

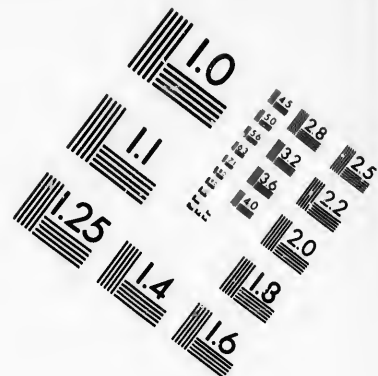
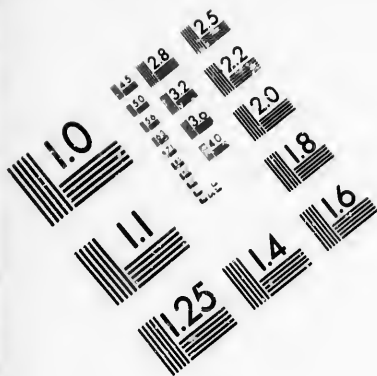
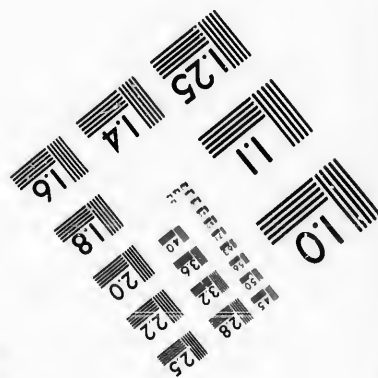
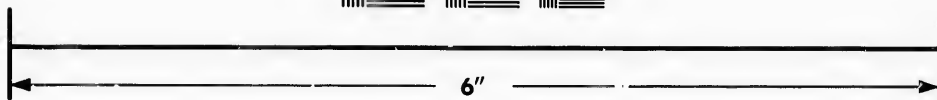
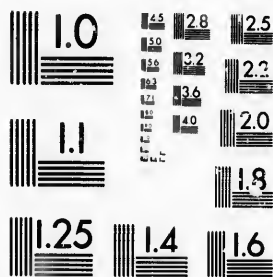


