment elongate yellow; distal third of second segment and succeeding segments shining black; this portion of second and all of third with moderately short coarse black pile; terminal segments golden pilose. Tufts of pile at base of coxæ light yellow. Otherwise as female.

There is considerable variation in the color of the pile of the abdomen and to a lesser extent in the density of the pollen on the proximal segments, but the general characters are very specific.

41. *Aciura maculata* Cole, new species

(Plate 19, fig. 27)

Male: Frons, face and antennæ yellow, the frons very broad with short whitish bristles; vertical and fronto-orbital bristles longer; head white pollinose; occiput gray with short white bristles; third joint of antennæ rounded at tip; arista brown.

Thorax, pleura and scutellum cinereous; mesonotum with four long bristles; whole dorsum of thorax thickly covered with short, thick white bristles; three long black bristles on the shoulders; two long bristles on margin of scutellum; pleura with short whitish bristles; halteres blackish.

Abdomen shining and mostly blackish, some reddish brown on dorsum of second, third and fourth segments.

Femora mostly black, cinereous pollinose; the tips and part underneath tibiæ and tarsi brownish yellow; tips of tarsi blackish; wings dark brown and marked with hyaline spots (Fig. 27); anal cell paler brown. The oblique hyaline band across end of wing is a good specific character.

Two specimens from Jackson Co., collected May 28, 1916.

Holotype (No. 510), male, in Museum of the California Academy of Sciences.

This species is very near *ferruginea* Doane in wing pattern but differs in several structural characters and has an apical hyaline cross-band on the wing.

Larvæ in fruit of service berry (*Amelanchier* sp.) and bred out at Medford, Ore.

42. *Tritoxa pollinosa* Cole, new species

(Plate 19, fig. 28)

Female: Not as slender in form as the typical species. Body of general brown color. The thorax comparatively long. Wings with the characteristic three hyaline cross-bands. Length 6 mm.

Median stripe of frons dull yellow; the reddish brown stripe on each side, bordering the eyes, is almost obscured by white pollen and is about half as wide as the median section; short black bristles, denser on sides of frons; ocellars short and slightly proclinate as are small scattered bristles; the vertical and fronto-orbitals slightly reclinate; face yellowish, white in certain lights, with a reddish mark in center from oral margin half-way up the face and down on to yellowish clypeus; palpi yellow with black hairs; antennæ reddish, the third joint blackish above and more than twice as long as first two joints; arista black and finely pubescent; middle of cheeks with a brown spot under the eye which reaches to oral margin (Fig. 28); occiput yellowish brown, white pollinose below, especially on sides.

Thorax and pleura reddish brown; dorsum with golden pollen; two widely separated gray pollinose stripes running length of dorsum; præscutellar callosities and region around them bare of pollen and reddish; dorsum with many short black hair-like bristles which do not reach pleural suture, however; one humeral bristle; two strong bristles in front of scutellum arising from brown spots; a smaller bristle on each side and in front of these two strong bristles on the dorso-central line; two strong

noto-pleurals; upper edge of mesopleura blackish, in most part golden polilose and with a few hairs; one strong spine on upper posterior corner of mesopleura; halteres yellow; scutellum reddish, shining, the apical half black; four scutellar bristles.

Abdomen brown, the most of first segment shining reddish brown; ovipositor wide, flat, amber colored; the rest of the abdomen brownish polilose, gray toward base of segments; venter varied, brownish and blackish; dorsum of abdomen with short, black, thick set pile.

Legs brownish yellow, the tarsi darker. The wings are brown with oblique hyaline stripes (Fig. 28a); the outer stripe running from end of first vein to wing margin in center of second posterior cell; whole anal angle of wing hyaline. Longitudinal veins and cross-veins sinuous.

Holotype (No. 511), female, in the Museum of the California Academy of Sciences, collected at Warm Springs Valley, Ore., July 7, 1906. Collector unknown. From material in the Oregon Agricultural College.

This species is not typical in the form of the abdomen or general appearance. The head is shaped as in *T. flexa* and *T. cuneata*. The wing markings are quite different from the described species. Dr. Aldrich corroborated my determination of this species.

43. *Aricia bicolorata* Malloch, new species

Female: Yellow, slightly shining; head brownish fuscous; second antennal joint yellowish testaceous; palpi and third antennal joint black; abdomen and tarsi fuscous; wings clear, veins yellow basally; cross-veins very slightly browned; halteres yellow.

Eyes bare, facets of almost uniform size; frons at vertex a little over one-third of the head-width; orbits each with five or six bristles and a few weak hairs; antennæ nearly as long as face; arista with the longest hairs nearly as long as width of third antennal joint; palpi slender; cheek about one-fourth as high as eye, with a series of strong marginal bristles and some short, weak hairs above them; presutural acrostichals four-rowed short and weak; postsutural dorso-centrals three; prealar short; sternopleurals 1:2; hypopleura bare; third and fourth tergites with strong discal and marginal bristles; fore tibia with a median posterior bristle; mid tibia with three or four posterior bristles; hind tibia with two antero-ventral and two antero-dorsal bristles; fore tarsus slender, longer than fore tibia; costal thorn long; outer cross-vein slightly curved; veins three and four divergent at apices.

Length, 6–6.5 mm.

Type, Hood River, Ore., June 21, 1917 (F. R. Cole). Paratype, Washington State (Kincaid).

Paratype in collection of Illinois State Natural History Survey.

This species is readily distinguished from its allies by the colors of the body.

44. *Aricia oregonensis* Malloch, new species

Male: Black, slightly shining, densely gray pruinose. Head black, frons, orbits, face, and cheeks with silvery pruinoscence, second antennal joint reddish at apex, palpi black; mesonotum very indistinctly quadrivittate; basal dorsal abdominal segment (second) with a pair of black spots, segments two and three each with a pair of black rectangular spots which extend from base to apex of segments. Legs black, apices of fore femora, apical third of mid-femora, most of hind femora and all tibiae rufous-yellow. Wings clear; cross-veins very slightly infuscated; calyptra white; halteres yellow.

Eyes bare, separated at narrowest part of frons by about as great a distance as width across posterior ocelli; orbits bristled more than midway to anterior ocellus; interfrontalia distinct; parafacial in profile as wide as third antennal joint; antennae not as long as face, third joint twice as long as second; arista with rather dense short hairs, the longest barely longer than basal diameter of arista; cheek about twice as high as width of parafacial; face slightly concave above vibrissa; thorax without strong presutural acrostichals; three pairs of postsutural dorsocentrals present; prealar bristle minute; sternopleurals 1:2, with a weak bristle below and behind the anterior one; hypopleura bare. Abdomen elongate-ovate, third and fourth dorsal segments with strong discal and posterior marginal bristles; fifth sternite with dense short stiff hairs on its entire surface, the posterior margin with a broad shallow excision; fore tibia without median bristles; mid tibia with from two to four posterior bristles; hind femur with about eight long strong bristles on apical half or apical third of postero-ventral surface; hind tibia with one or two antero-dorsal bristles, the antero-ventral, ventral, and postero-ventral surfaces with rather dense erect hairs of moderate length. Costal thorn short; veins three and four parallel apically; outer cross-vein bent in middle.

Length, 7 mm.

Type, Grant Co., Ore., one male.

45. *Cænusia oregonensis* Malloch, new species

Male: Black, slightly shining, covered with dense pale gray pruinoscence. Head black, interfrontalia darker than the densely gray pruinose orbits; antennae black, third joint entirely pale yellow; arista black; palpi pale yellow; proboscis blackish brown; dorsum of thorax not vittate, very noticeably shining and rather thinly pruinose (possibly abraded). Abdomen with a conspicuous pair of large brownish black spots on segments two, three, and four, the basal (first distinct) segment without spots; fifth sternite gray. Legs pale yellowish testaceous, mid and hind coxae, and all tarsi infuscated; wings clear, veins black; calyptra white; halteres yellow.

Frons one-third as wide as head; orbits narrow, each with three long and one short bristle; ocellar bristles distinctly longer than upper orbitals and very much longer than postvertical pair; antennae extending over two-thirds of the distance to mouth-margin, third joint not over twice as long as second, rounded at apex; arista almost bare, slightly swollen for a short distance at base; parafacial in profile narrower than third antennal joint; cheek about one-sixth as high as eye, with about three long marginal bristles; vibrissa long and strong, a short setula above it. Dorsocentral bristles long and strong; presutural acrostichals irregularly two-rowed; lower spiracular bristle distinct, directed ventrad; abdomen normal in form, the tergites subequal, fifth but little exposed when viewed from above;

hypopygium small; fifth sternite short, the processes short, and apically rounded; legs elongate, slender, all tarsi longer than their tibiae; fore and mid tibia each with one weak posterior median bristle; hind femur with three or four long widely-placed antero-ventral bristles, and a long one at middle on postero-ventral surface; hind tibia with a short antero-ventral bristle, and a much longer antero-dorsal one, the preapical dorsal bristle at one-fifth from apex of tibia. Last section of fourth vein twice as long as preceding section, inner cross-vein just beyond apex of first. Length, 2-5 mm.

Type. Corvallis, Ore., May 2, 1915 (A. L. Lovett). Ore. Exper. Sta., Accession No. 1796.

46. *Chironomus colei* Malloch, new species

Male: Yellowish testaceous, subopaque; antennal plumes dark at apex and base of flagellum; thorax with three reddish vittae; postnotum brown. Abdomen with dorsum of segments five and six and most of hypopygium black; apices of femora and bases of tibiae narrowly fuscous, the mid pair inconspicuously so; wings whitish, with a small brown dot at bases of veins, a fuscous median fascia which does not extend to margins, and a small fuscous patch at apices.

Fore tarsi without long hairs, basal joint about 1.25 as long as fore tibia and 1.75 as long as second joint; mid and hind legs with long hairs; costa extending almost to apex of wing.

Length, 5 mm.

Type and paratype, Forest Grove, Ore., June 3, 1918, at light (F. R. Cole).

This species closely resembles *taniapennis* Coq., *nephopterus* Mitch., and *pulchripennis* Coq., but may be readily separated from any of these species by the very much narrower wing fasciae and the much less conspicuously blackened legs.

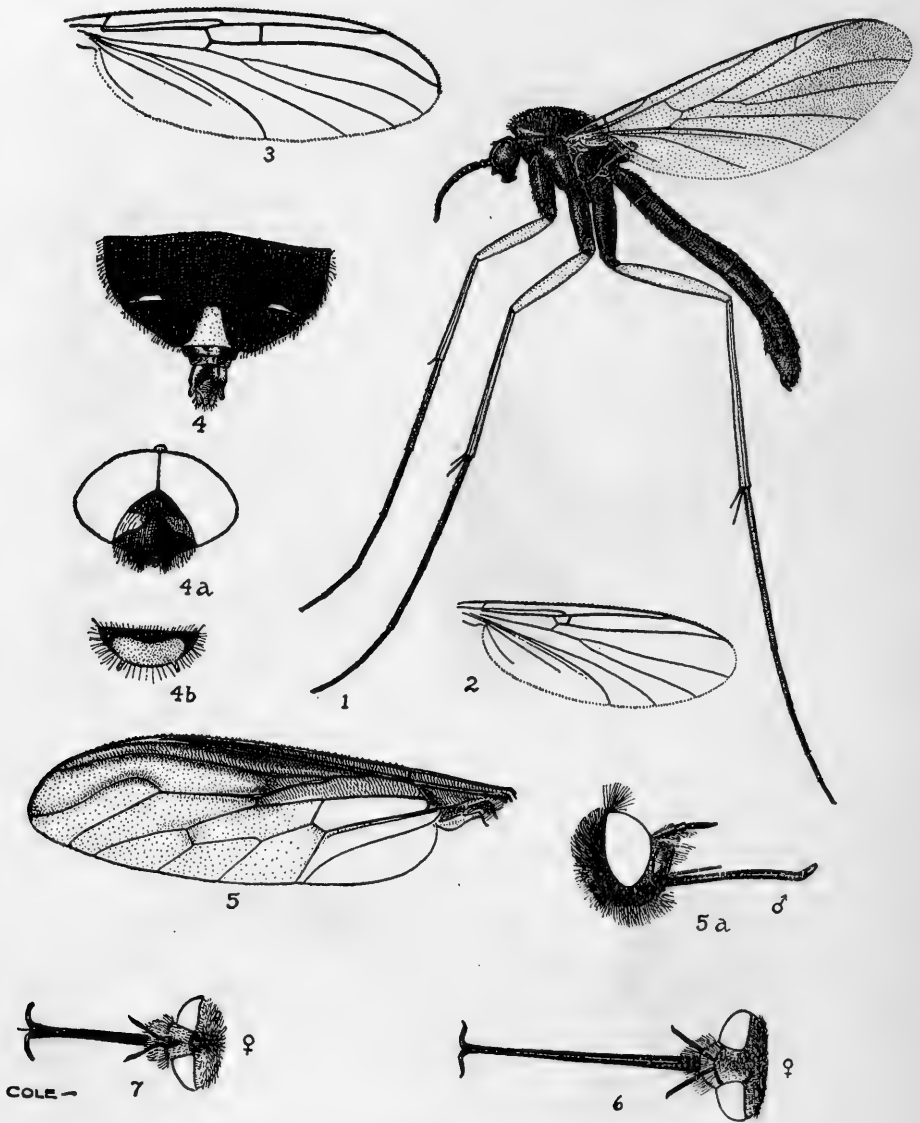


Fig. 1.—*Platyura nigra*, new species.
 Fig. 2.—*Dziedzickia immaculata*, new species. Wing.
 Fig. 3.—*Dziedzickia oregona*, new species. Wing.
 Fig. 4.—*Stratiomyia atra*, new species. Terminal segments of abdomen.
 Fig. 4a.—*Stratiomyia atra*, new species. Head from front.
 Fig. 4b.—*Stratiomyia atra*, new species. Scutellum.
 Fig. 5.—*Eclimus magnus* O. S. Wing.
 Fig. 5a.—*Eclimus magnus* O. S. Head from side.
 Fig. 6.—*Bombylius silvus*, new species. Head from above.
 Fig. 7.—*Bombylius aurifer pendens*, new variety. Head from above.

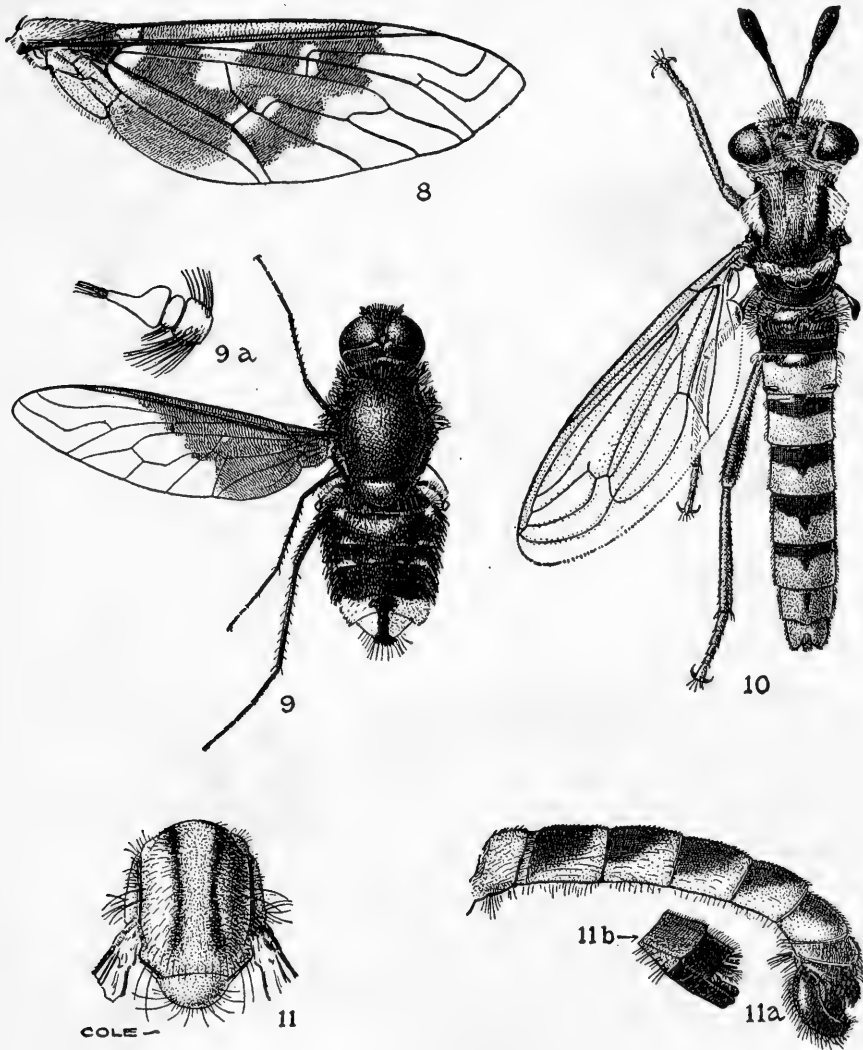


Fig. 8.—*Anthrax macula*, new species. Wing.
 Fig. 9.—*Spogostylum argentatum*, new species.
 Fig. 9a.—*Spogostylum argentatum*, new species. Antenna, much enlarged.
 Fig. 10.—*Leptomydas pantherinus* Gerst.
 Fig. 11.—*Lasiopogon cinereus*, new species. Thorax from above.
 Fig. 11a.—*Lasiopogon cinereus*, new species. Male abdomen from side.
 Fig. 11b.—*Lasiopogon cinereus*, new species. Female genitalia.

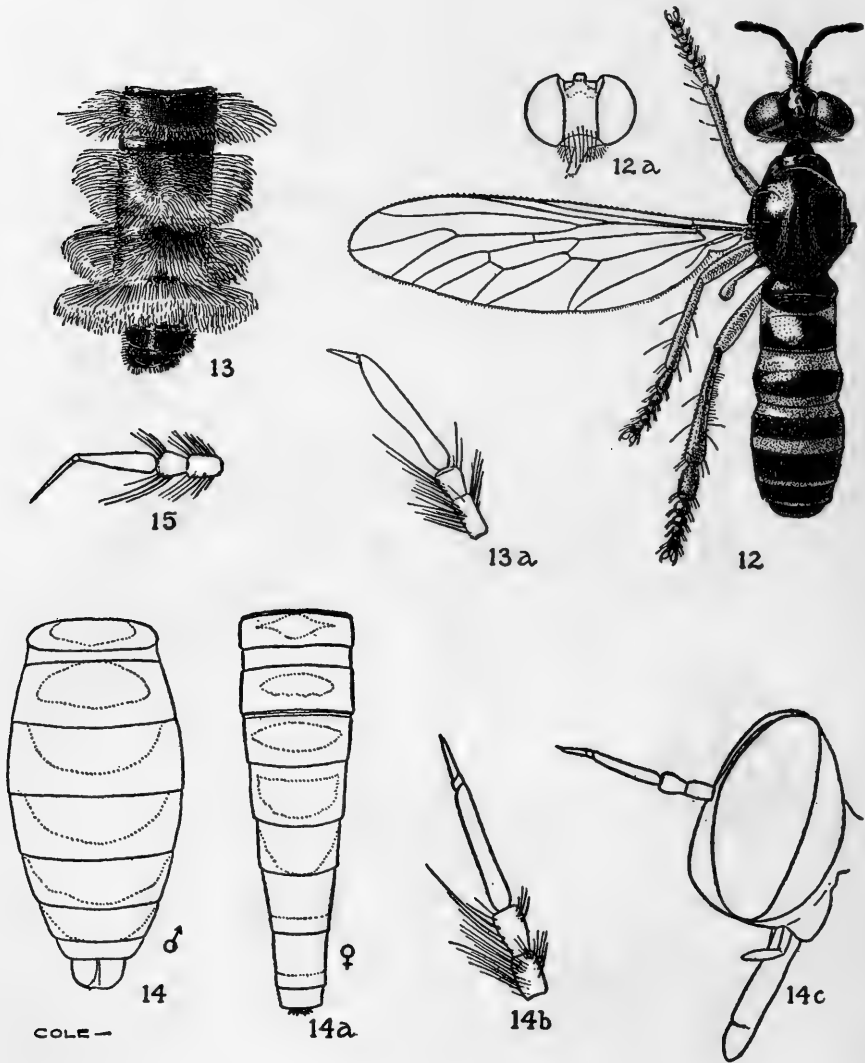


Fig. 12.—*Dioctria vertebrata*, new species.
 Fig. 12a.—*Dioctria vertebrata*, new species. Outline of head from front.
 Fig. 13.—*Cyrtopogon auratus*, new species. Abdomen of male.
 Fig. 13a.—*Cyrtopogon auratus*, new species. Antenna.
 Fig. 14.—*Cyrtopogon anomalus*, new species. Outline of male abdomen.
 Fig. 14a.—*Cyrtopogon anomalus*, new species. Outline of female abdomen.
 Fig. 14b.—*Cyrtopogon anomalus*, new species. Antenna.
 Fig. 14c.—*Cyrtopogon anomalus*, new species. Outline of head from side.
 Fig. 15.—*Cyrtopogon nebulo* O. S. Antenna.

COLE —

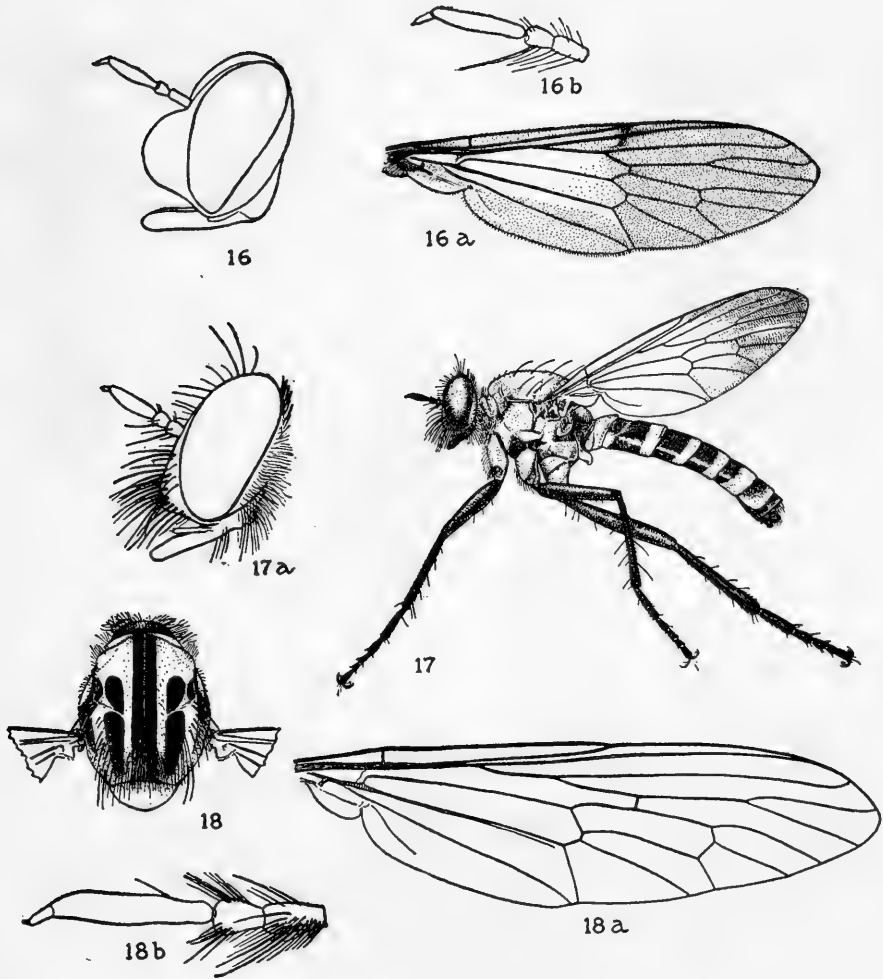


Fig. 16.—*Cyrtopogon infuscatus*, new species. Outline of head.
Fig. 16a.—*Cyrtopogon infuscatus*, new species. Wing.
Fig. 16b.—*Cyrtopogon infuscatus*, new species. Antenna.
Fig. 17.—*Metapogon setigerum*, new species.
Fig. 17a.—*Metapogon setigerum*, new species. Head, much enlarged.
Fig. 18.—*Chrysoceria pollenia*, new species. Thorax from above.
Fig. 18a.—*Chrysoceria pollenia*, new species. Wing.
Fig. 18b.—*Chrysoceria pollenia*, new species. Antenna, much enlarged.

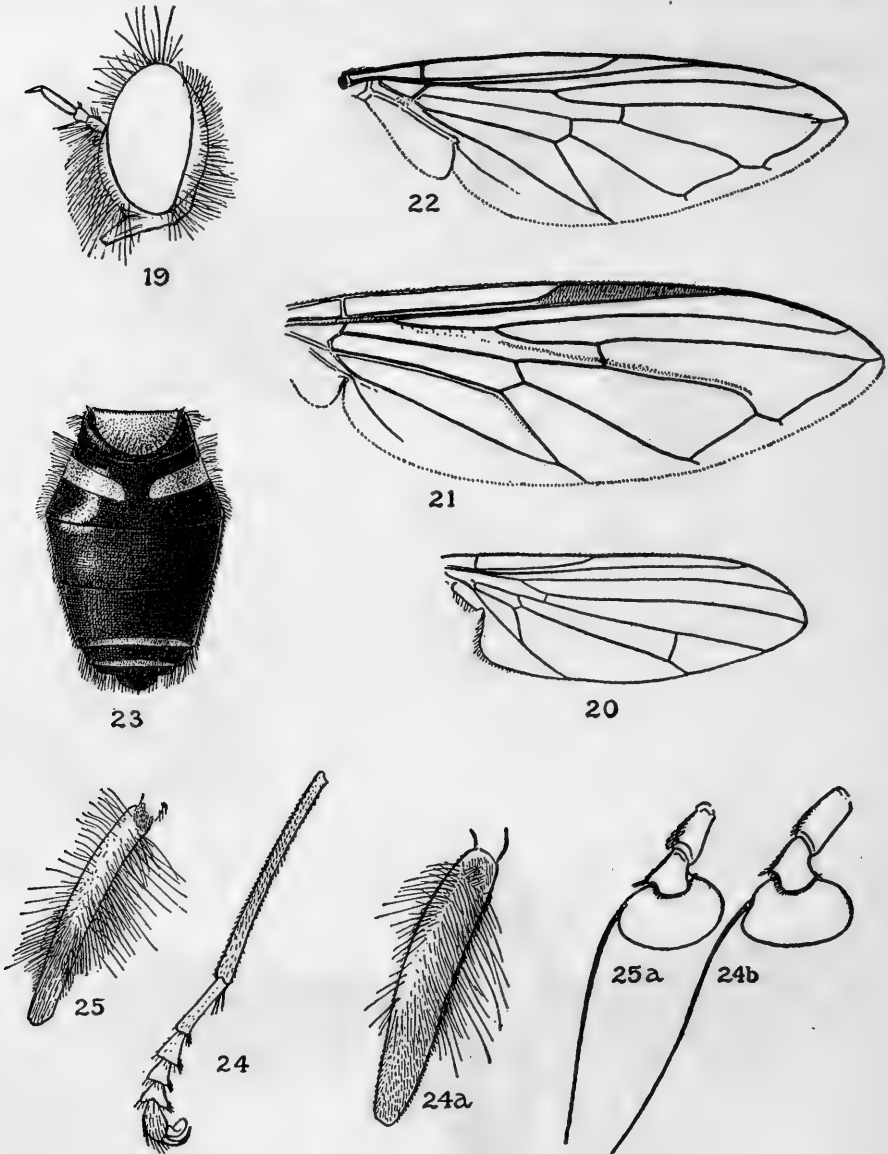
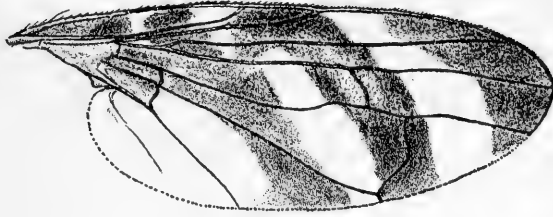
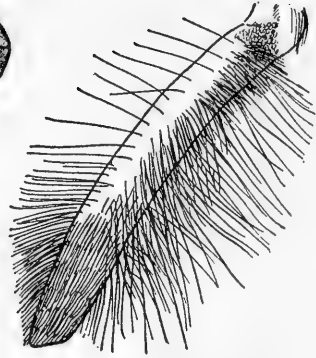


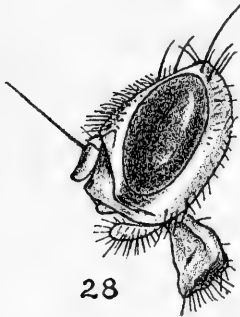
Fig. 19.—*Cophura cyrtopogona*, new species. Outline of head.
 Fig. 20.—*Agathomyia lutea*, new species, Wing.
 Fig. 21.—*Brachyopa gigas*, new species. Wing.
 Fig. 22.—*Pipiza oregona*, new species. Wing. (Spurious vein left out in drawing by mistake.)
 Fig. 23.—*Syrphus bimaculata*, new species. Abdomen.
 Fig. 24.—*Criorhina luna*, new species. Middle tibia and tarsi.
 Fig. 24a.—*Criorhina luna*, new species. Hind femur.
 Fig. 24b.—*Criorhina luna*, new species. Antenna, greatly enlarged.
 Fig. 25.—*Criorhina quadriboscis*, new species. Hind femur.
 Fig. 25a.—*Criorhina quadriboscis*, new species. Antenna, greatly enlarged.



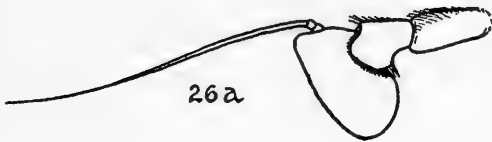
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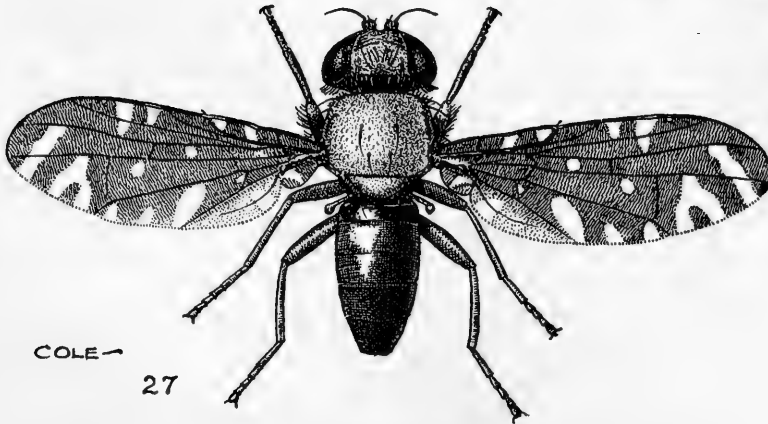
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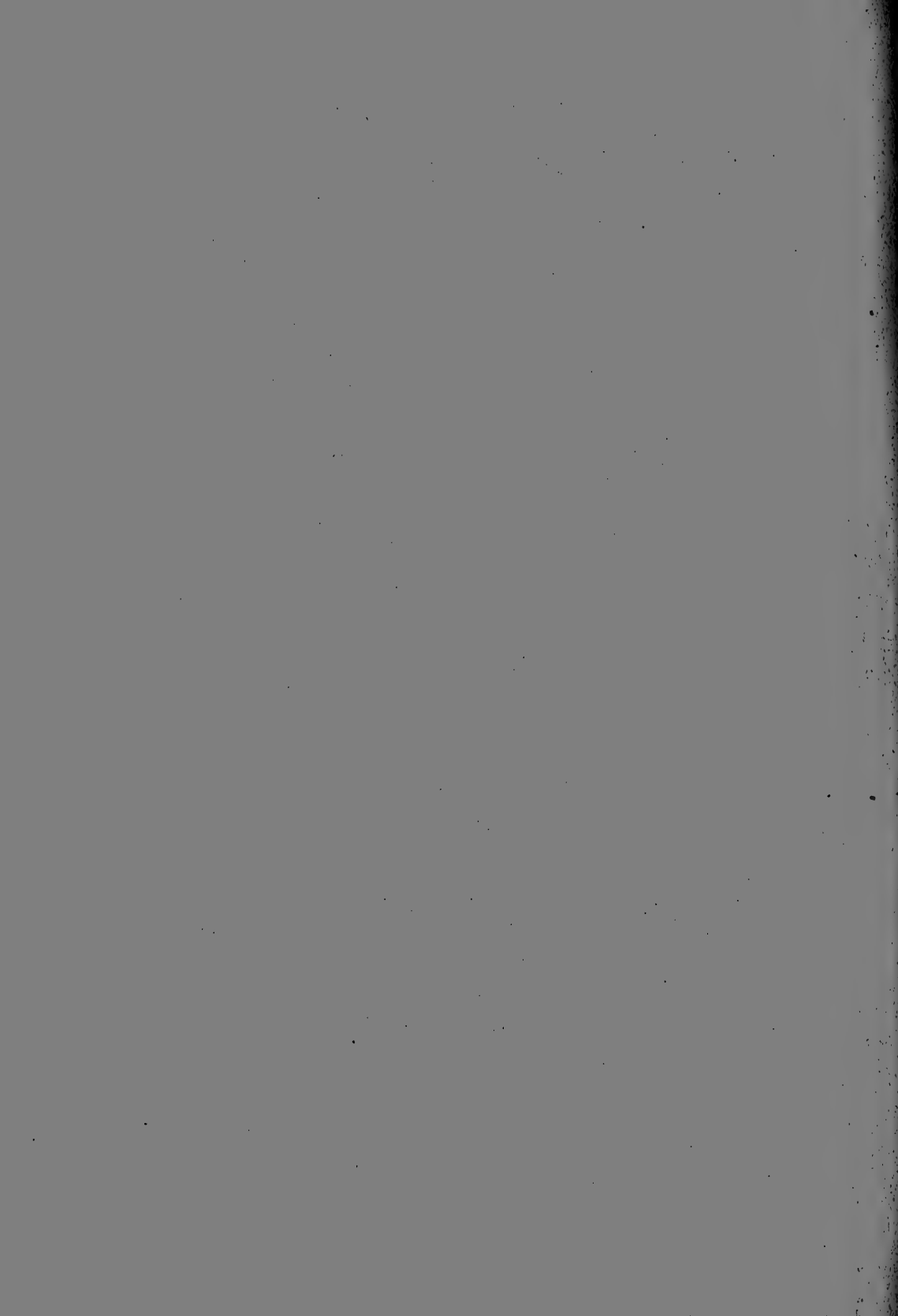
25b



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Fig. 25b.—*Criorhina quadriboscis*, new species. Outline of head.
 Fig. 26.—*Criorhina kincaidi* Coq. Hind femur.
 Fig. 26a.—*Criorhina kincaidi* Coq. Antenna, greatly magnified.
 Fig. 27.—*Aciura maculata*, new species.
 Fig. 28.—*Tritoxa pollinosa*, new species. Head.
 Fig. 28a.—*Tritoxa pollinosa*, new species. Wing.



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CALIFORNIA ACADEMY OF SCIENCES
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VOL. IX, No. 8, pp. 257-270

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VIII.

Key to the North American Species of the
Dipterous Genus *Medeterus*, with
Descriptions of New Species

BY
MILLARD C. VAN DUZEE

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VIII

KEY TO THE NORTH AMERICAN SPECIES OF THE
DIPTEROUS GENUS MEDETERUS, WITH
DESCRIPTIONS OF NEW SPECIES

BY

MILLARD C. VAN DUZEE

In the preparation of the following key I have found it necessary to employ a few characters that sometimes are not readily distinguished, but for the species included it should work very well, although, perhaps rather difficult to use on account of these obscure characters. The bristles above the fore coxæ are often small and it may be difficult to determine their color. The small tooth at the base of the metatarsi of some of the males is easily overlooked but in those species that have this tooth the metatarsi are narrowed at base for a short distance and the tooth is inserted on the narrowed portion. The scutellum has either one or two pairs of bristles on its margin, but where there is but one pair there is often a pair of small hairs taking the place of the second pair of bristles, and where there are two pairs of bristles the outer pair are often reduced to about half the size of the central pair; this, however, should give the student little trouble in running the

August 26, 1919

species through the key. Under "31" is an alternative, referring to the length of the distal segment of the fifth vein, that may cause some confusion. I could find no satisfactory character to take the place of this, but in case of doubt, the following note may be of assistance. Of the four species that run through "31" to "32-34" *veles* Loew can be separated by its third and fourth veins being more widely divergent at their tips than in the other species, and in fact, than in most of the species of this genus; *modestus* V. D. has the halteres infuscated and the feet black; *californiensis* Wh. has the second joint of the hind tarsi fully twice as long as the first, while in *distinctus*, new species, it is only one and a fourth times as long as the first.

I have described several species from females, as it seems to me that in this genus the females are as a rule as easily separated as are the males, there being few secondary sexual characters in the males.

This paper is not a revision of our species but only intended as a help to those who, like myself, have tried to determine their material and have found most of their species undescribed. I hope someone with more material and better equipped for the work will make a thorough revision of our species.

TABLE OF NORTH AMERICAN SPECIES

1. Scutellum with one pair of bristles (there may be a pair of small hairs outside of these).....	2
- Scutellum with two pair of bristles (the outer ones may be small).....	11
2. Antennæ, proboscis and legs, including fore coxæ, yellow.....	
..... <i>novus</i> , new species	
- Antennæ, proboscis and more or less of the femora black.....	3
3. Thorax with distinct vittæ.....	4
- Thorax without distinct vittæ.....	10
4. Thorax with a median bluish green vitta.....	
..... <i>obesus</i> , new species	
- Thorax with a median brown stripe running its entire length.....	5
5. Wings with a brown cloud at base of third vein.....	6
- Wings without a distinct cloud at base of third vein.....	7
6. Tibiæ and tarsi yellow.....	
..... <i>cuneiformis</i> , new species	
- Tibiæ brownish; tarsi black with the base of metatarsi yellowish..	
..... (female of) <i>nitidiventris</i> , new species	
7. Abdomen bluish but with gray pollen; male with the front produced into a four-sided pyramid.....	
..... <i>petulcus</i> Wh.	
- Abdomen shining black, front normal.....	8
8. Tibiæ and tarsi mostly yellow.....	
..... <i>similis</i> , new species	
- Tibiæ and tarsi black or brown.....	9

9. Last section of fifth vein only a little longer than the cross-vein...
 *æqualis*, new species
 -. Last section of fifth vein one and a half times as long as the cross-
 vein *nitidiventris*, new species
10. Femora mostly yellow; mesonotum and abdomen light green.....
 *longinquus*, new species
 -. Femora mostly black; mesonotum coppery; abdomen dark green..
 *æneus*, new species
 -. Femora mostly black; mesonotum covered with thick gray pollen.
 *falcatus*, new species
11. Bright metallic species..... 12
 -. Darker species; generally blackish..... 16
12. Length about 2 mm.; fore tarsi of male with a compressed lobe on
 the third joint..... *lobatus* V. D.
 -. Length nearly 3 mm..... 13
13. Face and all coxæ metallic green; (Eastern states)..... *aberrans* Wh.
 -. Face, front and anterior part of the thoracic dorsum violet; coxæ
 blackish; (Guatemala) 14
14. Fore tarsi plain, regularly tapering from base to tip.....
 *planipes*, new species
 -. Fore tarsi ornamented 15
15. Fore tarsi a little widened from base to tip of second joint, third
 joint only a little narrower but suddenly contracted to a slender
 projection to which the fourth is attached; fourth and fifth
 joints slender *abruptus*, new species
 -. Fore tarsi with the second and third joints very much compressed
 and expanded on upper edge; fourth and fifth joints minute....
 *flavipes*, new species
16. Bristles above fore coxæ black..... 17
 -. Bristles above fore coxæ white or yellowish..... 28
17. Second joint of hind tarsi more than twice as long as first..... 18
 -. Second joint of hind tarsi not more than twice as long as first..... 19
18. Legs altogether black *nigripes* Loew.
 -. Tibiæ largely yellowish *vittatus*, new species
19. Antennæ wholly black 20
 -. Antennæ partly yellow 22
20. Knob of the halteres black..... *halteralis*, new species
 -. Knob of the halteres yellow 21
21. Second joint of hind tarsi fully twice as long as first.....
 *vittatus*, new species
 -. Second joint distinctly less than twice as long as first..... 22
22. Second joint of hind tarsi one and a half times as long as first;
 last section of the fifth vein only a little longer than the cross-
 vein *obscuripennis*, new species
 -. Second joint of hind tarsi one and a fourth times as long as first;
 last section of fifth vein two and a fourth times as long as the
 cross-vein *frontalis*, new species
23. Thorax with distinct gray vittæ..... 24
 -. Thorax without distinct gray vittæ..... 25
24. With a distinct gray stripe on each side of the acrostichal bristles;
 male with prominent yellow hairs at tip of hind tibiæ.....
 *viduus* Wh.
 -. Thorax with four gray vittæ..... *aldrichii* Wh.
25. Mesonotum with thick brown pollen; length 5 mm.....
 *emarginatus* V. D.
 -. Mesonotum with thin grayish pollen; length 3.25 mm. or less..... 26
26. Last section of the fifth vein three-fourths as long as the cross-
 vein in the male and a little longer than that vein in the female.
 *oregonensis*, new species

- Last section of the fifth vein one and a half times as long as the cross-vein	27
27. Tegular cilia pale	<i>maurus</i> Wh.
- Tegular cilia black	<i>cærulescens</i> Malloch.
28. Abdomen blue	29
- Abdomen bronzed, green or black.....	30
29. Thorax with yellowish vittæ; antennæ black.....	<i>aurivittatus</i> Wh.
- Thorax with opaque gray pollen; antennæ with first two joints yellow	<i>cyanogaster</i> Wh.
30. Males and females	31
- Males only	40
31. Thorax with distinct vittæ.....	32
- Thorax without distinct vittæ.....	37
32. Last segment of the fifth vein only half as long as the cross-vein.....	<i>princeps</i> Wh.
- Last segment of the fifth vein as long or longer than the cross-vein	33
33. Last segment of the fifth vein about the same length as the cross-vein	34
- Last segment a little longer than the cross-vein.....	36
34. Legs and feet wholly black; knobs of halteres infuscated.....	<i>modestus</i> V. D.
- Tips of femora, tibiæ, base of tarsi and knobs of halteres yellow..	35
35. Tips of third and fourth veins close together (typical of genus).....	<i>californiensis</i> Wh.
- Tips of third and fourth veins a little wider apart than is usual in the genus	<i>veles</i> Loew.
36. Abdomen and pleuræ black; face opaque; thoracic vittæ very distinct; tips of third and fourth veins rather widely separated.....	<i>veles</i> Loew.
- Abdomen, pleuræ and face distinctly green; thoracic vittæ less distinct; tips of third and fourth veins close together (as is usual in the genus)	<i>distinctus</i> V. D.
37. Legs yellow; cross-vein angulated at its center and with a stump-vein	<i>appendiculatus</i> Wh.
- Legs black; cross-vein normal.....	38
38. Knobs of halteres infuscated, at least on one side.....	<i>modestus</i> V. D.
- Knobs of halteres yellow	39
39. Last section of fifth vein only half as long as the cross-vein.....	<i>xerophilus</i> Wh.
- Last section of fifth vein a little longer than the cross-vein (specimens in which the thoracic vittæ are almost obsolete).....	<i>veles</i> Loew.
40. Posterior cross-vein with a stump-vein near its middle.....	<i>xerophilus</i> Wh.
- Cross-vein normal	41
41. Hind matatarsus with a small tooth near its base.....	42
- Hind metatarsus without such a projection, not narrowed at base..	43
42. Small species, 2 mm.; third and fourth veins rather widely separated	<i>veles</i> Loew.
- Larger species, over 3 mm.; third and fourth veins normal.....	<i>californiensis</i> Wh.
43. Last section of fifth vein one half the length of the cross-vein.....	<i>xerophilus</i> Wh.
- Last section of fifth vein and the cross-vein of nearly equal length.....	<i>modestus</i> V. D.

DESCRIPTIONS OF NEW SPECIES

1. *Medeterus falcatus*, new species

Male and female: Length 1.75 mm. Face and front covered with gray pollen; antennæ black, third joint small, slightly emarginate at tip where the arista is inserted; orbital cilia white; thorax bronze black but so thickly covered with gray pollen as to conceal the ground color and appear gray in unrubbed specimens, without distinct vittæ; bristles above the fore coxæ small, white; scutellum with two bristles and two small hairs on the margin; abdomen dark greenish, obscured with gray pollen; hypopygium of male black, shining, rather thick; its appendages small, yellowish; coxæ and femora black; more or less of the femora apically, the tibiæ and tarsi yellow, the tips of the tarsi darkened; hind tibiæ somewhat enlarged at tip with a short, stout, hooked spur, in the female the hooked spurs are wanting; second joint of hind tarsi a little longer than the first; tegulæ, their cilia and the halteres yellow; wings hyaline, slightly gray, with yellowish veins; distal segment of fifth vein more than one and a half times as long as the cross-vein.

Described from four males and ten females taken by me at Fresno, Cal., May 6, 1915, while sweeping alfalfa in the park; and one male taken at San Francisco, Cal., May 22, 1915.

Holotype, male (No. 512), from Fresno, in collection of the California Academy of Sciences. Allotype, female, in collection of the author. Paratypes in both collections.

2. *Medeterus similis*, new species

Male and female: Length 2.2 mm. Face rather wide, covered with gray pollen, below the suture more shining and black with slight greenish reflections; front covered with gray pollen; antennæ small, black; proboscis of moderate size, shining black with yellow hairs; thorax covered with gray pollen leaving only a median, shining, bronze-brown vitta which extends to the hind margin of the scutellum when viewed from behind; acrostichal bristles small, in two rows; scutellum with two bristles; bristles above fore coxæ very small, white; abdomen black with a very slight green tinge, shining but somewhat dulled with gray pollen, its hairs pale; coxæ and femora black; fore coxæ with rather long white hairs; about the apical third of femora tibiæ and most of the basal two or three joints of the tarsi yellow; tarsi blackened towards the apex; hind tibiæ a little enlarged at tip and with bent claw-like spurs; second joint of hind tarsi more than one and a half times as long as the first; tegulæ, their cilia and the halteres yellow; wings slightly tinged with gray; veins black; last section of the fifth vein a little more than one and a half times as long as the cross-vein.

Described from three males and five females taken by me at Los Angeles, Calif., Apr. 27, and May 1, 1915, and one male taken at Fresno, Calif., May 6, 1915. This is closely related to *falcatus*, new species, but has the second joint of hind tarsi more than one and a half times as long as the first while in

falcatus it is scarcely one and a fourth times as long as the first; *similis* is also larger and the thorax has a distinct median vitta which is not found in *falcatus*.

Holotype, male (No. 513), from Los Angeles, in collection of the California Academy of Sciences. Allotype, female from Los Angeles, in collection of the author. Paratypes in both collections.

3. *Medeterus novus*, new species

Male: Length 1.75 mm. Face and front green with whitish pollen; proboscis rather large, yellow, shining; antennæ yellow, small; arista dorsal, pubescent; thorax, including the pleuræ, light green dulled with gray pollen; scutellum with the posterior margin yellow, covered with white pollen, and with one pair of long, very slender bristles; acrostichal bristles small; the bristles of thorax and scutellum yellowish brown in certain lights; bristles above fore coxæ pale yellow; abdomen dark greenish, more shining than the thorax; hypopygium brownish yellow; legs including fore coxæ pale yellow with yellow hairs and bristles; tarsi scarcely darkened at tip; first joint of hind tarsi scarcely half as long as second; tegulæ, their cilia and the halteres pale yellow; wings hyaline, tinged with gray; venation typical of the genus; veins yellowish brown, more yellow at the root of the wing; fourth vein ending in the apex of the wing close to the tip of the third; last section of fifth vein one and a half times as long as the cross-vein.

Described from one male taken at Great Falls, Va., June 12, by Mr. Nathan Banks.

The yellow antennæ, legs and bristles of this species together with its small size would suggest its being a *Thrypticus*, but the venation is that of a typical *Medeterus*, as is also its large proboscis and the form of its hypopygium.

Holotype, male, in collection of the author.

4. *Medeterus longinquus*, new species

Female: Length 2 mm. Face and front green with a very little gray pollen; antennæ black, third joint small; arista apical; proboscis small; thorax and scutellum light green, somewhat shining but dulled with gray pollen; acrostichal bristles in two rows; lateral and posterior bristles of the thorax large, black; scutellum with one pair of bristles; abdomen darker green than the thorax, shining, its hairs pale; coxæ and base of femora blackish; apical half or more of fore and middle femora, tips of hind femora, all tibiæ and tarsi pale yellow; last tarsal joint blackened; extreme tips of all tarsal joints brownish; hind femora with rather conspicuous yellow hairs; second joint of hind tarsi one and a fourth times as long as the first; tegulæ, their cilia and the halteres yellow; wings grayish; veins yellowish, brown, more brown on the outer and costal portion; last section of the fifth vein three times the length of the cross-vein.

Described from one female taken by me at Sacramento, Cal., June 4, 1915. The name was selected because the cross-vein was further from the wing margin than in the known related species.

Holotype, female, in collection of the author.

5. *Medeterus æneus*, new species

Male: Length 2 mm. Face dark green, shining but dulled with pollen; front opaque with gray pollen; proboscis rather small, black; antennæ small, black, third joint rounded at tip; arista apical; lower orbital cilia pale. Mesonotum bronze brown with purplish or coppery reflections and dulled with gray pollen, without any trace of a vitta; center of posterior depressed area green; pleuræ dulled with gray pollen, ground color blackish with green reflections; bristles above fore coxæ yellowish; acrostichal bristles small, in two rows; an area of small bristles above the humeri; dorsal bristles small in front, larger posteriorly; scutellum with one pair of large bristles and a pair of minute hairs just in front of them on the margin; abdomen dark bronze green, first segment more bluish; hypopygium of moderate size, black, its appendages yellowish; coxæ and femora black; broad tips of femora, the tibiæ and tarsi yellow; last tarsal joint of all feet black; fore tibiæ mostly brownish; hind metatarsi half the length of the second joint; tegulæ and halteres yellowish; tegular cilia white; wings grayish hyaline; last section of fourth vein slightly arched so that the third and fourth veins are nearly parallel at their tips; last section of fifth vein one and a fourth times as long as the cross-vein; veins black.

Described from one male taken by me at Los Angeles, Calif., Apr. 27, 1915.

Holotype, male, in collection of the author.

6. *Medeterus cuneiformis*, new species

Female: Length 2 mm., of wing 2.5 mm. Face below the suture greenish with thin gray pollen; face above the suture and the front thickly covered with gray pollen; proboscis rather small, black; antennæ black, third joint of moderate size, rounded, about as wide as long; arista subapical; orbital cilia white, long; mesonotum and scutellum greenish gray, nearly opaque with gray pollen and with a sharply defined, brown median vitta which extends from the front almost to the hind margin of the scutellum; scutellum with one pair of bristles; pleuræ and coxæ black, covered with gray pollen; fore coxæ with pale hairs on the front surface; acrostichal bristles in two rows; four dorso-central bristles on each side inserted in small brown dots; bristles above fore coxæ small, white; abdomen dark green with pale hairs; femora black; broad tips of femora, the tibiæ and tarsi yellow; tarsi darkened towards their tips; second joint of hind tarsi one and a half times as long as the first; tegulæ and halteres yellow, cilia of the tegulæ white; wings grayish hyaline, yellow at base, with a cuneiform, brown spot filling the angle between the second and third veins at the base of the third vein and extending a little back of that vein; third and fourth

veins rather closely approximated at their tips; last section of fifth vein twice as long as the cross-vein; veins brown, becoming darker towards the root of the wing.

Described from four females taken by me at Los Angeles, Cal., Apr. 27 and May 4, 1915.

Holotype, female (No. 514), in collection of the California Academy of Sciences. Paratypes in collection of the author.

7. *Medeterus nitidiventris*, new species

Male and female: Length 2 mm., of wing the same. Face and front covered with gray pollen, face below the suture more blackish; antennæ black, small, third joint rounded, small, scarcely as wide as long; proboscis rather small, black; inferior orbital cilia pale; thorax gray with a median brown vitta which extends from the front nearly to the posterior margin of the scutellum, in some females it is somewhat obliterated posteriorly; pleuræ black with gray pollen; acrostichals in two rows; four dorso-centrals inserted on minute brown dots; scutellum with one pair of bristles; abdomen black, shining, depressed, with gray pollen on the sides, its hairs pale; hypopygium rather slender, extending nearly to the base of the venter, black with its appendages black or testaceous; legs black, knees yellow; tibiæ in the females sometimes yellowish brown; second joint of the hind tarsi of the male about one and a half times, of the female one and a fourth times, as long as the first; tegulæ yellow with a narrow brown border and pale cilia; halteres yellow; wings grayish hyaline; veins brown, a little yellowish at the root of the wing; last section of fifth vein one and a half times as long as the cross-vein; in the female there is a brownish cloud at the base of the third vein which is sometimes very faint, in others distinct but not as sharply defined as in *cuneiformis*. This cloud extends along the third vein, more or less distinctly, nearly to its tip, tinging nearly the whole of the cell between the second and third veins with brown.

Described from one male and two females taken by me at San Francisco, Calif., May 12, to 27, 1915.

This species is very like *cuneiformis* but differs in having the abdomen shining black, the legs wholly black except the knees, and in having the brown cloud more diffused not sharply defined as in *cuneiformis*.

Holotype, male, and paratype in collection of the author.

Allotype, female (No. 515), in collection of the California Academy of Sciences.

8. *Medeterus obesus*, new species

Female: Length 2 mm., of wing 2.25 mm. Face and front blue-green, shining, with but little pollen; antennæ very small, black; arista about apical; proboscis small, black; orbital cilia pale; thorax bluish green with purple reflections, rather thickly covered with brownish pollen, which is more gray on the upper part of the pleuræ; the space between the rows

of acrostichal bristles shining bluish green as is also the center of the scutellum; scutellum with one pair of bristles and a pair of small hairs on the margin; abdomen more green and shining than the thorax; coxæ and femora black; extreme tips of the femora, the tibiæ and tarsi yellow; tarsi a little darker at tips; second joint of hind tarsi nearly twice as long as first; tegulæ, their cilia and the halteres yellow; wings hyaline slightly tinged with yellowish gray; veins yellowish brown; costa brown; last section of fifth vein a little longer than the cross-vein.

Described from one female taken by me at East Aurora, Erie Co., N. Y., July 28, 1915.

A stout little species with the thorax rather thick and the scutellum with one pair of bristles.

Holotype, female, in collection of the author.

9. *Medeterus æqualis*, new species

Male and female: Length 2 mm. Face narrow, brown; proboscis shining black, rather small; antennæ black, small; thorax coppery, with thick gray pollen, leaving a rather sharply defined median vitta which extends to the scutellum but is not very distinct on the depressed area, and a lateral, broad, not distinctly defined vitta on each side of the dorsum; acrostichal bristles represented by a few small bristles in front; bristles above fore coxæ black, very small; scutellum with one pair of bristles; in the female some of the bristles of the thorax are yellowish; abdomen shining black but dulled with gray pollen; hypopygium long and slender, shining black; coxæ and legs black; knees and fore tibiæ more yellowish; second joint of hind tarsi one and a half times as long as the first; tegulæ, their cilia and the knobs of the halteres yellow; wings grayish hyaline; distal segment of fifth vein only a little longer than the cross-vein; fourth vein ending just before the tip of the wing and close to the tip of the third vein; veins black, only a little paler at the root of the wing.

Described from two males and one female taken by me at San Diego, Calif., Apr. 5 and 12, 1915.

Holotype, male (No. 516), in collection of the California Academy of Sciences. Allotype, female, and paratype in collection of the author.

10. *Medeterus frontalis*, new species

Female: Length 3 mm., of wing the same. Face black, below the suture slightly greenish and shining; front thickly covered with brown pollen except a narrow border of gray pollen along the orbits; palpi and proboscis not very large, black with pale hairs; antennæ black, small, third joint very small; arista almost dorsal, as long as the height of the head; lower orbital cilia yellow; thorax with greenish ground color, thickly covered with pollen which is brown on the center of the dorsum and more gray on the posterior depressed area, scutellum and pleuræ; bristles well developed; acrostichal bristles strong, in two rows; scutellum with two pair of bristles, the outer pair about half as large as the central; bristles above fore coxæ small, black; abdomen shining black, with black hairs; legs black with only the tips of the femora yellow; fore coxæ with minute pale hairs and small

black bristles the whole length of the front surface; each femur with a row of stiff hairs below extending its whole length but larger towards the apex; hind tarsi with the second joint one and a fourth times as long as the first; tegulæ, their cilia and the halteres yellow; wings tinged with gray; veins brown; costa black; last section of fifth vein about two and a fourth times as long as the cross-vein.

Described from one female taken by me at Hamburg, N. Y., August 10. Another female taken at the same locality, May 14, has the cross-vein twice its length from the wing margin and the face and front more greenish but undoubtedly it belongs to the same species as the type specimen. I also have a male taken by Mr. Ouellet at Joliette, Quebec, July 13.

Holotype, female, in collection of the author.

11. *Medeterus distinctus*, new species

Female: Length 2.5 mm. Face rather wide, green, darker and more shining below the suture; proboscis black, shining, rather small and with yellow hairs; front opaque with gray pollen; antennæ black, third joint rather small, rounded, a little flattened in outline at tip; arista nearly apical; dorsum of thorax bronze-brown, shining, the gray pollen forming two vittæ, one each side of the acrostichal bristles, which unite with the gray of the posterior depressed area, and a less distinct vitta, abbreviated anteriorly, each side above the root of the wings; disc with a fine greenish line between the two rows of strong acrostichal bristles; bristles above fore coxæ small, yellow, appearing brownish in certain lights; scutellum with four bristles, the outer pair about half as large as the central; pleuræ and scutellum green with whitish pollen; abdomen green, the last two segments more black; hairs of the abdomen yellow; coxæ and legs black with yellow hairs; knees narrowly yellow; the yellowish hairs of the fore coxæ long and stiff; hind coxæ with an erect black bristle; second joint of hind tarsi one and a fourth times as long as the first; tegulæ yellow, knob of halteres yellow with a brownish spot on one side; wings slightly tinged with gray; veins brown, yellow at base; third and fourth veins rather closely approximated at their tips; fourth vein ending just before the tip of the wing; last section of fifth vein a little longer than the cross-vein.

Described from one female taken by me at East Aurora, Erie County, N. Y., June 25.

The greenish color of the face and body, less distinct vittæ of the mesonotum and the proximity of the tips of the third and fourth veins separate this species from *veles* Loew.

Holotype, female, in collection of the author.

12. *Medeterus obscuripennis*, new species

Female: Length 2 mm., of wing the same. Face and front covered with brown pollen; face below the suture more shining; antennæ black, third joint small, rounded; arista nearly apical; thorax dull green, with gray

pollen; marked with a quite distinct median, shining bronze vitta between the rows of acrostichal bristles, continued as a faint brownish line across the posterior depressed area and slight indications of lateral vittæ; bristles above fore coxæ black, small; scutellum with two pairs of bristles, the outer being nearly as large as the central pair, the latter not as long as in some species. Abdomen dark green, almost black, shining but dulled with pollen; coxæ black; legs brown with very short hairs; knees a little yellowish; tibiæ without bristles except a very small one on middle tibiæ at basal third; second joint of hind tarsi one and a half times as long as the first; tegulæ, their cilia and the knobs of the halteres yellow; wings tinged with brownish, especially on the basal half; veins brown; the tips of third and fourth veins rather close together; last section of fifth vein a little longer than the cross-vein.

Described from one female taken on the Berkeley Hills, in Alameda Co., Calif., June 20, by E. T. Cresson, Jr.

Holotype, female (No. 6116), in collection of the American Entomological Society.

13. *Medeterus halteralis*, new species

Male: Length 2.25 mm. Altogether black; face shining black below the suture; upper part of the face and the front opaque with brown pollen; cilia of the lower orbit pale brownish; proboscis large, shining black; thorax black, dorsum thickly and uniformly covered with brown pollen; acrostichal bristles in two rows, small; besides the larger bristles there are some scattering small ones on the fore part of the dorsum. Pleuræ and abdomen a little shining, the latter with black hairs; bristles above fore coxæ blackish, slender; scutellum with four bristles; hypopygium rather short, black, somewhat shining; its appendages long, brownish; coxæ and legs black; fore coxæ with minute brown hairs on the front surface; hind metatarsi half as long as the second joint; tegulæ yellowish brown with a brown border and yellowish cilia; stem of the halteres yellowish brown, knob blackish. Wings grayish hyaline; veins black; last section of fifth vein about equal in length to the cross-vein; root of the wing yellowish brown.

Female: Length 2.75 mm. Legs paler, root of wings, halteres and tegulæ, except the brown border, more yellowish; the bristles above the fore coxæ dingy white; ovipositor blackish.

This female seems to be somewhat immature and although taken on the same tree and at the same time as the male described above it may prove to be a distinct species.

Described from one male and one female which I took at Brule Lake, Ont., Aug. 2, 1911.

This species is very close to *M. modestus* V. D. (Ent. News, Vol. xxv, p. 440), but this male has blackish bristles above the fore coxæ while *modestus* has conspicuous white bristles; the lower part of the face also is more blackish and the halteres are more infuscated in this species.

Holotype, male, in collection of the author.

14. *Medeterus vittatus*, new species

Male: Length 2 to 2.25 mm. Face dark blue-green below the suture, the suture and above including the front thickly covered with brown pollen; proboscis swollen, shining black, as are also the palpi; antennæ small, black, third joint as long as broad, moderately flattened at tip; arista apical, pubescent; thorax brown with two, more or less distinct, pollenose vittæ; acrostichal bristles in two rows, the space between them a little darker than the rest of the dorsum; prescutellar depression and the pleuræ with gray pollen; scutellum black with thin gray pollen and four bristles on the margin, the outer pair the shortest; abdomen shining black with a slight greenish tinge and yellowish hairs, the last segment brownish; hypopygium (Fig. 8) large, shining black, with a well defined dull area covered with pale hairs on the left side, its appendages black; coxæ black; hairs on the fore coxæ pale brown, abundant and long; bristles above fore coxæ black; femora black at base, becoming yellow apically; tibiæ and tarsi yellow; extreme tips of tibiæ and of the tarsal joints usually brownish; first joint of hind tarsi a little less than half as long as the second; tegulæ, their cilia and the halteres whitish; wings with typical venation; veins brown; last section of the fifth vein slightly longer than the cross-vein.

Female: Agrees with male in all but sexual characters. Ovipositor brown with several slender hairs at tip.

Described from nine males and four females, taken by me at Kearney, Ont., July 26, Toronto, Ont., Sep. 2, Niagara Falls, Ont., July 20, and Erie Co., N. Y., July 9.

This is closely related to *nigripes* Loew but it has quite abundant and conspicuous brown hair on the front surface of the fore coxæ, the legs are largely yellow and the first joint of the hind tarsi is somewhat longer in proportion to the second.

Holotype, male (No. 517), from Kearney, Ont., in collection of the California Academy of Sciences. Allotype, female from Kearney, Ont., in collection of the author. Paratypes in both collections.

15. *Medeterus oregonensis*, new species

Length of male 4 mm., of female 3 mm. Face rather narrow, dark metallic blue with a transverse band of white pollen at the suture; front black (the specimens described seem somewhat greasy); first antennal joint dark reddish yellow, second and third black; third joint scarcely as long as wide, rounded at tip, with an apical arista; proboscis black with a few pale hairs; lower orbital cilia yellowish white, rather long; thorax black with brown pollen on the anterior portion of the dorsum and whitish pollen on the posterior depression and on the scutellum. In the male there is a brassy median vitta on the dorsum which extends to the scutellum, three or four black bristles above the fore coxæ and two pair on the margin of the scutellum; abdomen shining with basal third of segments pale greenish, the apical two thirds more bronze-brown; hypopygium shining black, its appendages black; coxæ, femora and tibiæ shining black, tarsi dull black; fore coxæ with brownish black hairs and bristles, hairs of the legs dark brownish, in certain lights appearing more reddish. The female has

the knees dark yellowish; the second joint of hind tarsus one and three-fourths times as long as first. Tegulæ and halteres brown, the former with brownish cilia showing white reflections in certain lights. Wings tinged with grayish; veins brown; venation normal. In the male the last section of the fifth vein is three-fourths as long, in the female a little longer than, the cross-vein; tips of third and fourth veins rather closely approximated in the female, slightly more widely separated in the male; fourth vein ending almost exactly in the apex of the wing.

Described from two males and one female from Ashland, Oregon, reared June 16, 1916, from *Pinus ponderosa*, by F. P. Keen. This species differs from *maurus* Wh. in having the antennæ darker, the cross-vein nearer the margin of the wing, the middle tibiæ wholly black in both male and female (in *maurus* they are yellow in the male), and the appendages of the hypopygium black, yellowish in *maurus*.

Holotype, male, and allotype, female, in collection of the United States National Museum; paratype in collection of the author.

16. *Medeterus planipes*, new species

Male: Length 2.8 mm. Face, front, and thorax bright shining green with violet reflections; dorsum of thorax with a little brownish gray pollen; antennæ blackish, small with slender arista; orbital cilia and bristles above fore coxæ black; scutellum with four bristles; abdomen shining green; hypopygium stout, not elongated, black with slender yellowish appendages; fore coxæ black with yellow tips; middle and hind coxæ yellowish; trochanters yellow; femora black with yellow hairs; tibiæ and tarsi pale yellow with fifth tarsal joint black and small, nearly as wide as long; fore tarsi plain, tapering from base to tip; fourth and fifth joints of nearly equal length; hind metatarsi a little shorter than the second joint; tibiæ with pale hairs; middle tibiæ with one black bristle above, three on the side on basal third, and black spurs at tip; posterior pair with a few yellow bristles near the tip and one black bristle near the base and another at tip; tegulæ brownish, their cilia and the halteres yellow; wings grayish with typical venation; last section of fifth vein about as long as the cross-vein; costa brown, veins yellowish.

Female: A female taken with the male described above has the first antennal joint yellow and all coxæ blackish.

Described from one male and one female taken at Los Amates, Guatemala, Feb. 18.

Holotype, male, and allotype, female, in collection of the author.

17. *Medeterus flavipes*, new species

Male: Length 3 mm. Face and front violet, shining; thorax green with violet reflections on its anterior half, almost wholly violet along the front; abdomen shining green; antennæ black small; lower orbital cilia black, but with pale hairs on the lower part of the head behind the cilia;

coxæ and femora black; fore tibiæ blackish; middle and hind tibiæ yellow with black hairs, the latter with a row of yellow hairs below and rather long numerous yellow bristles above, the bristle at tip black; fore tarsi yellowish, first joint a little compressed and considerably widened at tip, second and third joints much compressed, second about as long as wide with a thumb-like projection above at tip; third much expanded upwards; fourth and fifth minute, black or partly black; middle and hind tarsi infuscated towards their tips; their second joint one and a half times as long as first; tegulæ, their cilia and the halteres yellow; wings with typical venation; last section of fifth vein about as long as the cross-vein.

Apparently there are six bristles on the edge of the scutellum, but in the type specimen they are all broken off, leaving only the scars to mark the places of insertion.

Described from a single male taken at Los Amates, Guatemala, Feb. 18.

Holotype, male, in collection of the author.

18. *Medeterus abruptus*, new species

Male: Length 2.8 mm. Face, front, and anterior part of the thorax violet, remainder of the thorax and the abdomen shining green; first antennal joint black (other joints missing in type); lower orbital cilia yellowish; scutellum with four bristles; hypopygium black with yellow appendages; coxæ and fore and middle femora blackish; fore femora broadly, middle narrowly, yellow at tip; hind femora yellow, blackened a little at base; tibiæ and tarsi pale yellow with yellow hairs and bristles, the bristles at tip of tibiæ and one small one near base of middle tibiæ black; tarsi a little infuscated at tip; fore tarsi one and a half times as long as their tibiæ; first three joints a little compressed with a fringe of small black hairs above; first joint nearly as long as the three following taken together; third joint abruptly narrowed to a slender projection to which the fourth joint is attached; fourth small but slightly swollen; fifth slender; the projection at tip of third joint together with the fourth and fifth joints form a very slender tip to the fore tarsi; second joint of hind tarsi nearly twice as long as the first. Tegulæ their cilia and the halteres yellow. Wings with typical venation; veins and costa yellowish; last section of fifth vein only slightly longer than the cross-vein.

Described from one male taken at Pt. Barries, Guatemala, March 3.

M. planipes, *flavipes* and *abruptus* are remarkably alike in appearance but differ widely in the formation of the fore tarsi.

Holotype, male, in collection of the author.

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IX

DESCRIPTION OF A NEW FOSSIL FISH FROM JAPAN

BY DAVID STARR JORDAN



Iquius nipponicus Jordan, new genus and species

Type (No. 441, Museum California Academy of Sciences) is a well preserved imprint of the anterior three-fifths of a small fish from the island of Iki, off the north coast of Kiusiu, Japan. The portion preserved is four inches long, the whole fish probably about seven.

Head 1.3 times in depth at front of dorsal; eye 2.5 in head; gape of mouth 4 in head; length of mandible 5; height of dorsal 1.6 in head; length of pectoral 1.43; length of ventral 1.5.

Dorsal rays I, 8; pectoral 16; ventral 14. Vertebrae to front of dorsal 12; to first interspinal 10; abdominal vertebrae about 23 (some lost); total probably not far from 36.

General form like that of a herring; the occipital region rather depressed, the nape rising moderately behind it; snout apparently short, a little more than half eye, probably rather acute; mouth small, oblique, the lower jaw shorter and rather thin, but with a broad base at insertion; both jaws apparently with small bluntish teeth, one near tip of lower jaw larger.

October 22, 1919

(These statements as to the mouth may be fallacious as the bones may be distorted.) Eyes very large, separated by the sphenoid bone which lies at the base of the skull. Opercular bones entire; preopercle narrow, opercle broad. Head apparently scaleless, but there are marks on the snout as of small scales. (These are probably fallacious.)

Vertebrae small, the anterior not modified, all about as deep as long, hour-glass shaped anteriorly, less so behind, neural spines straight, rather weak, directed backward; dorsal interspinals rather strong, the anterior ones especially; ribs moderate, curved, not directed strongly backward.

Dorsal short and rather high with one appressed spine or simple ray, about half the height of the first soft ray, the rays rapidly shortened backward, the last ray not one-third the height of the first; pectoral inserted low, the lower rays shorter and much weaker than the upper; ventrals about under third ray of dorsal, the rays rather strong; 14 rays are present which number may include both fins, but in appearance there is one fin only.

Scales small, thin, rounded, cycloid, looking like herring scales. These are evident along the line of the back and elsewhere. No dorsal scutes, the scales being all of the usual type; no trace of ventral scutes, but the ventral outline is not well shown.

This specimen is apparently the first fossil fish yet recorded from Japan. It is embedded in firm grayish chalky rock, resembling the Miocene deposits about Los Angeles, much firmer and heavier than the Celite of Lompoc. The horizon of the deposits on the island of Iki are probably of Tertiary age if I may judge from this specimen alone. The genus *Iquius* is characterized by the short dorsal with a simple appressed ray in front as in most Cyprinidae, by the small mouth with included lower jaw, and by the evident teeth, one of them apparently enlarged. The dorsal fin is more like that of Cyprinoid fish, but the general structure suggests that of a herring and the vertebrae are isospondylous and I place the genus provisionally among the Clupeidae. In its mouth parts it bears some resemblance to the living genus *Clupeichthys*.



Iquius nipponicus Jordan. Type.



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X

Notes on the Avifauna of the Inner Coast
Range of California

BY
JOSEPH MAILLIARD
Curator, Department of Ornithology.



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NOTES ON THE AVIFAUNA OF THE INNER COAST
RANGE OF CALIFORNIA

BY

JOSEPH MAILLIARD
Curator, Department of Ornithology



In this paper are presented some of the results of field work done by the writer and Mr. Luther Little, assistant curator, in the inner Coast Range from Mt. St. Helena in Napa County, Calif., and northward to Mt. Sanhedrin in Mendocino County.

Leaving San Francisco on the morning of April 10, 1919, we reached Mt. St. Helena Inn about 3:00 P. M. the same day. On the way to Vallejo attention was given to the gulls which followed the boat. I wished to note the color of feet of the immature Western Gull (*Larus occidentalis*) over which there has been recent controversy. Very few of this species were seen, but there were some stragglers still left, and among them immature birds which sailed so close to the upper deck as to make examination an easy matter. We found their feet to be of a dingy flesh color.

November 25, 1919

The Mt. St. Helena Inn is a little over seven miles from Calistoga on the toll road to Middletown (Lake Co.), just over the top of the pass at the southeasterly end of the southernmost peak of the mountain itself, which rises abruptly from the long ridge extending several miles to the southeast and constituting the easterly wall of Napa Valley. The altitude of the pass is 2300 feet. Mt. St. Helena is the most southerly of the higher mountains of the inner Coast Range north of San Francisco Bay, with an altitude given variously on different maps, the greatest of which is 4337 feet for the highest of its three peaks. Its upper slopes are for the most part covered with rocks and brush, with forest extending up the sheltered ravines in some places nearly to the top. The brush is principally scrub oak, chamisal, and manzanita, with some ceanothus.

Near the top are found a few of the trees and plants of the Sierran association, such as yellow pine (*Pinus ponderosa*), sugar pine (*Pinus lambertiana*) and mahala mat, or squaw grass (*Ceanothus prostratus*). The character of the valleys on each side of most of these inner Coast Range mountains is Upper Sonoran, but the higher peaks of the long ridges still find enough moisture in the breezes from the sea to lift them and their northern slopes from their surroundings and enable them to form an island of Transition, Mt. St. Helena and its immediate vicinity being the southernmost part of this island.

On the northerly side of the mountain, and on the nearby ranges, the slopes are very steep and heavily covered with forest or brush, even down to a comparatively low altitude, and grassy or arable spots are few and far between for many miles, as are human habitations.

Dr. Walter K. Fisher spent something over two weeks in this place in 1900 (Aug. 29 to Sept. 14), the result of his observations appearing in *The Condor*, Vol. II, 1900, p. 135, wherein he gives a detailed list of the arboreal flora and the avifauna of this region. To quote from this paper:

"Some of the forms on Mt. St. Helena are characteristic of the drier inland districts, while nearly related races are found in the humid coast belt just to the west. . . . Thus we have closely related but ordinarily rather widely separated races brought close together."

This description is applicable to a great part of this region, both south and north of Clear Lake. Dr. Fisher's visit, however, was in the early fall, extended over a much longer period than ours, and evidently covered much more territory. Ours was in the spring, too early for many of the summer visitants, and was confined to the Transition zone. Fisher listed 57 species of birds, while we noted but 35, not counting some others met with at our next stopping place, which was two miles further on and could be said to be still a part of Mt. St. Helena. On the other hand, we noted 14 species not mentioned by him, as follows:—Sharp-shinned Hawk (*Accipiter velox*), Cabanis Woodpecker (*Dryobates villosus*), Western Flycatcher (*Empidonax difficilis difficilis*), Western Crow (*Corvus brachyrhynchos hesperis*), California Purple Finch (*Carpodacus purpureus californicus*), Golden-crowned Sparrow (*Zonotrichia coronata*), Western Chipping Sparrow (*Spizella passerina arizonæ*), Sierra Junco (*Junco oreganus thurberi*), Shumagin Fox Sparrow (*Passerella iliaca unalaschcensis*), Yolla Bolly Fox Sparrow (*Passerella iliaca brevicauda*), Barn Swallow (*Hirundo erythrogaster*), Lutescent Warbler (*Vermivora celata lutescens*), Audubon's Warbler (*Dendroica auduboni*), and Monterey Hermit Thrush (*Hylocichla guttata slevini*). Of these the Golden-crowned Sparrow, Shumagin Fox Sparrow, and Yolla Bolly Fox Sparrow were only lingering or passing migrants, but the others either bred there or not far away, in all probability. The Monterey Hermit Thrush, however, must have been merely a wanderer, a few miles only to the eastward of its known breeding ground.

Of Fisher's list the *Toxostoma* is evidently the Sonoma Thrasher (*Toxostoma redivivus sonomæ* Grinnell), and the *Chamæa* mentioned is *Chamæa fasciata henshawi*, a change in name only. While he was right in saying that this latter form resembles that of southern California, it is hardly typical, being somewhat intermediate toward *rufula*. His remarks concerning the Blue-fronted Jay (*Cyanocitta stelleri frontalis*), are of interest in view of our present knowledge that these two forms extend down the Russian River valley to the actual sea-coast (Sierra Forms on the Coast of Sonoma County, California, J. Mailliard, *The Condor*, X, 1908, p. 133). His California Jay does not seem to me to be separable from the

coast form, but his two towhees respectively approach the Sacramento Towhee (*Pipilo maculatus falcinellus* Swarth), and the Northern Brown Towhee (*Pipilo crissalis carolæ* McGregor). Other changes in his list would be only cases of up-to-date changes of nomenclature.

Curiously enough, Dr. Fisher did not mention the Sierra Junco (*Junco oreganus thurberi*), which we found breeding there. As we were being shown to our sleeping quarters at the Mt. St. Helena Inn, shortly after our arrival there on the afternoon of April 10, one of these birds with something in its mouth attracted my attention, and later search developed a nest in course of construction near the top of the excavated bank just back of the building. This nest was among the roots of a small oak growing on the very edge of the top, and the nest was nearly hidden by vines that covered the bank as well as protected it from the sun and ordinary rains by a slight overhang of earth. Returning to this place on May 3 we found that the nest contained five heavily incubated eggs. Nest, eggs and one parent (No. 19858, C. A. S.); were taken for the breeding record, as being the first for the locality.

Perhaps the most important result of our visit was the finding of the Yolla Bolly Fox Sparrow (*Passerella iliaca brevicauda* Mailliard) on Mt. St. Helena, apparently well established there. In the brush, from an altitude of about 2800 feet up to the top, they were quite numerous during our four days' stay, but wild as are most of this genus outside of the breeding season. It was an easy matter to "squeak them up" near one, but they would appear on the tops of the bushes only to dart down again at the slightest motion the observer might make. In spite of this characteristic, several specimens were obtained. At this date it seemed possible that this sparrow might be breeding on Mt. St. Helena, as it was so close to the nesting time, but a later visit (on May 3) failed to develop any sign or sound of fox sparrows. It is reasonable to suppose, from the number and actions of those we found there, that this locality must be within the general winter habitat of the Yolla Bolly Fox Sparrow, probably about the southern limit except for occasional straggling, but it will need some further seasonal observations to determine this. Specimens have been taken

often in southern California in winter, but no well populated wintering ground south of Napa County has yet been found.

A few fox sparrows of other forms were found among the Yolla Bolly which were evidently passing migrants, on their way to their more northern breeding grounds.

The weather during our stay here was chilly most of the time, rainy and consequently gloomy some of the time, and far from favorable for such observations as we wished to make, and as we were working almost altogether in the forest or brush of the Transition zone, this may account in part for our small list of birds noted. In addition to this, most of the winter visitants had left and it was too early for the summer influx. This latter fact, however, was to our advantage in that we could note the date of arrival of the summer visitants as they appeared. The Western Flycatcher was the only species of the latter found in the higher altitudes at this date, the first being noted on April 1.

The Sacramento Towhee seems to be the race inhabiting this locality, and is true to form as regards relative size of feet, but in coloration it appears to intergrade with *falcifer*, whose territory lies only some twenty or thirty miles westward in the more humid strip near the coast.

The Northern Brown Towhee of this region also somewhat approaches the coast form, *crissalis*, but can be easily distinguished. The Black-throated Gray Warbler was found in Transition here, and there seems to be every probability of its nesting, but this was not proved, few individuals being seen and none taken. Fisher mentions this species as being very numerous at the time of his visit in the late summer.

This locality was last visited on May 3, to ascertain if the Yolla Bolly Fox Sparrows were breeding here. That afternoon Mr. Little went up to the top of the first peak, while I remained lower down at the levels in which we had taken them previously, but not an individual was seen nor a note heard. It is barely possible that some might be breeding on one of the other peaks, neither of which is very much higher than the south peak we were on, but bad weather with dense fog set in, after a hot spell we had been having, showing signs of considerable duration. There being small likelihood of our finding any fox sparrows there the idea of further investigation was

abandoned, especially as upon the mountains to the north of this it does not appear to breed below 4500 feet at the lowest, this altitude corresponding with my experience in the Sierras at about the same latitude.

MOUNTAIN MILL HOTEL

As this expedition was more in the nature of a prospecting trip for the purpose of ascertaining as nearly as possible what localities in the area selected might be the most interesting for more protracted examination, our stay at Mt. St. Helena was limited to four days only, and on the afternoon of April 14 we moved down the grade, on the northerly side of the ridge, two miles to the Mountain Mill Hotel. This place is a small hostelry just inside the Lake County line, at an altitude of perhaps 1500 feet. It is situated in a very narrow valley one side of which really forms the east, or northeast base proper of Mt. St. Helena, and is visited chiefly at this time of year by anglers.

At the bottom of this valley is a creek named on some maps the St. Helena Creek, which runs past Middletown into the Putah Creek, flowing into the Sacramento River basin.

At this point Transition mingles with Upper Sonoran, and close around the buildings are a few small open areas, almost swallowed up by brush and woods, but for some miles down stream it is all heavy forest, with the valley narrowing into a canyon only to widen into a valley again as Middletown is approached. The locality at first appeared to be a very likely one for numerous species of bird life, but we were doomed to disappointment, for birds were scarce. In fact, they appeared to be scarce almost everywhere in the Transition zone. Here we came across more of the summer visitants, such as the Western House Wren (*Troglodytes aedon parkmanni*) and Cassin's Vireo (*Lanivireo solitarius cassini*), seen on April 15, and the Pacific Black-headed Grosbeak (*Zamelodia melanocephala capitalis*), on April 16. Along the stream were a few Marin Song Sparrows (*Melospiza melodia gouldi*), acting as if they took a great interest in the locality with a view to raising families there.

There was little suitable brush for fox sparrows nearby, but about half way up on a road leading to a walnut orchard and

country home, called "Montesol," high up on the ridge upon the east side of the valley, there was a break in the woods at about 1600 feet elevation showing a few acres of brush, and in this spot on April 15 and 16, I succeeded in "squeaking up" two or three of these birds and securing one Yolla Bolly on each occasion. The brush was too dense to allow of penetrating far or more might have been obtained.

Besides the song sparrows, the Western Winter Wren (*Nannus hiemalis pacificus*) was found along the stream. From its actions it was apparently breeding there although no nests were discovered. A flock of Cedar Waxwings (*Bombycilla cedrorum*), was noted by Little at the old Mirabel quicksilver mine, long abandoned and a likely looking place for bats (some of which he found there), on April 16. This place, however, was some miles down stream from our stopping place and in Upper Sonoran.

The weather turned so bad here, with a heavy rain all day on April 17, making everything in the forest and brush so wet and bedraggled, that we decided to move further inland, and on the morning of April 18 we went by auto to

HARBIN SPRINGS, LAKE COUNTY

This place is also in a narrow valley—almost a canyon—with some fairly open ground on which grow scattered oaks and digger pines (*Pinus sabiniana*) but most of the surrounding hills are very steep and covered principally with brush, of which a large proportion is chamisal and with trees in the sheltered places and ravines. On the way to Harbin Springs we passed through Middletown, four miles distant, which is in an Upper Sonoran open country at about 1200 feet elevation. We noted in traveling through many of the common birds natural almost anywhere at this latitude to country of like character in central California. Soon after leaving Middletown the road commences to ascend until it reaches the springs at about 1600 to 1800 feet altitude with the whole face of the range, here with a southerly exposure, in Upper Sonoran clear to its summit, which much reach something like 3000 feet elevation.

The afternoon of our arrival a recently commenced nest of Cassin's Vireo (*Lanivireo solitarius cassini*), was pointed out to us by a lady who was staying at the hotel and who had noticed the birds building in a live oak tree under which she was sitting. This nest was again visited on April 24, but no eggs as yet had been deposited. The following summer visitants were first met with at this point:—California Yellow Warbler (*Dendroica aestiva brewsteri*), April 18; Western Warbling Vireo (*Vireosylva gilva swainsoni*) and Bullock's Oriole, April 19; Long-tailed Chat (*Icteria virens longicauda*), April 20; Western Wood Pewee (*Myiochanes richardsoni richardsoni*), April 21; Ash-throated Flycatcher (*Myiarchus cinerascens cinerascens*), and Lazuli Bunting (*Passerina amœna*), on April 22. These dates might be considered as fairly approximating the actual dates of arrival for the respective species, for the reason that we had not met with them before in spots where one would reasonably expect to find them.

Up to this point we had not found any *Thryomanes*, nor positively identified its song, in spite of the fact that Fisher had reported it as "taken in the open chaparral, where it was apparently common" on Mt. St. Helena, but in the chamisal brush at Harbin Springs we heard several and captured one, which proved to be the San Joaquin Wren (*Thryomanes bewicki drymæcus* Oberholser), but intergrading toward *marinensis* Grinnell. The scarcity of this genus in the territory we covered is rather remarkable, as no specimens were taken after leaving this place, although we were constantly on the lookout for it. The form *marinensis*, or Nicasio Wren is the nearest neighbor to the *drymæcus*, or San Joaquin Wren at this point, being found, as with the other humid coast forms only 25 or 30 miles to the westward.

A couple of the Yolla Bolly Fox Sparrows were found here also, at an altitude of about 2000 feet, their actions indicating that they were paired, although as only one was taken this could not be proved. These two birds were in some low, flattened down wild grape vines alongside a road on a steep hillside and seemed to be accompanying a small flock of Golden-crowned Sparrows (*Zonotrichia coronata*). One of the fox sparrows was taken and the other hung around for some little time, but kept under cover so well that it was not secured. Mr.