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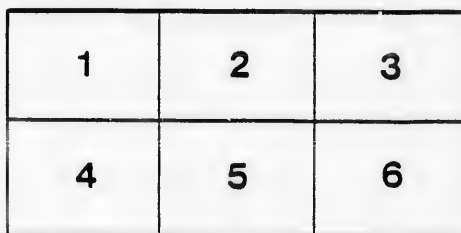
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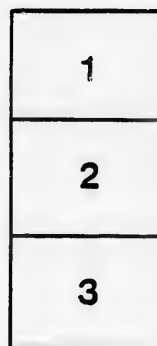
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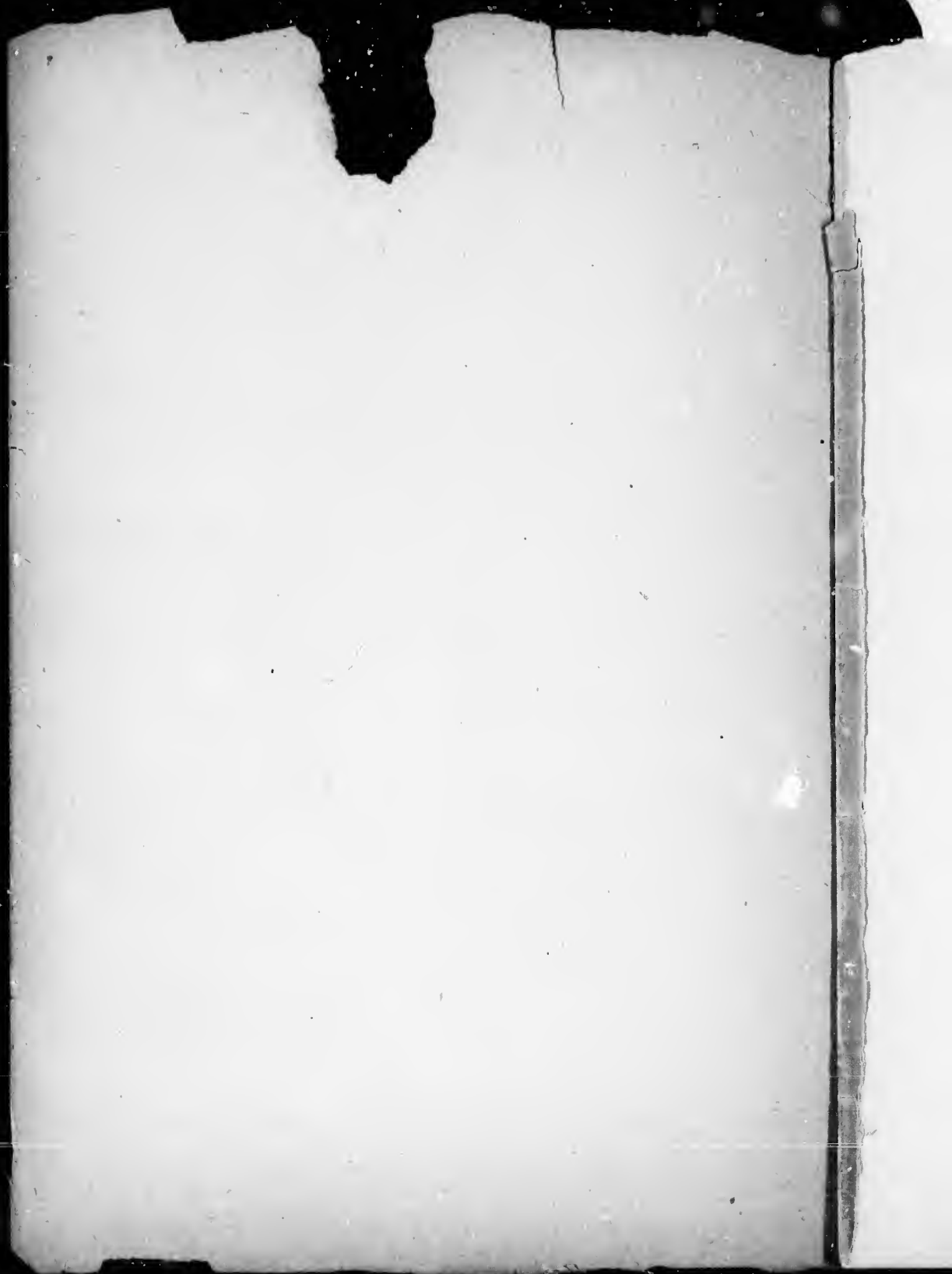
THE FAUNAS OF THE SHASTA AND CHICO FORMATIONS

BY

T. W. STANTON



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JUNE, 1893



THE FAUNAS OF THE SHASTA AND CHICO FORMATIONS

BY T. W. STANTON

(Read before the Society December 30, 1892)

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HISTORICAL REVIEW.

Earliest Literature.—The earliest published opinion concerning the age of the beds now known as the Chico formation seems to be that of Dr J. B. Trask,* who described *Ammonites chicoensis* and *Baculites chicoensis* in 1856. On account of the modern aspect of the fossils associated with those species he referred the strata containing them to the upper Eocene. Shortly afterward Professor J. S. Newberry† discussed the same beds,

*Proc. Cal. Acad. Nat. Sci., vol. i, 1856, p. 85.

†Pacific R. R. Reports, vol. vi, pt. 2 [1857?], pp. 21, 25. The title-page bears the date 1855, but there is internal evidence that the volume was not published before 1857.

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and, while admitting the presence of modern types of mollusks, considered that the cephalopods were stronger evidence of their Cretaceous age. He also stated that he had obtained a collection of fossils from Nanaimo, Vancouver island, that proved the Cretaceous age of the coal beds at that place. These fossils were placed in the hands of Professor F. B. Meek,* who soon afterward described them. Although at that time he thought that the entire collection came from Nanaimo, he believed that two distinct horizons were represented. Many years afterward, when republishing the descriptions with figures,† he stated that only those species which he believed to be the older came from Nanaimo, while the others were from Comox, northwest of Nanaimo, and from Sueia island. Those from the last two localities were thought to indicate about the horizon of the Fort Pierre shales, or number 4 of Meek and Hayden's upper Missouri section.‡

In 1858 Dr B. F. Shumard§ described three species of Cretaceous fossils from Nanaimo, and in 1861 Dr James Hector|| published an account of the Nanaimo coal field, giving the evidence of its Cretaceous age.