Little climbed to the top of the mountain range back of the springs in search of fox sparrows but failed to find any suitable brush for them. He brought back with him a thrush which I have placed with the Monterey Hermit Thrush (*Hylocichla guttata slevini*), but which seems to be intermediate between that form and *nana*.

Here we found the Slender-billed Nuthatch (*Sitta carolinensis aculeata*), and the Plain Titmouse (*Bæolophus inornatus inornatus*), for the first time on the trip. The Black-throated Gray Warbler (*Dendroica nigrescens*), we found present in considerable numbers, with indications of its breeding there, or in the vicinity. Unfortunately, on a reconnaissance of this sort, time does not permit one to devote much attention to the finding of nests, which is often slow, tedious work, for the spring-time passes rapidly and we had much to do. Besides our ornithological work we set out traps for small mammals every night, which had to be attended to in the mornings before we could think of the birds. So it can be said that our discovery of nests was more or less incidental, although ever on the watch for signs of them. There were very few Blue-fronted Jays in this part of the country, but we were informed that they gather here in numbers during the fall and winter.

Having examined this locality as much as we desired at this time, on the evening of April 24 we moved to

CASTLE SPRINGS, LAKE COUNTY, CALIFORNIA

This place is a resort with various sorts of hot and cold springs, four or five miles west of Middletown, on Castle Mountain at an altitude of about 2800 feet. The buildings are situated upon a short, steep-sided spur projecting from the eastern slope of the range, with the mountain rising back of it several hundred feet higher. While there are extensive tracts of timber on the east side below this elevation, most of the country above it is covered with brush, the timber running up only in the deeper gullies and canyons. A large proportion of the brush is chamisal, with patches of ceanothus, and thick growths of small spindly trees of various sorts, the whole mountain showing evidences of having been frequently swept by fires, which might account for the scarcity of rodents.

The principal object in visiting this place was to ascertain if any fox sparrows might be breeding on the mountain, but, although there seems to be sufficient brush of suitable sort to attract them, it was evidently not at a high enough altitude to meet their needs.

A few individuals of small-billed races of fox sparrows were still loitering on their northward journey to their distant breeding grounds, of which one or two were taken, but no Yolla Bollys.

Except for the species commonly found about gardens and dwellings in this central part of California, birds were notably scarce, although there was water in abundance in the springs and small streams—the latter in ravines too steep and rough for us to follow far. A number of Sonoma Thrashers inhabit the brushy hillsides, and their diversified vocal outpourings were most pleasing. At times none could be heard, at other times one or two would break into song for short periods, while again other individuals, from the top of some bush, would go through their entire repertoire only to repeat it again and again until a real or fancied danger caused a sudden dive into the thicket. The Pallid Wren-tit (*Chamaea fasciata henshawi*), also was here in abundance, in some parts their peculiar trilling notes seeming to come from all sides. Other birds and small mammals being so scarce and hard to find, a move was made on the morning of April 27 to

GLENBROOK, LAKE COUNTY, CALIFORNIA

At one time a well known resort for hunters and fishermen, this place at present is conducted as a sort of farm that will accommodate guests if they appear. It is situated at the northern base of Mt. Cobb, 12 miles west of Middletown on the road to Kelseyville and Lakeport, and is also on Kelsey Creek, which flows into Clear Lake. It is three miles west of Cobb P. O. in Cobb Valley, at an elevation of about 2300 feet, the divide, between this valley draining into Clear Lake and the Middletown Valley draining into the Sacramento River basin, being a short distance above Cobb. Here we found the vegetation much behind what we had so far been encountering, it being at about the same stage as that on Mt.

St. Helena upon our first arrival there, April 10. And here also the country gave even more evidence of Sierran characteristics in the way of magnificent yellow pines (*Pinus ponderosa*) growing in the fairly level fields of the valley, with sugar pines (*Pinus lambertiana*) on the hillsides nearby. The wild flowers were especially noticeable in their abundance and beauty, great beds of bleeding heart (*Dicentra formosa*) being perhaps among the most attractive.

We had been informed that the top of Mt. Cobb was easily reached from this spot, but found that this was not the case, as it is some six miles away and reachable only by a somewhat dubious trail. However, as we had been on two sides of the mountain and had been unable with our glasses to locate anything that looked like favorable brush for fox sparrows, together with the fact that its height was under 4000 feet, we decided that an attempt to reach the top would not be worth the while.

Around and in the farm orchard at Glenbrook there were more of the commoner species of birds, especially of song birds, than at any place we had so far seen on the trip. At the time of our arrival the avian chorus was certainly a fine one, with Linnets, California Purple Finches, Western Warbling and Cassin's Vireos, Marin Song Sparrows, Western House Wrens and Western Robins doing their utmost to swell it nearby, while from the distance came the notes of California Woodpeckers, Mountain Quail, Long-tailed Chats, etc., occasionally enlivened by the call of a Red-shafted Flicker.

We had reached this spot in time for lunch, soon after which we separated for a reconnaissance of the surrounding country, which appeared to be very favorable for bird life. But, as was the case at the other places visited, we found the birds much more numerous near the habitations than further away, although we soon heard the chorus greatly augmented by the rollicking tones of the Western Purple Martin (*Progne subis hesperia*), a small flock of which was trying to make up its mind as to which of a number of likely looking trees it would choose for its summer headquarters.

The surprise of the afternoon was when Little came upon a hummer that proved to be the Calliope Hummingbird (*Stellula calliope*), and hastened back with the report that he had

seen several in a little pocket in the hills where the wild white lilac was blooming in profusion. Going at once to the spot we endeavored to study their actions and to secure some specimens, both of which were somewhat difficult matters because of the shyness and rapidity of motion of the birds.

As soon as the traps had been visited on the morning of April 29, we repaired to the wild lilac patch to watch the hummingbirds, in order, if possible, to discover the reason for their presence in such a supposedly out-of-the-way place for the Calliope. Away from the Sierra Nevada Mountains there are but few records for the state except in the extreme north and south, and there solely upon high mountain ranges, the only authentic ones being of migratory birds. Singularly enough, however, there are two or three from the vicinity of Oakland, Berkeley, and Hayward, Alameda County (Pacific Coast Avifauna, No. 12, A Distributional List of the Birds of California, p. 88). There were, apparently, no trustworthy breeding records for any part of the state below 4000 feet, hence it was a matter of great interest to know what these birds were doing in this place at an altitude of only 2300. Their activities seemed to be confined to this sort of small, southerly exposed pocket lying against a low hill on one side, whose slope was covered with the white lilac in full bloom. On the east and south sides was the forest running up into the high hills, with its nearest edge partially cut over, while to the westward the little pocket opened out into the larger valley, forming a warm and sheltered nook. In its center ran a very low little ridge covered with scattered pine and oak trees, with here and there bunches of lilac and manzanita bushes among which small fir, pine and oak saplings were growing, at whose feet were many wildflowers—altogether a most favored spot.

There were several hummers darting about at the moment of our arrival that morning, among them being one or two Anna Hummingbirds (*Calypte anna*). Of the Calliopes there were mostly males in evidence, the females either being much scarcer or else keeping more out of sight—a point not definitely determined. The courting actions of the Calliope were as follows:—The males would poise in the air, each individual seeming to remain in his particular plane—that is, neither rising nor falling—for quite a prolonged period, often turning

around from side to side on an even keel, as it were, and back again, evidently on the lookout for females. The latter would be sedately sitting on a bare twig or dead limb, usually of a low bush, and very difficult for us to locate. From time to time they would emit a peculiar sort of *grunt*, if that will convey the idea, this word being defined in the dictionary as "a deep, guttural sound" and it was, relatively speaking, both deep and guttural—for a hummingbird! The male apparently caught this sound, or else caught sight of the female—it was impossible to say which came first, for it seems most probable that the sound was meant to attract his attention—and would immediately dart to the spot, at once commencing the ascending and diving antics common to all, or most, species of hummingbirds. There is a peculiar tone to the whizzing sound that the Calliope makes in the downward rush which could hardly be mistaken for that made by any other species, once it is fastened in the observer's mind, and this distinctiveness is accentuated by a very characteristic squeak given at or near the lowest point of the dive. The birds are so small and their evolutions so rapid that it is extremely difficult for the eye to follow them. Between times the males would perch on, or near, the top of an oak or fir sapling, from which they would have a good view, and remain quiet, perhaps just resting, for short periods, but were very difficult to approach. It was hard to determine whether their leaving their post of observation was due to fear of approaching danger or only the result of a sudden impulse that would have caused them to take flight anyway.

When shot they are exceedingly hard to find, small as they are and with so little brilliant coloring. In fact, even on open, practically bare ground they are by no means easy to retrieve. The safest way to procure specimens of the males was to watch in some promising spot which was fairly open, with but little grass or trash on the ground, and to shoot them from a distance with a good-sized load of dust shot as they poised in the air. There was little chance of more than one or two pellets out of the charge striking such a small object as one of these hummingbirds at twenty to thirty yards, there actually being quite a chance of none striking at all. Seven were secured at this time, five males and two females, and several lost. One of the females contained the

yolk of an egg of about full size. There was no sign of shell but it was probably the first of the clutch and would have been laid inside of forty-eight hours.

The country roundabout was searched for more of this species of hummingbird, especially where the wild lilac was abundant, but on this occasion only one other individual was positively identified, and this was a female, taken on the Mt. Hannah side of Cobb Valley at an altitude of about 3000 feet. This bird was noted among the inner and at the same time lowest dead branches of a large, umbrella-like black oak, which had no limbs for quite a height. After being watched for some time and no nest discovered this female was taken for the record.

Later developments with another bird under somewhat similar conditions lead me to believe that this female actually did have a nest high up in this oak tree, probably in the building stage. A few other hummingbirds were seen in the brush but none near enough for identification, and none was found performing courting evolutions except in the spot above described.

A second visit was made to Glenbrook, June 3 to June 5, in company with my brother, John W. Mailliard, and the results of this visit, as far as concerns the Calliope Hummingbird, may better be given here as a sequel to what has just been written. On the morning of June 4 the spot where these hummingbirds had been found on our April visit was examined, but not a trace of one was seen. The flowers had all disappeared, and so had the hummingbirds. Later in the morning a trip was made by auto up the old road to Adams' Springs, alongside of which the female Calliope mentioned above was taken in the oak tree, but hardly a hummingbird was seen and none identified. Returning to Glenbrook for lunch we found the early afternoon too hot for any satisfactory work abroad, and leaving Little to finish up some inside work my brother and I adjourned to a shady spot under some alder trees by the brookside, only a few rods from the house, as being a pleasant and favorable place in which to watch for birds. While we were sitting there, some few yards apart, a female Calliope Hummer came and fed upon a wild columbine almost within arm's reach of my brother. Shortly before this I had noticed a faint buzzing sound overhead when passing

under a certain tree—so faint as not to be recognized as being made by a hummingbird—but after seeing this female so close to the place our suspicions were aroused and we finally succeeded in locating a nest, finding it to contain two young almost ready to fly, and proving beyond doubt that the Calliope Hummingbird was breeding in this locality. The parent of this nest and the two young are respectively Nos. 19957, 19958 and 19954, C. A. S. The nest was saddled on a small dead limb, close to where it came out of a bunch of larger limbs that were alive, and situated in such a way that it was well sheltered from sun or rain by the largest limb of all. Barring the mountains in extreme northern and southern California, this is the first absolutely reliable, published record of the nesting of this species west of the Sierras and below 4000 feet altitude.

Returning to the earlier visit to Glenbrook, on the morning of April 30 I went up the old road to Adams' Springs before spoken of to a little way past the nearest summit. The first mile of this road at this end is entirely in the brush country, manzanita, white lilac, chaparral, etc., which here is interspersed with the Macnab cypress (*Cupressus magnabiana*). Very few birds were seen until some timber near the summit of the road was reached, in which were some vireos and warblers, and among the latter was a male Calaveras Warbler (*Vermivora ruficapilla gutturalis*), which was the only one noted on the whole trip. Just beyond this stretch of woods lay an open hillside field of perhaps ten acres in extent covered with short green grass, near the middle of which was a swampy spot, of maybe one acre or less, that was occupied by a small colony of red-winged blackbirds. Being high up in the hills, and surrounded by forest and brush, it was about the last place in which one would expect to run across these birds.

There were several small colonies of them scattered through Cobb Valley wherever swampy. Several specimens were taken, in the valley and on the mountainside, which seem to be in no way different from the Bicolored Red-wing (*Agelaius phoeniceus californicus*) of Marin and Sonoma counties bordering on San Francisco Bay.

Both Audubon's Warbler (*Dendroica auduboni auduboni*), and the Black-throated Gray Warbler (*Dendroica nigrescens*)

were present in limited numbers at Glenbrook and the surrounding hills, a juvenile not long from the nest of the former and a female of the latter with an egg in the oviduct proving that these two species breed here.

The juvenile Audubon escaped in some thick brush, but the female Black-throated Gray, taken on May 2, is No. 19940, C. A. S.

Several pairs of the Sierra Junco (*Junco oreganus thruberi*) were seen in Cobb Valley and a male was taken near Glenbrook on May 2 for the record. Golden-crowned Sparrows were still in evidence that morning, several being seen near the buildings in a hedge that seemed to be a favorite shelter for this species throughout our stay there. This date may be of some interest in the way of comparison of dates of migration of this species at various points.

Around Glenbrook, as was the case in regard to most of the localities visited on this trip, there was very little trash lying on the ground in the woods or under the brush, nor many dead leaves even where there were no signs of recent fires. In fact, the surface of the ground was remarkably bare in most places, as if all the leaves and branches that fell had either been burned up or washed away by extremely heavy rains, but there were neither ashes nor gullying to certify to either of these causes for the absence of organic matter.

One of the results of this condition was that but little cover existed for insects or small rodents, and the scarcity of the former may have more or less effect upon the bird life of the country, especially as concerns those species of birds which seek their food principally on the ground.

The vicinity of Glenbrook having been pretty well prospected by May 3, we started back for San Francisco, stopping overnight at Mt. St. Helena to have another look for fox sparrows, as related in a former paragraph. Finding nothing of interest there and the weather being greatly against us, we returned to San Francisco on May 4 to overhaul specimens and refit for further work in other localities.

In a paper published by Dr. Witmer Stone in 1904 (Proc. Acad. Nat. Sci. Phila., 1904, p. 583), the Thick-billed Fox Sparrow (*Passerella i. megarhyncha*) was mentioned as having been taken in late spring and summer on Mt. Sanhedrin, California, a mountain mostly in Mendocino County, and pre-

sumably breeding there. As, however, the Yolla Bolly Fox Sparrow (*P. i. brevicauda*) had since that date been found to be the form breeding in the mountains not far north of Sanhedrin, and as the breeding range of the Thick-billed Fox Sparrow has never been definitely determined, (Swarth, Proc. Biol. Soc. Wash., Vol. 31, p. 162) it seemed to be worth while to follow this matter up, especially as we had been examining the country not far to the south of this point, and had found the Yolla Bolly to be quite common there in the early spring, as shown in the first part of this paper. Hence our further prospecting was planned with this end in view and on May 16, Mr. Little and I proceeded, via Willits on the Northwestern Pacific R. R., to a point from which, we were informed, it would be an easy matter to reach the top of Mt. Sanhedrin, this being a place called Hearst, on a fork of the Eel River about 16 miles to the eastward of Willits. We found that Hearst is only a post office which used to be close to the county bridge, called the Hearst Bridge, but which has been moved up the valley two miles and is now at a summering place called Emandal. We staid at the Eel River Inn, close to the Hearst Bridge. There is no actual settlement in this part of the Eel River Valley other than an occasional farmhouse or resort for hunters or fishermen.

As had often before been the case we found the top of the mountain much farther away than we had been led to suppose, it being in this case about ten miles off, and not the easy walk our informant had spoken of. There is a road, however, leading through a large private holding at this spot and at an opportune meeting with the owner permission was obtained to use it, ordinarily kept closed by a locked gate. On May 21 a rig was secured and with a chance acquaintance Little succeeded in reaching a point from which he could find his way to the top on foot. Sanhedrin is a long, ridge-like mountain, and at this end no suitable brush for fox sparrows was found, all this part of the summit being covered with a dense growth—where the rock permitted any at all—of young oaks about two feet high, which had apparently leaved out early and had then been frostbitten, giving the whole growth a reddish appearance that had been noted by us as far away as the Hearst Bridge.

Although the mountain is something over 6000 feet high at the point here visited but few birds were noted that were not found down at the river level, which was about 1300 feet, where we were staying. The Sierra Red-breasted Sapsucker (*Sphyrapicus varius daggetti*) and the Pygmy Nuthatch (*Sitta pygmaea pygmaea*) were about the only ones worth special mention.

The most prominent bird in this locality was the Northern Pileated Woodpecker (*Phlæotomus pileatus albieticola*), several of which were seen and oftener heard, but no nests were found nor did any actions of those observed seem to indicate that they were then feeding young. Cassin's Vireo at first appeared to be very numerous here, and four nests were located within the first twenty-four hours of our stay, but it afterward turned out that we had come across a good proportion of those present in this short space of time, for but few other pairs were seen, and no more nests discovered. Black oaks seemed to be their favorite nesting place, but one nest was found in a scraggly manzanita bush, eight feet from the ground. Seven to ten feet appeared to be the usual height from the ground, although, of course, there may have been others at a greater height that we did not discover. The Western Tanager (*Piranga ludoviciana*) breeds here in limited numbers, one nest containing four nearly fresh eggs being taken near the river on May 22. As is common with this species this nest was out toward the end of a horizontal branch of a Douglas fir (*Pseudotsuga macrocarpa*) twenty-five feet from the ground, and was secured by Little, who "shinned" up a sapling pole held in place with guy ropes. One or two other nests of this species were found but were not finished at the time of our leaving. Several mergansers were seen on the river, one of which flew up or down stream nearly every day, uttering most unmusical notes in passing. We did not succeed in capturing any, but were near enough to be fairly sure that they were *americanus*.

The country at this point is all Transition, with a good deal of open pasture land on the southerly exposed hillsides, and looks as if it ought to be a very attractive place for birds. During our stay the vicinity was well gone over, within a radius of two or three miles at least, but the birds were

found as scarce as in the other localities visited, with rodents in the same category.

Wishing to get nearer to Sanhedrin's summit at the opposite end we decided to go to Lierly's Ranch—a combination ranch and old time hunters' resort which was the headquarters of Bunnell upon the occasion of his visit to this mountain before referred to. While it was only six or eight miles from where we were, being without pack animals we had to go back to Willits, to Potter Valley via Ukiah (almost), and thence in to Lierly's—a round-about journey of over *sixty* miles to reach our destination. On the way into the hills from Potter Valley birds seemed scarcer than ever, and the end of our journey did not give much promise of more encouraging prospects in that line. The only day upon which we could get horses and a guide was May 25, on which date Little reached the summit nearest to this point and found fox sparrows numerous on the mountain. Several specimens were secured, which proved to be the Yolla Bolly (*Passerella iliaca brevicauda*), as had been anticipated.

Except for the Northern Piliated Woodpecker there seemed to be nothing of special interest in the immediate vicinity of Lierly's, the only birds we saw being the commonest species that one would expect to find in such a locality, and as this place was too far away from the mountain top for satisfactory work with our equipment we left for home on May 26, seeing but little on the road through the forest save an occasional Sierra Junco, or perhaps a Western Robin nesting by the roadside.

What might be called the last trip of the season was made in company with my brother, John W. Mailliard, in his car to Fout's Springs, which is near the base of Snow Mountain, in the northwest corner of Colusa County, California. This place is in a very small, relatively level, well-watered valley, draining into the Sacramento basin, with chamisal-covered hills on the east and south and backed by mountains on the other two sides, the most important of which is Snow Mountain, about 7000 feet high and lying a little over 20 miles southeast of Mt. Sanhedrin. The country all around the valley is covered with a very thin, gravelly soil; and most of it has rather recently been burned over. There are some black oaks, "blue" oaks, and digger pines in the little valley, whose elevation is

about 1750 feet, with the flora changing on the mountain sides as the altitude increases.

Here again was a most attractive looking spot for bird life but, except around the houses, there were few birds in evidence. In the trees near the buildings some Northern Violet-green Swallows (*Tachycineta thalassina lepida*), California Woodpecker (*Melanerpes formicivora bairdi*), Slender-billed Nuthatch (*Sitta carolinensis aculeata*), the ubiquitous (all through this country, at least), Western Robin (*Planesticus migratorius propinquus*), and a few other common species, were nesting or feeding their young just out of the nest. And again, away up here in the brush country, were a few red-winged blackbirds. Only one was secured, which is very close to the Bicolored Redwing (*Agelaius phoeniceus californicus*) of San Joaquin County.

We were disappointed in the matter of obtaining horses for a trip to the summit of Snow Mountain, and had to abandon the idea of reaching that point, so while my brother and I prospected the lower levels, on June 2, Little went up on Goat Mountain to an altitude of something like 4500 feet. He did not come across any fox sparrows nor any brush suitable for them, but the Yolla Bolly has been taken on Snow Mountain, for Dr. Joseph Grinnell tells me he has seen specimens from that point. Poor-wills were heard in the dusk of evening and some were called down into open spots, but guests of the place wandering about prevented our securing any for identification. However, there is no reason to suppose that they were anything else than the Dusky Poor-will (*Phalænoptilus nuttalli californicus*).

Our stay here was shortened by this absence of saddle horses and we left on June 3, intending to stop at some place on the way back if conditions seemed to warrant. The principal incident of the morning was the taking of a nest of Bell's Sparrow (*Amphispiza belli*) at the summit of the toll road between Bartlett Springs and Upper Lake. From time to time along the road we had been stopping to look about for birds and listen for their notes, and on this occasion had come out of the forest on to a sort of saddle, or V-shaped gap, where the road suddenly shifted from the north side of the range to the south side, and out of the timber into chamisal brush. Not a bird was to be seen, but on taking a few steps

into the low chamisal, burnt over within the last two or three years, a bird flushed from a small bush and revealed a nest with four eggs. The parent was finally secured and proved to be *Amphispiza belli*. Except for its mate not another of this species was heard or noted within many miles of this spot. One or two, however, were seen and heard on the Langtry Ranch, between Middletown and Aetna Springs, in Lake County, on June 5.

We decided to visit Glenbrook again, and arrived there on the evening of June 3. At once we were struck by the difference in the avian life here. Instead of being greeted with a boisterous bird chorus all was silent save for a few chirpings—the songs had died away. Many of the birds had gone, and most of those that were left were busy looking after their young. A few were late in their nesting and we found a nest of Cassin's Vireo (*Lanivireo solitarius cassini*), containing three fresh eggs, in an old apple tree in the orchard, near the end of a branch only about five feet from the ground.

We were amply repaid for this second visit to Glenbrook by the finding of the nest of the Calliope Hummingbird, as already related.

Not wishing to interfere with the parental duties of the avian population any more than necessary, or to run the risk of taking the lives of parents of young, we concluded to call a halt in the field work for the time being and returned to San Francisco on June 5.

Appended herewith is a tabulated list of birds noted at the various places mentioned which shows in concise form the results of our observations as regards the species met with.

	Mt. St. Helena Inn, Napa Co., Calif.	Mt. Mill Hotel, Lake Co., Calif.	Harbin Springs, Lake Co., Calif.	Castle Springs, Lake Co., Calif.	Glenbrook, Lake Co., Calif.	Bel River Inn (Hears), Mendocino Co., Calif.	Larty's, Mendocino Co., Calif.	Mt. Mendocino, Calif.	Sandholm, Mendocino Co., Calif.	Fort's Springs, Colusa Co., Calif.
Spotted Sandpiper (<i>Actitis macularia</i>)										
Killdeer (<i>Oxyechus vociferus</i>)										
Mountain Quail (<i>Oreortyx p. plumifera</i>)										
Valley Quail (<i>Lophortyx c. vallicola</i>)			t							
Western Mourning Dove (<i>Zenaidura m. marginella</i>)	*									
Turkey Vulture (<i>Cathartes a. septentrionalis</i>)										
Cooper's Hawk (<i>Accipiter cooperi</i>)										
Sharp-shinned Hawk (<i>Accipiter velox</i>)										
Western Red-tailed Hawk (<i>Buteo b. calurus</i>)										
American Sparrow Hawk (<i>Falco s. sparverius</i>)										
Pacific Horned Owl (<i>Bubo v. pacificus</i>)										
Western Belted Kingfisher (<i>Ceryle a. caurina</i>)										
Cabanis' Woodpecker (<i>Dryobates v. hyloscopus</i>)										
Willow Woodpecker (<i>Dryobates p. turati</i>)		t								
Sierra Red-breasted Sapsucker (<i>Sphyrapicus v. daggetti</i>)										
Northern Pileated Woodpecker (<i>Phloeotomus p. abieticola</i>)										
California Woodpecker (<i>Melanerpes formicivorus bairdi</i>)	t									
Red-shafted Flicker (<i>Colaptes c. collaris</i>)										
Dusky Poor-will (<i>Phalaenoptilus n. californicus</i>)										
Anna's Hummingbird (<i>Calypte anna</i>)			t							
Allen's Hummingbird (<i>Selasphorus alleni</i>)										
Calliope Hummingbird (<i>Stellula calliope</i>)										
Western Kingbird (<i>Tyrannus verticalis</i>)										
Ash-throated Flycatcher (<i>Myiarchus c. cinerascens</i>)										
Black Phoebe (<i>Sayornis nigricans</i>)										
Olive-sided Flycatcher (<i>Nuttallornis borealis</i>)		u								
Western Wood Pewee (<i>Myiochanes r. richardsoni</i>)										
Western Flycatcher (<i>Empidonax d. difficilis</i>)										
Blue-fronted Jay (<i>Cyanocitta s. frontalis</i>)	t									
Northwestern California Jay (<i>Aphelocoma c. oodeptica</i>)	t									
Western Crow (<i>Corvus b. hesperis</i>)										
Bicolored Red-winged Blackbird (<i>Aegialus p. californicus</i>)										
Western Meadowlark (<i>Sturnella neglecta</i>)										
Bullock Oriole (<i>Icterus bullocki</i>)										
Brewer's Blackbird (<i>Euphagus cyanocephalus</i>)										
California Purple Finch (<i>Carpodacus p. californicus</i>)										

* = noted
t = taken
u = nesting, or signs of nesting noted

	Mr. St. Helena Inn, Napa Co., Calif.	Mr. Mill Hotel, Lake Co., Calif.	Harbin Springs, Lake Co., Calif.	Castle Springs, Lake Co., Calif.	Glenbrook, Lake Co., Calif.	Eel River Inn (Hearst), Mendocino Co., Calif.	Lierly's, Mendocino Co., Calif.	Mr. Sanhedrin, Mendocino Co., Calif.	Four's Springs, Colusa Co., Calif.
* = noted	*	*t	*tn	*tn	*	*	.....	.....	*t
t = taken	*	*t	*t	*t	*	*	.....	.....	.....
n = nesting, or signs of nesting noted	*	*t	*t	*t	*	*	.....	.....	.....
Pallid Wren-tit (<i>Chamaea f. henshawi</i>)	.....	.....	.....	.....	.....	.....	.....	.....	.....
California Bush-tit (<i>Saliniparus m. californicus</i>)	.....	.....	.....	.....	.....	.....	.....	.....	.....
Western Ruby-crowned Kinglet (<i>Regulus c. cineraceus</i>)	.....	.....	.....	.....	.....	.....	.....	.....	.....
Western Gnatcatcher (<i>Poliophtila c. obscura</i>)	.....	.....	.....	.....	.....	.....	.....	.....	.....
Russet-backed Thrush (<i>Hylocichla u. ustulata</i>)	.....	.....	.....	.....	.....	.....	.....	.....	.....
Dwarf Hermit Thrush (<i>Hylocichla g. nana</i>)	*t	.....	.....	.....	.....	.....	.....	.....	.....
Monterey Hermit Thrush (<i>Hylocichla g. slevini</i>)	*t	.....	.....	.....	.....	.....	.....	.....	.....
Western Robin (<i>Planesticus m. propinqua</i>)	u	*tn	.....	.....	.....	.....	.....	.....	.....
Western Bluebird (<i>Sialia m. occidentalis</i>)	.....	.....	.....	.....	.....	.....	.....	.....	.....

REMARKS

American Merganser (*Mergus americanus*)..... Some mergansers, of presumably this species, noted on Eel River near Hearst Bridge.

English Sparrow (*Passer domesticus*)..... Seen only at Hearst, Mendocino County, Calif.

Bell's Sparrow (*Amphispiza belli*)..... Noted on Langtry Ranch, between Middletown and Aetna Springs, Lake County, and nest with parent taken on toll road between Bartlett Springs and Upper Lake, Lake County, Calif.

Yakutat Fox Sparrow (*Passerella i. meruloides*), and subsps.... Fox sparrows other than *brevicauda* were noted in the first four places visited, but taken only in two, as indicated. Those seen only are marked in the column with question marks, as the subspecies was, of course, not ascertained.

Aphelocoma c. subsp.?..... The jays of this genus taken on the expedition are very similar to those found in parts of Marin and Sonoma counties where some of the Sierran forms reach the coast. Mr. H. S. Swarth mentions the coming together of *immanis* and *oocleptica* in such places in his paper entitled "The Pacific Coast Jays of the Genus Aphelocoma," (University of California Publications in Zoology, Vol. 17, No. 13, pp. 415-422). His comparisons therein were made with fresh fall specimens, while those we took were all in more or less faded and abraded plumage, with consequent alterations in coloration, and abbreviation of wing and tail measurements. All are listed above as *oocleptica*, but there is more or less leaning toward *immanis*.

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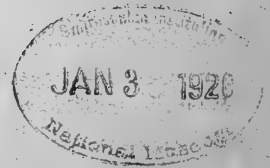
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XI

New Species of Flies (Diptera) from California

BY
J. R. MALLOCH



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XI

NEW SPECIES OF FLIES (DIPTERA) FROM
CALIFORNIA

BY J. R. MALLOCH

Family ANTHOMYIDÆ

In this paper are presented descriptions of some species of Anthomyiidae from the collections of the California Academy of Sciences, in the museum of which institution the types are deposited. In all cases the species described are briefly compared with their nearest allies, but in addition they have been incorporated in synopses of their respective genera which I have drawn up and purpose publishing as soon as I have exhausted the material now in my hands.

1. *Hydrotæa lasiophthalma*, new species

Male.—Deep black, glossy; thorax not vittate; abdomen with pale gray pruinescence, the dorsum with a black central vitta; legs entirely black; wings slightly grayish; calyptra white; halteres black.

December 23, 1919

Eyes densely hairy, separated at narrowest part of frons by a distance a little less than width across posterior ocelli; parafacial as wide as third antennal joint, and over half as wide as height of cheek, the latter with a glossy, strongly haired area which covers all except a narrow strip of cheek along eye-margin and a small patch behind vibrissæ; arista almost bare. Prealar absent; intra-alar bristles both long; presutural acrostichals absent; hypopleura bare. Abdomen as in *H. houghi* Malloch. Fore femur with a stout outer and a slender inner preapical ventral thorn, the inner, or anterior, one whitish; postero-ventral surface on basal half with numerous bristles, many of them short; fore tibia stout, except on basal third where it is very slender; mid-femur without strong ventral bristles; mid-tibia with two antero-dorsal and four or five postero-dorsal bristles; mid-tarsus normal; hind femur with a stout straight short double ventral spine about one-fifth from base, and four or five bristles on apical half of antero-ventral surface; hind tibia with one or two postero-dorsal bristles, and long hairs on apical half on all surfaces except postero-dorsal, those on antero-dorsal extending almost to base. Venation as in *H. houghi*.

Type, male, 6 mm. long, No. 523, C. A. S., Fallen Leaf Lake, near Lake Tahoe, Calif., July 15, 1915; E. C. Van Dyke, collector.

This species is most closely allied to *occulta* Meigen, but may be separated from it by the larger size, different armature of the hind tibia and several other characters.

2. *Helina fuscomarginata*, new species

Female.—Bluish black, with distinct, but not dense grayish-pruinescence. Ocellar triangle shining; antennæ and palpi black; thorax quadrivittate; abdomen without markings; legs black; wings slightly grayish, cross-veins faintly infuscated, veins black; calyptræ gray, with conspicuous black margins; halteres black.

Eyes pubescent; frons over one-third of the head-width; each orbit with seven or eight bristles and many lateral setulose hairs, most numerous anteriorly; face concave in profile;

parafacial at base of antenna about twice as wide as third antennal joint, about half as wide at middle of face; cheek about one-third as high as eye and slightly higher than widest part of parafacial, its lower margin with two or three series of bristles, the upper series anteriorly upwardly curved; vibrissal angle in line with lower margin of eye, a few bristles above vibrissa; third antennal joint broad, about twice as long as second; arista pubescent. Thorax without strong presutural acrostichals; postsutural dorso-centrals four; prealar about one-third as long as the bristle behind it; scutellum bare below and on sides; hypopleura bare; sternopleurals 2:2, the lower anterior bristle weak. Basal abdominal sternite bare. Fore tibia unarmed at middle, with four apical bristles; mid-femur with an almost complete series of bristles on postero-ventral surface; mid-tibia with two or three posterior bristles, and about eleven apical bristles, some of the latter very long; hind femur with an almost complete series of bristles on antero-ventral surface and a few bristles on basal half of postero-ventral; hind tibia with two or three antero-ventral and antero-dorsal bristles; all tarsi longer than tibiae. Third vein with one or two weak setulae at base on under surface; costal thorn long.

Type, female, 7 mm. long, No. 524, C. A. S., San Francisco, Calif., April 15, 1919; E. P. Van Duzee, collector.

Distinguished from its allies by the presence of the setulae at base of third vein and the black-margined calypterae.

3. *Limnophora incrassata*, new species

Male.—Black, subopaque, owing to the dense covering of pale gray pruinescence. Orbits, face, and cheeks with silvery tomentum; antennae and palpi black; thorax with a faintly indicated brown dorso-central vitta; abdomen with a pair of subtriangular black spots on the basal three tergites, those on second and third extending from near base to apex, fourth tergite with the spots almost obsolete; legs black; wings clear, veins black; calypterae white; halteres yellow.

Eyes separated by a little more than width across posterior ocelli; orbits much wider than the linear interfrontalia, with

slender bristles to level of anterior ocellus; parafacial at base of antenna almost as wide as third antennal joint, slightly narrowed below; cheek about three times as high as width of parafacial, vibrissal angle produced; third antennal joint rounded at apex; arista pubescent; presutural acrostichals slender, long, two-rowed; postsutural dorso-centrals four; disc of scutellum with numerous long hairs; lower posterior sternopleural weak. Abdomen cylindrical, slightly tapered posteriorly, fourth tergite and sternite the longest; hypopygium not exerted; fifth sternite almost transverse apically. Fore tibia without median bristle; mid-tibia with one or two posterior bristles; hind femur rather abruptly thickened at base ventrally, and distinctly thicker near base than at middle, the antero-ventral surface with three bristles near apex; hind tibia with one median antero-dorsal bristle. Fourth vein with but little indication of the forward curvature so distinct in allied species.

Female.—Similar in color to the male, but the thorax has three brown vittæ, the central one not extending over scutellum.

Profile as in male; frons over one-third of the head-width; each orbit with six or seven bristles and a few lateral hairs. Apical genital segment with numerous stiff, short bristles below. Tibial bristles as in male but there is very often an antero-ventral bristle on hind tibia.

Length, 5-6 mm.

Type, male, No. 525, C. A. S., Huntington Lake, Calif., altitude 7000 feet, July 28, 1919; Mrs. E. P. Van Duzee, coll., and allotype, female, No. 526, C. A. S., also one male and one female paratype, topotypical, all from same locality. There are also three males, paratypes, taken July 16, 17 and 22, 1919, at same place by E. P. Van Duzee, and one female taken July 29, 1919, by E. P. Van Duzee at Cascada, Calif., alt. 5000 feet.

A female taken at same place as type differs in being much darker and in having two antero-dorsal bristles on hind tibia.

From other species of *Limnophora* this species may readily be distinguished by the peculiar shape of the hind femur. It belongs to the group which has the ventral plate of prothorax with setulose hairs along its margins and the third vein setulose at base.

4. *Limnophora magnipunctata*, new species

Male.—Deep black, shining. Orbits and parafacials with white tomentum; thorax black, with slight grayish pruinescence, most distinct on lateral margins anteriorly and on pleuræ; abdomen with the usual paired black dorsal spots very large, similar to those of *L. nobilis* Stein, but separated by a pale line in centre; legs black; wings infuscated, most noticeably so basally, veins black; calyptreæ and halteres yellow.

Eyes separated by a little less than width across posterior ocelli; orbits linear above, with numerous long bristles and hairs extending to anterior ocellus; parafacial almost as broad at base of antennæ as the rather narrow third antennal joint, not narrowed below; cheek about three times as high as width of parafacial, with several series of bristles along lower margin, the upper two or three series upwardly curved, those near anterior margin strong, vibrissal angle slightly produced; arista rather densely pubescent, the longest hairs a little longer than its basal diameter. Thorax with the presutural acrostichals rather long, fine, four-rowed; postsutural dorso-centrals three; anterior sternopleural short, lower posterior one very weak. Abdomen narrowly ovate, fourth tergite a little longer than third; hypopygium small; fifth sternite with a rather deep, basally truncate posterior excision, the angularly produced lateral extremities with a few bristly hairs. Fore tibia without a median bristle, the apex with a long dorsal and a short posterior bristle; mid-femur with bristles on both antero- and postero-ventral surfaces, the former very short, the latter long basally; mid-tibia with three or four posterior bristles; hind femur with long bristles on apical half of antero-ventral surface and a few on basal half of posterior; hind tibia with two antero-dorsal and one or two antero-ventral bristles, and one or two postero-dorsal setulæ; hind tarsus longer than tibia. Costal thorn very short.

Female.—Differs from the male in having the thorax with a distinct dorso-central vitta, and a less distinct lateral vitta on each side, the abdominal spots less distinct and more widely separated, and the wings almost clear.

Eyes at vertex separated by about one-fourth of the head-width, wider anteriorly; each orbit with six or seven bristles

and some long hairs, laterad of these are some short setulose hairs. Genitalia with two long processes as in *Helina*, and without thorns or strong bristles.

Length, 5-6 mm.

Type, male, No. 527, C. A. S., Huntington Lake, Calif., altitude 7000 feet, July 9, 1919; E. P. Van Duzee, coll.; allotype, female, No. 528, C. A. S., and female paratypes, same locality, July 9, 1919 (F. C. Clark, coll.), and July 26, 1919 (E. P. Van Duzee, coll.).

This species closely resembles one before me from Labrador, which is undescribed, and is not very closely related to any described North American species, though it superficially resembles *L. nobilis* Stein.

5. *Dialyta nigropolita*, new species

Male and female.—Black, shining, almost glossy; orbits, face, and cheeks with white, almost silvery tomentum. Thorax and abdomen with slight grayish pruinescence, the former with very faintly indicated dorsal vittæ; legs black; wings grayish; calyptreæ and halteres yellowish white.

Male.—Eyes separated by one-fourth of the head-width, each orbit nearly as wide as narrowest part of interfrontalia, with six or seven bristles; parafacial nearly as wide as third antennal joint, the latter about twice as long as second, extending three-fourths of the way to mouth-margin; arista with its longest hairs distinctly longer than its basal diameter; cheek a little higher than width of third antennal joint. Thorax with three or four pairs of short presutural acrostichals, three pairs of postsutural dorso-centrals, and no prealar; sternopleurals in a nearly equilateral triangle. Abdomen short and thick, cylindrical, the hypopygium very large, giving the abdomen a slightly clubbed appearance; second, third, and fourth tergites each with discal, and the third and fourth with posterior marginal bristles; fifth tergite declivitous, armed with numerous strong bristles; fifth sternite conspicuous, with a pair of long processes which are strongly bristled. All coxæ and the ventral part of sternopleura with long hair-like bristles; femora with very long fine bristles basally on postero-ventral surfaces; fore tibia with a weak antero-dorsal

and a long posterior bristle, the four apical bristles long; mid-tibia with two antero- and two postero-dorsal bristles; hind femur with fine hairs at base ventrally, the antero-ventral surface with about five long strong widely placed bristles, the postero-ventral surface with fewer bristles which do not extend to apex; hind tibia with one antero-ventral, two antero-dorsal, and two postero-dorsal bristles, tip with four long and two short bristles. Costal thorn long.

Female.—Similar to the male. The frons is one-third of the head-width, the abdomen is conical, the femoral basal bristles are shorter and stronger, and the tibial bristles stronger and usually there is an additional one basad of those present in the male.

Length, 5–5.5 mm.

Type, male, No. 529, C. A. S., Huntington Lake, Calif., alt. 7000 feet, July 9, 1919; E. P. Van Duzee, coll.; allotype, female, No. 530, C. A. S., and one paratype, topotypical, same locality; two female paratypes, same locality, July 10, 1919.

This species is much smaller than *D. flavitibia* Johannsen, the only other species of the genus described from this country, and differs from it in having the legs entirely black and with different bristling.

6. *Cænusia alticola*, new species

Male.—Black, distinctly shining, with gray pruinescence on body, that on head whitish and dense, on thorax and abdomen darker and not so dense. Antennæ and palpi black; thorax with three brown pollinose vittæ; scutellum dorsally colored as vittæ; abdomen with a pair of brown pollinose spots on each of the basal four tergites. Legs black, the femora shining, pale at extreme apices; tibiæ yellowish testaceous; wings clear, whitish basally, veins pale brown; calyptæ and halteres whitish yellow.

Frons one-third of the head-width, slightly widened anteriorly; each orbit with four strong bristles and a few short hairs; ocellar bristles long; third antennal joint narrow, about twice as long as second, extending four-fifths of the distance to mouth-margin; arista pubescent; parafacial narrower than

third antennal joint; cheek about twice as high as width of parafacial; Thoracic presutural acrostichals two-rowed, rather strong; all thoracic bristles long and strong; lower stigmatal bristle long, directed downward. Abdomen broad, not much longer than thorax; fifth tergite with four long bristles and a number of short setulæ; hypopygium of moderate size, basal segment subglobose; processes of fifth sternite large, broad, rounded at apices, their length greater than their greatest width, surfaces with sparse setulæ and some moderately long bristles apically. Legs rather stout; fore tibia with the posterior median bristle short; mid-femur with a few short bristles on basal half of antero-ventral surface and three or four long widely placed bristles on postero-ventral; mid-tibia with the median bristles at nearly the same height; hind femur with three or four widely spaced bristles on antero-ventral surface and one or two on postero-ventral; hind tibia with the antero-dorsal bristle much longer than the antero-ventral, the apical dorsal bristle about one eighth from apex.

Female.—Similar in color to the male, the abdominal spots not so clearly defined and the wings not so pale. Differs from the male in having the tibial bristles all much stronger.