Views of W. M. Gabb.—Up to this time both the geologic and the paleontologic work had been mainly preliminary, the latter based on very small collections brought in by explorers; and it was not until 1864, when the first volume of the Paleontology of California was published, that any serious attempt was made to classify the Cretaceous formations of the Pacific coast or to present their paleontology in a systematic manner. In that volume Mr W. M. Gabb described about 260 species of fossils which he referred to the Cretaceous. In the introduction some general statements concerning the classification and correlation of the California Cretaceous were given by Professor J. D. Whitney,¶ the state geologist, on the authority of Mr Gabb. All the Cretaceous beds on the Pacific coast were assigned to two divisions (*A* and *B*), which were together supposed to represent the Upper Chalk or White Chalk of Europe and the Fort Pierre and Fox Hills groups of the upper Missouri, although the Cretaceous of the latter region seemed to have no species in common with the California strata.

The Tejon Controversy.—The publication of this volume precipitated a discussion between Messrs Gabb, Conrad and others as to the age of

*Trans. Albany Institute, vol. iv, 1858-'61, pp. 36-49.

†Bull. U. S. Geol. Surv. Terr., vol. ii, 1876, pp. 351-374.

‡The same opinion is expressed in Professor Meek's last work, U. S. Geol. Surv. Terr., vol. ix, Invert. Paleontology, p. xxv.

§Trans. St. Louis Acad. Sci., vol. i, 1858, pp. 123-125.

||Quart. Jour. Geol. Soc. Lond., vol. xvii, 1861, pp. 428-436.

¶Paleontology of Cal., vol. i, 1864, p. xix.

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division "B," now known as the Tejon formation, Mr Conrad asserting that it is Eocene and Mr Gabb as strenuously maintaining its Cretaceous age.* On the one hand, the unquestionable fact that a number of the fossils are identical or closely related with species that elsewhere characterize the Eocene was regarded as proof of its Tertiary age; while on the other hand, the presence of an ammonite (*Ammonites jugalis*) and the apparently close faunal and stratigraphic connection with the Cretaceous beds beneath were believed to prove its Cretaceous age. According to Mr Gabb's† statement in one of his controversial articles, 23 species of the 107 in division B are found in the underlying beds. When his list of common species is critically examined, however, it is seen that, with the exception of the *Ammonites* and perhaps two or three others, they all belong to genera that have lived from the Cretaceous or earlier to the present time without undergoing much change. Professor Angelo Heilprin‡ has given a careful review of all the published evidence bearing on this question, and in preparing it he has studied a large part of Mr Gabb's original collections of California fossils. His article is a strong argument for the Eocene age of the Tejon and incidentally it throws considerable doubt on the accuracy of Mr Gabb's statements concerning the species that occur in both the Chico and the Tejon.

Professor Jules Marcou§ and Dr C. A. White|| have also referred the Tejon, or division B, to the Eocene, and this view is now generally accepted. While admitting its Tertiary age, both Dr White¶ and Dr G. F. Becker,** after studying the subject in the field, have stated their belief that in southern California the Tejon, is only the upper part of an unbroken series, the Chico-Tejon, in which the sedimentation as well as the life was continuous from the Cretaceous into the Tertiary.

In the second volume of the Paleontology of California, published in 1869, Professor Whitney†† again summarized Mr Gabb's latest views on the classification of the Cretaceous. Division B is named the Tejon and considered to be the probable equivalent of the Maestricht beds. Division A is separated into three groups: the Martinez group, which is doubtfully separated from the one next below; the Chico group, which

* Conrad's articles are in *Am. Jour. Conch.*, vol. i, 1865, pp. 362-365; vol. ii, 1866, pp. 97-100, and *Am. Jour. Sci.*, vol. xlv, 1867, pp. 376-377. Gabb's replies may be found in *Am. Jour. Conch.*, vol. ii, pp. 87-92; *Am. Jour. Sci.*, vol. xlv, pp. 226-229, and *Proc. Cal. Acad. Nat. Sci.*, vol. iii, 1867, pp. 301-306.