Length, 3.5–4.5 mm.

Type, male, No. 531, C. A. S., Huntington Lake, Calif., alt. 7000 feet, July 9, 1919, and allotype, female, No. 532, C. A. S., same locality, July 16, 1919, E. P. Van Duzee, coll.; also one female paratype, same locality, July 28, 1919; E. P. Van Duzee, collector.

An immature specimen from the same locality, July 9, may represent a distinct species.

This species resembles *C. fraterna* Malloch, but is larger and has the tibiæ entirely pale.

7. *Cœnosia parvisquama*, new species

Female.—Color as in the preceding species but the thorax not so distinctly shining, and more densely pruinulent. Legs black, densely gray pruinulent, bases of tibiæ reddish.

Frons as in preceding species; antennæ short, third joint not twice as long as second, its apex about two-fifths of the

distance from mouth-margin; parafacial linear; cheek higher than width of third antennal joint; arista nearly bare. Thorax and bristles of legs as in preceding species; the hind tibia with a small bristle at middle on postero-dorsal surface.

Type, a female, 4.5 mm. long, No. 533, C. A. S., and one paratype, Huntington Lake, Calif., alt. 7000 feet, July 9, 1919; E. P. Van Duzee, collector.

This species has the calyptre smaller than in most species of *Cœnosia*, the lower one scarcely projecting, and the hind tibia has a small bristle on the postero-dorsal surface. It may require a new genus for its reception, but until the male is found it may remain in *Cœnosia*.

8. *Macateeia atra*, new species

Male.—Black, slightly shining. Head with the interfrontalia, parafacials, and a portion of the cheeks reddish; palpi fuscous, paler basally. Thorax greasy in type but with indications of three vittæ; abdomen gray pruinulent, when viewed at certain angles with a broad indefinite black dorso-central vitta; legs black; wings clear, veins brown; calyptre and halteres yellowish.

Eyes separated by one-third of the head-width; each orbit about one-half as wide as interfrontalia, with about six inwardly directed slender bristles on anterior half and three or four outwardly directed on posterior half; interfrontalia without cruciate bristles; arista thickened on basal third, pubescent; parafacial not as wide as third antennal joint, and as wide as height of cheek. Thorax with two pairs of presutural acrostichals; prealar over half as long as the bristle behind it; sternopleurals 2:2, the lower anterior one weak. Abdomen short and broad, fourth tergite longest; hypopygium large; fifth sternite with two long narrow processes which are not remarkably bristled. Legs stout, the femora noticeably thicker than is usual in the family; fore tibia with a weak preapical dorsal bristle; mid-femur with a few short bristles on antero- and postero-ventral surfaces; mid-tibia with a short stout bristle beyond middle on antero-ventral surface, and three or four weak posterior bristles; hind femur with a complete series of weak antero-ventral bristles, and one or two slender

bristles at base on postero-ventral surface; hind tibia with two short antero-ventral, five or six short stout antero-dorsal, and three or four slender postero-dorsal bristles; both mid- and hind tibiæ with several strong curved apical bristles; tarsi shorter than tibiæ. Costal thorn short; outer cross-vein straight.

Type, male, 4 mm. long, No. 534, C. A. S., Salada Beach, San Mateo County, Calif., April 21, 1918; E. P. Van Duzee, collector.

This species has the head less elongated than has the female of the genotype (*protuberans* Malloch), but the other characters agree very closely with those of that species and it may really prove to belong to the same species.

9. *Hydrophoria seticauda*, new species

Male.—Deep black. Face, orbits, and cheeks with white pruinescence. Thorax indistinctly trivittate; abdomen with a uniformly broad dorso-central vitta which covers about one fourth of the dorsum; wings slightly brownish; calyptæ white; halteres yellowish.

Eyes separated by a little less than width across posterior ocelli; arista with its longest hairs not longer than width of third antennal joint; parafacial at base of antenna as wide as third antennal joint, not narrowed below. Presutural acrostichals weak, irregularly two-rowed; scutellum broader than long. Processes of fifth sternite very broad, very inconspicuously haired on surfaces, their inner margins with a fringe of long hairs. Mid-femur with two or three antero-ventral bristles; mid-tibia with an antero-ventral bristle; hind femur with a series of widely spaced postero-ventral bristles; hind tibia with four or five bristles on each of the following surfaces: antero-ventral, antero-dorsal, and postero-dorsal, the posterior surface with a few setulose hairs on basal half. Costal thorns of moderate size.

Female.—Frontal bristles strong. Genital thorns distinct. Length, 6-7.5 mm.

Type, male, No. 535, C. A. S., Huntington Lake, Calif., alt. 7000 feet; July 5, 1919 (F. C. Clark, coll.), and allotype,

female, No. 536, C. A. S., same locality, July 9, 1919 (F. C. Clark, coll.), paratypes, male and female, Mt. Moscow, Ida., June 4, 1910, female, same locality, July 1, 1909; J. M. Aldrich, collector.

10. *Pegomyia vanduzeei*, new species

Male.—Black, slightly shining, with slight grayish pruinescence on thorax and dense drab-gray pruinescence on dorsum of abdomen. Head black, orbits, face, and cheeks with dense but not conspicuous whitish pruinescence; antennæ black; palpi reddish testaceous; thorax faintly trivittate; abdomen with a moderately broad black dorso-central vitta; hypopygium black, the small rounded knoblike bases of the forceps yellowish testaceous; legs black, all tibiæ rufous-testaceous; wings clear, veins dark brown; calyptra and halteres yellow.

Eyes separated by about twice the width of anterior ocellus; orbital bristles extending more than midway to anterior ocellus, parafacial a little broader than third antennal joint, not narrowed below; third antennal joint nearly twice as long as second, the latter with numerous short stout hairs and some longer bristles on dorsal surface; arista nearly bare, very conspicuously swollen on basal sixth. Thorax with three pairs of long presutural acrostichals; prealar half as long as the bristle behind it; sternopleurals 1:2. Abdomen flattened, parallel-sided; second (first visible) segment longer than third; hypopygium moderate in size, bases of forceps almost globose, very noticeable owing to their pale color; fifth sternite with a number of stiff short bristles at apex of each process. Fore tibia with a posterior bristle; fore tarsus normal, much longer than tibia; mid-femur with a series of bristles extending from base to beyond middle on postero-ventral surface; hind femur with a series of very long bristles on antero-ventral surface and another on basal half of postero-ventral; hind tibia with two antero-ventral, two antero-dorsal, and two postero-dorsal bristles. Costal thorn small; veins three and four subparallel; outer cross-vein straight. Lower calypter but slightly protruded beyond upper.

Type, male, 5.5 mm. long, No. 537, C. A. S., San Francisco, Calif., March 30, 1919; E. P. Van Duzee, collector.

This species differs from any species of the genus known to me in its color, the pale bases of the hypopygial forceps being very conspicuous and characteristic.

11. *Hylemyia recurva*, new species

Male.—Black, slightly shining, densely yellowish gray pruinulent. Head black, interfrontalia slightly reddish. Thorax not vittate; abdomen with a black dorso-central vitta; legs black, tibiae reddish, usually entirely so, but in some specimens only so at bases; wings clear, calyptæ and halteres pale yellow.

Eyes separated by a little more than width of anterior ocellus; parafacial nearly as broad as third antennal joint; arista with its longest hairs a little shorter than width of third antennal joint. Presutural acrostichals irregularly two-rowed; prealar bristle minute or absent; sternopleurals 1:2. Abdomen slender, depressed, segments subequal; hypopygium small; fifth sternite with sparse, slender bristles on outer half. Fore tibia with a median posterior bristle, the apical posterior bristle of moderate length, slender, not blunt at apex; mid-tibia with a posterior bristle about two-fifths from apex, and beyond it on the postero-dorsal surface two long strong bristles; hind femur with fine bristles on entire length of antero-ventral surface which are short at base; hind tibia with three postero-dorsal and two antero-dorsal bristles, the longest of the latter just beyond middle and a little less than half as long as the tibia; in addition to these bristles there is a series of four or five long bristly hairs running diagonally from anterior surface at tip basad and on to antero-dorsal surface, the anterior surface with the hairs longer than usual. Costal thorn small.

Length, 5-5.5 mm.

Type, male, No. 538, C. A. S., Huntington Lake, Calif., alt. 7000 feet, July 27, 1919; E. P. Van Duzee, coll.; two paratypes, both males, topotypical, and one male, same locality, July 10, 1919; F. C. Clark, collector.

This species is one of a group of three all of which are undescribed and have either one or two very strong bristles on postero-dorsal surface of mid-tibia near apex.

In order to make clear the relationships of the new species and its most closely related forms I append a synopsis of the characters for the separation of the three species now before me. As they are all similar in color and habitus it is unnecessary that they be described in full.

1. Hind tibia with two antero-dorsal and three postero-dorsal bristles, no long slender recurved bristles near apex on antero-dorsal surface; sternopleurals three in number (1:2) . . . *normalis*, new species
- Hind tibia, in addition to the normal antero-dorsal and postero-dorsal bristles, with about four long slender recurved bristles in a diagonal series which begins at tip on anterior surface and runs diagonally basad on to antero-dorsal surface. 2
2. Sternopleurals two in number (1:1); hind tibia with three very long slender bristles on antero-dorsal surface, the longest one distinctly proximad of middle and over half as long as tibia.
 *extremitata*, new species
- Sternopleurals three in number (1:2); hind tibia with two long slender bristles on antero-dorsal surface, the longest one distad of middle and less than half as long as tibia. *recurva*, new species

12. *Hylemyia normalis*, new species

Male.—Similar to *H. recurva* in color. The hind tibia differing as stated in synopsis and having the setulose surface hairs shorter.

Length, 5 mm.

Type, Armstead, Mont., July 3, 1913, in collection of Montana Agricultural Experiment Station. Paratypes, three males, Dillon, Mont., July 5, 1913; ten males, Lima, Mont., July 1, 1913; two males, Powderville, Mont., July 6, 1916; one male, Bozeman, Mont., July 7, 1902; one male, Blitzen River, Ore., July 6, 1906; one male, East Flathead, Mont., July 25, 1902, and one male, Musselshell, Mont., July 30, 1917.

Two paratypes from Lima, Mont., deposited in Calif. Acad. Sci., No. 539.

13. *Hylemyia extremitata*, new species

Male.—Similar in color to *H. recurva*. Differs from *recurva* as stated in synopsis and also in having the hairs on anterior and antero-ventral surfaces of hind tibia much longer.

Length, 5 mm.

Type, Gallatin County, Mont., July 19, 1911, in collection of Montana Agricultural Experiment Station. Paratype, Bozeman, Mont., July 25, 1915.

14. *Eremomyia major*, new species

Male.—Black, distinctly shining, slightly gray pruinulent. Head black; interfrontalia, second antennal joint, parafacial adjacent to vibrissa, and bases of palpi rufous; orbits face and cheeks with white pruinescence; thorax with five black vittæ; abdomen without well defined markings, the dorso-central vitta hardly traceable; legs black, extreme apices of femora and all of tibiæ rufous; wings grayish, veins brown, a faint brown tinge along outer cross-vein and near base of wings; calyptra yellow; halteres brownish yellow.

Eyes separated at narrowest part of frons by a distance equal to about twice the width across posterior ocelli; orbital bristles strong, extending almost to anterior ocellus, a few weak hairs laterad of the bristles anteriorly; parafacial about 1.5 as wide as third antennal joint and nearly two-thirds as wide as height of cheek; antennæ not extending to mouth-margin, third joint about 1.5 as long as second, rounded at apex, second transverse at apex on inner side, its surface granulose, a few punctures along inner side near apex; arista almost bare, moderately swollen on basal fifth; vibrissal angle with about 20 closely placed bristles of moderate length. Thorax with three pairs of long presutural acrostichals; both posthumeral bristles long and strong, close together; prealar very long, sternopleura with three or more posterior bristles. Abdomen cylindrical, sixth tergite with long bristles; basal hypopygial segment with long hairs but no long bristles; fifth sternite with some short hairs on apical half of inner margin of each process and a number of strong bristles on outer portion of each. Fore tibia with an antero-dorsal bristle about one-fifth from apex, one postero-ventral bristle a little basad of it, and sometimes a stronger one just distad of middle; mid-tibia with one antero-dorsal, one postero-dorsal, and three or four posterior bristles; hind femur with a complete antero-ventral and a partial postero-ventral series of bristles; hind tibia with two antero-ventral, two antero-dorsal, and two

postero-dorsal bristles. Costal setulæ very short; costal thorns both long; last section of fourth vein subequal in length to preceding section.

Type, male, 10 mm. long, No. 540, C. A. S., Sonoma Co., Calif., April 16, 1911; J. Aug. Kusche, coll.

This species differs from *H. incompleta* Stein and *H. humeralis* Stein in having the second antennal joint rufous, in being larger, and in the bristling of the cheeks and tibiæ.

Family SCATOPHAGIDÆ

The species described below is the first of the genus to be recorded from America. The genus is well represented in Europe, where some of the species are very common. The adults are predaceous, feeding upon other insects.

The type of the new species is deposited in the collection of the California Academy of Sciences.

15. *Norellia occidentalis*, new species

Female.—Yellowish testaceous, shining, with gray pruinescence; abdomen with a dark fascia at base and another at apex of each tergite; wings clear, cross-veins slightly infuscated.

Each orbit with three or four bristles in front of lower supraorbital; arista with its longest hairs a little longer than its basal diameter; cheek with some pale hairs along its lower margin; no bristles at base of vibrissa. Thorax with two or three rows of weak presutural acrostichals; the dorsal bristles strong; apical scutellar bristles very small, the lateral pair long; propleural bristle long, stigmal absent; abdomen normal; fore femur with the antero-ventral bristles less than half as long as the postero-ventrals; fore tibia with four very strong postero-ventral, and four much weaker antero-ventral bristles, the postero-dorsal surface with one, and the dorsal with two fine bristles on basal half; mid- and hind femora with three bristles on apical third of antero-ventral surface; mid-tibia with one antero-ventral, two antero-dorsal, two postero-dorsal, and two or three postero-ventral bristles; hind

tibia with three antero-dorsal, and two or three postero-dorsal bristles. First vein bare.

Male.—Similar to the female. Fifth sternite with two long processes which taper slightly apically and have some long hairs along their inner margins.

Type, female, 7 mm. long, No. 541, C. A. S., Corvallis, Ore., May 2, 1915; A. L. Lovett, coll. Paratype, Beaver Creek, Newport, Ore., August 13, 1902; J. M. Aldrich, coll.

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XII

Mechanism in the Production of the Throat-
Fan in the Florida Chameleon,
Anolis carolinensis

BY
CHAS. E. VON GELDERN

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XII

MECHANISM IN THE PRODUCTION OF THE
THROAT-FAN IN THE FLORIDA CHAMELEON,
*ANOLIS CAROLINENSIS*¹

BY CHAS. E. VON GELDERN

I

The production of the throat-fan in the Florida Chameleon (*Anolis carolinensis*), is, aside from the remarkable cutaneous color changes, one of the most striking features of this lacertilian.

The distended throat-fan, dewlap or gular pouch, which is best developed in the males, is a thin fold of skin attached along the mid-ventral line of the throat. It is somewhat semicircular in outline and extends from the intersection of the mid-ventral line and a line drawn at right angles passing through the eyes, to a variable distance on the chest.

The color of the distended fan varies from a delicate pink to a bright vermilion and, on closer observation, is spotted with scattered white scales.

When the fan is retracted, the skin on the throat is loose and arranged in longitudinal folds. It is white in appearance with minute longitudinal red, linear markings. The scales are prominent and appear as small, laterally depressed cones.

¹ The dissection of *Anolis* was made in the department of Anatomy of Tulane University. The comparative work was done in the department of Zoology at Stanford University. I am indebted to Professor J. O. Snyder for the material used in dissection.

It is evident that in distending the fan, the folds flatten out and the closely approximating scales become more or less separated, showing the pink or vermilion epidermis between them.

The fan is distended frequently and during various emotional states. It is a common observation to see one of the lizards sitting on a branch or fence rail, suddenly rise up on its front legs, distend the fan and accompany this by a quick succession of up-and-down motions produced by flexing and extending the front legs. No purpose for the act is apparent since the animal is undisturbed by outside influences.

A male *Anolis* will, upon spying a female, bob up and down and distend his fan with great frequency as if he were displaying himself to his greatest advantage.

Two males in combat will keep their fans distended, rise up on their toes, flatten out their bodies from side to side, and erect a fold of skin along the midline of the back of the neck. The usual appearance of the animal is thus markedly changed, even the prominent eyes, with their visible yellow irises, recede and appear as black beads. With grotesque, lateral swaying motions the combatants slowly encircle one another, each awaiting an opportunity to make a final rush and end the struggle victoriously. When one of these lizards is captured and held in the hand it will attempt to bite in a most vicious manner and distend the fan at the same time.

II

The underlying mechanism in the production of the fan is the hyoid apparatus, as has been stated by Ditmars, Gadow, Chemin, Bronn and others. None of these authors except Chemin has, as far as I have been able to ascertain, described the mechanism and the forces employed.

For the purposes of description the hyoid apparatus of *Anolis* may be divided into a basi-hyal; anterior extension or processus entoglossus; third horn of Chemin, posterior horn of Huxley or the processus retrobasalis; anterior horns, lesser horns or cerato-hyals and the posterior horns, middle horns of Huxley, greater horns, cerato-branchials or thyro-hyals. (Fig. 1 A.)

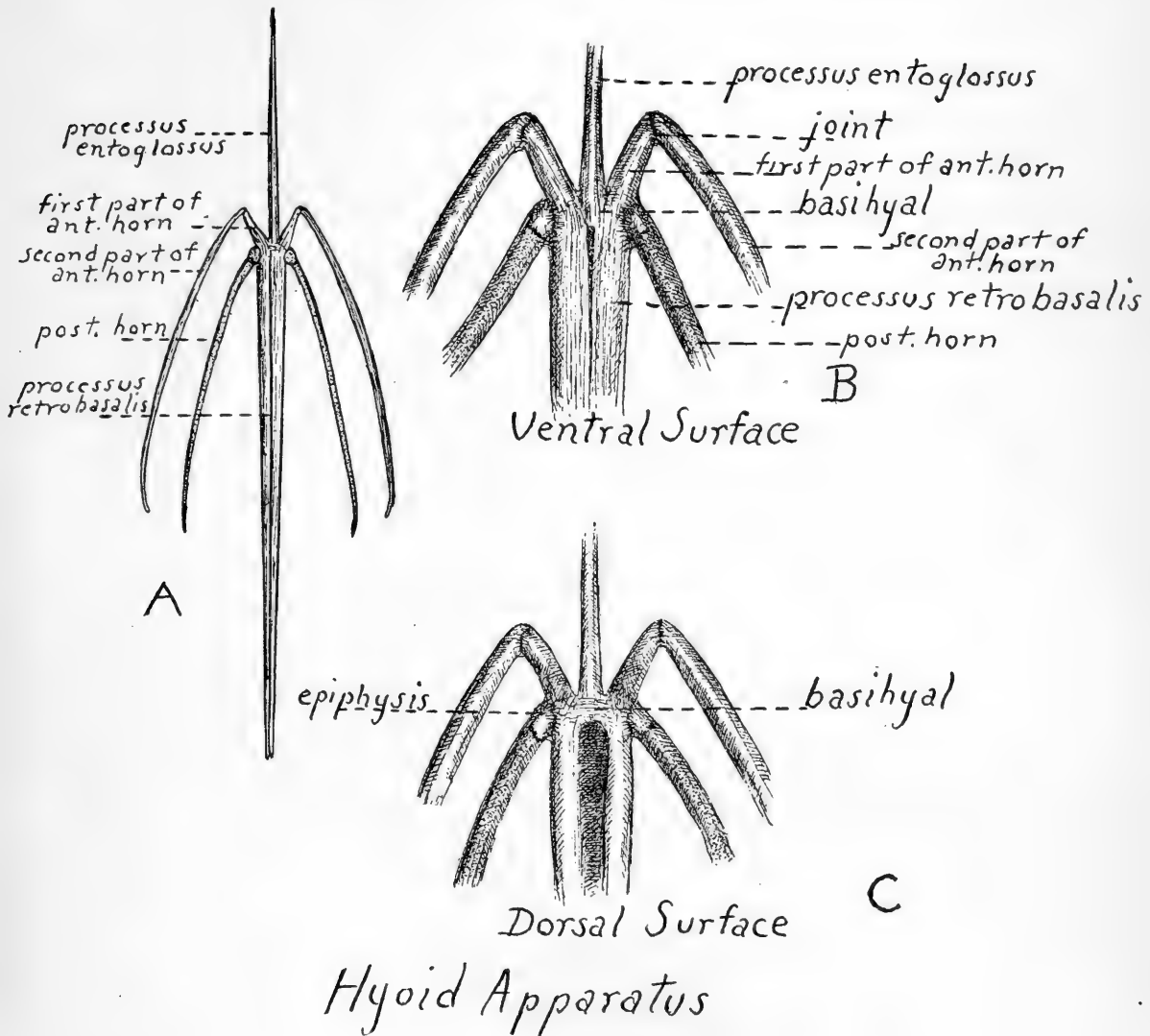


Fig. 1 A, B, C

By the body or basi-hyal is meant that part to which the other structures attach. This is a small bar of cartilage with a slight concavity dorsally. It measures about 1 m.m. in length and about .5 m.m. in thickness. (Fig. 1 A, B, C.)

Arising from the middle of the cephalic border is the processus entoglossus or anterior extension. This is a fine, tapering, cartilaginous rod. It measures about 8 to 10 m.m. in length and ends in a fine point. (Fig. 1 A.)

From each extremity of the body and extending caudally, arises the paired processus retrobasalis or the posterior horns (Huxley). These are fairly firm, cartilaginous rods which gradually taper to a fine point at their caudal extremity. They are 18 to 22 m.m. in length. Near the cephalic extremity they lie in close approximation showing a groove dorsally between them but only a fine slit ventrally. They are bound together by firm connective tissue. More caudally the distinction between the dorsal and ventral aspect is lost. They closely approximate each other, yet are easily separated with a teasing needle. These cartilages are rather stiff in their cephalic third but become more and more flexible distally. (Fig. 1 A, B, C.)

The anterior horns or cerato-hyals arise from the extremities of the body or basi-hyal with which they are continuous. They are divided into two parts which are separated by a movable joint. (Fig. 1 A, B, C.) The first part, which is continuous with the body, is a short, tapering, cartilaginous rod measuring 1.5 to 2 m.m. and terminating bluntly. It runs cephalad, laterad and slightly dorsad. The angle formed by it and the corresponding horn is about 60 degrees. The second part, also cartilaginous, is attached to the first by a joint capsule allowing fairly free movement. This part extends laterad and caudad, tapering as it approaches its extremity, thence curving dorsad. With the first part it forms an angle of about 75 degrees. (Fig. 1 A, B, C.)

The posterior horn, middle horn (Huxley) or cerato-branchial articulates with the basi-hyal at the junction of the anterior horn and the processus retrobasalis. This structure is a fine, tapering, osseous rod, measuring 12 m.m., with a rounded, cartilaginous epiphysis at the proximal extremity and a pointed epiphysis at the distal extremity. There is a medullary cavity in the compact bone. The joint formed with the basi-hyal is surrounded by a fibrous capsule allowing a great range of motion. This horn runs nearly parallel with the posterior part of the anterior horn. (Fig. 1 A, B, C.)

III

The basi-hyal lies in the midline just caudad to the larynx and base of the tongue, being intersected by a line running through the eyes. It is covered by skin, superficial fascia and the thin, superficial mylohyoid. (Fig. 2.)

The processus entoglossus lies deeply embedded between the extrinsic muscles of the tongue and terminates near the symphysis of the jaw. (Figs. 2, 3, 4.)

The anterior horn lies beneath the suprahyoid and hyoglossus muscles, crosses the pterygoid muscle, thence curving around the mandible and ending in a mass of connective tissue just caudal to the ear. (Fig. 2.)

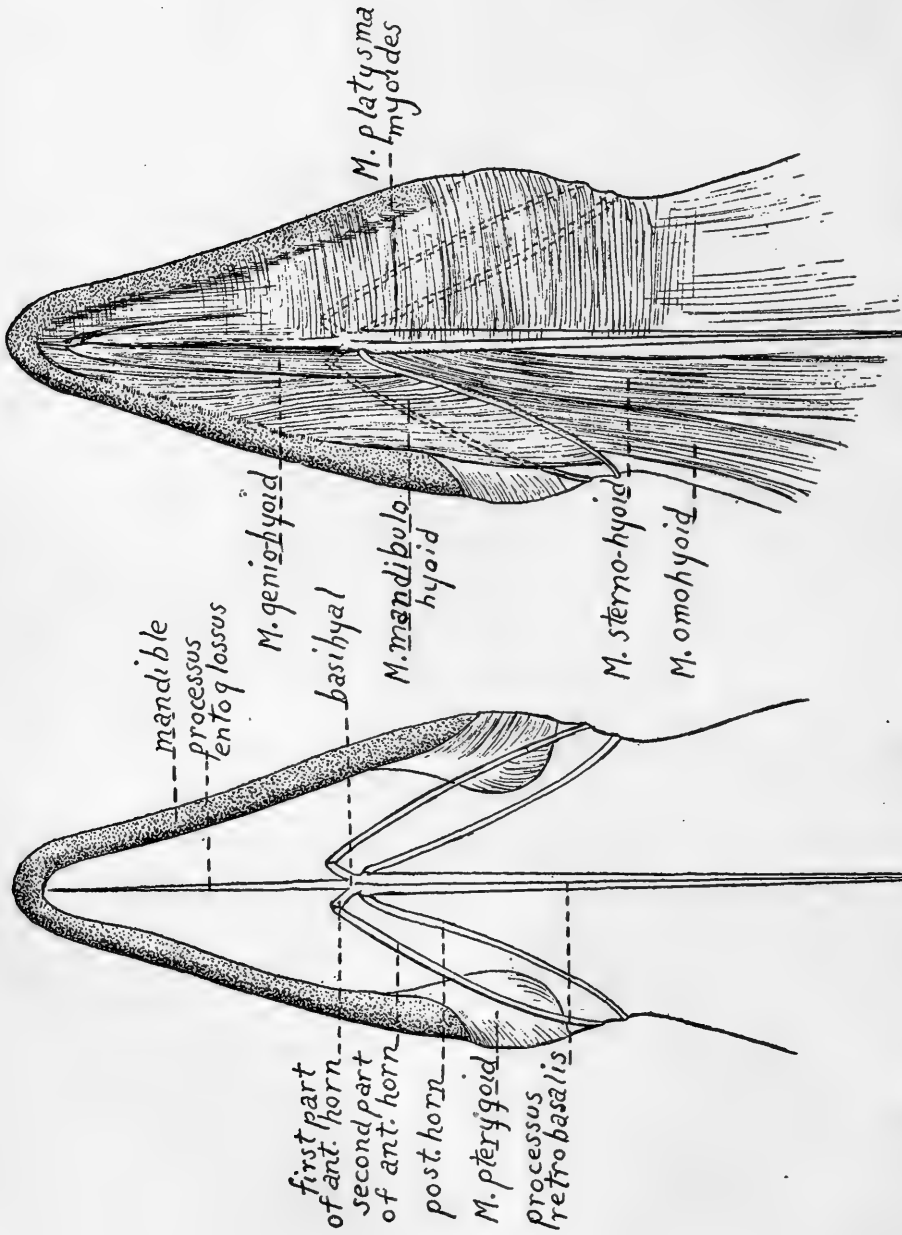
The posterior horn is more superficial, being covered in part by the thin mylo-hyoid only. Distally it curves over the side of the neck just caudad to the mandible, ending in the superficial connective tissue. (Figs. 2 and 3.)

The processus retrobasalis is superficial, being embedded in loose connective tissue just beneath the skin. It lies in the midline and extends to the chest wall. (Figs. 2 and 3.)

The hyoid apparatus forms a typical lever of the first class. The fulcrum is at the junction of the basi-hyal and the posterior horn. The short arm of the lever, which is the power arm, is the first part of the anterior horn. The processus retrobasalis forms the long arm. (Fig. 1 A.)

A force exerted from the extremity of the anterior horn or short arm in a caudal direction, will, due to a slight dorsal inclination of the latter, cause it to swing dorsad and caudad, thus rotating the body at the fulcrum and swinging the horizontal processus retrobasalis through an arc of 90° in a cephalad and ventrad direction, to assume a vertical position. Necessarily the force must be equally applied to the first part of both horns. The second part of the anterior horns and the posterior horns act as supports and tend to prevent any lateral displacement of the long arm of the lever during its assumption of the vertical position.

Necessarily the processus entoglossus would, on meeting the resistance of the tongue during the rotation of the body, be bent dorsally, but its extreme flexibility renders this possible.



First and Second Layers of Hyoid Muscles

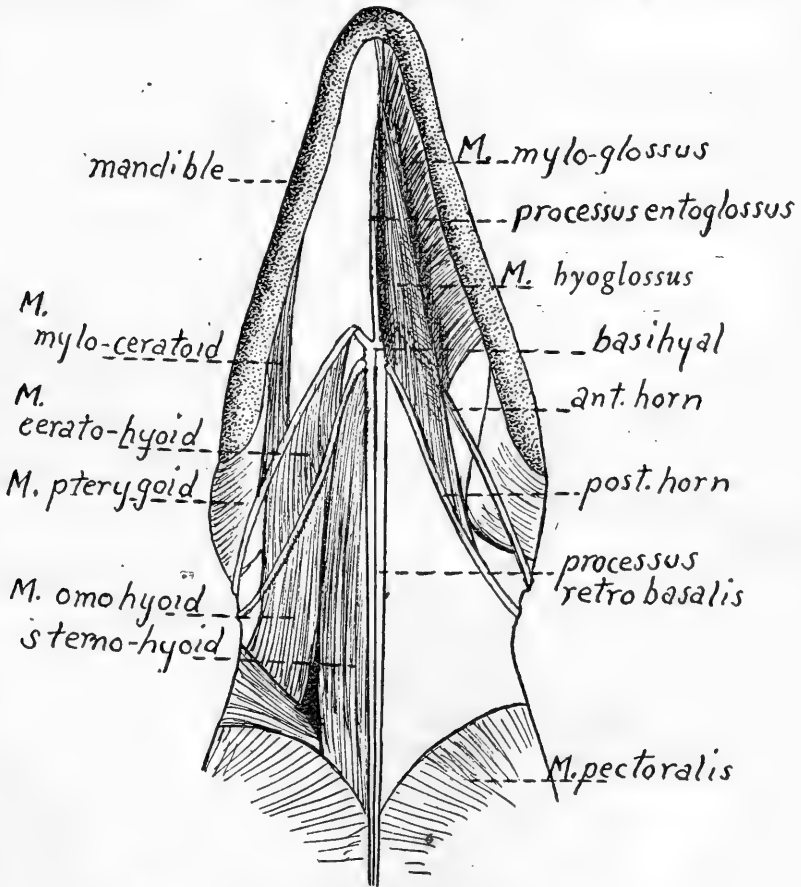
Relation of Hyoid Apparatus to Mandible

Figs. 2 and 3

In order that the muscular forces necessary to erect the processus retrobasalis be understood, it is necessary to take up the individual muscles of the hyoid apparatus.

IV

These muscles are arranged in three layers. First, there is a thin, superficial layer not directly connected with the hyoid. Secondly, there are the supra- and infra-hyoid muscles, and thirdly, the muscles of the tongue. (Figs. 3, 4.)



Third Layer of Hyoid Muscles

The mylo-hyoid or platysma myoides is poorly developed in *Anolis* and is visible only under the dissecting microscope or in microscopical cross sections. It is a thin sheet having its origin along the mandible and inserting in a median raphe. (Fig. 3.)

The second layer consists of four muscles, namely, the genio-hyoid, mandibulo-hyoid, sterno-hyoid and omo-hyoid. (Figs. 3, 4.)

The genio-hyoid is a thin strip of muscle tissue extending from its origin, just lateral to the symphysis, to its insertion on the posterior horn of the hyoid, near its junction with the body. It tends to pull the hyoid cephalad, or, if the latter be fixed, assists in opening the jaw.

The mandibulo-hyoid is a thin sheet of muscle tissue having its origin along the inner aspect of the anterior two-thirds of the mandible interdigitating with the mylo-hyoid and inserting along the posterior horn of the hyoid. It tends to pull the hyoid cephalad and dorsad, or, if the latter be fixed, it also assists in opening the jaw.

The sterno-hyoid takes its origin from the upper extremity of the sternum and inserts on the medial third of the posterior horn of the hyoid and proximal portion of the processus retrobasalis. It pulls the hyoid caudad and at the same time slightly ventrad. If the processus retrobasalis be vertical it pulls it back to a horizontal position. (Figs. 3, 4.)

The omo-hyoid takes its origin from the upper border of the scapula and inserts along the middle third of the posterior horn. It pulls the scapula cephalad and ventrad if the posterior horn be fixed. If the scapula be fixed, it pulls the posterior horn caudad. (Figs. 3, 4.)

If both the supra- and infra-hyoid group act simultaneously, the posterior horn is raised ventrad and firmly fixed. The basi-hyal is thus also raised ventrad, allowing a greater freedom of rotation. This action was noted in lizards under anesthesia, in which the muscles were exposed.

The third layer consists of the mylo-ceratoid, cerato-hyoid, hyoglossus and mylo-glossus. The mylo-ceratoid takes its origin near the middle of the inner aspect of the mandible, thence running over the pterygoid and inserting along the middle third of the second part of the anterior horn of the

hyoid. It tends to pull the anterior horn cephalad after the latter has been pulled caudad by the cerato-hyoid. (Fig. 5.)

The cerato-hyoid takes its origin from the medial two-thirds of the second part of the anterior horn. Its fibres run almost directly caudad and insert along the posterior horn, except for about one-sixth of the proximal and distal ends. This muscle pulls the first part of the anterior horn caudad and dorsad, thus rotating the body at the fulcrum and swinging the processus retrobasalis cephalad and ventrad. (Fig. 4.)

The hyoglossus takes its origin along the posterior horn except for one-sixth of the distal end. The fibres converge and form a rounded belly which inserts along the inferior surface of the tongue by attachments to the intrinsic muscles. This muscle pulls the tongue backwards.

The mylo-glossus has a common origin with the mandibulo-hyoid along the inner aspect of the anterior two thirds of the mandible. It inserts along the side of the tongue. Its fibres run medio-caudad so that besides pulling the tongue from side to side when acting independently, it may be protruded when it acts with the one on the opposite side. (Fig. 4.)

V

In the distension of the throat fan the elastic skin of the throat is raised by the raising of the processus retrobasalis from the horizontal to the vertical position. The thinness of the distended fan is due to the cohesive quality of the two moist, opposing surfaces of skin, as well as atmospheric pressure. Its semi-circular outline is due to the tapering cartilages which, near their proximal end, are able to resist the elasticity of the skin but are unable to do so at their distal part, owing to increased flexibility.

The assumption of the vertical position by the processus retrobasalis from the horizontal, is due to the contraction of the cerato-hyoids which pulls the first parts of the anterior horns dorsad and caudad and causes the second parts of the anterior horns to slide caudad and laterad. At the same time, the basi-hyal is raised by the pull of the sterno-hyoids on the posterior horns. The entire apparatus is steadied by the antagonistic action of the mandibulo-hyoids and genio-hyoids

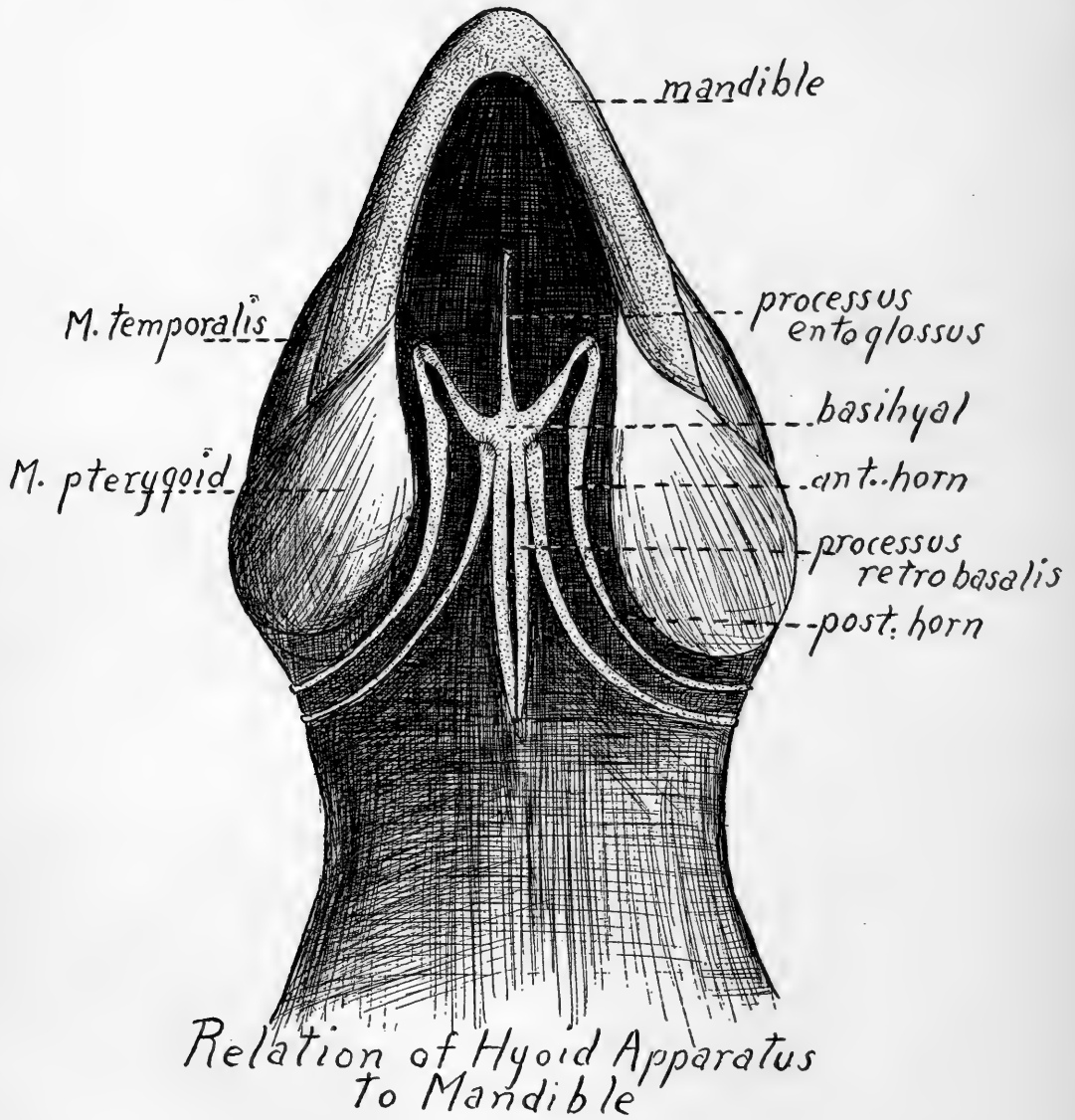


Fig. 5

on the posterior horn, against the pull of the sterno-hyoid and omo-hyoid. In this way the fulcrum is fixed. The muscles of the tongue probably play a small part in the action.

The retraction of the fan is accomplished by the elasticity of the skin, the contraction of the fibres of the sterno-hyoid, inserting on the processus retrobasalis and the pulling of the anterior horns cephalad by the mylo-ceratoids. The elasticity and spring of the entoglossus probably also aids to some extent.

For purposes of comparison, a dissection was made of the hyoid apparatus of a large Iguana. (Figs. 5, 6, 7.) With the exception of a well developed mylo-hyoid and for the reason that none of the muscle fibres of the sterno-hyoid insert on the processus retro-basalis, the structures were essentially the same.

VI

Some difficulty was encountered in naming the muscles of the hyoid apparatus. There was a question as to whether the nomenclature of the earlier investigators should be retained or whether these muscles should be given the names of homologous structures in the mammalia. If the old names be retained, which should be chosen among the various synonymous terms? If the muscles be named after mammalian homologues another difficulty arises, for the names of muscles in the mammalia usually represent the definite origin and insertion and consequently the name may lose its significance and become absurd when applied to a reptile in which there is a different origin and insertion. It was finally decided to retain for the most part the older nomenclature and leave the question for further investigation. (See list of synonyms.)

The same difficulty arose over naming the various structures of the hyoid apparatus. Again the older names were retained with the exception of the processus retrobasalis. This structure is called the posterior horn by Huxley, but since this would necessitate the changing of the name of the true posterior horn to middle horn, it was thought best to designate it by a new name. That it is part of the basi-hyal and not a true horn is evident by following its embryological development.

VII

I was unable to find any literature on the hyoid apparatus of *Anolis*, but Dr. A. Chemin gives a good description of the hyoid apparatus and its relation to the throat-fan in *Colotes versicolor*. From the drawings in his paper there is a similarity between the hyoid apparatus of *Colotes* and *Anolis*, but the action varies markedly. Chemin considers the hyoid apparatus as a lever of which the basi-hyal forms the fulcrum, the processus entoglossus the power arm, and the processus retrobasalis the weight arm. He believes that the processus retrobasalis is made to swing cephalad and ventrad by pressure exerted in the dorsal direction on the processus entoglossus. This pressure is brought about by the pulling of the basi-hyal ventrad by means of the sterno-hyoids and since the processus entoglossus is prevented from moving ventrad with the basi-hyal because of a band of tissue extending from one hyoglossus to the other, the basi-hyal would rotate as the fulcrum and swing the processus retrobasalis forward. The cerato-hyoids simply pull on the anterior horns and increase the angle between the first and second parts. Chemin states that preceding the distension of the fan the animal swallows air and distends its dilatable pharynx.

Evidently then, according to Chemin, the greater the distension of the fan the greater must be the ventral excursion of the basi-hyal, since that is the only way in which pressure can be brought to bear on the processus entoglossus or the power arm of the lever. The anterior and posterior horns merely act as braces.

It is also evident that in *Colotes* the most important muscles are the sterno-hyoids, since these pull the basi-hyal ventrad. The cerato-hyoid plays a minor and insignificant part.

I have no desire to contradict the conclusions of Chemin on the mechanism of the production of the throat-fan in *Colotes*, but I cannot agree with the general statement that the mechanism in *Colotes* is essentially the same for all the *Iguanidæ*. Certainly it differs markedly in *Anolis* where the processus entoglossus is not the arm of the lever and only acts as a hindrance to the production of the throat-fan. In *Anolis* the cerato-hyoids play the most important role and the sterno-hyoids a minor role. Furthermore, the production of

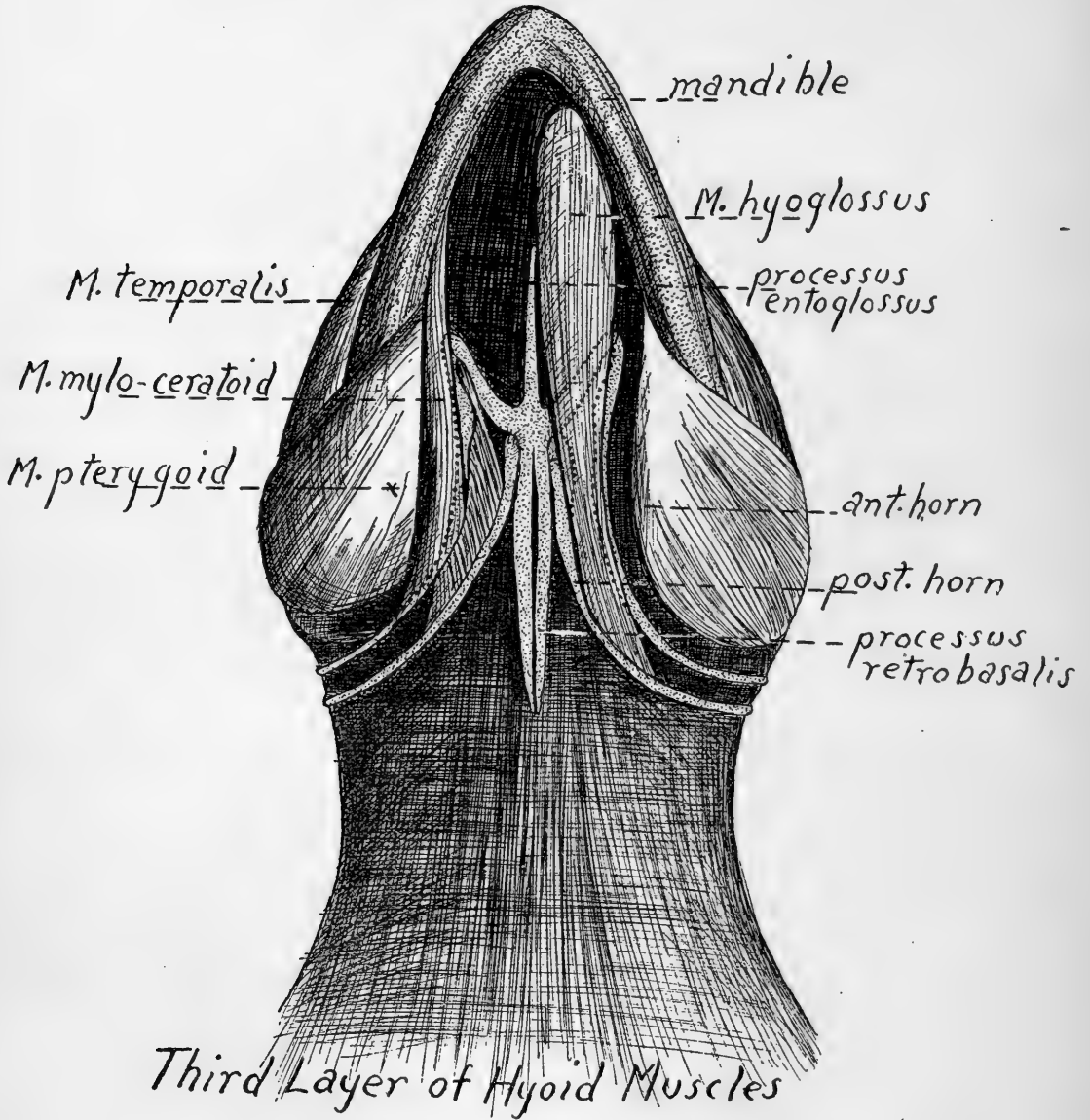


Fig. 7

the throat-fan in *Anolis* is independent of the swallowing of air, or any great ventral excursion of the basi-hyal. The hyoid apparatus in *Anolis* forms a lever of the first class while in *Colotes*, although not so stated by Chemin, it forms a lever of the second class. What Chemin calls the fulcrum, namely the basi-hyal, is not a fulcrum since this is the point where force is employed. The true fulcrum lies somewhere along the processus entoglossus.

CONCLUSIONS

1. The throat-fan of the *Anolis carolinensis* is distended when the animal is apparently undisturbed. It is also distended during various emotional states interpreted as anger, fear or sex impulses.

2. The throat-fan is produced by the hyoid apparatus. It is accomplished by the tapering processus retrobasalis, which swings ventrad and cephalad carrying a fold of skin before it. Since the distal portion of the retrobasalis is more flexible than the proximal portion, the semi-circular outline of the fan is produced. The thinness of the fan is due to the cohesion of the moist opposing surfaces of the fold of skin and to atmospheric pressure.

3. The hyoid apparatus may be compared to a lever in which the first part of the anterior horn acts as the power arm, the basi-hyal as the fulcrum and the processus retrobasalis as the long arm. The anterior and posterior horns act as lateral supports and when acted upon by the muscles, fix the fulcrum.

4. The power is produced by the cerato-hyoids, which exert force in a caudal direction and draws the short arm of the lever dorsad and caudad, which in turn causes the weight arm to move cephalad and ventrad. The fulcrum is fixed by the antagonistic action of the supra- and infra-hyoid group of muscles.

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SYNONYMS

1

- M. Cerato. hyoideus. Bronn.
 Cératoidien latéral externe (Cuvier) Dumèril.
 Cerato-hyoid. Sanders.
 Céra-cératoidien. Chemin.

2

- M. Cerato-mandibularis. Bronn.
 Cérato-maxillaire. Chemin.
 Mylo-hyoideus. Sanders.
 Mylo-cératoidien. (Cuvier) Dumeril.
 Seitwärtszieher des Zungenbeins. Meckel.
 Mandibulo-hyoid.

3

- M. Episterno-hyoideus sublimis. Bronn.
 Sterno-hyoideus. Mivart, Sanders, Stannius.

Sterno-hyoidien. (Cuvier) Duméril.
 Niederzieher des Zungenbeins oder Brustbeinzungenbeinmuskels. Meckel.
 Episterno-cleido-hyoideus sublimis; Fürbringer.
 Sterno-cleido-hyoidien superficial. (Chemin.)

4

M. Omo-hyoideus. Bronn.
 Omo-hyoidien. (Cuvier) Duméril, Chemin.
 Episterno-cleido-hyoideus sublimis. 2th. Fürbringer.
 Omo-hyoid. Mivart, Sanders.
 Omo-hyoideus, Stannius.
 Rückwärtszieher des Zungenbeins oder Schulterblattzungenbeinmuskels. Meckel.

5

M. Mylo-ceratoideus. (Apparently hitherto unnamed.)

6

M. Mylohyoideus.
 Mylo-hyoidien. (Cuvier.) Duméril.
 Zwischenkiefermuskel. Meckel.
 Mylo-hyoideus. Stannius.
 Hyomandibulare. Sanders. (Platydictylus.)
 Platysma myoides. Sanders. (Lirolepis, Phrynsoma.)
 Mylo-hyoideus and Platysma myoides. Mivart.

7

Genio-hyoid.
 Cerato-génien. (Chemin.)

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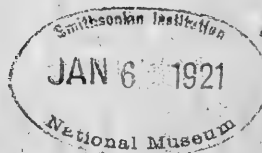
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XIII

New Hemipterous Insects of the Genera
Aradus, Phytocoris and Camptobrochys

BY

EDWARD P. VAN DUZEE



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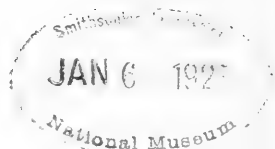
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NEW HEMIPTEROUS INSECTS OF THE GENERA
ARADUS, PHYTCORIS AND CAMPTOBROCHYS

EDWARD P. VAN DUZEE
Curator, Department of Entomology



1. *Aradus apicalis*, new species

Allied to *duzeei* Bergr.; blackish fuscous, a mark on the expanded base of the elytra partially covering the base of the mesocorium, the apex of the scutellum, and the incisures of the connexivum pale or yellowish; antennæ stout, black. Length 7 mm.

Female: Head as long as the width across the eyes; vertex with the longitudinal depression broad, armed with a prominent tubercle anterior to the eye. Antennæ stout, scarcely shorter than the head and pronotum together; first segment obtuse-conical, scarcely longer than the apical thickness of II, dull castaneous at base; II and III cylindrical, as thick as the cephalic protuberance, II somewhat narrower at base; III three fifths the length of II; IV oblong, two thirds the length of III, its tip conical and clothed with pale hairs as in allied species. Rostrum pale, attaining the basal third of mesosternum. Pronotum a little shorter than the head, its width somewhat more than twice its length; greatest width at basal one third, sides less expanded than in *duzeei*, latero-anterior margins nearly straight, coarsely and closely crenulated as in *duzeei*, discal carinæ as in *duzeei*, the median pair percurrent and but very little divergent posteriorly. Scutellum longer and narrower than in any allied species, one third longer than its basal width, the sides of the depressed apical portion rectilinear, apex obtuse. Elytra narrower than in *duzeei*, membrane touched with pale along basal margin, obscurely dotted. Legs, including

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coxal cavities yellowish testaceous, the middle of the femora and tibiæ broadly brown; disk of the ventral segments and marginal incisures obscurely paler. Fifth ventral segment a little longer at median line than at sides, the hind margin straight across the middle; sixth segment as long as fifth and twice longer than the first genital segment which in turn is twice longer than the second; the apical lobes transverse, very feebly sinuated at apex.

Described from one female taken by me at the northern end of Fallen Leaf Lake, Eldorado Co., Cal., June 25, 1915. This species, while most closely related to *duzeei* much resembles *behrensi* but the antennæ are longer, the scutellum longer and narrower, the pronotum broadest behind the middle with the median pair of carinæ nearly parallel, the rostrum longer and the humeral expansions and apex of the scutellum conspicuously yellowish. *Aradus fuscomaculatus* Stål has about the same form of scutellum but it has the antennæ a little shorter, the pronotum broadest at the middle and marked with pale, the elytra and abdomen more strongly maculated and the apical plates of the female more oblique.

Holotype, female (No. 679) in collection of the California Academy of Sciences.

2. *Aradus pannosus*, new species

Very near *fuscomaculatus* Stål, the antennæ shorter and thicker with the apex of the second segment whitish, the valves of the second female genital segment longer and subacute at apex and the genital lobes of the female narrower and more angled when viewed from below. Length $6\frac{1}{2}$ mm.

Female: Head a little longer than broad; antenniferous tubercles obtuse, scarcely attaining the tip of the first antennal segment. Antennæ a little shorter than basal width of pronotum; stout; second segment tapering to base, as long as III and IV together; III thickest, hardly one fourth longer than wide; IV shorter and narrower than III, oval, conical at tip which is not conspicuously cinereous. Rostrum attaining basal one fourth of mesosternum. Pronotum a little over twice wider than long, the expanded sides more rounded than in *fuscomaculatus*, with five or six larger teeth anterior to the widest point; carinæ prominent, the median pair outwardly arcuate on posterior lobe. Scutellum about one fifth longer than wide; sides straight and strongly elevated. Elytra a little shorter than in the allied species. Valves of second genital segment longer and more pointed than in *fuscomaculatus* where they are distinctly rounded at apex; the genital lobes viewed from beneath narrower and more angled at apex.

Color blackish fuscous; posterior edge of humeral lobes, extreme tip of scutellum, apex of second antennal segment and annulations of femora and tibiæ whitish; abdomen variegated with dull reddish fulvous, about

as in *fuscocomaculatus*; elytra largely whitish, their extreme base and the meso and exocorium beyond their basal third heavily marked with fuscous, the membranal nervures and their margins conspicuously white; the white apical portion of the second antennal segment nearly equal to the width of the cephalic protuberance.

Described from one female taken by me at Berkeley, Cal., February 2, 1915. While very near *fuscocomaculatus* this form seems to be sufficiently distinct by the characters of the antennæ and second genital segment. *A. fuscocomaculatus* is not uncommon under bark of rotting live oaks about the bay region and I have specimens taken by Rev. G. W. Taylor on Vancouver Island that do not seem to differ specifically.

Holotype (No. 680) in collection of the California Academy of Sciences.

3. *Aradus blaisdelli*, new species

Closely allied to *inornatus* Uhler but with the body much narrowed posteriorly as in *debilis* and *inornatus*, the rostrum shorter, antennæ stouter, sides of pronotum more narrowed anteriorly and the elytra distinctly varied with cinereous, the membrane especially being conspicuously veined with pale. Length 9–11 mm.

Head about as in *inornatus*; antennæ similar, scarcely shorter than the head and pronotum together, blackish fuscous, the second segment shorter and a little thicker at base, as long as the head from tip to hind margin of eyes; III and IV subequal, each nearly twice the length of I and a little thinner than apex of II; apex of IV conical and clothed with the usual grey pubescence. Pronotum twice as wide as long, widest just behind the middle, the broadly expanded sides obliquely narrowed anteriorly, not broadly rounded as in *inornatus*; margin irregularly denticulate, about three teeth anteriorly much larger; carinæ thicker than in *inornatus*, the median more distinct across the anterior lobe; tubercles of callosities more prominent, conical. Scutellum more depressed posteriorly with its margins strongly reflexed. Elytra reaching on to the sixth segment in the female, to the genital lobes in the male; humeral expansion broad as in *inornatus*. Rostrum passing the middle of the mesosternum, but little exceeding its base in *inornatus*. Genital lobes of male transverse, moderately oblique, of equal length across their whole width; fifth and sixth ventral segments in the female truncate at apex, sixth one fifth shorter than fifth; apex of first genital segment truncate, straight across its whole margin, in *inornatus*, a little oblique and feebly notched at center; second segment half the length of first; genital lobes dorsally triangularly ovate with their hind margin feebly arcuated, their inner margins separated, the ultimate dorsal segment nearly one-half as long as wide, its basal margin regularly rounded, its apical subangularly rounded; in *inornatus* this segment is much broader proportionately with the hind edge but little produced, distinctly transversely wrinkled in common with the inner ends of the genital lobes.

Color blackish fuscous; apex of first antennal segment and base of III indistinctly paler, as is also the edge of the bucculae, lower surface of antenniferous tubercles and tip of first segment of rostrum; expanded sides of pronotum pale; elytral venation mostly pale, the membrane with a whitish spot at base, the veins pale and margined with whitish; disk of connexival segments varied with pale rufo-fulvous, their hind margins more conspicuously pale; the venter quite largely varied with dull rufo-fulvous; tips of the tibiae pale. At least a portion of the granulations are pale, including a few on the legs and antennae.

Described from 10 male and 14 female examples taken at Huntington Lake, Fresno Co., Cal., July 7 to 22, 1919, at an altitude of 7-8,000 feet. These were all taken under loose bark of old stumps and logs of lodge-pole pine. It affords me pleasure to name this interesting addition to our fauna for Dr. F. E. Blaisdell of San Francisco, well known for his work on the Eleodini and other groups of the Coleoptera, as a token of friendship and in recognition of his enthusiasm in the pursuit of his favorite study and of his kind and prompt response to all appeals for assistance in the increase and improvement of the Academy's collection of insects. This species pertains to the group embracing *debilis*, *hubbardi* and *inoratus*; the thicker antennae will distinguish it from the former two and the more oblique latero-anterior margins of the pronotum and variegated membrane from the latter.

Holotype, male (No. 681) and allotype, female (No. 682) and paratypes in collection of the California Academy of Sciences.

4. *Aradus vadosus*, new species

Closely allied to *debilis* Uhler but with unicolorous antennae, shorter rostrum and more oblique pronotal margins. Length 10 mm.

Female: Head little longer than broad across the eyes, the apical process twice longer than its greatest width; spines of the antenniferous process terete, subacute, attaining the apical one fourth of the first segment, its base armed with a distinct tubercle; preocular tubercle large; middle of vertex with a double row of coarse tubercles, these rows diverging at apex; lateral depressions deep, narrow, parallel. Antennae almost as long as the head and pronotum together; segment II distinctly longer than median line of pronotum, slender, but slightly clavate at apex; III and IV subequal, the latter thickest of all, widened to base of the conical apex; all segments finely granulate without distinct apical teeth. Rostrum attaining apical third of mesosternum, the basal segment much shorter than the head. Pronotum two and a third times as wide as its median length; finely granulate, the sides broadly expanded and upturned, coarsely and irregularly crenate; the latero-anterior margins rectilinear

to the truncate anterior angles; widest point just behind the middle; carinæ moderately prominent, distant, nearly parallel, terminating anteriorly in a pale tubercle; callosities with a prominent tubercle; humeral lobes subangulate, the posterior evenly rounded and smooth. Scutellum one-third longer than broad, nearly flat, the sides gently arcuated to the rounded apex, the basal field but slightly elevated, feebly tricarinate. Elytra reaching on to the third tergal segment; costa moderately expanded at base; femora with a few small white tubercles. Genital plates broad and short, the basal about one-third the length of the sixth ventral segment, fully three times the length of the apical; genital lobes short, transverse, their greatest length hardly one third their width, their oblique apex arcuated.

Color testaceous varied with brown and tinged with rufous on the abdomen, scutellum and disk of the pronotum; antennæ becoming fuscous toward the apex with the extreme tips of segments II and III pale; elytral veins pale on a darker ground; tergum with a fuscous cloud on each segment at the connexival suture, the disk of segment six and the genital segment fuscous; rostrum fuscous, paler at base.

Described from one female taken on Vancouver Island, September 6, 1899, by Rev. G. W. Taylor. This specimen is paler than any allied form known to me.

Holotype in collection of the author.

5. *Aradus taylori*, new species

Allied to *acutus* Say but with more slender antennæ and the body less maculated; blackish fuscous, narrow hind margin of humeri and some marks on the elytra pallid; basal lunule of the head and incisures of abdomen pink; sides of pronotum strongly toothed. Length, male $7\frac{1}{2}$ mm., female 9 mm.

Male: Head a very little longer than broad across the eyes; antenniferous spines long, acute, reaching nearly to the apex of first antennal segment; preocular tubercle small, the postocular large, obtuse; anterior process as long as the width between the eyes; the lateral impressed vittæ moderately deep, finely granulate like the rest of the surface. Antennæ as long as head and pronotum together, more slender than in *acutus*; second segment one fifth longer than III and IV together, a little thickened at apex; IV three fourths of III, its tip conical and clothed with the usual grey pubescence. Rostrum pale, attaining hind margin of prosternum. Pronotum more than twice wider than long, widest just behind the middle; humeral angles broadly rounded; latero-anterior margin nearly straight, finely crenulate as are the humeri, and in addition armed with about four stout irregular teeth; surface nearly flat, the longitudinal carinæ feeble, the median pair diverging a little posteriorly. Scutellum flat, edges nearly rectilinear to the obtuse apex, but feebly elevated. Elytra narrow, attaining the genital segment, the humeral expansion narrow. Genital lobes oblique at apex with their angles rounded.

Color blackish fuscous; extreme base of vertex and incisures of connexivum above and below pinkish; venter dark castaneous; narrow hind edge of humeral lobes, a mark on the basal expansion of the corium and

the transverse veins on the latter pale; membrane with the narrow margins of the veins and a spot at base pale. Legs brown, paler beneath.

Genital lobes of the female a little longer than in *compressus*, distant, with their inner angles more acute.

Described from one male taken by the late Rev. G. W. Taylor on Vancouver Island from under bark, March 4, 1898. A female taken at the same time is notable in having the left elytron much abbreviated, the corium not attaining the apex of the scutellum and the rounded membrane reaching only to the second tergal incisure, the left wing complete, almost reaching the apex of the right elytron. This species has the flat surface and pale humeral margins found in *compressus* but the pronotal margin is shorter and strongly denticulate, the antennæ are more slender and the colors are different.

Holotype, male (No. 683) in collection of the California Academy of Sciences; allotype, female, in collection of the author.

6. *Aradus parshleyi*, new species

Allied to *compressus* Heid. but with the antennæ thinner at base, the latero-anterior margin of pronotum minutely granulate and strongly sinuated and the elytra more strongly marked; antennæ basally and legs brown; hind margin of humeral lobes and markings on the corium pale. Length 8 mm.

Female: Head a little longer than wide across the eyes; antenniferous tubercles short, reaching to middle of first segment; preocular tubercles small, obtuse; lateral impressed areas smooth and anterior to the line of the hind margin of the eyes; base with a slender oblique whitish line. Antennæ as long as head and pronotum together; segment II as long as III and IV together, regularly thickened to its apex where it is as wide as III; the latter cylindrical and as thick as the anterior femora; IV scarcely shorter than III and but little thinner, about twice as long as I. Rostrum attaining basal one fourth of mesosternum. Pronotum a little wider than its median length, depressed as in *compressus*; sides broadly expanded and rounded almost to the anterior angles which are right-angled, thus forming a deep sinus; minutely crenulate or granulated, the crenulations stronger in the anterior sinus; carinate lines moderately elevated, the median pair about parallel. Scutellum longer than the pronotum, its basal width two thirds its length; its surface nearly flat, the sides moderately sinuated before the rounded apex and well elevated. Elytra subparallel, its basal margin somewhat expanded; membrane reaching the genital segment with a number of supernumerary cross-veins. Genital lobes obliquely rounded and well separated; sixth ventral segment a fourth longer than the truncate fifth segment and emarginate at apex; basal genital plate tumid, nearly four times as long as the short apical plates.

Color fuscous brown, paler on the humeral lobes, especially posteriorly, and on the elytra; the latter varied with fuscous at base and in the areoles; membrane fuscous with the brown veins bordered with whitish. First segment of antennæ and basal two thirds of second ferruginous; rostrum legs and venter more or less rufo-ferruginous; incisures of connexivum pale.

Described from one female taken by M. H. Ruhmann at Vernon, B. C., April 28, 1915, and kindly sent to me for study by Dr. H. M. Parshley to whom this species is dedicated in appreciation of the valuable and painstaking work he is doing on our North American Hemiptera. This species belongs to the group having the pronotum depressed and minutely crenulate or granulated on the lateral margins and including *compressus* Heid., *tuberculifer* Kirby and *funestus* Bergr.

Holotype in the Canadian National Museum at Ottawa.

7. *Aradus orbiculus*, new species

Apparently allied to *heidemanni* Bergr., but with a longer rostrum and nearly circular abdomen in the female. Length: male 8 mm.; female 12 mm.; width of abdomen, male 3 mm., female 6 mm.

Male: Body oblong, a little wider posteriorly, broadest at fifth abdominal segment. Head a third longer than wide across the eyes, much longer than median length of pronotum, the anterior process forming one half its length; impressed mark either side the vertex granulated; antenniferous tubercles long, subacute, much divergent; preocular tubercle small; post-ocular obsolete. Antennæ almost as long as the head and pronotum on the median line, moderately stout; first segment short, hardly twice longer than wide; II longer than the head, one half longer than III and IV together, a little thickened apically; III cylindrical, nearly twice the length of the fusiform fourth segment. Bucculæ slightly angularly elevated; rostrum attaining hind margin of anterior coxæ; first segment not reaching base of head. Pronotum much narrowed anteriorly; sides straight; hind angles broadly rounded; width on anterior margin equal to length on median line, less than half the basal width; hind margin deeply excavated. Scutellum narrow, deeply excavated, the basal elevation scarcely indicated; its length equal to that of the head, and nearly twice its basal width; sides parallel on basal one half; apex obtuse. Elytra long and narrow, reaching on to the genital plates, the expanded basal portion just passing the scutellum; their combined width at apex of corium one third greater than their individual width at base; veins prominent, closely ramose on mesocorium; principal veins of the membrane very prominent, the ramose veins almost obsolete. Genital lobes long, subangled and oblique at apex, formed much as in *compressus* Heid.

Female much larger than male, with the abdomen as wide as long beyond tip of scutellum; elytra short, oblong but slightly exceeding the scutellum, with no indication of membrane; sixth ventral segment as long as the two genital segments together; second genital segment very short,

rounded or subangular; genital lobes short and broad, scarcely angled behind, their inner margins rounded, distant, much as in *compressus*.

Color uniformly blackish fuscous; legs, inner edge of the genital lobes and sometimes the hind edge of the ventral segments tinged with castaneous.

Described from two male and three female specimens taken by me under loose bark of a stump of lodge-pole pine at Huntington Lake, Fresno Co., Cal., July 17, 1919, at an elevation of 7,000 feet. In this species the pronotum has about the form found in *heidemanni* but without the marginal crenulations; the male elytra are narrowed much as in the female *heidemanni* but in a less degree, while the females are brachypterous. It has much in common with *compressus* near which it should, perhaps, be placed.

Holotype, male (No. 684), allotype, female (No. 685), and paratypes in collection of the California Academy of Sciences.

8. *Aradus evermanni*, new species

Near *gracilicornis* Stål; form narrow, subparallel; antennæ shorter; pronotum shorter, its sides paler and more deeply denticulate, humeral angles more rounded; scutellum broader; elytral areoles reticulate. Length $4\frac{1}{2}$ mm.

Female: Head as in *gracilicornis*. Antennæ slender, as long as the head and pronotum united; first segment but little longer than thick, cylindrical; II distinctly longer than III and IV together, its immediate apex thickened, but little narrower than I; III and IV subequal, about as long as the dorsal thickness of the cephalic process; III cylindrical, IV fusiform. Rostrum just attaining the anterior coxæ. Pronotum distinctly shorter than the head, its median length one half its basal width; sides broadly flattened, strongly crenulate, slightly sinuated anteriorly without a distinct apical tooth; humeri broadly rounded, (in *gracilicornis* the sides are nearly parallel behind the widest point); six discal carinæ about as in its ally except that the median pair diverge more posteriorly. Scutellum a little shorter and proportionately broader than in *gracilicornis*, nearly one fourth longer than the pronotum. Elytra as in the allied species, all the areoles white, crossed by irregular fuscous veins; membrane distinctly maculated. Apex of fifth ventral segment truncate across the middle, its median line distinctly longer than the sides, its disk without a transverse impressed line; sixth segment on its median line as long as the fifth, very slightly excavated at apex, its apical angles equalling the genital segment; first genital segment truncate at apex, about twice as long as the apical, the valves of the latter triangular; genital lobes narrow and strongly curved at apex, almost meeting beyond the genital segment, their apical margin truncate and a little oblique.

Color black; first three segments of antennæ, expanded margins of pronotum, elytral veins, except at base and apex, and the connexivum obscure brown; incisures of the connexivum broadly pale.

Described from one female taken by me in Golden Gate Park, San Francisco, September 16, 1917. While very close to *gracilicornis* this species may readily be distinguished by the diagnostic characters given above. *Aradus marginatus* Uhler differs in color of antennæ, etc. Named for Dr. Barton W. Evermann, director of this Academy, in recognition of his ready assistance and of his unfailing interest in the broader phases of entomological study.

Holotype, female (No. 686), in the collection of the California Academy of Sciences.

9. *Aradus snowi*, new species

Allied to *falleni* but narrower, parallel, with thick, white antennæ, which are black only at base and extreme tip. Length 4 mm., width $1\frac{1}{3}$ mm.

Male: Head as in *falleni*, the anterior process quite strongly constricted near the base; vertex almost entirely depressed with a small median raised area and a few minute granulations, the margin prominent and a little produced behind the eyes. Antennæ about as long as in *falleni* but much thicker; first segment scarcely exceeding the antenniferous tubercle and hardly longer than wide; II somewhat shorter than III and IV together, regularly increasing in thickness from base to middle, beyond cylindrical and equal in thickness to an eye; III almost as thick as II and two thirds its length, a little narrowed basally; IV cylindrical, a little thinner than III and two thirds its length. Rostrum attaining the anterior coxæ. Pronotum a fourth shorter than the head, its median line one half its greatest width; sides strongly expanded and upturned, sinuated behind the prominent rounded anterior angles; behind the middle very feebly arcuated; discal carinæ as in the allied species but quite obviously arcuated, the edge closely, minutely crenulate. Scutellum longer than in *falleni*, the carinate sides rectilinear almost from their base. Costal margin of corium rectilinear from base nearly to apex, the areoles subhyaline and crossed by irregular veinlets.

Color black becoming brown on the expanded pronotal margins and on most of the elytral veins; the elytral areoles and membrane whitish hyaline, the latter quite distinctly maculated; antennæ creamy white; first segment, basal half of second and apical half of fourth black.

Described from one male taken by the late Prof. F. H. Snow in the Santa Rita Mts., Arizona, in June, between five and eight thousand feet elevation. The parallel form and conspicuous black and white antennæ will readily distinguish this interesting species. This specimen is carded so the genital characters are mostly covered.

Holotype, male, in collection of the author.

10. *Phytocoris ingens*, new species

Large and broad, oblong, pale grey, quite evenly dotted with fuscous points, those along the costa larger. Length 8; width 3 mm.

Male: Head short, vertical, projecting below the eye for a space less than the width of the eye below the antennæ; eyes very large, below attaining the line of the bucculæ; vertex depressed, narrow, its least width about half that of the eye viewed from above; front flat; clypeus prominent, convex, projecting strongly above the plane of the front; cheeks tumidly convex. Antennæ slender; segment I nearly as long as from its base to hind margin of pronotum, a very little thickened basally; II more slender, as long as from base of scutellum to apex of clavus; III a little longer than commissural margin of clavus; IV (wanting in male) in female one half of II. Length of pronotum two fifths its basal width; hind margin broadly rounded; callosities distinguished by a deep suture. Scutellum as long as pronotum, its basal field well exposed; hind femora nearly seven times as long as wide, gradually tapering from basal third; hind tibia one half longer than its femur, its spines short, not longer than thickness of the segment. Sinistral notch of genital segment right-angled, the dorsal angle produced in a blunt tooth arising from an extension of the dorsal tergite and lying beneath the margin of the genital segment; sinistral clasper of medium size, curved at apex, with a prominent obtuse shoulder near its base; dextral clasper small, blunt at apex, lying along the ventral wall of the notch.

Color cinereous, tinged with fulvous on the head, callosities, basal lobe of scutellum and abdomen; propectus, sides of the venter basally, a broad vitta on the sides of the pronotum inferiorly and a narrow line below this, blackish, the genital segment with a fuscous cloud either side. Above minutely but quite regularly dotted with fuscous, these dots imperfectly segregated into larger spots along the veins and costal margin; apex of corium with a black point near the angle of the cuneus; membrane white, regularly dotted with fuscous points, the veins dull fulvous. Antennæ pale brownish; base of II and III broadly paler; I pale with about six fuscous marks exteriorly. Femora varied with fuscous on apical half; tibiæ with about three imperfect fuscous annuli, usually but one distinct. Upper surface sparsely clothed with stiff black hairs intermixed with pale ones on head and pronotum and short white deciduous tomentum. Female with fuscous markings beneath less extended.

Described from two males and two females taken by Mr. Fordyce Grinnell at Pasadena, Calif.

Holotype, male (No. 687), and allotype, female (No. 688), in collection of the California Academy of Sciences. Paratypes in collection of the author.

11. *Phytocoris aurora*, new species

Allied to *palmeri* but with more cinereous elytra and different male genitalia. Length 7 mm.; width 2 mm.

Male: Head oblique, produced beyond the eye for a space equal to the greatest width of the eye; front little convex, clypeus moderately so.

Antennæ slender; segment I as long as head and pronotum together, linear with a few long weak bristles; II more than twice the length of I; III one fourth longer than I, IV as much shorter. Pronotum twice wider than long; scutellum unusually convex, longer than wide at base. Elytra nearly parallel; hind femora seven times as long as wide; a little narrowed on basal and apical one fourth; hind tibiæ very long, almost equal to elytra including the membrane; rostrum reaching third ventral segment. Sinistral notch of genital segment shallow, its dorsal angle produced in a short upright tooth; sinistral clasper, large, convex, in form of a broad triangle with its apical margin a little concave; lower angle curved and hidden beneath the apex of the segment, dorsal angle acute and incurved, attaining the dorsal angle of the segment.

Color whitish testaceous, tinged with yellow on head and pronotum; a cloud on the vertex, about seven arcs on the front and a transverse vitta across cheeks and clypeus ferruginous; sides of pronotum broadly, the narrow base and median line, deep black, leaving a squarish discal spot which includes a few ferruginous marks about the callosities and on the collum; hind edge slenderly white. Scutellum fuscous with the median line and sides marked with whitish. Elytra dusky testaceous, a little more clouded along the apical margin, the veins and costa with inconspicuous brown and white marks; membrane fuscous obscurely irrorate with pale; a spot at apex of cuneus and a discal arc whitish. Beneath mostly blackish fuscous with the coxæ white. Legs whitish, the femora rufous-brown irrorate with whitish; tibiæ varied with brown, the anterior triannulate. Basal segment of antennæ rufous-brown, dotted with white, two of the spots larger; II pale brown with a white basal annulus twice longer than the thickness of the segment, followed by a fuscous cloud; III and IV infuscated, the former white at base as in II. Surface clothed with black hairs and white tomentum.

Described from one male taken by me at Cayton, Shasta Co., Cal., July 19, 1918. The male genital clasper is so distinctive the species cannot be confounded with any other known species; the markings of the head and pronotum are about those found in *palmeri*.

Holotype, male (No. 689) in collection of the California Academy of Sciences.

12. *Phytocoris tenuis*, new species

Aspect somewhat of *canescens* Reut.; smaller and more slender, more yellowish in color and marked with a fuscous vitta following the claval suture; the male genitalia very distinctive. Length $6\frac{1}{2}$ mm.

Male: Head oblique, produced beyond the eye for a space equal to two-thirds the length of the eye; front and clypeus tumidly prominent, leaving a deep sinus at base of clypeus; cheeks tumidly raised, almost tuberculate; vertex nearly flat, a little wider than the eye viewed from above. Antennæ long; segment I as long as head and pronotum together, moderately clothed with long pale hairs and a few stiff bristles; II not quite the length of I; III and IV together shorter than II. Pronotum twice wider than long, with prominent humeri. Elytra parallel, twice longer to

apex of cuneus than together wide; hind femur six times longer than wide, subparallel to beyond the middle, then a little narrowed to apex; hind tibiæ with weak bristles not longer than thickness of the segment; rostrum attaining third ventral segment. Sinistral notch of genital segment shallow; sinistral clasper linear, curved around the apex of the segment, at base giving off an erect dorsal branch as long as the horizontal member and rising to the dorsal line of the segment where it is bent abruptly backward, terminating in line with the apex of the genital segment; dextral clasper small, distorted in the type, apparently triangular.

Color yellowish testaceous, darker on head and pronotum; pronotum with a fuscous basal vitta before the slender white hind edge, carrying about six spots of tufted black hairs. From this dorsal vitta seven indistinct longitudinal rays run to the anterior lobe, the lateral two the most obvious. Scutellum with a pale median line more or less indicated and a fuscous spot either side before apex. Corium with an indefinite fuscous vitta following the claval suture and deflected along the apical margin to apex of cuneus, this vitta marked with a few pale spots bearing clusters of white hairs; membrane pale, quite thickly irrorate with fuscous; veins yellowish. Hind femora more or less distinctly marbled with fuscous; venter infuscated, the tip of the rostrum black. Apex of antennæ infuscated, the base of III paler. Upper surface clothed with black hair in fresh specimens.

Described from one pair taken by me on Mt. Tamalpais, Marin Co., Cal., June 23, 1918, and a female taken by Dr. E. C. Van Dyke at same locality, September 19, 1909. This is the most slender *Phytocoris* known to me and seems to connect *canescens* with *lineatus* and *validus*; the rayed pronotum and the fuscous vitta on the elytra will distinguish females while the remarkable male genitalia will at once locate that sex.

Holotype, male (No. 690), allotype, female (No. 691), and paratype in collection of California Academy of Sciences.

13. *Phytocoris sonorensis*, new species

Aspect of *canescens* but larger and broader, the elytra and antennæ more varied; sexes similar. Length 7 mm.

Male: Head vertical, produced below the eye for a space greater than the length of the eye; eyes small, but moderately produced inferiorly; front a little convex between the antennæ. Antennæ long; segment I a fourth longer than pronotum; a little thicker near the base; II twice as long as I; III a third shorter than II; IV one fourth shorter than I. Elytra together nearly as wide as their length to tip of clavus. Rostrum passing hind coxæ. Hind femora nearly equal to length of elytra to tip of cuneus, slender, nine times longer than wide, widest near base then gradually a little narrowed to apex. Sinistral notch of genital segment rather small, right-angled, margin oblique dorsally and there carrying a large curved, suberect lenticular tooth arising from the produced angle of the apical tergite; sinistral clasper large and broad, its dorsal angle forming a blunt tooth, the apical portion abruptly slender and incurved; dextral clasper small, lying along the ventral wall of the notch.

Color obscure testaceous-grey clouded with fuscous; head black at apex with a transverse white vitta below the antennæ. Antennæ brown; segment I black dotted with white; II with a white annulus at base and an obscure one beyond the middle; III white at base. Pronotum fuscous, clothed with black hairs; hind margin white, preceded by six black spots bearing tufts of black hairs; scutellum with a double fuscous vitta, diverging posteriorly leaving a pale median line expanded at apex. Discal region of elytra fuscous; costa brown, becoming black at apex of corium, varied with pale dots; apex of corium with a polished angular pale spot; cuneus pale, mottled, becoming black at apex and on internal margin; membrane fuscous closely irrorate with pale; nervures fuscous, white at apex. Femora pale at base, fuscous and irrorate with pale at apex; tibiæ blackish with three broad white annuli. Beneath black, coxæ paler, rostrum rufous. Female paler and more clearly marked above than male.

Described from two males taken by me at Alpine, San Diego Co., Cal., June 7, 1913, and two females taken on the Cuyamaca Mts. at Descanso, Cal., at 5,000 feet elevation, October 5, 1913.

Holotype, male (No. 692), in collection of the California Academy of Sciences. Allotype, female, and paratypes in collection of the author.

14. *Phytocoris calvus*, new species

Form and aspect of *sonorensis* nearly, a little smaller and more reddish in color; head and anterior margin of pronotum pale yellowish; second antennal segment obscurely annulated; coxæ white; membrane irrorate; apex of corium with angular polished pale spot. Length 6 mm.

Male: Head short, nearly vertical, produced below the eye for a space equal to greatest width of eye; front full, clothed with long procumbent white hair; clypeus feebly arcuate; vertex flat, as wide as the eyes viewed from above. Antennæ slender; segment I but little shorter than basal width of pronotum; II three fourths longer than I; III one fourth longer than I, IV as much shorter; I armed with a cluster of long white hairs exteriorly near the base. Pronotum a little more than twice broader than long. Scutellum a little broader than long, its length subequal to that of the pronotum; upper surface clothed with short black hairs intermixed with flattened black hairs and white tomentum; tibial spines long and stout, rufous-brown. Sinistral notch of genital segment rectangular, armed with a large acute tooth above which is produced backward; sinistral clasper attaining tip of genital segment, at base with a dorsal obtusely angular tooth; dextral notch with a short acute tooth above, the clasper filling the ventral portion of the notch and attaining its apex.

Color rufous-brown, but slightly maculated; head and anterior portion of pronotum yellowish white; base of vertex with an angular pale fulvous vitta; clypeus with an angular mark and spot at base fulvous-brown, the cheeks still darker with a white suture, a spot at base of antennæ white edged with brown. Pronotum posteriorly castaneous brown with a sinuate black vitta before the white basal margin. Scutellum feebly varied with

paler. Elytra dusky on the disk, becoming rufous at tip of corium and anterior to the white angular spot at apex; cuneus rufous; membrane white, irrorate with fuscous, leaving two white marginal spots. Below rufous, the pleural pieces piceous; coxæ white; legs white, the femora marked with fuscous apically, the posterior more broadly so, with two white annuli; tibiæ faintly triannulate with fuscous. Antennæ pale brown; segment I white marked with rufous; II with base and a broad annulus beyond the middle white; III white at base.

Described from one male taken by Mr. Fordyce Grinnell on Mt. Wilson, Los Angeles Co., Cal., August 10, 1909. The uniform rufous color, pale head and coxæ, flattened black hairs above, and the cluster of white bristles on first antennal segment with the genital characters will sufficiently distinguish this species.

Holotype, male, in collection of the author.

15. *Phytocoris onustus*, new species

Allied to *eximius* Reut., a little larger and darker with darker antennæ and, like that species, belonging to the group with marmorate membrane; differing widely in male genitalia. Length 7 mm.

Male: Head a little longer and more oblique than in *eximius*, exceeding the eye for a space equal to the greatest width of the eye; vertex more flattened. Antennæ slender; segment I a little thickened basally, as long as from their insertion to the base of the pronotum; II thinner, more than twice the length of I and about equal to the costal margin of the corium; III and IV together equal to II; III longer than I, IV shorter. Pronotum as in *eximius*, its length three fifths its basal width, sides straight, humeri prominent. Scutellum equal to pronotum in length; rostrum passing hind coxæ; legs as in *eximius*. Male genital segment large, convex; sinistral notch right-angled, the dorsal angle obtuse, unarmed; sinistral clasper large, sickle-shaped, with a prominent dorsal tooth near its base; black with luteus apex; dextral clasper long as the sinistral, bent near the base and armed there with a dorsal tooth equal to its own width, at apex paler and curved inward and upward, subacute.

Color yellowish cinereous, much invaded with fuscous; head pale, the disk of the cheeks, apex of clypeus and about six arcs on the front fuscous; disk of pronotum pale, sides and base broadly blackish, the latter area broken at the middle; hind edge white; callosities marked with a double pale arc; scutellum pale with a blackish vitta either side the pale median line, these diverging posteriorly, basal angles with a fuscous spot. Elytra fuscous, obscurely irrorate with pale and each marked with three polished areas, one subbasal, one median and one apical invading the base of the fuscous cuneus. Membrane pale fuscous marmorate with whitish forming a pale spot at apex of cuneus and two obscure discal areas; nervures fuscous, the cubital thick and black. Antennæ fuscous; segment I irrorate with pale with a few black bristles near base; II with base narrowly pale; III with base and extreme tip pale. Legs irrorate with fuscous at apex, the hind femora becoming fuscous at apex with paler

band and irrorations; tibiae fuscous with about four pale annuli, tibial bristles pale, longer than thickness of the segment. Beneath mostly black with the coxæ pale.

Female somewhat paler than the male with disk of pectus and venter pale, the fuscous basal area of pronotum having about six black spots on the submargin.

Described from one pair taken by me at Salamanca, N. Y., July 20, 1911, and one female taken at Boston, Erie Co., N. Y., August 1, 1909.

Holotype, male (No. 693), and allotype, female (No. 694), in collection of the California Academy of Sciences; paratype in collection of the author.

16. *Phytocoris erectus*, new species

Aspect of *eximius*, differing principally in the very distinct male genitalia. Length 6 mm.