† *Proc. Cal. Acad. Nat. Sci.*, vol. iii, 1867, p. 392.

‡ *Proc. Acad. Nat. Sci. Phila.*, 1882, pp. 195-211; *Contributions to Tertiary Geol. and Paleont. of the United States*, 1884, pp. 102-117.

§ *Bull. Soc. Géol. de France*, tome xi, 1885, pp. 417-435.

|| *Bull. 15*, U. S. Geol. Survey, 1885, pp. 11-17; *Bull. 51*, 1889, pp. 11-14; *Bull. 82*, 1891, p. 193.

¶ See references just given.

** *Bull. 19*, U. S. Geol. Surv., 1885.

†† Pages xiii and xiv.

is correlated with the Upper Chalk or Lower Chalk and, it is thought, may prove to be the equivalent of both, is said to include all the known Cretaceous of Oregon and of the extreme northern part of California and the coal-bearing beds of Vancouver island; and the Shasta group, provisionally formed to include a series of beds of different ages below the Chico. According to Whitney "it contains fossils, seemingly representing ages from the Gault to the Necoman, inclusive. . . . Few or none of its fossils are known to extend upward into the Chico group."

Work of the Canadian Geological Survey.—In 1871 the geological survey of Canada began the work in British Columbia which has contributed greatly to our knowledge of the Mesozoic formations of the Pacific coast. It is beyond the scope of this paper to consider the detailed geologic description of the Cretaceous on Vancouver and Queen Charlotte islands and the mainland of British Columbia, as given by Mr James Richardson* and Dr George M. Dawson.†

These reports have shown that the Cretaceous attains thicknesses of over 5,000 feet on Vancouver island and of about 13,000 feet on Queen Charlotte islands. The invertebrate fossils from both these areas have been described and fully discussed by Mr J. F. Whiteaves.‡ The most recently published conclusions of this author are that the larger part (divisions C, D, and E) of the Queen Charlotte islands section is the equivalent of the Shasta formation, and that the same horizon is represented in the northern part of Vancouver island and at several localities on the mainland of British Columbia; that the beds of the Nanaimo and Comox coal fields on the eastern coast of Vancouver island are more recent and referable to the Chico formation, and that none of these beds are older than the Gault. Previously Mr Whiteaves had expressed the opinion that the Shasta formation and its equivalents in British Columbia should be separated into two formations, referring the older beds, which are especially characterized by an abundance of *Aucella*, to the Necoman and the upper portion to the Gault; but additional collections showed such a blending of the faunas that they could not be separated and this view was abandoned.

* Report on the coal fields of the east coast of Vancouver island: Geol. Surv. Canada, Rept. of Prog. 1871-72, pp. 73-100; Rept. on the coal fields of Vancouver and Queen Charlotte Islands: Ibid., 1872-73, pp. 32-65.

† For example—Report on the Queen Charlotte Islands: Ibid., 1878-79, pp. 1-101 B; On a Geological Examination of the northern Part of Vancouver Island: Ann. Rept. Geol. Survey Canada, 1886, pp. 1-107 B; On the earlier Cretaceous Rocks of the northwestern Portion of the Dominion of Canada: Ann. Jour. Sci., vol. xxxviii, 1889, pp. 120-127.

‡ Geol. Survey Can.: Mesozoic Fossils, vol. i, pt. 1, Invertebrates from Queen Charlotte Islands, 1876; pt. 2, Fossils of the Cretaceous Rocks of Vancouver, 1879; pt. 3, Fossils of the coal-bearing deposits of Queen Charlotte Islands, 1881. See also Trans. Roy. Soc. Canada, vol. i, 1882, sec. iv, pp. 81-86, and Cont. to Canadian Paleont., vol. i, pt. 2, 1889.