Characters of *eximius* nearly. Eyes a little more narrowed below. Colors more strongly contrasting, the elytral markings tending to form a vitta on the disk of the clavus and another on the corium next the claval suture; apex of corium with a conspicuous polished angular pale spot preceded by a triangular fuscous mark and bordered outwardly by the fuscous apex of the corium. Cuneus with fuscous irrorations segregated at apex, its inner margin with two black points. Membrane pale fuscous with a double subhyaline mark beyond the apex of the cuneus, one in the larger areole and a loop on the disk, with some irregular marks toward the base. Sides of the pectus and venter and the genital segment mostly black. Hind femora with moderately distinct pale subapical annulus; scutellum with a pair of fuscous points near apex. Genital segment of male short; sinistral notch right-angled, its dorsal angle prominent, forming a blunt tooth; sinistral clasper large, sickle-shaped, strongly curved, with its apex acute and reaching under the dextral clasper, its base with a long ligulate erect dorsal tooth attaining the dorsal angle of the segment, of nearly equal width throughout or a little enlarged at apex; dextral clasper very large, flattened and curved to conform with the figure of the segment, its subacute apex lying close to the base of the dorsal tooth of the sinistral clasper, its broad base produced in a subacute, vertical tooth.

Described from one male taken by me at Salamanca, N. Y., July 20, 1911, one male taken at Kearney, Ont., July 27, 1919, by my brother, M. C. Van Duzee, and two females taken by W. J. Palmer at Lake Temagami, Ont., August 12, 1906.

Holotype, male from Salamanca (No. 695), and allotype, female from Temagami (No. 696), in collection of California Academy of Sciences, paratypes in collection of the author.

17. *Phytocoris canadensis*, new species

Very close to *erectus* but with distinct genital characters and the pale ventral area more widened posteriorly, covering the entire last ventral segment; genital segment fuscous either side, the median line and apex pale. Length 6 mm.

Sinistral male clasper with its dorsal tooth hardly half as long as in *erectus*, triangular as viewed from before and acute at apex; dextral clasper shorter and more slender on apical portion, its dorsal tooth much larger, acute, nearly parallel with the ventral member than which it is one-half shorter.

Described from one male taken at Kearney, Ont., July 29, 1911, by my brother, M. C. Van Duzee. It is with some misgivings that I found a species on such slight genital characters, but the differences here are far greater than those that have been used in the discrimination of species by workers in other genera of the Hemiptera and it is quite probable that the study of a large series will justify the separation of this species. In using male genital characters in distinguishing species I much prefer to employ those of the claspers, which are essential organs in copulation, than those of the *ædeagus* which is chitinized to a less degree and therefore more subject to distortion. The claspers also are frequently observable externally without dissection of the specimen, which, with scant material, is inadvisable. As a final test in close cases it probably would be better to use both sets of organs when the material will allow.

In my comparative notes on these species I have used Mr. Heidemann's determination of *eximius* which I believe is correct. Reuter's determination of 1909 (Nearct. Capsiden, p. 23) is plainly incorrect and refers to a species with irrorate membrane, apparently *inops* Uhler.

Holotype, male, in collection of the author.

18. *Phytocoris histriculus*, new species

Aspect of *minutulus* Reut., a little larger and paler with the elytra more variegated; first antennal segment armed with many erect long white bristles. Length $5\frac{1}{2}$ mm.

Male: Head rather long, oblique, produced before the eye for a space almost equal to the length of the eye; front rather prominent. Antennæ long; segment I as long as the basal width of the pronotum; II about twice the length of I; III and IV together longer than I, subequal. Basal

width of pronotum more than twice its length; scutellum equilateral. Elytra as in *sonorensis*, more parallel than in *minutulus*; hind tibiae about one half longer than their femora, the spines long and pale, rather distant. Sinistral notch of genital segment rounded, the dorsal angle retreating; sinistral clasper small and black, angled at base, its slender apex abruptly rufous; dextral clasper narrow, terete, attaining apex of the genital segment.

Color cinereous with a slight pinkish tint; anterior lobe of pronotum and venter rufous-brown, varied with darker, the collum with a white median point; front with six dark arcs, cheeks brown with two pale bands that cross the clypeus, the base of the latter with an angled dark mark; pronotum dark olive brown with a broken black band anterior to the white hind edge; scutellum marked with fuscous on the disk and with two dark points before the apex. Elytra whitish, much varied with fuscous, these marks tending to form two transverse bands; angular apical spot on corium indistinct; apical vein with a black point, the inner margin of cuneus varied with black and white beyond the pale base; membrane white blotched and irrorate with fuscous, the veins pale becoming black at end of the areoles. Legs white, the apex of the femora maculated with fuscous, the posterior showing two pale annuli. Beneath pale with the mesosternum and sides of the venter abruptly fuscous, the inferior sides of pronotum black, bisected by a white line. Antennæ pale brown, the base of segments II and III white; I white, banded and dotted with fuscous and armed with many erect stiff white bristles that are considerably longer than the thickness of the segment; II showing a faint pale annulus beyond the middle. Female not as clearly marked as male but otherwise similar.

Described from two male and eight female examples taken by me at Sweetwater Valley, near Alpine, San Diego Co., Cal., June 18, 1913, and at La Jolla, Cal., July 14, 1914. This neat little species much resembles *plenus* but aside from sexual characters it may be distinguished by its smaller size, the more hispid first antennal segment, the fuscous border to the venter and especially by the equality of the last two antennal segments.

Holotype, male (No. 715), and allotype, female (No. 716), in collection of California Academy of Sciences; paratypes in collection of the author.

19. *Phytocoris carnosulus*, new species

Size and aspect of *minutulus* Reut., differing in the irrorate membrane and more varied maculation as well as the more pinkish tint. Length 5 mm.

Male: Head a little oblique, produced beyond the eye for a space equal to two thirds the length of the eye; front full; clypeus very prominent, regularly arcuated. Antennæ rather short; segment I three fourths as long as basal width of pronotum, linear, with but few stiff hairs; II a little more than twice the length of I; III and IV together longer than II, III scarcely longer than IV. Pronotum twice as wide as long; scutellum one fourth wider than long, the basal lobe well exposed; elytral costa feebly yet distinctly arcuated; upper surface sparsely clothed with

short grey hairs interspersed with longer black ones, the fringe of long hairs, or lashes, on the collum conspicuous. Hind femora about seven times as long as wide, tapering from before the middle; hind tibiæ with but few short erect spines. Sinistral notch of genital segment right-angled, with a large blunt tooth above forming the apex of the produced angle of the last tergite; sinistral clasper with a rounded angle dorsally about one third from base, the sinuate apex attaining the tip of the segment; dextral clasper ligulate, its rounded apex just passing the tip of the segment.

Color pale testaceous or whitish with a faint tinge of pink on the elytra; head and pronotum brownish fulvous the apex of the clypeus, disk of the cheeks, sides of pronotum above and below and the collum, except at middle, fuscous or black. Scutellum black or mostly so, with a pale apex and an orange spot either side on the basal lobe. Elytra irregularly mottled with fuscous forming a blackish cloud on base and apex of clavus and on basal third and inner angle of corium; apical angle of corium fuscous; angular pale apical spot scarcely indicated; costa white dotted with fuscous; cuneus pale with fuscous apex; membrane whitish, sparsely irrorate with pale brown, the areoles mostly brown, margin with two white spots beyond the cuneus, veins fuscous, pale at apex. Beneath mostly fuscous, the prosternum and coxæ whitish. Legs whitish, the femora maculated toward their apex, the posterior showing a broad vitta before the apex, the tibiæ with their base and three annuli fuscous. Antennæ pale brown, the narrow base of segments II and III white; I white, maculated with brown forming about two broad bands. Female with the elytral markings more diffuse and the pale annulus on the hind femora scarcely distinguished.

Described from two male and two female examples taken at Prescott, Arizona, July 1, 1917, by Mr. C. A. Hill. The faint pinkish tinge is more pronounced in the male and may not persist long after the specimen has become dry.

Holotype, male (No. 697), and allotype, female (No. 698), and paratypes in collection of California Academy of Sciences.

20. *Phytocoris rusticus*, new species

Related to *inops* Uhler but darker and less maculated with the tibiæ unicolorous. Length $6\frac{1}{4}$ mm.

Male: Head a little oblique, produced beyond the eye for a space but little less than the length of the eye; vertex flat; front moderately convex. Antennæ as long as in *inops*; segment I a fourth longer than the pronotum, moderately stout, a very little thicker near the base, armed with a few erect bristles longer than the thickness of the segment; II almost twice the length of I; III about one half of II; IV as long as pronotum. Rostrum attaining apex of hind coxæ. Pronotum twice wider than long; costal margin of elytra very feebly arcuated; hind femora lenticular, widest a little before the middle, about five times as long as wide; hind tibiæ as long as elytra to tip of cuneus, with a double row of about 12 spines. Sinistral genital notch hardly right-angled, its dorsal angle rounded; sinistral clasper broad with a large blunt tooth dorsally, the attenuated apical member curved in conformity with the contour of the segment and terminating beneath the dextral clasper; the latter broad and flat, angled near its base, arcuated, and passing the truncated apex of the segment.

Color rufous-brown, moderately polished, the head a little darker; pronotum with an even black vitta before the slender pale hind margin; elytra with an obscurely paler area on the disk of corium and an angular one at apex; cuneus more rufous, blackish at tip and on inner edge; membrane fuscous, irregularly and confluentlly irrorate with pale, the veins rufous. Beneath paler on the coxæ and apex of genital segment. Legs concolorous with upper surface, obscurely irrorate with paler; tarsi paler on the middle; rostrum pale. Antennæ a little paler; segment I very obscurely dotted with pale; II very narrowly pale at base, the pale portion not longer than thickness of segment; III scarcely paler on immediate base. Upper surface clothed with short stiff black hairs and deciduous white tomentum.

Described from two males from Mt. St. Helena, Napa Co., Cal., June 9, 1918, four females from Colestin, Jackson Co., Oreg., August 1, 1918, one male from Cayton, Shasta Co., Cal., July 15, 1918, and one from Sisson, Cal., July 25, 1918, all taken by myself on pines, and one male from Yosemite, Cal., June, 1916, and one female from Tallac, Eldorado Co., Cal., August 22, 1916, both taken by Mr. W. M. Giffard. The almost uniform dark reddish brown color and the very narrow pale annulus at base of second antennal segment will distinguish this species.

Holotype, male (No. 699) from Mt. St. Helena, allotype, female (No. 700) from Cayton, and paratypes in collection of California Academy of Sciences.

21. *Phytocoris maritimus*, new species

Aspect of *rusticus*, smaller and more fuscous with the pale annulus at base of second antennal segment longer and followed by a darker band; hind margin of pronotum and front of hind femora blackish. Length nearly 6 mm.

Male: Head about as in *rusticus*, little oblique, produced before the eye for a space equal to two thirds the length of the eye. Antennæ rather short; segment I as long as from hind margin of pronotum to middle of the eye, moderately stout, scarcely thicker at base, clothed with appressed dark hairs and a few long slender bristles; II one half longer than basal width of pronotum; III very little longer than basal width of pronotum; IV as long as I. Pronotum twice longer than wide; elytral costa scarcely arcuated. Hind femora short, about as long as second antennal segment, nearly six times as long as wide, widest at basal third. Rostrum attaining third ventral segment; spines on hind tibiae much longer than thickness of the segment, distant. Genital segment long and narrow; sinistral notch shallow, its dorsal angle retreating; sinistral clasper small, black, convex, strongly obtusely angled dorsally near base, apex paler, obtuse, incurved; dextral clasper ligulate, apex rounded and armed above with an acute point; as long as the ventral wall of the notch.

Color brownish fuscous, paler on head and anterior lobe of pronotum; hind margin of pronotum with an even black vitta as in *rusticus*, the

exterior edge pale; elytra with a broad obscure transverse fuscous band at basal fourth covering most of the clavus; apex of corium with a fairly distinct angled pale polished spot preceded by a fuscous mark; costal margin varied with fuscous; cuneus pale with inner margin and apex blackish; membrane fuscous, sparsely and obscurely irrorate with pale and leaving a pale spot at apex of cuneus; veins pale at apex. Venter tinged with rufous and varied with fuscous; breast mostly black, the coxæ white; male genital segment infuscated; femora rufous-brown irregularly dotted with pale, paler at base, the posterior pair blackish anteriorly; anterior and intermediate tibiæ pale with about three fuscous annuli, the posterior dotted with fuscous. Antennæ pale brown becoming darker at apex; segment I fuscous obscurely dotted with pale; II with a basal white annulus three times as long as thickness of the segment, followed by a somewhat wider fuscous cloud. Upper surface with black hairs intermixed with white tomentum as in *rusticus*.

Described from two males and four females taken at Carmel, Cal., March 24, 1919. In this species and *rusticus* the irrorate aspect of the elytra is wanting, the pattern of marking being more as in *cunealis*.

Holotype, male (No. 701), and allotype, female (No. 702), and paratypes in collection of California Academy of Sciences.

22. *Phytocoris stellatus*, new species

Allied to *maritimus* with the size and aspect somewhat of *conspersipes* Reut., reddish or testaceous brown with scattering pale points bearing clusters of deciduous white hairs, body clothed with long black hairs in places; second antennal segment with narrow pale base. Length 6 mm.

Male: Head nearly vertical, produced beyond the eye for a space nearly equal to the width of the eye; vertex flat, about as wide as an eye; front scarcely convex; eyes large, prominent, round when viewed from above. Antennæ short; segment I scarcely longer than the pronotum, linear; II almost three times as long as I; III and IV together equal to II, III a little the longer. Pronotum more than twice wider than long; elytra almost parallel. Hind femora about six times longer than wide, widest at basal third; rostrum reaching apex of hind coxæ. Head, pronotum and elytra rather thickly clothed with decumbent stiff black hairs that are as long as the thickness of the hind tibiæ, those on head and anterior margin of pronotum longer, procumbent or nearly erect; segment I of antennæ with numerous erect stiff bristles longer than the thickness of the segment; gula and lower surface with a few pale hairs. Sinistral clasper nearly terete, slender, its base without the dorsal angle found in the allied species, its apex recurved and slender; dextral clasper slender, little flattened, just passing apex of genital segment.

Color rufous or testaceous-brown varied with pale; hind edge of pronotum white, preceded by six or eight black spots forming an interrupted band; vertex with a median pale yellow vitta; pronotum and elytra with scattering round white spots bearing clusters of silvery hairs, these sometimes segregated in a median and an apical spot, connected along the claval suture; membrane subhyaline with rufous veins and faint clouding,

especially about the apex. Legs pale rufous dotted with whitish, the posterior darker and clothed with long brown hairs; spines of hind tibiae long, pale. Antennae pale brown; segment I pale and dotted with fuscous; II becoming black at apex, its base with a white annulus not longer than thickness of the segment. Body beneath castaneous, the coxae whitish. Female a little broader and more rufous than male.

Described from one male and two females taken by me on pines at Carmel, Cal., March 24, 1919.

Holotype, male (No. 703), and allotype, female (No. 704), and paratype in collection of California Academy of Sciences.

23. *Phytocoris commissuralis*, new species

Size and form of *fenestratus* Reut., nearly; mottled ash-grey, base of second antennal segment clear white; commissural margin of clavus whitish, immaculate; membrane white, conspicuously dotted with blackish. Length 8 mm.

Male: Head nearly vertical, much produced, length below the eye equal to length of eye; vertex flat, front slightly swollen. Antennae of medium length; segment I about as long as head and pronotum together when viewed vertically, a little thickened toward base, basally armed with stout bristles, mostly white and as long as the thickness of the segment; II fully twice the length of I; III nearly as long as basal width of pronotum; IV two thirds of I. Pronotum a little more than twice wider than long. Hind femora six times as long as wide, widest at basal one fourth; spines of hind tibiae as long as thickness of the segment. Rostrum passing middle of venter. Upper surface clothed with flattened deciduous black and white hairs, the collum and base of vertex with the usual long bristles or lashes. Sinistral genital notch shallow, rounded; sinistral clasper broad, angularly toothed dorsally near the base and again before apex of the ventral extension of the genital segment, its apex covered; dextral clasper rather long, curved, angled exteriorly above the base.

Color cinereous-grey much varied with fuscous. Head and anterior lobe of pronotum whitish with a few ferruginous marks; cheeks bilineate with black; posterior lobe of pronotum infuscated, forming a sinuated vitta or six black tufted spots before the white posterior margin; scutellum pale, the basal lobe black trilineate with fulvous, apex black with the median line and a short one either side whitish. Elytra varied with fuscous, especially at base and along the veins, the commissural margin of the clavus broadly pale; cuneus pale, its inner margin marked with black; membrane white, sprinkled with numerous vermiculate marks, the veins heavy, fuscous. Femora white varied with fuscous, the posterior with a white subapical vitta; tibiae triannulate with black, these confused on the hind pair; tarsi pale medially; beneath largely black, the coxae white. Female broader than male with the venter paler.

Described from two males and two females taken by me at Huntington Lake, Fresno Co., Cal., July 24, 1919, at an altitude of 7,000 feet.

Holotype, male (No. 705), allotype, female (No. 706), and paratypes in collection of California Academy of Sciences.

24. *Phytocoris sagax*, new species

Allied to *commissuralis*; head and pronotum anteriorly yellowish; pronotum margined and elytra maculated with fuscous; membrane irrorate. Length 7 mm.

Male: Head long, oblique, produced beyond the eye for a space equal to greatest width of the eye; front moderately convex; clypeus broad, prominent. Antennæ long; segment I as long as head and pronotum together when seen from above; II as long as costal margin of corium; III one half of II; IV a little longer than pronotum. Pronotum twice wider than long, somewhat polished; elytra nearly parallel; hind femora (female) six times as long as wide, its tibial spines long. Upper surface clothed with black decumbent hairs and flattened white tomentum; rostrum reaching middle of venter. Genital segment small; sinistral notch deep; sinistral clasper small with a dorsal angle some ways from the base; forming a blunt tubercle; tip of the clasper hidden beneath the apex of the segment; dextral clasper very long, broad and flattened at base, its truncate apex curved so as to almost meet the dorsal angle of the sinistral notch.

Color testaceous white; head and middle of anterior margin of pronotum more yellowish, varied with ferruginous; sides of pronotum anteriorly and inferiorly black, marked with a white point behind the eye; hind margin with an even black vitta before the white edge. Scutellum with a black point either side before the apex. Elytra fuscous, opaque; clavus, base of corium, a large spot on the middle extended along the costa to apex and an angular spot at apex of the corium polished whitish, inner edge of cuneus varied with black; membrane blackish, irrorate more or less with white, forming a white spot at apex of the areole. Beneath mostly pale with the pectoral pieces largely black, the coxæ white. Legs pale, the femora marmorated with fuscous at apex, on anterior pair interrupted by a pale longitudinal line on either side; tibial spines long, brown, on brown dots, the apex of the tarsi infuscated. Basal segment of antennæ black dotted with white; II fuscous at base and apex, brownish on the middle, base rather broadly white; III brown, white at base; IV brown. Female a little broader than the male and more clearly marked in the type.

Described from one pair taken by me at Sisson, Cal., July 24, 1918.

Holotype, male (No. 707), and allotype, female (No. 708), in collection of California Academy of Sciences.

25. *Phytocoris nigrifrons*, new species

Large, elongate-ovate; pale yellowish white; vertex with a large polished black spot; posterior vitta of pronotum and lineations on elytra black. Length $8\frac{1}{2}$ mm.

Female: Head oblique; produced beyond the eye for a space greater than the length of the eye; eyes seen from above ovate. Antennæ long; segment I as long as basal width of pronotum, slightly thickened to the base; II as long as costal margin of corium; III one fourth longer than I; IV a little longer than the pronotum; Pronotum less narrowed anteriorly than usual, as long as the head viewed from above, its anterior margin about one half

the posterior; collum broad, callosities prominent. Scutellum longer than wide, as long as the pronotum. Costal margin of the elytra quite strongly arcuated, their greatest combined width is to the basal as seven to five. Legs very long; hind femur nine times as long as wide, broadest before middle; hind tibiæ nearly one half longer than their femora, their spines scarcely longer than the thickness of the segment; rostrum long attaining middle of venter.

Color whitish, becoming tinged with yellow on pronotum and scutellum; head polished, fulvous, with a large black spot covering the front between the antennæ from middle of vertex to base of clypeus; cheeks bilineate with rufo-fuscous; pronotum with an even black vitta before the white hind edge; elytra whitish tinged with yellow on the costa; margin, nervures and claval suture lineate with blackish; disk with dark marks indicating two transverse bands, tip of corium and of cuneus black; membrane whitish hyaline, its apex and the border of the areoles maculated with fuscous; femora sparsely irrorate with fuscous; the apex of the hind pair infuscated; apex of tibiæ and tarsi blackish. Antennæ pale, darkened by the short appressed hairs; apex of II broadly black; III and IV infuscated, the base of the former pale. Upper surface clothed with appressed white hairs with a few stiff black ones on the dark areas and on the collum.

Described from four females taken by me at Huntington Lake, Fresno Co., Cal., July 16–25, 1919, at an elevation of 7–9,000 feet. This large species is so distinct it can safely be described from females alone.

Holotype, female (No. 709), and paratypes in collection of the California Academy of Sciences.

26. *Phytocoris barbatus*, new species

Similar to *cuneatus* Van D. in color with a mark on the clavus, a transverse band on the corium and the cuneus ochraceous; head, pronotum, antennæ and legs clothed with scattering long erect hairs; antennæ and legs annulate. Length 6 mm.

Male: Head oblique, produced before the eye for a space about equal to the length of the eye; gula nearly horizontal; clypeus prominent; vertex flattened, the front more convex than in *cuneatus*. Antennæ slender; segment I as long as head and pronotum together, moderately thickened toward the base and at immediate apex; II not quite twice the length of I, linear; (III broken, IV wanting in type); rostrum attaining hind coxæ. Pronotum much narrowed anteriorly, more than twice wider on hind margin than on the anterior, its posterior width not quite twice its length; sides straight. Scutellum as long as the pronotum. Hind femora nearly as long as corium and cuneus together, gradually tapering from near base, its greatest width one ninth its length, its tibia nearly one half longer than the femur. Genital segment large, convex; sinistral notch deep, its fundus acutely angled, its dorsal angle produced in a blunt tooth as long as its basal width, this tooth seemingly terminating a projection of the last tergite; sinistral clasper broad, its apex oblique for half its length, its dorsal angle rounded and apex subacute; dextral clasper small, oblique and subacute at apex.

Color pale yellowish ochraceous becoming deeper fulvous on the pronotum, femora and beneath; elytra whitish or lurid with an oblong area on middle of clavus, a broad band across corium and the apex of the clavus and of the cuneus fulvous; membrane white, sparsely irrorate with fulvous at base and apex. Antennæ blackish; segment I varied with pale; II with a broad white annulus at base and another just beyond the middle; III pale at base; I and base of II clothed with a few scattering erect stiff white hairs, the longest as long as the horizontal diameter of the eyes. Legs ochraceous, clothed with short appressed fuscous hairs and very long erect white bristles, even longer and stouter than those on the antennæ; tibiæ with either end and three broad annuli dusky; cheeks and clypeus infuscated, the neck with two fuscous lines behind the eye, visible when the head is exerted.

Described from one male taken by Mr. Fordyce Grinnell at Pasadena, Cal. The hairs in this species are much longer than in *hirtus*.

Holotype (No. 710) in collection of California Academy of Sciences.

27. *Camptobrochys borealis*, new species

Closely allied to *nitens*, differing principally in the form of the male claspers; antennæ darker; scutellum less convex. Length 7 mm.

Head as in *nitens* and *grandis*; smooth and polished above. Antennæ with segments I and II a little stouter than in either allied species; I exceeding the tylus by a little more than half its length, in *nitens* by scarcely more than one third its length; II three fifths the basal width of the pronotum; III a fourth longer than IV, these together about equal to II. Pronotum as in *grandis* but the punctures less coarse and deep, the callosities well elevated, smooth and polished, broader and more conspicuous than in *nitens*. Scutellum as in *grandis*, less convex than in *nitens*; embolium sometimes entirely without punctures, the elytra otherwise as in the allied species. Rostrum attaining the apex of the intermediate coxæ. Hairy vestiture of the antennæ longer than in *grandis*, about as in *nitens*.

Color variable as in the allied species averaging darker than in *nitens* and paler than in *grandis*; fulvotestaceous varied with piceous or brown and coarsely punctate with blackish; pronotum mostly piceous with the margins and broad median line pale, the callosities deep black; vertex pale with a broad longitudinal piceous vitta either side, in pale examples represented by a blackish spot between the eyes; clypeus bivittate with piceous. Scutellum brown with a broad piceous vitta either side, the margins and apex of the median vitta broadly whitish; in *nitens* the scutellum is yellowish with the piceous vittæ more or less strongly indicated; in *grandis* black with the apex and narrow median line and lateral margins at base pale. Elytra clouded, becoming piceous on base of clavus and disk of corium, the embolium pale. Membrane fuliginous with the broad basal margin and a large area at apex of cuneus pale or hyaline, the cuneus hyaline with a fuscous apex. Antennæ fuscous brown, the incisures and apical two segments paler brown. Rostrum and legs pale testaceous, the apex of the rostrum, femora and tarsi darker, the hind femora often piceous on their apical one half. Beneath varied with testaceous and brown, becoming blackish on the venter in the male.

Dextral male clasper slender, thickened at base and obtusely bifid at apex; sinistral broad, a little arcuated above, with its base prominently convex and polished, not produced in a tooth. In *nitens* the base of the sinistral clasper is produced in an acute recurved tooth nearly one third the length of the ventral portion, while in *grandis* this tooth is nearly as long as the ventral member, erect, a little curved and obtuse at tip.

Described from two pairs taken by me at Portland, Me., July 4, 1909, a male from Hamburg, N. Y., taken July 1, 1911, one pair taken at Quinze Lake, P. Q., August 18, 1907, and one male and two females taken at Smith's Cove and Bear River, Nova Scotia, and kindly sent to me for study by Mr. W. H. Brittain, and a series from Ithaca and Batavia, N. Y., received from Mr. H. H. Knight.

This species with *grandis* and *nitens* form a difficult group but distinguishable by the form of the male claspers. The color in *nitens* is paler with the punctures more distinct, the antennæ pale or slightly infuscated at apex and the scutellum more convex and paler and the membrane hyaline. In *borealis* the antennæ are darker with the basal two segments thicker and piceous, the basal longer, the scutellum flatter with a piceous vitta, the margins and median line hardly paler and the membrane largely fuscous. In *grandis* the antennæ and general color is even darker than in *borealis* with the scutellum piceous but narrowly edged and lined with pale and the membrane fuscous at apex.

Holotype, male (No. 711), and allotype, female (No. 712), from Portland, in collection of California Academy of Sciences. Paratypes in collections of author and of H. H. Knight.

28. *Camptobrochys manitou*, new species

Form of *fenestratus*, short, ovate, convex, the cuneus and membrane strongly deflexed; whitish testaceous, polished, a little tinged with yellowish on the head, coarsely fusco-punctate and varied with fuscous; callosities and lateral areas of scutellum black, polished; base of cuneus broadly pale. Length $4\frac{1}{2}$ to 5 mm.

Head as in *nitens*, as wide as anterior margin of pronotum, hardly polished; clypeus less prominent than in *fenestratus* and its allies. Pronotum broader anteriorly than in *fenestratus*, the anterior margin a little more than one half the basal width and slightly greater than the median length; sides straight, slenderly carinate but not at all explanate, hind edge ob-

viously emarginate; surface strongly convex, polished; coarsely, sometimes confluent, punctate. Scutellum convex and polished as in the allied species, impunctate; medially obscurely transversely wrinkled. Elytra as in *fenestratus*, broad, convex, including the embolium coarsely fusco-punctate; base of cuneus sometimes punctate. Membrane obscurely bi-areolate. Rostrum reaching the intermediate coxæ; first segment attaining base of head. Sinistral clasper of male with a long acute porrect basal tooth as in *grandis*, the ventral member in the type concealed but apparently very acute at apex and passing beyond the dextral clasper which is of the usual form, ovate at base and produced in an acute point.

Color testaceous white, coarsely fusco-punctate and maculate; head tinged with yellow, infuscated; vertex and front with four or five transverse arcs and margined with the same color, deepened to piceous above the antennæ; clypeus pale, bilineate with piceous, the sutures of the cheeks also piceous. Antennæ with long scattering pale hairs; segment I obscurely lineate, as long as the greatest length of the eyes; II as long as pronotum, slightly clavate and infuscated on apical third; III and IV infuscated, III longer than I, IV shorter. Pronotum slenderly edged with pale, the fuscous punctures usually forming a cloud either side of the disk; anterior margin forming a broad testaceous collum; callosities contiguous, black, polished, bordered anteriorly by a pale sinuate vitta. Scutellum whitish with a dark spot either side, basally contiguous. Elytra with a large piceous cloud at apex produced basally to cover the disk of the corium and apex of the clavus; cuneus pale, piceous at apex; membrane enfumed, with a pale band across at apex of areoles, the veins piceous at base and apex. Legs pale, the femora mostly piceous. Beneath more reddish, invaded at times with piceous; anterior coxal cavities and osteolar region white.

Described from one male and ten female specimens taken by me in the Garden of the Gods at Manitou, Colo., July 19, 1900, and July 25, 1903, and five specimens from Colorado, received from Mr. H. H. Knight. This is the species I formerly determined as *Camptobrochis cerachates* Uhler but a study of the type in the museum of the California Academy of Sciences shows the latter to be a paler form common in California more allied to *fulvescens*.

Holotype, male (No. 713), and allotype, female (No. 714), in collection of California Academy of Sciences. Paratypes in collections of the author and of H. H. Knight.

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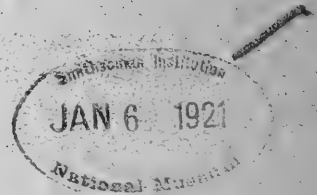
AUGUST 4, 1920

XIV

Report of the President of the Academy
for the Year 1919

BY

C. E. GRUNSKY
President of the Academy



XV

Report of the Director of the Museum
for the Year 1919

BY

BARTON WARREN EVERMANN
Director of the Museum

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Expedition of the California Academy of Sciences to the Galapagos Islands, 1905-1906.

Pages 1-6. I. Preliminary Description of Four New Races of Gigantic Land Tortoises from the Galapagos Islands. By John Van Denburgh. (*Issued December 20, 1907*)..... \$.25

Pages 7-288. II. A Botanical Survey of the Galapagos Islands. By Alban Stewart. Plates I-XIX. (*Issued January 20, 1911*)... 1.75

Pages 289-322. III. The Butterflies and Hawk-Moths of the Galapagos Islands. By Francis X. Williams. Plates XX-XXI. (*Issued October 7, 1911*)..... .50

Pages 323-374. IV. The Snakes of the Galapagos Islands. By John Van Denburgh. Plates XXII-XXX. (*Issued January 17, 1912*) .50

Pages 375-404. V. Notes on the Botany of Cocos Island. By Alban Stewart. Plates XXXI-XXXIV. (*Issued January 19, 1912*) .35

Pages 405-430. VI. The Geckos of the Galapagos Archipelago. By John Van Denburgh. (*Issued April 16, 1912*)..... .35

Pages 431-446. VII. Notes on the Lichens of the Galapagos Islands. By Alban Stewart. (*Issued December 17, 1912*)..... .25

VOLUME II, PART I

Expedition of the California Academy of Sciences to the Galapagos Islands, 1905-1906.

Pages 1-132. VIII. The Birds of the Galapagos Islands, with Observations on the Birds of Cocos and Clipperton Islands (Columbiformes to Pelecaniformes). By Edward Winslow Gifford. Plates I-VII. (*Issued August 11, 1913*)..... \$1.00

Pages 133-202. IX. The Galapagoan Lizards of the Genus *Tropidurus*; with Notes on the Iguanas of the Genera *Conolophus* and *Amblyrhynchus*. By John Van Denburgh and Joseph R. Slevin. Plates VIII-XI. (*Issued September 19, 1913*) .50

Pages 203-374. X. The Gigantic Land Tortoises of the Galapagos Archipelago. By John Van Denburgh. Plates XII-CXXIV. (*Issued September 30, 1914*)..... 2.00

Pages 375-382. XI. Preliminary Descriptions of New Species of Pulmonata of the Galapagos Islands. By William Healey Dall. (*Issued December 31, 1917*)..... .10

VOLUME II, PART II

Pages 1-187. XII. A Review of the Albatrosses, Petrels, and Diving Petrels. By Leverett Mills Loomis. Plates 1-17. (*Issued April 22, 1918*)..... 1.50

Pages 189-258. XIII. Field Notes on the Land Birds of the Galapagos Islands and of Cocos Island, Costa Rica. By Edward Winslow Gifford. (*Issued June 16, 1919*)..... .50

Pages 259-310. XIV. The Ants of the Galapagos Islands. By William Morton Wheeler. (*Issued June 16, 1919*).....

XV. The Ants of Cocos Island. By William Morton Wheeler. (*Issued June 16, 1919*).....

XVI. A New Species of the Hymenopterous Genus *Scleroderma* from the Galapagos Islands. By Charles T. Brues. (*Issued June 16, 1919*). Price for the three papers .25

PROCEEDINGS
OF THE
CALIFORNIA ACADEMY OF SCIENCES
FOURTH SERIES

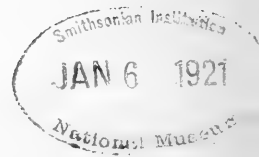
VOL. IX, Nos. 14 AND 15, pp. 357-396

AUGUST 4, 1920

XIV

REPORT OF THE PRESIDENT OF THE ACADEMY
FOR THE YEAR 1919

BY
C. E. GRUNSKY
President of the Academy



The Academy has during the year 1919 continued its activities in research work and on the installation of museum exhibits. The effectiveness of this work is apparent to any one who visits the research departments and the halls, gradually being filled with the habitat groups of mammals and birds and with other exhibits. But when the halls are filled, when the space for habitat groups is exhausted, there is still room for larger service and the Academy stands ready to render the service to the full limit of means placed at its disposal.

Having reached the point where the installations in the Bird and Mammal halls have filled nearly all the large alcoves, it was thought timely by the Council to make some active effort to increase the membership. A committee was named for this purpose, with Mr. M. Hall McAllister as Chairman. The effectiveness of the committee's work is already apparent in the larger membership which can now be reported.

August 4, 1920

The membership in the Academy at the close of the year 1918 was 455, and at the close of 1919 it was 550, a gain of 95.

The present membership is made up of:

Patrons	7
Honorary Members	33
Life Members	82
Fellows	20
Members	408

During the year 1919, 115 new members were admitted and the Academy lost by death 11, and by resignation 5.

Those who were called by death are as follows:

Mr. James V. Coleman.....	Life	April 13, 1919
Dr. Washington Dodge	Member.....	June 30, 1919
Prof. William G. Farlow.....	Honorary.....	June 3, 1919
Mrs. Phœbe A. Hearst	Life.....	April 13, 1919
Mr. A. Legallet.....	Member.....	December 13, 1919
Mr. Jesse W. Lillenthal.....	Member.....	June 3, 1919
Mr. James K. Lynch.....	Member.....	April 28, 1919
Mr. George T. Page.....	Member.....	June 30, 1919
Mr. Osgood Putnam.....	Member.....	January 23, 1919
Mr. Herman Schussler.....	Life.....	April 27, 1919
Mr. Vanderlynn Stow.....	Member.....	July 13, 1919

The Academy carries on its list of patrons the following names:

Living

Mr. William B. Bourn	Mr. A. Kingsley Macomber
Mr. William H. Crocker	Mr. John W. Mailliard
Mr. Peter F. Dunne	Mr. Joseph Mailliard
Mr. Herbert Fleishhacker	Mr. Alexander F. Morrison
Mr. Joseph D. Grant	Mr. William C. Van Antwerp
Mrs. Charlotte Hosmer	

Deceased

Mr. William Alvord	Mr. James Lick
Mr. Charles Crocker	Mr. Ignatz Steinhart
Mr. John W. Hendrie	

The Treasurer's report for the year 1919 shows total receipts, exclusive of the \$250,000 received from the Ignatz Steinhart estate and the \$5000.00 donation by Mr. Van Antwerp hereinafter referred to, of \$71,328.02, of which \$15,-129.32 were paid out as interest. The floating debt of the Academy was practically wiped out. The year's general expenses including the installation of the Fur Seal habitat group and of a number of small bird and mammal groups have been

about \$50,000. The net excess of revenues over expenditures was about \$7000. The assets of the Academy as carried in the book accounts, not including the Ignatz Steinhart Trust Fund, were in round numbers \$1,495,000 at the close of the year, but subject to a debt of \$300,000 for which the Market Street property is a pledge.

During the year 1919, ten free lectures have been delivered at the stated meeting of the Academy, as follows:

- JANUARY 15. How Migrating Birds Find Their Way.
Mr. Leverett Mills Loomis, San Francisco, California.
- MARCH 19. Pine Insects and their Depredations.
Mr. Ralph Hopping, United States Forest Service.
- APRIL 16. Tehachapi as a Faunal Barrier.
Prof. John O. Snyder, Department of Zoology, Stanford University, and Dr. Roy E. Dickerson, California Academy of Sciences.
- MAY 21. The Naked Mollusks of Monterey Bay.
Dr. F. M. MacFarland, Professor of Histology, Stanford University.
- JULY 16. Fish and Game Legislation of the 1919 Legislature.
Mr. Carl Westerfeld, Executive Officer, Fish and Game Commission of California.
- AUGUST 20. Notes on the Birds of Lake County, California.
Mr. Joseph Mailliard, Honorary Curator, Department of Ornithology, California Academy of Sciences.
- SEPTEMBER 10. Egypt, the Land where Ancient and Modern Civilizations Meet.
Mr. I. H. Morse, San Francisco, California
- OCTOBER 1. The Butterfly Map; or The Ground Plan of the World to Scale
Mr. B. J. S. Cahill, Oakland, California.
- NOVEMBER 5. The New Theory of the Aether and of the Molecular Forces.
Captain Thomas J. J. See, Professor of Mathematics, United States Navy.
- DECEMBER 3. The Need of more serious Effort to rescue a Fragment of Vanishing Nature.
Dr. Francis B. Sumner, Professor of Zoology, University of California.

The Sunday afternoon lectures delivered in the Museum building during 1919 were generally attended by about as large an audience as the limited facilities of the temporary auditorium permit. They include the following:

- JANUARY 5. Thirty Thousand Miles in China.
Dr. C. K. Edmunds, President of Canton Christian College, Canton, China.

- JANUARY 12. California's Recreation Ground, Her National Forest.
R. F. Hammatt, Forest Examiner, United States Forest Service.
- FEBRUARY 9. Trees and Shrubs of the Grand Cañon.
Miss Alice Eastwood, Curator, Department of Botany, California Academy of Sciences.
- FEBRUARY 16. The Bacteriology of Peanut Butter.
Dr. Ivan C. Hall, Department of Bacteriology, University of California.
- FEBRUARY 23. Birds of Extreme Northern Alaska.
Joseph Dixon, Economic Mammalogist, Museum of Vertebrate Zoology, University of California.
- MARCH 2. The Natural History and Control of California Ground Squirrels.
Dr. Joseph Grinnell, Director, Museum of Vertebrate Zoology, University of California.
- MARCH 9. Some Philosophical Considerations in Mathematics.
Dr. Rufus L. Green, Professor of Mathematics, Stanford University.
- MARCH 16. Inheritance of Mental Ability.
Dr. S. J. Holmes, Professor of Zoology, University of California.
- MARCH 23. The Natural History of some Bats.
Tracy I. Storer, Field Naturalist, Museum of Vertebrate Zoology, University of California.
- MARCH 30. Mushrooms, Edible and Non-Edible.
Prof. James I. W. McMurphy, Department of Botany, Stanford University.
- APRIL 13. Life History and Habits of Some Marine Crustacea.
Prof. F. W. Weymouth, Department of Zoology, Stanford University.
- APRIL 20. The Hook-worm Campaign in the Mines of California.
Dr. W. W. Cort, Assistant Professor of Zoology, University of California.
- APRIL 27. Military Sanitation.
Major W. B. Herms, Associate Professor of Parasitology, University of California.
- MAY 4. Birds of the High Sierras and their Environment.
Dr. William F. Badè, President, California Associated Societies for Conservation of Wild Life.
- MAY 11. Hunting with a Camera.
Paul J. Fair, Department of Exhibits, California Academy of Sciences.
- SEPTEMBER 14. Insect Life.
Dr. E. C. Van Dyke, Assistant Professor of Entomology, University of California.
- SEPTEMBER 21. Sanitary Milk Production.
Dr. George H. Hart, Associate Professor of Veterinary Science, University of California.
- SEPTEMBER 28. Forests and Forestry in California.
Dr. W. Metcalf, Assistant Professor of Forestry, University of California.
- OCTOBER 5. Plant Breeding.
Dr. E. B. Babcock, Professor of Genetics, University of California.

- OCTOBER 12. The Work of the United States Biological Survey.
Dr. W. P. Taylor, Assistant Biologist, United States Biological Survey, Washington, D. C.
- OCTOBER 19. Pine Insects and their Depredations.
Ralph Hopping, National Forest Examiner, United States Forest Service, San Francisco.
- OCTOBER 26. California's Future; What the Forest Service is doing to determine and meet the coming demands for Timber and other National Forest Resources.
C. A. Kupfer, Forest Examiner, United States Forest Service, San Francisco.
- NOVEMBER 2. Some Forestry Problems, both Government and Private.
R. F. Hammatt, Forest Examiner, United States Forest Service, San Francisco.
- NOVEMBER 9. Range Management on the National Forests in California.
F. D. Douthitt, Grazing Examiner, United States Forest Service, San Francisco.
- NOVEMBER 16. Industrial Research in the Forest Service.
Don P. Johnston, Assistant District Forester, United States Forest Service, San Francisco.
- NOVEMBER 23. The Trees and Flowers of the High Sierras.
Prof. Howard G. McMinn, Department of Botany, Mills College.
- NOVEMBER 30. How the Map of Europe Has Been Redrawn.
Prof. Earle G. Lindsley, Department of Geography and Geology, Mills College.
- DECEMBER 7. Hook-worm and Human Efficiency.
Major Charles A. Kofoid, Professor of Zoology, University of California.
- DECEMBER 14. A Travalogue on Continental Europe.
J. Emmet Hayden, Member San Francisco Board of Supervisors.
- DECEMBER 21. Construction Activities of the San Francisco Mountain Water Supply.
M. M. O'Shaughnessy, City Engineer, San Francisco.
- DECEMBER 28. A Tramp Around San Francisco in the Early Days.
Charles B. Turrill, San Francisco.

The accessions to the Museum and Library were numerous as will be fully set forth in the report of the Director of the Museum. Among them the donation by Dr. G. Dallas Hanna of 8464 specimens of Mollusks from Alaska, about 100,000 specimens of land and fresh water shells from the Mississippi Valley, and 568 bird eggs from the islands of Bering Sea, is worthy of special note.

In continuation of the Fourth Series of the Proceedings, the Academy has published during 1919 the following papers:

Vol. II, Part II, No. 13, pp. 189-258

FIELD NOTES ON THE LAND BIRDS OF THE GALAPAGOS ISLANDS AND OF
COCOS ISLAND, COSTA RICA,
by Edward Winslow Gifford.