White's Classification of the California Cretaceous.—Dr C. A. White, whose work on the Cretaceous of California has already been referred to, also recognized two divisions in the Shasta, to which he gave the local names, Knoxville and Horsetown beds, although he believed them to be closely related; and several species of the Horsetown fauna were afterward found associated in the same strata with *Aucella*, the characteristic fossil of the Knoxville beds, near Riddles, Oregon.* It may therefore be regarded as established that the Knoxville beds should not be considered distinct from the remainder of the Shasta formation, although they may usually be recognized by the great abundance of *Aucella*, a fossil that seems not to range into the upper part of the series.

The great apparent difference in the faunas of the Shasta and the Chico formations at the localities studied by him led Dr White to believe that there is a break between these two formations, representing a great time-hiatus,† although they are apparently conformable. The list of species assigned to each formation by Mr Gabb also seemed to justify this belief, but the sequel will show that the stratigraphic position and the vertical range of many of the species were very imperfectly known until quite recently.

RELATION OF SHASTA AND CHICO FAUNAS.

Identity of Faunas indicated.—Various members of the United States Geological Survey working in California and Oregon during the last few years have from time to time made small collections of Cretaceous fossils that have been submitted to Dr White for examination. The largest of these collections was received from Mr J. S. Diller in 1889, and was assigned to me for study and identification, under the direction and supervision of Dr White. The collection embraced small lots of fossils from about seventy-five different localities in northern California and southern Oregon, the most of which are in the valley of Sacramento river.‡ There were usually only a few species of fossils from each locality, as they were collected by the geologists in connection with other field-work and without any attempt at making exhaustive collections. The fossils were identified and those from each locality were, so far as practicable, assigned to the Shasta or to the Chico-Tejon, in accordance with the distribution of species in those formations given by Mr Gabb. But some of the localities seemed to show a mixture of Shasta and Chico species, and when

* See G. F. Becker, Notes on the early Cretaceous of California and Oregon: Bull. Geol. Soc. Am., vol. 2, 1891, pp. 204-205.

† See Bull. U. S. Geol. Survey, numbers 15, 22, 51 and 82.

‡ For description of the geology of this region and further discussion of the paleontology see Mr Diller's paper, this volume, pp. 205-221.

Mr Diller plotted all the localities on the map those that were assigned to different horizons were seen to be inexplicably mixed. Mr Diller at that time suggested that the two faunas were more closely related than had hitherto been supposed, but the evidence did not then seem to be conclusive.

Local Lists of both Faunas from northern California.—During the past field season Mr Diller had considerable collections made at Horsetown,* Shasta county, California, and at Texas springs, less than two miles east of Horsetown. These fossils, which have recently been studied, gave unquestionable proof of the blending of the Shasta and Chico faunas. Mr Diller says that the beds from which the fossils were collected at these two localities are of no considerable thickness. Besides the nature of the matrix, the state of preservation of the fossils and the manner in which the species are commingled on hand specimens, all indicate that the entire collection came from the same horizon. I have therefore listed the fossils from both localities together, as follows:

* <i>Ammonites hoffmanni</i> , Gabb.	† <i>Trigonia apiculostata</i> , Gabb.
* <i>Ammonites becheri</i> , "	† <i>Trigonia leana</i> , "
* <i>Diptyhoceras larvis</i> , "	<i>Trigonia</i> .
* <i>Auclocceras (?) lineatus</i> , "	† <i>Pecten operculiformis</i> , Gabb.
* <i>Belemnites impressus</i> , "	† <i>Tectis annulata</i> (Gabb) = <i>Cardium</i>
<i>Licium punctatum</i> , "	(<i>Loricardium</i>) <i>annulatum</i> .
* <i>Lanatia arellana</i> , "	† <i>Corbula traskii</i> , Gabb.
<i>Gyrodes</i> .	† <i>Mytilus quadratus</i> , Gabb(?)
<i>Fusus aratus</i> , Gabb.	<i>Mytilus lanceolatus</i> , Sowerby.
* <i>Anisomyza meekii</i> , Gabb(?)	† <i>Leda translucida</i> , Gabb.
<i>Scapharia albensis (?)</i> , D'Orb., Whiteaves.	* <i>Pleuromya levigata</i> , Whiteaves.
	† <i>Tellina hoffmanniana</i> , Gabb.
<i>Acteonina californica</i> , Gabb.	† <i>Tellina mathersonii</i> , "
<i>Cinadia</i> .	† <i>Mastra asubrueri</i> , "
† <i>Ringicula varia</i> , Gabb.	† <i>Chione varians</i> , "
* <i>Ringicula polita</i> , "	† <i>Meekia radiata</i> , "
† <i>Panopæa concentrica</i> , "	† <i>Meekia naris</i> , "
† <i>Cucullæa truncata</i> , "	† <i>Meekia sella</i> , "
† <i>Neuodon rancouercensis</i> , Meek.	<i>Rhynchonella</i> .

* Most of the localities mentioned are shown on the sketch map prepared by Mr J. S. Diller, forming plate 4, page 205, of this volume.

† The species belonging to Mr Gabb's Shasta fauna are marked with an asterisk (*), those belonging to the Chico with an obelisk (†). The others have not been positively assigned to either horizon.

Mr Gabb's nomenclature is used, in most cases without revision, throughout this paper.

Of the 36 species in this list, the Paleontology of California gives 8 as coming from the Shasta and 18 from the Chico, while 2 of the others are doubtfully referred to the former and 2 to the latter. At least 12 of these species are also represented by identical or very closely related species in the Queen Charlotte islands (lower shales), and 7 are similarly represented in the equivalent of the Chico on Vancouver island.

It will be remembered that Horsetown is a typical and well known Shasta locality, and that the types of two of Mr Gabb's species were obtained there.

Many of Mr Diller's localities for fossils are on Cottonwood creek and its branches, a few miles southwest of Horsetown. It will be instructive to group together some of these places and consider the fossils that were obtained from them. On Hulen creek, and near its mouth on Cottonwood creek, the following were collected:

<i>Ammonites batesi</i> , Trask.	<i>Trigonia crassa</i> , Meek.
<i>Ammonites hoffmanni</i> , Gabb.	<i>Trigonia trigoniae</i> , Gabb.
<i>Ammonites remondi</i> , "	<i>Nemodon vanconrencensis</i> , Meek.
<i>Tarritella</i> .	<i>Cucullaea truncata</i> , Gabb.
<i>Cytherea</i> .	<i>Pecten operculiformis</i> , "

This collection adds two Shasta and two Chico species to the Horsetown and Texas springs list.

At and about Ono, California, mostly within a mile of the village, the following species were obtained:

<i>Ammonites batesi</i> , Trask.	<i>Martesia clausa</i> , Gabb.
<i>Ammonites breweri</i> , Gabb.	<i>Turris plenus</i> , "
<i>Ammonites hoffmanni</i> , "	<i>Plenomya lavigata</i> , Whiteaves.
<i>Ammonites remondi</i> , "	<i>Trigonia leana</i> , Gabb.
<i>Ammonites (Phylloceras) ramosus</i> , Meek.	<i>Trigonia aquicostata</i> , "
<i>Ancylloceras remondi</i> , Gabb.	<i>Trigonia crassana</i> , Meek.
<i>Belemnites impressus</i> , "	<i>Nemodon vanconrencensis</i> , "
<i>Cinctia mathewsoni</i> , " (?)	<i>Plicatula variata</i> , Gabb.
<i>Lunatia arellana</i> , "	<i>Pecten operculiformis</i> , "
<i>Potamides diadema</i> , "	<i>Aricula mucronata</i> , Whiteaves.
<i>Ringicella polita</i> , "	<i>Pinna</i> .
<i>Anchura</i> .	<i>Ostrea</i> .
<i>Nerinea mandensis</i> , Whiteaves.	<i>Eriphyla</i> .

Most of the species in this list not contained in the preceding ones were originally described as from the Shasta.

Localities at Gas Point post office and on Roaring river, not far distant, yielded the following:

Ammonites chicoensis, Trask.

Torritella scriatim-granulata, Gabb, not Roemer.

Nucula truncata, Gabb.

On the Cold fork of Cottonwood creek the following collection was obtained:

Baculites chicoensis, Trask.

Cucullaea truncata, Gabb.

Belonites impressus, Gabb.