- Vol. II, Part II, No. 14, pp. 259-297
THE ANTS OF THE GALAPAGOS ISLANDS,
by William Morton Wheeler.
- Vol. II, Part II, No. 15, pp. 299-308
THE ANTS OF COCOS ISLAND,
by William Morton Wheeler.
- Vol. II, Part II, No. 16, pp. 309-310
A NEW SPECIES OF THE HYMENOPTEROUS GENUS *SCLERODERMA* FROM THE
GALAPAGOS ISLANDS,
by Charles T. Brues.
- Vol. VIII, No. 8, pp. 309-316
REPORT OF THE PRESIDENT OF THE ACADEMY FOR THE YEAR 1918,
by C. E. Grunsky.
- Vol. VIII, No. 9, pp. 317-351
REPORT OF THE DIRECTOR OF THE MUSEUM FOR THE YEAR 1918,
by Barton Warren Evermann.
- Vol. IX, No. 1, pp. 1-36
NOTES ON WEST AMERICAN CHITONS—II,
by S. Stillman Berry.
- Vol. IX, No. 2, pp. 37-67
LIFE-ZONE INDICATORS IN CALIFORNIA,
by Harvey Monroe Hall and Joseph Grinnell.
- Vol. IX, No. 3, pp. 69-121
NOTES ON MAMMALS COLLECTED PRINCIPALLY IN WASHINGTON AND CALI-
FORNIA BETWEEN THE YEARS 1853 AND 1874 BY DR. JAMES GRAHAM
COOPER,
by Walter P. Taylor.
- Vol. IX, No. 4, pp. 123-173
CLIMATIC RELATIONS OF THE TERTIARY AND QUATERNARY FAUNAS OF
THE CALIFORNIA REGION,
by James Perrin Smith.
- Vol. IX, No. 5, pp. 175-196
CONTRIBUTION TO THE OPTICS OF THE MICROSCOPE,
by C. W. Woodworth.
- Vol. IX, No. 6, pp. 197-220
THE GOPHER-SNAKES OF WESTERN NORTH AMERICA,
by John Van Denburgh and Joseph R. Slevin.
- Vol. IX, No. 7, pp. 221-255
NEW OREGON DIPTERA,
by F. R. Cole and A. L. Lovett.
- Vol. IX, No. 8, pp. 257-270
KEY TO THE NORTH AMERICAN SPECIES OF THE DIPTEROUS GENUS *MED-*
ETERUS, WITH DESCRIPTION OF NEW SPECIES,
by Millard C. Van Duzee.
- Vol. IX, No. 9, pp. 271-272
DESCRIPTION OF A NEW FOSSIL FISH FROM JAPAN,
by David Starr Jordan.
- Vol. IX, No. 10, pp. 273-296
NOTES ON THE AVIFAUNA OF THE INNER COAST RANGE OF CALIFORNIA,
by Joseph Mailliard.
- Vol. IX, No. 11, pp. 297-312
NEW SPECIES OF FLIES (DIPTERA) FROM CALIFORNIA,
by J. R. Malloch.
- Vol. IX, No. 12, pp. 313-329
MECHANISM IN THE PRODUCTION OF THE THROAT-FAN IN THE FLORIDA
CHAMELEON,
by Charles E. Von Geldern.

In the matter of the bequest to the Academy of a tract of land of 247 acres near Santa Cruz by the late S. F. Thorn, which was referred to in the President's last annual report, it should be noted, that objection was made by some of the heirs to the probating of the will. The superior court allowed the probating of the will and on appeal this action was sustained by the Supreme Court. It appears, therefore, that the Academy will get this property and possibly something more, the Academy having been named residuary legatee in the will. The appraisers of the estate have found property which they valued at about \$29,200 including the land near Santa Cruz which is listed in the appraisal at \$6500.

Near the close of the year 1919 a distribution of the \$250,000 bequeathed by Ignatz Steinhart to the Academy for the erection of an aquarium in Golden Gate Park was ordered by the court, and Dr. Evermann and Civil Engineer Trygve Ronneberg, representing Architect Lewis P. Hobart, as soon thereafter as practical, left for the East to inspect the aquariums of Detroit, Washington, New York, Philadelphia, Boston, and Miami in order that the experiences at these might accrue to our benefit. Of the results of this trip Dr. Evermann will speak in his report as Director of the Museum. It is estimated that about a year and a half will be required to perfect the plans and erect the aquarium building.

It gives me particular pleasure to make a record at this time of the completion of the Olympic or Roosevelt Elk group, which was opened to public view on January 1, 1920. The excellence of the material which was made available for this group and its artistic setting, must, we feel sure, be a source of gratification and pleasure to the generous donor of this group, Mr. William C. Van Antwerp. The Academy, on behalf of the public for whose benefit such installations are made, desires to thank Mr. Van Antwerp for having made this habitat group possible. The grouping and mounting of the animals by Mr. Paul J. Fair conform to the standards already set by the Academy and are receiving much favorable comment; so, too, the high quality of the work of Capt. Charles B. Hudson, who painted the background.

The last of the spaces reserved for seals was filled during the year by the completion of a Fur-Seal group showing a rookery

on one of the Pribilof Islands. Here, too, Mr. Fair and Captain Hudson cooperated in the work of the installation. The available material was not entirely satisfactory in quantity or quality. More fur-seal specimens have recently been received, thanks to the courtesy of the U. S. Government, and a re-arrangement and amplification of the foreground may be expected in the near future.

The last alcove in the Mammal Hall is to show, as nearly as may be, what the California grizzly bear looked like. The Academy has already been intrusted with a fund of \$5000 for the installation of such a bear group. The donor is Mr. Ogden Mills to whom also we express our sincere appreciation of his generosity and our gratification in his approval of our efforts to interest and instruct the public in natural science. It will, of course, be impossible to secure the necessary specimens for this group in California, the real California grizzly being extinct; but the nearest related species will be secured and it is expected that within the current year this group, too, may be opened to view.

For one of the small habitat groups, funds to the amount of \$103.00 were provided by Mr. S. Levi, a long-time member of the Academy. His example is worthy of emulation. There are still quite a number of small mammal and bird groups to be installed. There is opportunity also for some one to provide means for the preparation of the portable habitat groups which would prove exceptionally valuable for use in schools. And, while I am speaking of the needs of the Academy, may I not again call attention to the need of an addition to the museum building? There should be another unit equal to, or larger than, the present one at once made available, but this can only be done with the help of one or more public spirited citizens. And, if the plans for a close connection of the Steinhart aquarium with our museum building be carried out, then, too, further provision should be made for suitable architectural ornamentation of the main entrance to the resulting central court. I allude to these matters in order that the willingness of the Academy to enlarge its service to any extent for which means are provided may be generally understood.

In the President's last annual report it was stated that ownership of the John W. Mailliard and Joseph Mailliard collection

of eggs and bird skins was to be transferred by them to the Academy. This is now an accomplished fact and the collection has been made the property of the Academy. I repeat the Academy's thanks for this exceptionally valuable addition to its research material. The attractions of the Academy and the opportunity which it affords for study have proved so alluring to Mr. Joseph Mailliard that it has been possible to induce him to take the honorary curatorship of the Academy's department of Ornithology.

Dr. Roy E. Dickerson has been compelled by important demands on his time to sever his active connection with the department of Invertebrate Paleontology, but has been retained as honorary curator and Dr. G. Dallas Hanna was made curator and has been active in that capacity during the last months of the year.

The activities of the several departments in which the scientific work of the Academy received attention, are fully set forth in the report of the Director of the Museum, Dr. Barton Warren Evermann, and in the reports of the curators. It will be noted from these reports that much valuable work has been done and that the studies afield have extended in some cases beyond the limits of the state.

May I not suggest in closing, that the members of the Academy have a right to feel that this institution is their institution which they control through their officers and that a proper sense of proprietorship should prompt an endeavor, as opportunity offers, to enlist further financial support. The Academy should be in position to assemble and house the wealth of material afforded by nature in and about the shores of the Pacific Ocean which is worthy of collection in such a museum, as has already been well started but which remains capable of great expansion.

Again I must thank the staff and employees of the Academy for another year of faithful service.



XV

REPORT OF THE DIRECTOR OF THE MUSEUM FOR THE YEAR 1919

BY

BARTON WARREN EVERMANN
Director of the Museum

The annual report of the Director for the year 1918 was presented to the Academy at the annual meeting of February 19, 1919. At that time there had been completed 14 large, 4 intermediate and 8 small groups. Since then the following have been completed: Large groups, Alaska Fur-Seal and Roosevelt Elk; small groups, Cottontail and Water Ouzel.

Alaska Fur-Seal Group.—This group shows a typical harem and breeding rookery of the Alaska Fur-Seal. The particular rookery shown is that known as the North Rookery on St. George Island, Pribilof Group, in Bering Sea, Alaska. The animals constituting the harem—one bull, six cows, and six pups—were supplied by the United States Bureau of Fisheries at a nominal cost.

The number of cows and pups shown in the group is not as great as is necessary to make the exhibit the most typical of the average harem. Arrangements were therefore made by means of which there were secured from the Pribilof Islands 19 additional specimens. These are now being prepared for installation by Mr. William Heim. When they have been installed the group will contain one bull, ten cows, and fifteen pups.

In the preparation of this group the taxidermists and artist were materially assisted by Dr. G. Dallas Hanna under whose immediate supervision the specimens were collected, and by Dr. Harold Heath who visited the Seal Islands in 1918. Dr. Hanna supplied measurements for each of the specimens taken that were needed by the taxidermists. He also took numerous photographs that were very useful to the taxidermists and the artist. Dr. Heath supplied descriptive notes, photographs and colored sketches of the North Rookery which were of very

great help to the taxidermists and the artist. The assistance rendered by the Bureau of Fisheries and by Doctors Heath and Hanna is greatly appreciated by the Academy.

The Fur-Seal Group was prepared by Mr. Paul J. Fair, assisted by Mr. Arthur L. Reed. The background was painted by Charles Bradford Hudson. An inspection of this group shows that both taxidermists and artist did their work well. The group is very realistic and gives one a glimpse into the wonderful life-history of this really wonderful animal.

Roosevelt Elk Group.—This group occupies the first case on the right of the main entrance to the California mammal hall. It consists of one very large bull, one spike, two cows, and one calf. The animals were secured on the Hoh River in the Olympic Mountains, Washington, by Mr. C. J. Albrecht, director of vertebrate exhibits in the Museum of the University of Washington, Seattle.

The scene is a beautiful one. It shows the animals in the fall of the year on a grassy slope at the edge of a typical redwood forest such as one may see in northwestern California. The animals are on the grassy slope in the foreground; the old bull is bugling to a rival bull somewhere in the distance. In the background to the right is a dense redwood forest through which the sunlight shows very beautifully, while to the left several more or less barren mountain ranges are shown, increasingly higher in the distance. Altogether, the picture is an exceedingly beautiful one and the group is regarded as one of the most impressive and instructive that has been completed.

The Roosevelt Elk inhabits the dense coniferous forests of the humid Pacific coast from near the northern end of Vancouver Island southward through the coast ranges of Washington and Oregon to northwestern California. Its present center of abundance is in the almost impenetrable forests of the Olympic Mountains west of Puget Sound. It formerly probably ranged along the California coast as far south as Marin County, and a few are still left in the northwest corner of the state. Apparently its range never extended eastward to connect with that of the Rocky Mountain Elk (the species which is still common in northwestern Wyoming), which is a fact of great importance to the student of geographic distribution.

This splendid animal is known variously as the Roosevelt Elk or Wapiti, Olympic Elk, or Humboldt Elk. It differs from the common Canadian or Rocky Mountain Wapiti in several respects, the most important of which are its larger size, larger, broader and more massive skull, and much darker coloration.

The late Colonel Roosevelt, in his entertaining book, "THE WILDERNESS HUNTER," speaks of the Rocky Mountain Elk as "not only the most stately and beautiful of American game, but also the noblest of the stag kind throughout the world"; and adds: "Whoever kills him has killed the chief of his race, for he stands far above his brethren of Asia and Europe." But this was written before the elk of the Olympics had been described as a distinct species by Dr. C. Hart Merriam who very properly says that "these remarks must now be transferred from the common Wapiti to the Pacific coast animal." Dr. Merriam further says: "I deem it a privilege to name this splendid animal Roosevelt's Wapiti. It is fitting that the noblest deer of America should perpetuate the name of one who, in the midst of a busy public career, has found time to study our larger mammals in their native haunts and who has written the best accounts we have ever had of their habits and chase."

For this beautiful habitat group the Academy is indebted to Mr. William C. Van Antwerp who very generously gave to the academy the funds necessary to meet the cost.

The group was prepared by Paul J. Fair, assisted by Arthur L. Reed. The background was painted by Charles Bradford Hudson.

It was completed December 20, 1919, photographed on the 22d, and the plate-glass front was put in on the 23d. On December 30 a private view of the group was given to Mr. Van Antwerp and his friends and on New Year's day it was formally opened to the public.

The public-spirited generosity of Mr. Van Antwerp in thus so materially aiding the Academy in its scientific and educational work is greatly appreciated not only by the Trustees, Council and entire membership of the Academy, but equally so by the general public, many thousands of whom have already viewed this imposing group and been fascinated as well as instructed by its beauty and fidelity to nature.

I wish also to express to Mr. Fair and Mr. Reed the Academy's appreciation of the splendid results which they attained in the preparation of this group, and to Captain Hudson equal appreciation of the unusually artistic and beautiful background.

Audubon Cottontail Group.—This is one of the small panel groups completed in the past year. This interesting little rabbit was originally described from San Francisco by Professor Baird who named it for John James Audubon, the great American ornithologist. It occurs not only in the San Francisco Bay region but its range extends northward in the Sacramento Valley at least as far as Tehama County, and southward in the San Joaquin Valley to Merced County. In Golden Gate Park it is, next to the squirrels, the most familiar and attractive of the native mammals. It is found throughout the Park wherever suitable cover exists. One or more pairs may be seen almost any day, particularly early in the morning or late in the evening, feeding at the edge of the large patch of procumbent bushes of the Stink-bean (*Albizia lophantha*) on the hillside on the east side of the walk just after passing through the first tunnel when entering the Park from Tenth Avenue. These little "bunnies" make their home under these bushes. From this safe retreat they come out to feed upon the grass nearby. As you pass by this place you can see that the little rabbits keep the grass pretty thoroughly eaten off for several feet about the bushes.

The plant shown in the group is the Thimbleberry, *Rubus parviflorus*.

This group was prepared by Mr. Paul J. Fair, assisted by Mr. Arthur L. Reed. The background was painted by Miss Olive E. Cutter.

Water Ouzel Group.—This is another of the small panel groups completed within the year. Of the many interesting birds which one may see in the mountains of California there is none more interesting or attractive than the Water Ouzel with its plump little body, slaty gray plumage, and very unusual habits. Wherever there is a stream of clear, turbulent, running water, there you may possibly find these curious little birds. You may see one standing on a rock jutting out from

the shore or on a boulder out in the stream where the water rushes and swirls in the wildest way, the spray giving the bird a veritable shower bath. But, as if this were not enough, the ouzel bows to you a few times then takes a "header" off the rock to the bottom of the stream where, clinging and scraping along by means of claws and bill, it searches for caddis-fly larvæ and other aquatic insects upon which it feeds. That this little bird can thus remain and move about under water is very surprising, indeed.

The nest of the Ouzel, a large globular structure composed almost entirely of moss which is kept alive and green by the spray, is usually placed in a cavity in the bank or on a rocky ledge where it is splashed by the water; sometimes it is placed even behind a waterfall. The nest shown in this group was about a foot above the water in a hole in a large rock in Pescadero Creek, San Mateo County, California. One of the birds is shown sitting on the rock, the other is seen in the entrance to the nest. Above the nest is shown an azalea shrub (*Azalea occidentalis*) in flower. The Water Ouzel is the only species in North America of the family to which it belongs. It is found from the Yukon south in the mountains to the Mexican border and from the Black Hills westward to the Pacific.

This group was prepared by Mr. Paul J. Fair. Miss Olive E. Cutter painted the background.

The Museum therefore has completed at this date 16 large groups (ten mammal and six bird), four intermediate (all mammals), and ten small panel groups (seven bird and three mammal).

Space is left for only one more large group and 25 small panel groups. It has been provisionally decided to install in the one remaining large case a group of Grizzly Bears. As the California Grizzly Bear which occupied such a prominent place in the early history of the State is now believed to be extinct, it is proposed to get one of the nearly related species, either from the Yellowstone Park or from the Stikine River, Alaska.

PERSONNEL

A few changes in the personnel of the Museum staff have taken place within the year.

On February 1, 1919, Mr. Joseph Mailliard was appointed honorary curator, department of Ornithology and Mammalogy, this position having been vacant for several years. April 1, Mr. Luther Little was appointed assistant curator, department of Ornithology and Mammalogy. Mr. Little resigned January 31, 1920, to go into business. During Mr. Little's connection of ten months with the Museum he rendered very efficient service and it is with real regret that we see him leave us.

Mr. William Heim was temporarily employed as taxidermist from February 1 to May 22. He was again employed in the same capacity October 1. On August 1 Mr. Paul J. Fair and Mr. Arthur L. Reed were taken off the roll as regular employees and began the preparation of the Roosevelt Elk group under contract, which they completed December 20. Miss Olive Cutter resigned July 31, as preparator. Dr. Roy E. Dickerson, having been employed by the Standard Oil Company to do field work in the Philippines, which precluded the possibility of his giving that attention to the department which was necessary, was appointed honorary curator of Invertebrate Paleontology April 1, and Dr. G. Dallas Hanna was appointed curator. Dr. Hanna, at the time of his appointment was on the Pribilof Islands as agent of the U. S. Bureau of Fisheries. He returned from the Seal Islands in October and entered on his duties with the Museum November 1.

Georges Vorbe and Merle Israelsky, temporary employes, department of Paleontology, were laid off, the former on April 25, the latter on June 8.

Miss Lula M. Burt was employed as osteological preparator from December 1, 1918, to April 30, 1919, and from July 30 to August 6, 1919.

Mrs. Marian L. Campbell has, since November 30, 1919, been giving one day a week to the department of Botany, and Mrs. Kate E. Phelps has been serving as assistant in that department since December 1.

The employes of the Academy at this date are the following: Dr. Barton Warren Evermann, Director and Executive Curator of the Museum, and Editor; W. W. Sargeant, Secretary to the Board of Trustees; Miss Susie Peers, Secretary to the Director; Joseph W. Hobson, Recording Secretary; Miss Alice Eastwood, curator, Department of Botany; Edward P. Van

Duzee, curator, Department of Entomology and assistant librarian; Dr. John Van Denburgh, curator, Department of Herpetology; Dr. Roy E. Dickerson, honorary curator, Department of Invertebrate Paleontology; Dr. G. Dallas Hanna, curator, Department of Invertebrate Paleontology; Dr. Walter K. Fisher, curator, Department of Invertebrate Zoology; Joseph Mailliard, honorary curator, Department of Ornithology and Mammalogy; Joseph R. Slevin, assistant curator, Department of Herpetology; Mrs. Marian L. Campbell, assistant, Department of Botany; Mrs. Kate E. Phelps, assistant, Department of Botany; Mrs. Helen Van Duzee, assistant, Department of Entomology and in the Library; Miss Mary E. McLellan, library assistant; William Heim, assistant, Department of Exhibits; Raymond Smith, general assistant; William C. Lewis, janitor; Fred Maag, assistant janitor and carpenter; George W. Edwards, assistant janitor; Frank W. Yale, night watchman; Mrs. Johanna E. Wilkens, janitress; Patrick J. O'Brien, day watch; William Burns, night watch.

ACCESSIONS TO THE MUSEUM AND LIBRARY

As in previous years, the accessions to the Museum and the Library have been numerous, as shown by the detailed list in the appendix to this report (pp. 389-396).

VISITORS TO THE MUSEUM

The Museum has been open to the public every day in the year, and there was a marked increase in the number of visitors over that for 1918. The attendance by months during the year 1919, was as follows:

January	17,241
February	17,586
March	27,397
April	25,994
May	28,369
June	32,248
July	48,028
August	43,730
September	34,007

October	30,463
November	25,246
December	21,246
	<hr/>
Total	351,497

That the public and private schools are finding the exhibits in the Museum interesting and helpful in their educational work is evidenced by the large number of schools that, with their teachers, visit the Museum each year. During 1919 there were schools from San Francisco, Berkeley, Oakland, Alameda, Piedmont, San Jose, and San Anselmo.

Whenever opportunity offered it has been the policy of the Director to accompany the schools through the Museum, explaining briefly the general features of installation and calling attention to the educational value of certain exhibits, and then taking the schools into the lecture hall and showing them stereopticon slides and moving pictures of the species of animals shown in one of the groups.

The visits by schools in the year have been as follows:

Number of schools represented.....	80
Number of classes or grades.....	214
Number of teachers in charge.....	215
Total number of pupils	7000

LECTURES

The practice of maintaining courses of free lectures on popular scientific subjects has been continued. These have been, as heretofore, in two series—first, those given at the regular stated meetings of the Academy in the hall of the Engineers' Club of San Francisco, 57 Post Street, on the third Wednesday evening of each month (changed September, 1919, to the first Wednesday of each month), and, second, those given at three o'clock each Sunday afternoon in the Auditorium of the Museum. These lectures have without exception been well attended, the audiences at the Sunday lectures usually equalling or exceeding the seating capacity of the hall.

A list of the lectures given in 1919 will be found in the President's report (pp. 359-361).

FIELD WORK OF THE MUSEUM STAFF

Within the year, the Museum carried on a number of field investigations, as follows:

Channel Islands.—A collecting party consisting of Dr. Van Denburgh, Mr. Slevin, Mr. Van Duzee and the Director spent a week (May 15-21) on the Channel Islands off the California coast, the particular islands visited being Anacapa, Santa Cruz, Santa Rosa, Prince, and San Miguel.

The party was able to visit these islands through the courtesy of the California Fish and Game Commission, and I wish to take this opportunity to express to the officials of that Commission, especially Mr. Carl Westerfeld, Executive Secretary; Mr. Norman B. Scofield, assistant in charge of commercial fisheries; and Captain H. B. Nidiver of the Commission's patrol boat "Albacore," the appreciation of the members of the party of the courtesies extended. Captain Nidiver did everything possible to make the trip a success. Our thanks are due also the Messrs. Arthur and Fred Caire of the Justinian Caire Company for permission to land on Santa Cruz Island, to Vail and Vickers for permission to land on Santa Rosa Island, and to Captain H. W. Rhodes, Inspector of the 18th Lighthouse District, to land on Anacapa and San Miguel islands.

The trip to these islands proved quite successful and considerable collections of natural history specimens were obtained, the most important in the following departments: Entomology, 1965 specimens; herpetology, 201 specimens; oölogy, 190; conchology, 100.

Riverside County.—Mr. Joseph R. Slevin spent May 21-31 in the vicinity of Mecca, Riverside County, making collections for the department of Herpetology. About 70 specimens were obtained.

Lower California.—An expedition was sent to the Cape region of Lower California to make collections for the departments of Herpetology and Invertebrate Zoology. The party, consisting of Mr. Joseph R. Slevin, and Mr. G. F. Ferris of Stanford University, left San Francisco June 14 and returned September 23. Owing to illness while in the field of both members of the party the expedition was not as successful as it

otherwise would have been. Nevertheless Mr. Slevin brought home a total of 1396 reptiles and amphibians, among which are represented several rare or little known species.

Olympic Mountains.—September 12 to 28 was spent by the Director of the Museum and the Curator of Herpetology in a trip to the Olympic Mountains west of Seattle. The primary objects of the trip were to secure, if possible, moving pictures of the Roosevelt Elk and to make collections of reptiles and amphibians. Though we had with us Mr. Will Hudson, an expert Pathé photographer, and Mr. C. J. Albrecht, an expert hunter who had secured for the Academy all the animals used in the Roosevelt Elk group and who was thoroughly familiar with the region, we were entirely unsuccessful in securing any elk pictures. We spent several days (September 18-24) on the Hoh River some 70 miles west of Port Angeles. This is in the region where Mr. Albrecht obtained the specimens for our group and where the elk might be expected at that season, but we saw only six bulls all told. There had been no snow in the mountains to drive the herds down into the river valley. Another effort will be made next fall.

In herpetology the trip was much more successful, 239 valuable specimens having been obtained.

Huntington Lake.—Mr. E. P. Van Duzee spent the month of July (July 3 to 31) at Huntington Lake in the Sierras east of Fresno, in the interest of his department, when he added about 5000 specimens to the Academy's entomological collections. Besides this field trip Mr. Van Duzee made several other short collecting trips, all fully set forth in his report.

Yosemite National Park.—Mr. William Heim spent the time from October 6 to 28, collecting birds and mammals in the Yosemite region. He obtained fifty specimens.

Napa, Lake, Mendocino, and Colusa counties.—Most of the months of April to June and September and October were spent by Mr. Joseph Mailliard and Mr. Luther Little in these counties studying and collecting the birds and mammals of that region. The total number of specimens secured was: mammals, 190; birds, 753; birds' nests and eggs, 50; reptiles and amphibians, 13.

Besides the field work in these counties numerous short collecting trips in the interest of the department of Ornithology and Mammalogy were made by the curator, assistant curator, Mr. Heim, and the Director to Marin, Santa Clara, Alameda, Santa Cruz, and Monterey counties.

Arizona.—Miss Alice Eastwood spent the period from March 15 to May 30, in Arizona making collections for the Arnold Arboretum and the Academy of Sciences, and in San Diego County from June 23 to July 6, in the same interests.

The details of these various collecting trips are set forth fully in the reports of the respective curators.

PASADENA MEETING OF THE PACIFIC DIVISION OF THE
AMERICAN ASSOCIATION FOR THE ADVANCEMENT
OF SCIENCE

The meeting was held June 18 to 23, at the Throop College of Technology. The Academy was represented by the Director of the Museum, Secretary W. W. Sargeant, and Miss Alice Eastwood, curator of Botany. The Director was present as vice-president and chairman of the executive committee of the Division, and Mr. Sargeant as secretary of the Division.

The Academy was represented on the program by the following members:

- Mr. W. E. Allen of the Scripps Institution;
- Dr. W. W. Campbell, Director of the Lick Observatory;
- Prof. John N. Cobb, Dean of the Fisheries College of the University of Washington;
- Miss Alice Eastwood, Curator of Botany;
- Dr. Charles H. Edmondson, Professor of Zoology, University of Oregon;
- Dr. Barton Warren Evermann, Director of the Museum;
- Dr. David Starr Jordan, Chancellor Emeritus, Stanford University;
- Dr. George D. Louderback, Professor of Geology, University of California;
- Dr. William E. Ritter, Director of the Scripps Institution for Biological Research;
- Mr. N. B. Scofield of the California Fish and Game Commission;
- Dr. Chester Stock of the Standard Oil Company;
- Dr. F. B. Sumner of the Scripps Institution for Biological Research;
- Mr. E. P. Van Duzee, Curator of Entomology;
- Dr. Charles E. von Geldern of Sacramento;
- Dr. Bailey Willis, Professor of Geology, Stanford University;
- Dr. B. L. Clark, University of California;
- Dr. S. D. Townley of Stanford University.

USE OF THE ACADEMY'S COLLECTIONS AND LIBRARY BY
INVESTIGATORS AND STUDENTS

Students and investigators continue to make use of the Academy's collections, library, and facilities for study and research. A few of those who have done so in the past year may be mentioned. Mr. L. M. Loomis has continued to make use of the Academy's collection of sea birds. The bird, and bird egg and mammal collections have been used also by Harry S. Swarth, Joseph Grinnell, Harold E. Hanson, John Van Denburgh, and several teachers in public and private schools. In Entomology the entomologists not only of the San Francisco Bay region but of other parts of the Pacific Coast have continued to make use of our collections. The number is too formidable to name here individually; the names are all given in the department's records. The same is true of the departments of Botany and Paleontology.

Much time of the Curators and of the Director has been given to supplying data and information to correspondents, specialists and students who, in increasing numbers, are turning to the Academy for information and assistance in matters in which they are interested.

DEPARTMENT ACTIVITIES

The curators and assistants have been active and efficient in the work of their respective departments. They have each not only labored unceasingly to increase the collections but they have been untiring in their efforts to see that the collections are properly cared for. To prevent deterioration of museum specimens requires unceasing vigilance and attention on the part of the curators; only in this way can the loss of valuable specimens be avoided.

The condition and activities of the various departments are fully set forth by the curators in their departmental reports. The Director wishes to take this opportunity to express his appreciation of the splendid spirit which each and every member of the Museum staff has shown in his work. Every member has shown that he is deeply interested not only in his particular line of work but also in the Museum, and all have cooperated whole-heartedly and effectively in making the Museum of real scientific and educational value.

DEPARTMENTAL REPORTS

DEPARTMENT OF BOTANY

By Alice Eastwood, *Curator*

The herbarium of the California Academy of Sciences now numbers 59,589 specimens, mounted, classified and systematically arranged. Approximately 17,000 species are represented.

Accessions have been received from various sources: Forty-eight different individuals have sent specimens, most of them for identification. The largest accession was the herbarium of the late Dr. E. K. Abbott, of Salinas, which was presented to the Academy in 1918, but not incorporated in its herbarium until 1919. In addition to a fairly complete collection from the vicinity of Monterey and Salinas, it included collections from Michigan and Illinois, and a most interesting lot of European specimens collected many years ago in the region of northern France devastated by the late war.

Exchanges have been received from the U. S. National Museum, from Ira W. Clokey, of Denver, Colorado, and the Rev. John Davis, of Hannibal, Missouri.

Duplicates have been sent to the following from which we shall obtain specimens in return when they distribute duplicates:

The Arnold Arboretum.....	786
Gray Herbarium	1454
Missouri Botanical Garden.....	489
New York Botanical Garden	940
U. S. National Herbarium.....	2164
Ira W. Clokey	864

The middle of March the curator started on a collecting trip in Arizona and New Mexico. This was financed by the Arnold Arboretum of Harvard University, and at the request of Professor C. S. Sargent, Director of the Arnold Arboretum and Professor of Forestry, who wished to have a systematic collection made of the cottonwoods of the places visited, particularly, the country around Silver City, New Mexico. Collections were accordingly made at the following places: Indio and Needles, California; Yuma, Casa Grande, Sacaton, Tucson, Bowie, Globe, Roosevelt Dam and Fish Creek (on the Apache Trail), Ash Fork, Prescott, and Topock, Arizona; and Silver City, Fort Bayard, Santa Rita, Whitewater Junction, Tyrone, and Lordsburg, New Mexico. Ten days were spent at Tucson, and five weeks at Silver City.

At most other places only a day, or perhaps a few hours between trains, was spent. Several days were devoted to Los Angeles, chiefly at a camp in San Gabriel Canyon. About the middle of June a trip was made to the Cleveland Forest Reserve, San Diego County, in search of a rare *Celtis* for Professor Sargent, at which place a large collection was made. Altogether there were added to the herbarium, 1,723 specimens, but several

thousand specimens were collected, duplicates of most of them being sent direct to Professor Sargent.

During the year, the Academy purchased a label printing machine for the purpose of labelling the trees and shrubs of the park with their scientific names. The Academy bore the initial expense but hereafter the Park authorities pay for the materials and furnish the labor. Mr. Eric Walther, one of the gardeners, has been assigned to this work because of his knowledge and enthusiasm, but so far, has been able to give but a month of his time to the work on account of the press of other duties. However, about 1,200 labels have been printed and attached to the trees and shrubs, chiefly in the parts of the park most frequented. This represents about 500 species and varieties and 200 genera.

The exhibition of flowers in bloom out of doors, both cultivated and wild, has been continued in the vestibule of the Museum, throughout the year. Mrs. Johanna Wilkens has been most faithful in keeping all in cleanliness and order, and to her is due great credit for the success of the exhibition. Mrs. Marian L. Campbell and Mrs. E. C. Sutcliffe, as well as other members of the Botanical Club, have been assiduous in keeping up the supply of wild flowers, and Eric Walther has made collections from the Park.

The usual activities of the Botanical Department have continued during the year. The Botanical Club has held frequent meetings and excursions and the evening class of the gardeners has met weekly when the curator has been in San Francisco. In addition to this, lectures have been given to various clubs and popular articles have been contributed to magazines.

DEPARTMENT OF ENTOMOLOGY

By E. P. Van Duzee, *Curator*

The work in the Department of Entomology during 1919, as in the previous year, was largely confined to the acquisition, determination, and arrangement of North American insects, especially those from California. Additions to the department during the year number 17,891 specimens, of which 12,504 were taken by the curator, 1,020 were added through the efforts of Mr. J. R. Slevin while in Lower California last July, 1,096 through purchase from Mr. R. H. Beck, and 3,271 were presented by friends of the Academy. This donated material came in small lots but it added many interesting species to the Academy collection. From Dr. F. E. Blaisdell the Academy received 665 specimens; from Dr. F. C. Clark, 546 specimens; from Mr. C. L. Fox, 448, including a remarkably fine series of Diptera or two-winged flies from Mt. Rainier, Washington; from Mrs. E. P. Van Duzee, 260 specimens; from Mr. J. O. Martin, 252 specimens, largely named species to fill vacancies in the Academy series; from Dr. E. C. Van Dyke, 239 specimens; from Mr. E. A. Dodge of Santa Cruz, 189 specimens, including some interesting Catocalæ and a special collection of Tabanidæ, or "horse-flies," made by his brother, the late G. M. Dodge, in the Mississippi Valley; from Ralph Hopping, 182 specimens; from Mr. J. Preston Clark of Boston, 148 specimens taken by Mr. J. A. Kusche

at Mazatlan, Mexico; and smaller series from Major Chapman Grant of Oklahoma City, Mr. J. C. Huguenin of San Francisco, and from Dr. Evermann, Miss Eastwood, Mr. Mailliard, and Mr. Little of the Academy staff, and others. These figures do not include many donations of most valuable material which it has been impossible for the curator to mount and prepare for incorporation in the collections of the Academy. These will be acknowledged later when help for mounting them is available.

The field trips of the curator with the material obtained are as follows: March, three days at Carmel with Mrs. Van Duzee, as guest of Mr. L. S. Slevin, 956 specimens; April, nine days by automobile from Bradley to San Luis Obispo and return, with Mr. L. S. Slevin, 1,628 specimens; May, six days on the Channel Islands of Anacapa, Santa Cruz, San Miguel, and Santa Rosa, with members of the Academy staff, as guests of the California State Fish and Game Commission, 1,965 specimens; June, three days with Mrs. Van Duzee at Santa Cruz as guests of Mr. and Mrs. E. A. Dodge, 1,002 specimens; July, one month with Mrs. Van Duzee and Dr. and Mrs. Blaisdell at Huntington Lake, Fresno County, 4,810 specimens; August, three days at Stockton, 630 specimens; and various short trips about the bay region on Sundays and evenings, 1,513 specimens.

During the year considerable progress was made in the classification and arrangement of the collections. Most important is, perhaps, the work accomplished on the Diptera or two-winged flies. Material in that order has been determined by Mr. J. R. Malloch of Urbana, Illinois, Prof. J. S. Hine of Columbus, Ohio, Mr. E. T. Cresson, Jr., of Philadelphia, Mr. C. P. Alexander of Urbana, Illinois, Mr. C. W. Johnson of Boston, Mr. M. C. Van Duzee of Buffalo, and Mr. A. L. Lovett of Corvallis, Oregon, but of most value has been the help received from Mr. F. R. Cole of Stanford University, who has worked over our entire collection, determining a large number of species that had not been studied by other specialists and assorting and placing in the arranged series the numerous species added during the year. Fifteen families in this order have now been classified and arranged. In the Lepidoptera Mr. W. S. Wright of San Diego has completed the determination of our material in family Geometridæ and the curator has arranged these and has also worked over and arranged the material in the Noctuidæ, *Ægeridæ* and *Hepialidæ*, determining many species and verifying others where their determination seemed doubtful. In the Coleoptera, or beetles, Dr. F. E. Blaisdell has again given much time and effort to the determination of our material and the increase of our collection. Additional assistance has been received from Dr. E. C. Van Dyke in the *Elateridæ* and *Buprestidæ* and from Mr. Ralph Hopping in the *Cerambycidæ*, and the latter family and the *Tenebrionidæ* have been re-arranged in new boxes after the forthcoming Leng Catalogue, proof sheets for this purpose having very kindly been loaned to the Academy by Mr. Leng. In the Orthoptera, or grasshoppers and their relatives, almost the entire series has been sent to Mr. Morgan Hebard of Philadelphia for study and another year should see that order in excellent shape.

One important piece of work accomplished during the year has been the cataloguing and arranging in a new metal cabinet of the insect types in possession of the Academy. Six hundred and seventy-eight types, representing 461 species, have been entered in our register of type specimens, most of which are either holotypes or allotypes, in a few cases only were paratypes included where types were not available. The work of entering these records on the type register as well as the writing of the species labels for most of the insects arranged during the year and the preparation of a large number of record cards, has been done for the department by Mr. J. R. Carlson. The accumulation and preservation of the types of our west coast insects is a duty the Academy owes to future students of insects here in the west and it is earnestly hoped that those describing new species of insects from the west coast will see that the holotypes of such species are deposited in the collection of this Academy where they will be as safe from destruction as it is possible to make them. In addition to the types of all species described from material in the Academy collection quite a number have been received from friends of the Academy. Mr. W. M. Giffard of Honolulu has given the Academy the types of two rare beetles from the Rivers collection (*Amblychila baroni* and *Necydalis barbaræ*), and those of all the Hemiptera described from material taken by him in California, 46 in number, and the paratypes of the Hymenoptera described by Mr. Rohwer from his material taken in the Sierras in 1916; Messrs. Lovett and Cole have donated the types of 42 species of Oregon Diptera published by them in 1919; Mr. M. C. Van Duzee has donated the types of six species of Diptera described by him in his paper on the genus *Medeterus*; Mr. J. R. Malloch, the types of two species of Diptera described by him; Mr. E. O. Essig, the types or cotypes of 21 species of plant-lice published by him in 1918; and Mr. E. A. Dodge, the type of a new butterfly (*Pamphila pawnee*) described by his brother, G. M. Dodge, in 1874. Types of 15 species have been added during the year from the description of Academy material.

Excepting the month of July, the Department of Entomology has kept "open house" every Saturday afternoon for those who wished to use or inspect the collections or to meet with others interested in this line of study. These gatherings have been well attended most of the days and perhaps have served a useful purpose in bringing together our local students and such visiting entomologists as were able to attend. During the year the Academy has lost through removal elsewhere three of its most regular attendants and co-workers, Mr. and Mrs. L. R. Reynolds, who have removed to Mexico City, and Mr. Ralph Hopping to Vernon, B. C.

The routine work of mounting and labeling the numerous specimens added during the year has taken up so much of the time of the curator that very little systematic work has been accomplished. A small report on the Hemiptera of the Canadian Arctic Expedition, prepared last year, has been published by the Dominion Government at Ottawa and another paper describing 28 new species of Hemiptera is now in the hands of the printer. The same cause has operated to hinder the classification and arrangement of the Academy's collection in all orders.

The most important work ahead of this department for the coming year is, as it was last year, the building up of a representative collection of west coast insects, a collection that for our west coast fauna will be the equivalent of the great collections in the museums of the east. In the Hemiptera and Diptera at least we already have material that cannot be ignored by students undertaking monographic work in these orders. Still, this is but a beginning and our energies for a few years should be largely concentrated upon the local fauna. The greatest needs of this department during the coming year is for more cases for the arrangement of our material and for more help for the curator in the mounting and labeling of specimens. There are large accumulations of valuable material on hand to be mounted or immediately available when there is suitable help for preparing the specimens. The call for more assistance and more cases will continue for a few years until the foundation for our collection of local insects has been laid by the acquisition and arrangement of a good series of our common and more characteristic species.

LIBRARIAN'S REPORT

By E. P. Van Duzee, *Assistant Librarian*

The year 1919 has seen satisfactory advance along all lines of work in the library. Additions to the library during the year number 444 complete volumes and a considerable number of pamphlets and society publications not yet completing volumes. Of the additional volumes noted 39 were received by gift and 200 through exchange with other institutions. The total number of volumes accessioned on December 31, 1919, was 11,880 of which 4,750 were entered during the past year. The collation and classification of the miscellaneous government and institutional publications is rapidly nearing completion and a good proportion of these have been fully catalogued and the cards incorporated in the library catalogue. About 125 boxes that had not been opened since the library was moved to the new building were unpacked and their contents assorted and distributed. Additions from this and other sources necessitated the rearrangement of the entire series of periodicals and society publications in the English language so they now occupy five of the six cases in the up-stairs reading room.

As during the previous year, Miss McLellan and Mrs. Van Duzee have each devoted a portion of their time to the care of the library, Miss McLellan taking charge of the reading room, caring for the current accessions and making all entries in the accessions register, while Mrs. Van Duzee has done the classifying and cataloguing of the books. Both have done careful and efficient work and are rapidly getting the library into excellent condition. Use of the library by the public and by members outside of the regular staff of the institution has shown a satisfactory increase and the books purchased have included such as will prove valuable to those readers, as well as technical works for the use of the curators. A considerable number of books have been ordered from European sources

but not yet received, and two new book cases will soon be installed in the lower library room which should add much to the efficiency of the library equipment.

DEPARTMENT OF HERPETOLOGY

By John Van Denburgh, *Curator*

The Department of Herpetology during the year 1919 progressed satisfactorily, and the work accomplished compares favorably with that of previous years.

At the beginning of the year 1919 the Academy's collection of reptiles and amphibians numbered 37,372 specimens. There have been added during the year 2,666 specimens, so that the collection has grown to more than 40,000 specimens.

The number of specimens added during each of the past six years has been about as follows:

1914	800 specimens
1915	800 "
1916	1500 "
1917	1600 "
1918	1724 "
1919	2666 "

Gifts of specimens during the year have been received as follows:

From Edward J. Brown	94 specimens
" J. R. Slevin	4 "
" Ralph Borden	4 "
" Dr. J. Van Denburgh.....	1 specimen
" H. H. Hunt	1 "
" Miss Susie Peers	1 "
" W. C. Lewis	1 "
" Paul Wallace	2 specimens
" Mayor James Rolph, Jr.	1 specimen
" Ryan Fruit Co.	1 "
" August Kusche	3 specimens
	<hr/>
	113 specimens

Three collecting trips were undertaken to:

1. Mecca, Riverside County, California, Anacapa, Santa Cruz and San Miguel islands;
2. Cape Region of Lower California;
3. Northwestern Washington.

Aside from the collection made on the islands, specimens have been secured from 12 counties of California, as follows:

Contra Costa	1 specimen
Lake	5 specimens
Los Angeles	86 "
Marin	2 "
Mendocino	5 "
Napa	3 "
Orange	10 "
Riverside	70 "
San Francisco	2 "
San Joaquin	1 specimen
San Mateo	1 "
Santa Cruz	4 specimens

Specimens from other localities are:

Florida	3 specimens
Kentucky	2 "
North Carolina	5 "
Texas	3 "
Virginia	2 "
Washington	239 "
Brazil	609 "
Dutch East Indies	4 "
Gautemala	1 specimen
Hawaiian Islands	3 "
Lower California.....	1296 "
Nicaragua	4 "
Pacific Ocean between Yokohama and Honolulu...	1 specimen

The classification and arrangement of the collection was continued during the early part of the year.