Pecten traskii, " (?)

Neptunca hoffmanni, "

Ostrea.

Nucula truncata, "

Terebratella obesa, "

Two of these species are common to Horsetown and Texas springs.

Going a few miles farther southward, the first important localities are on Elder creek, on the lip of one of Mr Diller's measured sections. Near Lowry's and at other places farther westward specimens of *Cucullaea piachii*, Gabb, were obtained, while a higher horizon about two miles east of Lowry's yielded the following species:

Gyrodes crearata (Michelin), Whit-

Venus lenticularis, Gabb.

eaves.

Tellina parilis, "

Lamotia.

Tellina ashburneri, "

Anchura californica, Gabb.

Cucullaea truncata, "

Dentalium stramineum, "

Astarte couradiana, " (?)

Thetis annulata, "

Pecten operculiformis, "

Chione varians, "

Aricula.

This lot shows a greater difference than any of the others, although it contains at least four species enumerated from other localities above given.

Sufficient evidence has therefore been presented to show that all the species from the several localities mentioned very probably belong to one fauna.

Near Redding, on Sacramento river, a large number of species were collected, many of which were not obtained at any of the above localities, but the presence there of such forms as *Cucullaea truncata*, *Trigonia crassana*, *Pecten operculiformis*, *Cochlea traskii*, etc, make it probable that the beds belong to the same continuous series, though they may represent a somewhat higher horizon.

Collections from several localities in Oregon that have always been referred to the Chico formation, such as Crooked river, Siskiyou moun-

tains, Ashland, and several places in Jackson county, indicate about the same horizon as that of the bed at Horsetown.

Original Localities of Chico Fossils.—In the second volume of the Paleontology of California there is a "Synopsis of the Cretaceous invertebrate fossils of California," giving a complete list of the species then known, with the localities at which they had been obtained. For convenience in making comparisons I have made a list of the species reported from each locality there mentioned. Leaving out of consideration the localities from which only from one to three species are reported, there are sixteen localities from which Chico fossils were obtained. An examination of the faunal lists from these places show that eleven of them may be referred without question to the Shasta-Chico fauna as represented at Horsetown and in the neighborhood of Cottonwood creek. These localities are: Benicia, Cottonwood creek, Crooked creek of the Des Chutes (Oregon), Curry's, Jacksonville (Oregon), Martinez, mount Diablo, Orestimba, Pacheco pass, Siskiyou mountains and Tuscan springs. The other five localities, viz, Chico creek, Cow creek, Folsom, Pence's and Texas Flat, yielded a greater proportion of species not contained in Mr Diller's collections from Shasta county, but there are several well marked Horsetown species reported from each of these localities; and they are all so intimately related to the other Chico localities by means of species held in common with one or more of them that they cannot be regarded as belonging to another fauna.

The Martinez group of Gabb has long since been abandoned as inseparable from the Chico; and, as Mr Diller has shown in his paper on the Cretaceous and early Tertiary deposits of this region,* the Wallala formation probably also belongs in the same series.

FAUNAS OF QUEEN CHARLOTTE AND NANAIMO FORMATIONS.

Correlation of Queen Charlotte Formation with the Shasta.—The correlation of the Queen Charlotte formation (divisions C, D and E of Dr Dawson's section) with the Shasta has already been mentioned in speaking of Mr Whiteaves' work. The additions now made to the Horsetown fauna materially increase the number of species that occur in both the Shasta and Queen Charlotte formations. It should be stated, however, that several genera of ammonites found on Queen Charlotte islands and not yet seen in the Shasta suggest a somewhat earlier period for the bed in which they occur. It would simplify the matter if it could be proved that these ammonites came from a lower horizon. It is worthy of note

* Ante, pp. 205-221.

in this connection that the upper shales and sandstones, or division 4 of the Queen Charlotte section, contain *Inoceramus problematicus*, Schloth., a species that is characteristic of the Colorado formation in the Rocky mountain region and is not known to range higher than the Turonian in Europe.