Considerable research work has been accomplished during the year and a detailed study of the gopher-snakes of the states west of the Rocky Mountains has been published.¹

During the year the Assistant Curator, Mr. J. R. Slevin, carried on explorations in the Cape Region of Lower California, where he spent the months of July, August, and part of September, and secured large collections.

The growth of the collections is retarded by the limited funds available for field work. These funds should be increased very materially, and a sum should be available for the purchase of collections when offered for sale by individual collectors or institutions.

¹ Proc. Calif. Acad. Sci., 4th Ser., vol. 9, no. 6. pp. 197-220, pls. 11-13.

DEPARTMENT OF ORNITHOLOGY AND MAMMALOLOGY

By Joseph Mailliard, *Curator*

Work in the Department of Ornithology, which had been in abeyance for some time, was actively resumed at the beginning of February, 1919, and has been carried on without interruption since that date.

A matter of first importance was the compilation of a proper card index of the research collection of birds which consisted, at the beginning of this year, of something over 19,000 specimens. The preparatory work for this has been accomplished, and the typewriting of the cards is now nearly completed.

All the specimens in the cases were examined and cleaned with an air blast, and periodical inspections have been maintained.

Field work has been carried on, as far as the fund appropriated allowed, by the curator and his assistant, Mr. Luther Little. The principal event in this line has been the exploration of the Inner Coast Range of California in parts of Napa, Lake, Mendocino, and Colusa counties, which was carried on during the months of April, May, and June and in September and October. In this work the department was greatly assisted by Mr. John W. Mailliard, who placed his services and the use of his car at our disposal on several occasions, thus enabling us to examine districts and aiding us in collecting material which would otherwise have been beyond our reach. Interesting additions to our knowledge of the avifauna of California have been the reward of this field work and material of much assistance toward the solutions of some puzzling problems in distribution has been obtained. The results of the spring field work were published in the *Proceedings of the Academy*.²

Acting upon a request for cooperation from the Bureau of Biological Survey, this department has preserved and forwarded to that bureau, for content examination, the stomachs of a considerable proportion of the birds taken as specimens during the explorations and field work, and will continue to assist in this manner as far as time and opportunity permit.

Among the educational exhibits of special interest now being prepared by the department is one of the birds of Golden Gate Park. The purpose is to show a pair of properly mounted specimens of each of the species of birds known to occur in the Park. The species that are permanent residents will be shown in one case, and those present only as winter, spring or fall visitants or migrants in other cases. Then in the final case will be represented the current species. This last group will be a constantly changing one, as it will be kept up to date by removing the species that leave and adding those which arrive in the Park from day to day. It is believed these exhibits will prove of real value to the public schools in their nature study work. These specimens are being prepared by Mr. Wm. Heim. Specimens have been contributed to this exhibit by various persons, among whom may be mentioned Messrs. J. V. Donovan, Charles Budd, and Sergt. P. H. McGee of Golden Gate Park, Prof. J. O. Snyder of Stanford University, and the California Fish and Game Commission.

² Vol. IX, No. 10, 4th Ser., pp. 273-296, November 25, 1919.

Accessions to the department during the year have been numerous, as shown in detail in the general list of accessions. The total number of specimens of birds in the Academy collection entered on the register at the end of the year 1919 amounts to 31,528.

As part of the work of this department should be included the placing in dust-proof, glass-topped containers of the Academy's oölogical collection, thus making the eggs safe from damage that might result from ordinary causes. This collection is only awaiting additional cases for its definite systematic arrangement. A number of nests accompany the sets of eggs and many of these have been mounted in an attractive and useful manner.

Press of other work having prevented the cataloguing of the eggs in this branch of the department, the actual number of specimens can only be approximated.

The principal gift during the year was that of the oölogical collection of J. and J. W. Mailliard, containing 12,431 eggs in 3,270 sets, representing 612 species. The Academy's oölogical collection now contains about 1,700 sets, or about 17,430 eggs.

Some work was done in the mammalogical section of the department. Collecting of rodents and other small mammals was carried on in connection with the field work in ornithology, and some 225 specimens of mammals were thus obtained from localities not heretofore represented in the Academy collection, such as parts of Napa, Sonoma, Lake, Mendocino, and Colusa counties. Luther Little and Wm. Heim also made specimens of a number of *Thomomys* and *Scapanus* kindly brought to us by the park trappers, which, with some other gifts, make the additions to the collection for the year about 285 specimens.

The additions to the collections are all recorded in the list of accessions (pp. 389-396).

Miss Lula Burt made good progress with the cleaning of skulls, which work was later taken up by Mr. Little, so that this branch of the department work has been brought practically up to date.

No opportunity has been available for classifying or arranging this collection, and no card catalogue can be compiled until this is done. In the meantime it is being well cared for, and field work will be continued in conjunction, as far as possible, with that of the Department of Ornithology.

DEPARTMENT OF INVERTEBRATE PALEONTOLOGY

By G. Dallas Hanna, *Curator*

The former curator of the Department, Dr. Roy E. Dickerson, continued on leave of absence during the early part of the year. Geological field work in Oregon, Washington, and California for one of the large oil companies, however, presented an opportunity to gather a considerable amount of material for the collection of the Academy which illustrates some little known horizons of these states. Some field work was done in the Petaluma Quadrangle and an important collection of freshwater shells from the Miocene Lake Petaluma was secured and partially worked up. In April Dr. Dickerson was appointed honorary curator of the Department and in

May departed for extensive field work in the Philippine Islands for the Standard Oil Company.

The present curator was appointed in April, 1919, but did not assume active duty until the first of November. This was due to engagement in work on the Pribilof Islands, Alaska, for the United States Bureau of Fisheries. When not otherwise engaged the time was spent in gathering specimens of various kinds for the Academy. In this way large collections of shells and bird eggs were secured as well as material to complete the fur-seal group, and miscellaneous plants, birds, mammals, and invertebrates.

After his arrival at the Academy his attention has been given chiefly to the distribution of the large numbers of recent mollusks which have accumulated in the collection. These are an indispensable aid to the study of the paleontology of the state and it seems desirable to have them placed in the most accessible manner for comparison and consultation. Considerable study has been given to the fossil land and freshwater mollusks in the collection and those received from correspondents. This phase of the paleontology of the Pacific Coast has not received a great deal of attention in the past. The former existence of many large lakes is known however. Considerable collections of shells from the old beds have accumulated and are available for study in the Academy and neighboring institutions whose cooperation has been assured.

The study of the fossil land and freshwater shells has necessitated a review of all of the literature on the recent forms, a task of no little magnitude in itself. Over two thousand references have already been indexed. Fortunately the collections are extensive and the various accessible libraries are well represented with desirable publications. The work, it is hoped, will enable the various faunal areas on the Pacific side of the Rocky Mountains to be plotted as they exist today as well as the age and other features of the numerous fossil deposits. It is also expected that this work will enable the curator to assemble the complete synonymy of the land and freshwater species of the Rocky Mountain region. Such a work has not been attempted for about forty years and the result is, there is great uncertainty regarding many of the species.

Students of paleontology continue to find the collection of the Academy of value in their researches. Professor Bruce L. Clark of the University of California has consulted the material here in his study of the Oligocene of California, Oregon, Washington, and Vancouver Island. A considerable number of specimens has been loaned to him and in return he has favored the curator with the land and freshwater mollusks in his charge. One of his graduate students has been assigned as thesis work the preparation of a monograph on the recent and fossil mollusks of the family Turritellidæ of the Pacific Coast. Miss Richardson, who is making the study, has found in the Academy's collection, numerous species which otherwise would not have been accessible for her work. Such monographs are greatly desired by all active geologists and paleontologists and it is to be hoped that this group which is so poorly understood will at last be clearly discussed.

Dr. Earl S. Packard of the University of Oregon (temporarily on duty with the Standard Oil Company) has done some field work for the Academy in the Cretaceous deposits of northern California and in Oregon.

The collection which he has assembled and is studying will form a valuable addition to the Academy's Cretaceous series.

The large collection of recent shells gathered by Henry Hemphill and which now forms a part of the Department of Invertebrate Paleontology has been consulted for study by Mrs. I. S. Oldroyd of Stanford University.

Several valuable lots of recent shells have been received during the year. The land shells obtained from the Channel Islands of California by Messrs. Evermann, Van Duzee, and Slevin include some species which have rarely been collected. These islands are the type locality for several species and owing to their isolation have rarely been visited by naturalists. Mr. Slevin of the Department of Herpetology also secured a considerable number of land shells during his explorations in Lower California in 1919. A collection of over 8,000 mollusks was secured by the curator by dredging in Bering Sea and collecting on the Alaska and British Columbia islands. Numerous species not previously represented in west coast collections were thus secured.

Through the absence most of the year of a head of the Department not much in the way of exchanging could be attempted. However, a collection of the local shells in the vicinity of Sulphur City, Arkansas, was received in this manner from Mr. A. J. Brown. Also some radulæ of mollusks were received from Mrs. L. J. Thompson and Mr. Fred Tableman in exchange.

ACCESSIONS TO THE MUSEUM AND LIBRARY

- Abbott, Mrs. E. K., Salinas, (The herbarium of the late Dr. E. K. Abbott): One hundred and fifty-five herbarium specimens from northern France, the region where the war has been fought, received by Dr. Abbott as an exchange in 1888; 400 herbarium specimens from Hillsdale, Mich., and Dekalb County, Illinois, collected by Dr. Abbott and labelled; 743 herbarium specimens from Monterey County, California, collected by Dr. Abbott, mostly not labelled; 166 specimens collected by Mrs. Joseph Clemens in Montana, Utah, and Texas, chiefly not labelled; total 1464 specimens. Gift.
- Allen, Mr. C. A., San Geronimo: One ornithological specimen from Marin County. Gift.
- American Museum of Natural History, New York: Three lizards from Gulf of California. Exchange.
- Beck, Mr. R. H., San Jose: One thousand and ninety-six specimens of South American insects, mostly beetles. Purchase.
- Bent, Mr. Edward F., San Francisco: Two bound volumes (Museum of Natural History, New York, Vols. I, II). Gift.
- Berry, Dr. S. S., Redlands: Eleven lots of land- and freshwater mollusks from Western United States, a total of 65 specimens. Gift.
- Bethel, Mr. E., Denver, Colorado: Two botanical specimens. Gift.
- Bickle, Miss Margaret Emily, and Master John Richard Peers, Niagara Falls, Ontario, Canada: Fifty botanical specimens collected near Clive, Alberta, Canada. Gift.

- Bishop, Miss W. E., San Francisco: Mammoth tooth from Marin County, California. Gift.
- Blaisdell, Dr. F. E., 1520 Lake Street, San Francisco: One thousand five hundred and thirty-three specimens of beetles to fill vacancies in Academy's collection; 284 insects taken at Huntington Lake, California; 56 beetles, mostly from eastern states; and 189 specimens of Diptera from southern California. Gift.
- Boardman, Mrs. George C., Jr., and Sanchez, Mrs. R. B., San Francisco: A collection of Indian baskets and curios. Gift.
- Bollo, Mr. Luis Cincinato, Whitehall Building, New York: One book, South America Past and Present by Luis Cincinato Bollo. Gift.
- Borden, Mr. Ralph, Alameda: Four terrapins from Macassar, Celebes Island. Gift.
- Brittain, Mr. W. H., Department of Agriculture, Truro, Nova Scotia: Forty-three specimens of Hemiptera from Nova Scotia. Gift.
- Brown, Mr. A. J., Sulphur City, Arkansas: Two lots of land- and fresh-water mollusks from Arkansas, consisting of about 150 specimens. Exchange.
- Brown, Mr. Edward J., Los Angeles: Twenty lizards from Antelope Valley, Los Angeles County, and 37 lizards and 37 frogs from southern California. Gift.
- Brown, Mr. N. E., Kew Herbarium, England: Echinocactus species, 1 photograph, 1 colored plate, and 12 tracings; mamillaria species, 3 tracings; Echinopsis species, 1 tracing; Malacocarpus, 1 colored plate; Epiphyllum, 1 tracing; Opuntia, 1 tracing; Discocactus, 2 tracings; Mesembryanthemum, 1 photograph. Gift.
- Budd, Mr. Charles G., San Francisco: One albino robin in the flesh. Gift.
- Burriss, Mr. W. S., San Francisco: One anteater's skin floor rug. Gift.
- Buttle, Mrs. Alvina, San Diego: Eighteen botanical specimens. Gift.
- Byrd, Mrs. Caroline Rixford, Canton, China: Twenty-six herbarium specimens of plants from Canton, China. Gift.
- California State Mining Bureau, San Francisco: Fossil fish imbedded in diatomaceous shale, about 5 miles south of Lompoc, California. Gift.
- Museum of Comparative Zoology, Cambridge, Massachusetts: Five salamanders from North Carolina, 2 from Kentucky, and 3 from Texas, and 2 snakes from Virginia, and 3 lizards from Florida. Exchange.
- Campbell, Mrs. Marian L., Mill Valley: Three botanical specimens. Gift.
- Canton Christian College, Canton, China: One hundred and ninety-nine specimens of plants from South China. Gift.
- Christofferson, Mr. A., San Francisco: A piece of one of the branches of a tree of *Ceanothus velutinus*, from Kitsap County, Washington. Gift.
- Clark, Prof. B. C., Berkeley: Fifty specimens of fossils from Bridgeville, California. Gift.

- Clark, Mr. B. Preston, Boston, Massachusetts: One hundred and forty-eight Hemiptera taken by Mr. J. A. Kusche at Mazatlan, Mexico. Gift.
- Clarke, Dr. F. C., Los Angeles, California: Seven hundred and eighty-four insects taken in Fresno and Napa counties. Gift.
- Clokey, Mr. Ira W., Denver, Colorado: One hundred and twenty specimens of Colorado plants; 36 specimens of plants. Exchange.
- Cole, Mr. F. R., Stanford University: Twenty-eight Diptera types, representing 19 species. Gift.
- Coleman, Mrs. Marian and Mr. R. A., San Francisco: Shark teeth found on Pacific Beach, San Diego County. Gift.
- Coleman, Mr. R. A., San Francisco: Two bottles and three packages of shells, and one piece of whalebone. Gift.
- Coy, Miss Georgie V., San Diego: One botanical specimen. Gift.
- Davis, Rev. John, Hannibal, Missouri: Two hundred and fourteen botanical specimens. Exchange.
- Davis, Mr. William T., New Brighton, N. Y.: One specimen *Scaphonotus vidus* Dej.; two specimens *Anmodonua fossor* Lec.; two specimens *Nicagus obscurus* Lec. Gift.
- Decker, Mr. Frank, Anchorage, Alaska: Mastodon tusk from Yukon River below the mouth of the Tanana. Gift.
- Dickerson, Dr. Roy E., California Academy of Sciences: Seven lots of fossils from Oregon. Gift.
- Dodge, Mr. E. A., 546 Bay St., Santa Cruz, California: One hundred and ninety-nine insects as listed: Catocalas, 27 specimens; butterflies, 5 specimens including types, male and female, of *Pamphila pawnee* Dodge; Tabanidæ, 165 specimens. Gift.
- Donovan, Mr. Vincent J., San Francisco: Two canvasback ducks. Gift.
- Eastwood, Miss Alice, California Academy of Sciences: Twenty-two moths from Mill Valley, 104 specimens of plants. Gift. Thirty Chinese food plants from Chinese vegetable gardens at Marysville, San Mateo and San Francisco, collected also in duplicate for the Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C. Expenses paid by U. S. Department of Agriculture. Exploration. Two hundred and eighty-two specimens of exotics, chiefly from Golden Gate Park, 34 specimens from Mendocino County, 456 specimens from southern California, chiefly from Los Angeles and San Diego counties; 504 specimens from Arizona consisting of 40 from Bowie, 13 from Casa Grande, 27 from Sacaton, 32 from Tucson, 25 from Globe, 6 from Ash Fork, 79 from Prescott, 44 from Topock, 17 from Yuma and Bard and 221 from Apache Trail; 417 specimens from New Mexico, chiefly from Silver City and country adjacent. Total 1693 besides numerous duplicates. Exploration. Expenses paid by Arnold Arboretum.
- Ehrhorn, Mr. E. M., Honolulu: Seven jars of natural history specimens, mostly marine invertebrates from the Hawaiian Islands. Three jars and 13 phials of crustaceans and miscellaneous invertebrate material, and one large crab from Kaiwi Channel. Gift.

- Erwin, Mr. R. P., Boise, Idaho: Ten snakes from Ketchum, Idaho. Gift.
- Evermann, Dr. Barton Warren, California Academy of Sciences: Two volumes (Natural History Survey of Illinois, Vol. III, and Atlas), one botanical specimen, 1 snake and 1 lizard from Mount Wilson, 1 snake from Contra Costa County. Gift. Two snakes and 2 lizards from Glenwood, Santa Cruz County; 2 snakes from Marin County, 12 ornithological specimens from Alameda County and 11 from Santa Cruz County; 7 land mollusks from Hoh River, Washington, 10 from San Miguel Island, 3 from Whale Rock, Crescent City, 1 from Mowry, 5 from Santa Cruz Island and 20 from Oakland. Exploration.
- Fauntleroy, Miss Sophie, Santa Barbara: Three specimens of plants from Ventura County. Gift.
- Ferris, Mrs. Roxana, Stanford University: Two hundred specimens of plants from desert region of Arizona and California and 346 specimens of California plants. Purchase.
- Fox, Mr. C. L., 1621 Vallejo St., San Francisco: Forty specimens of mounted Lepidoptera (moths) and 93 insects from California; 258 insects mostly from Mount Rainier, Washington, and 97 insects of all orders. Gift.
- Geister, Mrs. Elisa, 72 Lundy Lane, San Francisco: One Kinkajou (*Cercoleptes caudivolvulus*) from Central America. Gift.
- Ghirardelli, Mrs. D., San Francisco: Fourteen specimens of plants from the Grand Canyon. Gift.
- Golden Gate Park, San Francisco: One downy swan, 1 male ostrich and 1 female ostrich. Gift.
- Gorton, Mr. C. R., La Jolla: Seven specimens of *Helix pissnia*, 1 botanical specimen, and 6 land mollusks from La Jolla. Gift.
- Grant, Major Chapman, Oklahoma City: Twenty beetles from Globe, Arizona, and 51 insects from Oklahoma. Gift.
- Hanna, Dr. G. Dallas, California Academy of Sciences: Eight thousand four hundred and sixty four specimens of mollusks from Alaska, 118 land mollusks from Fire Island, and 72 specimens of plants from St. Paul Island, Alaska, collected by Mr. and Mrs. George Haley. Gift.
- Harris, Mr. G. D., 126 Kelvin Place, Ithaca, New York: One book, Bulletin of American Paleontology, Vol. VI, 1919. Gift.
- Hawkins, and Phillips, Messrs., San Francisco Police Department: One Great Blue Heron, from Mud Lake near Boy Scouts' Camp. Gift.
- Heim, Mr. William, California Academy of Sciences: Fifteen ornithological specimens from Marin County, 5 specimens from Alameda County, 6 specimens from San Francisco County; 50 specimens of birds and mammals from Yosemite National Park. Exploration.
- Henry, Prof. J. K., Vancouver, B. C.: One botanical specimen. Gift.
- Herrin, Mr. William F., San Francisco: Eleven specimens of plants for identification with duplicates. Gift.
- Hickman, Mr. J. B., Aromas, San Benito County: One botanical specimen. Gift.

- Hook, Miss Marjorie, 1858 Fell Street, San Francisco: One pure albino gopher. Gift.
- Hopping, Mr. Ralph, Berkeley, California: Thirty-eight insects from southern California, and 144 insects from other localities. Gift.
- Huff, Captain Charles P., United States Navy, donated through Sergeant Patrick McGee, Golden Gate Park, San Francisco: One specimen of Scorpion obtained at Kemolina Point, Honduras. Gift.
- Huguenin, Mr. J. C., San Francisco: Fifty-two insects with other biological material. Gift.
- Hunt, Mr. H. H., San Francisco: One snake from Escalon, Calif. Gift.
- Huntington, Miss Marion, San Francisco: One botanical specimen. Gift.
- Israelsky, Mr. Merle, 464 Noe St., San Francisco: Twenty-five Merced Pliocene fossils, and 22 specimens of land and freshwater mollusks from Cazadero. Gift.
- Jones, Mr. Vincent, San Francisco: Two specimens of plants. Gift.
- Kelly, Mrs. G. Earle, Alameda: Sixteen botanical specimens from Plumas County, California, for identification, and one other botanical specimen. Gift.
- Kip, Mr. Frederic E., 38 East 25th St., New York: One book, (Tariff Facts and Effects from 1789 to 1916.—and Equal Opportunity For All.—F. E. Kip). Gift.
- Kneiss, Mrs. Earl, 1150 Clay St., San Francisco: Seventeen packages of corals. Gift.
- Kusche, Mr. J. August, San Francisco: Five ornithological specimens from Los Angeles County, 1 specimen from San Mateo County, 5 specimens from Ketchikan, Alaska; 1 set (6 eggs and nest) Dotted Cañon Wren from Nogales, Arizona; 2 scorpions from Nogales, Arizona; three lizards from Hawaiian Islands; a few insects from Hawaiian Islands; 10 bottles of shells and a quantity of Pele's hair from the Hawaiian Islands; 4 ferns, 1 bundle lichens, 1 bundle mosses and 1 bundle flowering plants. Gift.
- Leach, Mr. E. R., Piedmont: Fifteen beetles. Gift.
- League to Enforce Peace, New York: One book (Win the War for Permanent Peace). Gift.
- Lepper, Mr. Gerge Henry, Pittsburg, Pa.: One book. Gift.
- Lewis, Mr. W. C., Tiburon: One botanical specimen for identification and one lizard from San Francisco. Gift.
- Little, Mr. Luther, California Academy of Sciences: Five snakes, one frog and one salamander from Lake County, 1 snake from Napa County, 2 snakes and 3 lizards from Mendocino County; 2 freshwater mollusks from Harbin Springs, and 2 bats (*Eumops californicus*). Exploration.
- Lovett, Prof. A. L., Corvallis, Oregon: Twenty-four types of Diptera, representing 22 species. Gift.
- Mailliard, Hon. John W., San Francisco: Publications of the California Academy of Sciences and the University of California, and other scientific papers. Gift.

- Mailliard, Messrs. John W. and Joseph, San Francisco: Ten thousand seven hundred and eighty-five bird skins and 3270 sets of eggs of 612 species, number being 12,431 eggs. Gift.
26 ornithological specimens from Marin County, 30 specimens from Lake County, 28 specimens from Mendocino County, and 20 specimens from Colusa County. Gift.
- Mailliard, Mr. Joseph, California Academy of Sciences: Twenty specimens of insects from near Hearst, Mendocino County. Exploration.
- Mailliard, Mr. J., and Little, Mr. Luther, California Academy of Sciences: Two ornithological specimens from San Francisco County, 150 from Marin County, 433 from Lake County, 233 from Mendocino County, 83 from Napa County, 28 from Sonoma County, 12 from Contra Costa County and 4 from Colusa County; 190 mammals and 50 oölogical specimens collected in Marin, Napa, Lake, Mendocino and Colusa counties, California. Exploration.
- Malloch, Mr. J. R., Urbana, Ill.: Fourteen separates from various publications. Gift.
- Martin, Mrs. Emma, Glenwood, Calif.: One Cedar Waxwing. Gift.
- Martin, Mr. J. O., Berkeley, Calif.: One hundred and thirty-one insects. Gift.
- Massachusetts, Commonwealth of (Humane Society), Boston, Mass.: One book. Gift.
- Mathews, Mr. Henry E., San Francisco: One book (Reminiscences James Lick Trust). Gift.
- McDonald, Mr. A., San Francisco: One albino gopher. Gift.
- McGee, Sergeant Patrick H., Golden Gate Park, San Francisco: Fifteen Quail eggs, one set of three Black Swan eggs. Gift.
- McLaren, Mr. John, Park Lodge, Golden Gate Park, San Francisco: The Gardeners' Chronicle, 2 volumes; Park and Cemetery, 1 volume. Gift.
- McLellan, Miss M. E., California Academy of Sciences: Two volumes, Mountain Wild Flowers of Canada, and Philippine Bureau of Science, Annual Report 1912. Gift.
- Meiere, Mrs. Ernest, San Francisco: Six botanical specimens. Gift.
- Miller, Mrs. Charles E., Berkeley: Twenty-two botanical specimens. Gift.
- Miller, Mrs. Charles E., and Swain, Mrs. Alonson, Berkeley: Sixty-eight botanical specimens from Santa Cruz Island. Gift.
- Morse, Mr. I. H., 1691 Bush St., San Francisco: One old mill stone. Gift.
- National War Garden Commission, Washington, D. C.: One bronze medal. This medal is a replica, in bronze, of medals in silver-gilt which have been struck for presentation to President Wilson and the heads of the allied governments. Gift.
- Niagara Fire Insurance Company, through Mr. Parrish, San Francisco: Six pictures of Niagara Falls taken in 1874 by J. Zyback. Gift.
- Noyes, Mr. Russell, Afognak, Alaska: Sixty botanical specimens from Alaska. Gift.
- Oldroyd, Mrs. Ida S., Stanford University: Twenty-five mollusks from Monterey and 2 mollusks from Gatun Cut. Gift.
- Orcutt, Mr. C. R., La Jolla, Calif.: Two lots of small marine mollusks from Magdalena Bay, consisting of about 100 specimens. Gift.

- Otis, Mr. I. C., Seattle, Wash.: One hundred and sixty-four specimens of plants of Washington. Gift.
- Parish, Mr. S. B., San Bernardino, Calif.: Sixty-six botanical specimens from southern California. Gift.
- Peers, Miss Susie, Burlingame: One snake from San Francisco. Gift.
- Phillips, Miss, San Francisco: Three volumes. Gift.
- Reed, Mr. C. A., Santa Cruz, Calif.: Five botanical specimens. Gift.
- Reynolds, Mrs. L. R., City of Mexico: Two specimens of plants. Gift.
- Rolph, Mayor, San Francisco: One turtle from Pacific Ocean between Yokohama and San Francisco. Gift.
- Ryan Fruit Company, San Francisco: One snake from Guatemala. Gift.
- Slevin, Mr. L. S., Carmel: Forty specimens of insects in alcohol. Gift.
- Slevin, Mr. J. R., California Academy of Sciences: One thousand three hundred and ninety-three reptiles and amphibians from Lower California; 28 lizards from Anacapa Island; 3 snakes, 73 frogs, 92 lizards, and 3 salamanders from Santa Cruz Island; 2 lizards from San Miguel Island; 49 lizards, 19 toads, 2 snakes, and 1 salamander from Mecca, Calif.; 8 lots of mollusks containing about 65 specimens of land and freshwater shells from Lower California; 1020 insects from Lower California. Exploration. Four lizards from Nicaragua. Gift.
- Smith, Miss E. S., San Francisco: One botanical specimen from Bird's Landing. Gift.
- Snyder, Prof. J. O., Stanford University: Twenty-two birds' eggs. Gift.
- Stanford University: Seventy-one snakes, 341 lizards, 68 frogs, 118 toads, 10 turtles, and 1 salamander. Purchase.
- Stephens, Dr. W. Barclay, San Francisco: One botanical specimen for identification. Gift.
- Stoner, Mr. R. G., Bakersfield, Calif.: Two lots of fossils from south-eastern Nevada. Gift.
- Strohbeen, Mr. J. P., 15 Pennsylvania Ave., Santa Cruz, Calif.: One specimen of large Scarabid from Columbia, South America (collected by Mrs. John Boyle). Gift.
- Summerton, Miss Amelia: One book (The Heavens, by Amédée Guillemin). Gift.
- Sutcliffe, Mrs. E. C., San Francisco: Fifty-five botanical specimens from Plumas and Sierra counties for identification and 18 botanical specimens. Gift.
- Swann, Mr. H., Kirke: Two pamphlets. Gift.
- Thompson, Mrs. Lillian Dyer, 18 Aspen Road, Swampscott, Mass.: Three radulae and shells of *Viviparus contectoides*, *Buccinum undatum*, and *Trachydermon hartwegi*, 21 mollusks and 24 microscopic mounts of molluscan radulae. Exchange.
- Townsley, Mr. F. S., Chief Park Ranger, Yosemite National Park: One skin and skeleton of mountain beaver, 1 gray squirrel, 1 ring-tailed cat, 1 cougar skin, 1 skeleton *Bassariscus* sp., and 1 German trout. Gift.
- Turner, Mrs. G. M., Hollywood: Two botanical specimens for identification. Gift.

- Underwood & Underwood, Arlington, New Jersey: Five stereoscopic views, and 7 stereopticon slides. Gift.
- United States Forest Service, through Mr. R. F. Hammatt, 114 Sansome St., San Francisco: One reel moving picture film of elk. Gift.
- United States National Herbarium, Washington, D. C.: Three hundred and sixty-five miscellaneous specimens of plants. Exchange.
- Urbahns, Mr. T. D., 2610 Bancroft Way, Berkeley, Calif.: Thirteen specimens of *Hippiscus californicus* (grasshoppers) from Orland, Glenn County, Calif. Gift.
- Van Denburgh, Dr. John, California Academy of Sciences: Two hundred and fifteen salamanders, 16 frogs, 6 toads, 1 lizard and 1 snake from State of Washington. Exploration. One frog from San Mateo County. Gift.
- Van Duzee, Mr. E. P., California Academy of Sciences: Two hundred and fifty-three entomological specimens from Anacapa Island: 1028 specimens from Santa Cruz Island; 132 specimens from Prince Island; 223 specimens from San Miguel Island; 218 specimens from Santa Rosa Island; 111 specimens from Santa Barbara; 1628 specimens from Monterey and San Luis Obispo counties; 1002 specimens from Santa Cruz; 617 insects from San Francisco, Alameda, and Marin counties; 5717 insects collected during explorations in Fresno, San Mateo, Contra Costa, and San Joaquin counties, in August and September; 100 specimens of land shells from San Miguel Island. Exploration.
- Van Duzee, Mrs. Helen, San Francisco: Four hundred and forty-four spiders, and 260 insects taken at Huntington Lake, California. Gift.
- Van Duzee, Mr. Millard C., Buffalo, N. Y.: Nine types of Diptera, representing 9 species. Gift.
- Van Dyke, Dr. E. C., University of California: Eighty-two miscellaneous insects, and 15 insects, mostly Hemiptera, from Berkeley. Gift.
- Wall, Mrs. L. S.: Four botanical specimens. Gift.
- Wallace, Mr. Paul, San Jose, Calif.: Two snakes. Gift.
- Walther, Mr. Eric, San Francisco: One hundred and five botanical specimens, chiefly exotics. Gift.
- Walter, Mr. Frank, Los Angeles, Calif.: Sixteen specimens of exotics sent for identification. Gift.
- Weil, Miss Ida, Fort Whipple, Prescott, Arizona: Three botanical specimens for identification. Gift.
- Westdahl, Mrs. F., San Francisco: One opium pipe and chop sticks from China; beads, 15 shells and 2 sponges from the Philippine Islands. Gift.
- Wilson, Mr., United States Weather Bureau, San Francisco: Bottle containing sample of volcanic deposit taken at Kodiak, Alaska, June 9, 1912, from eruption of Katmai Volcano June 6-8, 1912. Gift.
- Wisner, Mr. Einar, 1439 Forty-third Ave., San Francisco: One male flicker. Gift.
- Wood, Dr. Casey Albert, 7 West Madison St., Chicago, Ill.: One book (The Fundus Oculi of Birds by Casey Albert Wood). Gift.

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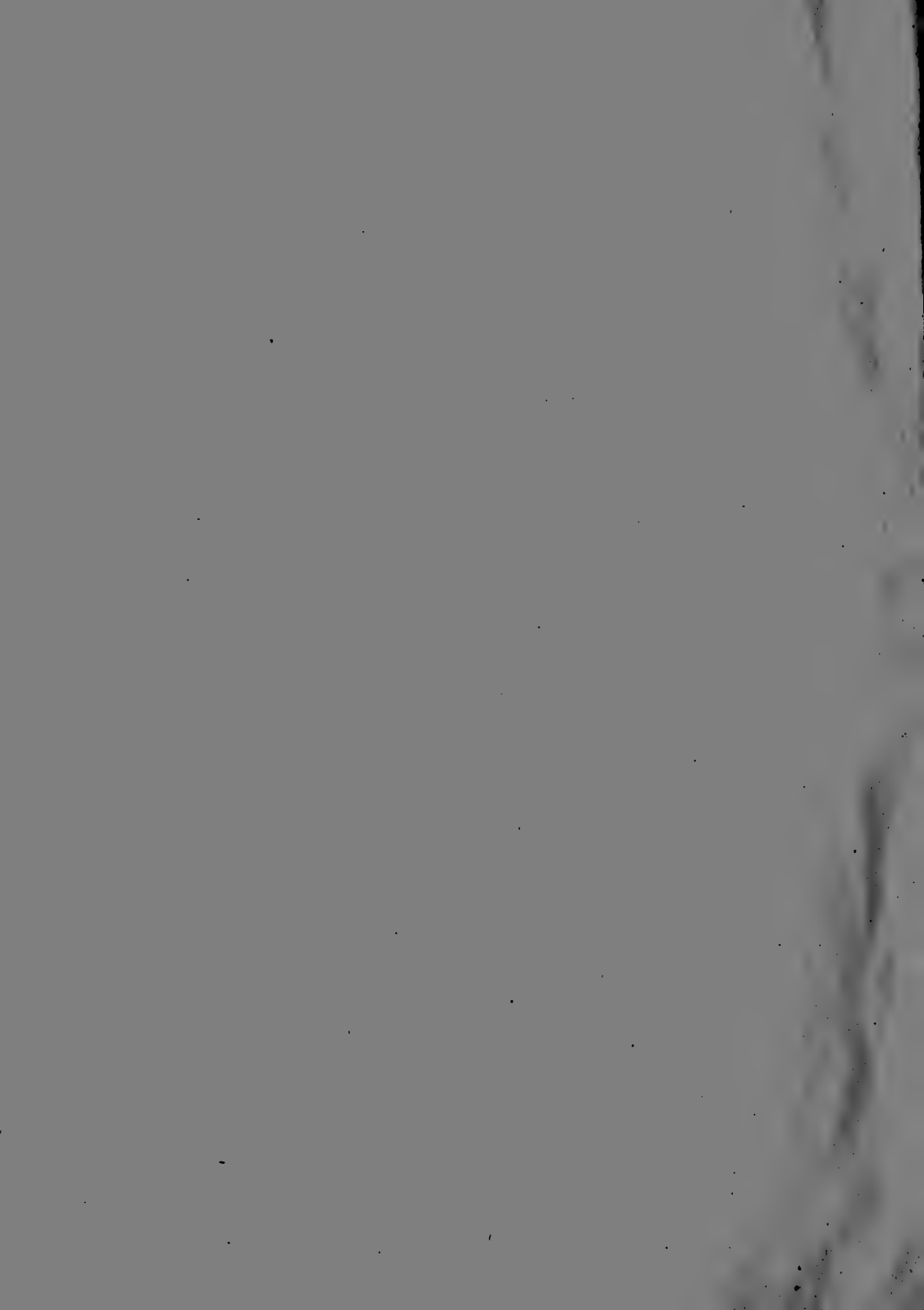
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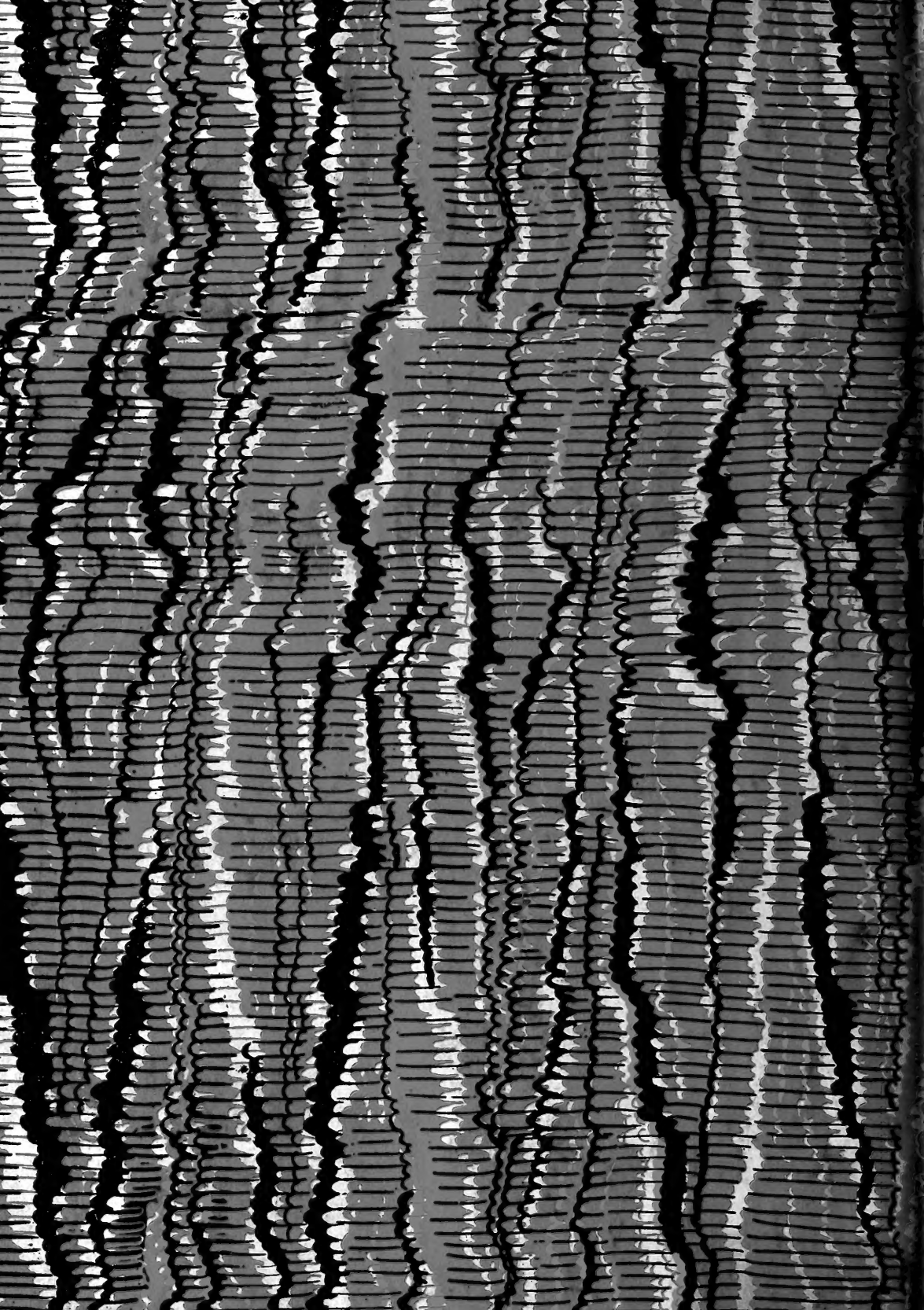
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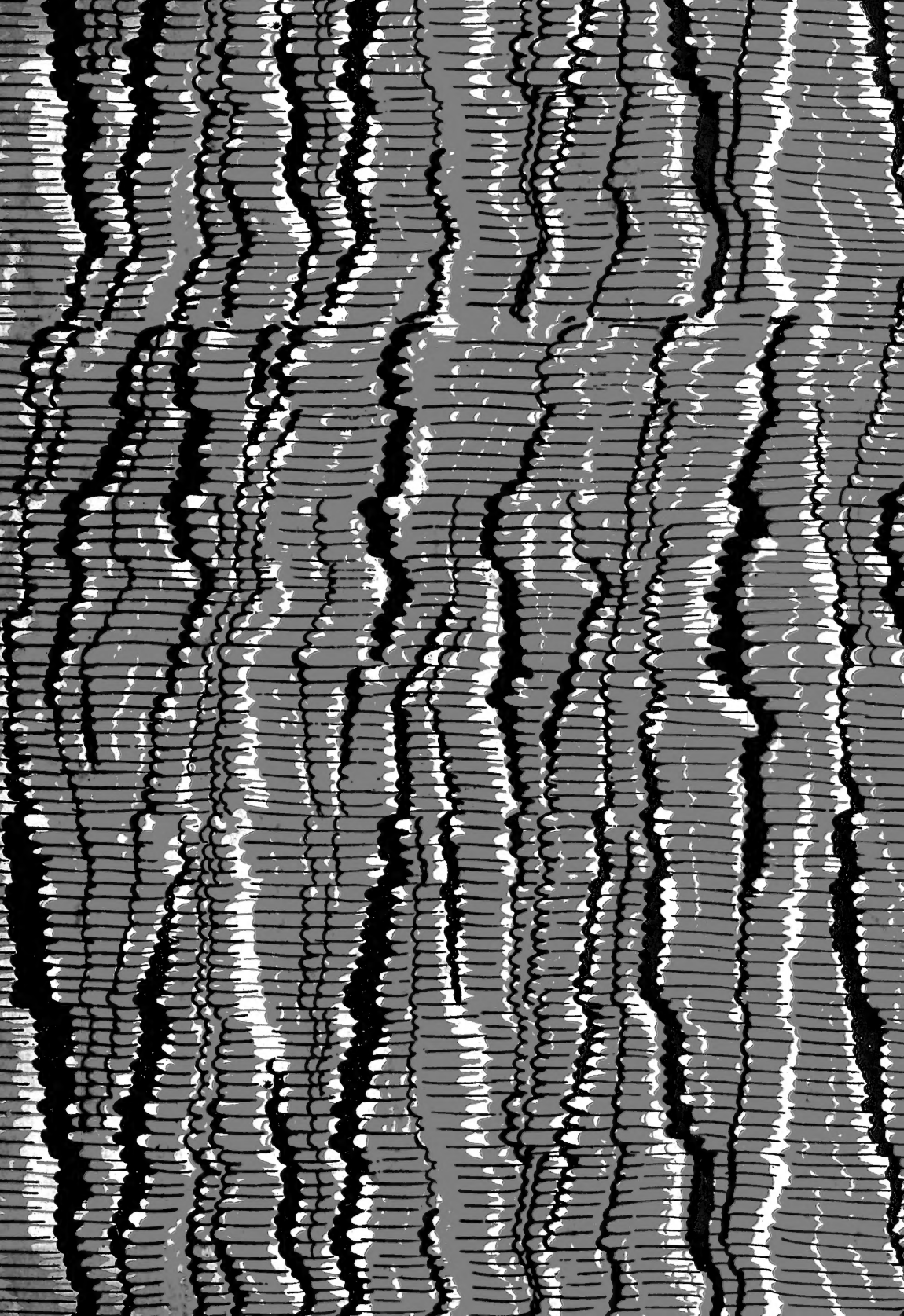
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