Correlation of Nanaimo Beds with the Chico.—The correlation of the Nanaimo beds on Vancouver island with the Chico formation, taken in connection with the facts already given, implies that these beds are more closely related to the Queen Charlotte formation than has been supposed, and I think that a comparison of the faunas found in the three regions, California, Vancouver and Queen Charlotte, will give evidence of this relationship. The principal facts that seem to be opposed to this conclusion are that some of the species of *Baculites* and of *Inoceramus* found on Vancouver island are apparently closely related to species in the Montana formation of Nebraska, Colorado and elsewhere in the interior region, and that the plants found in the Nanaimo coal field are said to be of upper Cretaceous types.

With the possible exception of the species just mentioned and a few others that have little diagnostic value, it is doubtful whether any of the species of the Shasta-Chico fauna occur in the upper Cretaceous beds east of the Rocky mountains.* The ammonites nearly all belong to genera that are not found in the upper Cretaceous of the interior region, and differences almost as great might be pointed out in other classes of mollusks.

These facts may readily be explained by supposing that the faunas lived contemporaneously in different oceans separated by a long continental area, but they would also be equally well explained if it could be proved that they were not strictly contemporaneous.

THE SHASTA-CHICO FAUNA COMPARED WITH THE FAUNA OF THE BLACK-DOWN BEDS.

Mr Whiteaves has correlated the Queen Charlotte formation with the Gault, and as confirmatory of this reference it may be of interest to give the results of the comparison I have made with one of the English Cretaceous faunas.

In Sowerby's "Mineral Conchology" 46 species of Cretaceous fossils are described from the Blackdown beds of Devonshire, England. These beds have usually been referred to the Gault, though some authors now regard them (at least in part) as representing the lowest beds of the

* See Dr C. A. White's statement on this point in Bull. 15, U. S. Geol. Surv., pp. 27-29.

Cenomanian. Of the 46 species figured by Sowerby as coming from Blackdown, at least 23, or one-half of the entire number, are represented in the Shasta-Chico fauna by closely related species. These include such well marked forms as—

From Blackdown—

Astarte striata.
Cucullaea costellata.
Cucullaea fibrosa.
Exogyra conica.
Mytilus edentulus. }
Mytilus lanceolatus. }
Thetis major. }
Thetis minor. }
Trigonia aliformis.
Trigonia davidalea. }
Trigonia spectabilis. }
Turritella granulata.

Represented in California by—

Eciphylla umbonata. (?)
Nemodaa rancourcensis.
Cucullaea tenuicosta.
Exogyra parasitica.
Mytilus lanceolatus. (?)
Thetis annulata.
Trigonia crassum.
Trigonia leana.
Turritella scitatum-granulata. (?)

In addition to these the Blackdown beds contain a number of species belonging to the Veneridae and Aporrhaidae, both of which groups are well represented in the Shasta-Chico fauna. In fact, so far as can be judged by figures and descriptions, the whole fauna of the Blackdown beds, if it had been found in the western part of the United States, would be referred to the Shasta formation and about to the horizon of the Horsetown beds.

Whether the Chico beds above the fossil-bearing Horsetown horizon represent all the rest of the upper Cretaceous remains to be determined. The close relationship of their fauna to that of the underlying beds which has been compared with the Gault and Cenomanian, and its distinctness from the upper Cretaceous faunas east of the Rocky mountains representing the Turonian and Senonian of Europe seem to favor the view that a large part of the upper Cretaceous series is absent from the Pacific coast.

CONCLUSIONS.

In view of all these facts, it seems to me that the exact relationship of the Chico and Tejon formations and the extent to which their faunas are connected must still be regarded as an open question that can be solved only, if at all, after exhaustive collections have been made from both formations and thoroughly studied.

- The specific conclusions reached may thus be summarized : There is
- no faunal break any where in the entire series of strata that have been referred to the Shasta and Chico formations. Certain portions of the series are characterized by the abundance of particular species, *e. g.*, *Aucella* in the lower beds and several species and genera of ammonites in the Horsetown division ; but these sub-faunas are so bound together by connecting species that they cannot be regarded as really distinct, and I have therefore adopted Mr Diller's suggestion and called the whole the Shasta-Chico fauna. The age of this fauna, or at least of the portion found in the Horsetown beds, seems to be not more recent than the Cenomanian.

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