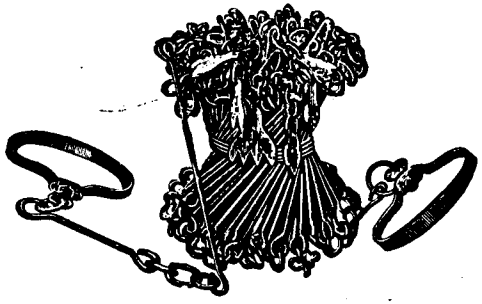
CHAINING THE LAND

A HISTORY OF SURVEYING IN CALIFORNIA



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Appendix N

LENGTH OF CHAIN
1880 Annual Report,
Commissioner of the General Land Office

You will establish a United States standard of measure at some point convenient to your office. Before commencing a survey the deputy must be required to provide himself with not less than two good surveying chains of steel wire, which should be of No. 12 American gauge, all the joints of which should be securely brazed. The four-pole chains must be adjusted to lengths of 66.06 feet. The deputy must be required to preserve one of said chains unused in ordinary field-work, and the chain or chains used in the field must be compared therewith before and after each day of field service. The object in adding six-hundredths of a foot to the sixty-six feet of a four-pole chain is to assure thereby that sixty-six feet will be set off upon the earth's surface without the application of a greater strain than about twenty pounds by the chainmen, thus providing for loss by vertical curvature of the chain, and at the same time avoiding the uncertain results attending the application of strains taxing its elasticity.

LENGTH OF VARA
1854 Annual Report,
Commissioner of the General Land Office

In a report of the 14th November, 1851, from the surveyor general of California, it is stated that all the grants, etc, of lots or lands in California or that of Mexico, refer to the "vara" of Mexico as the measure of length; that, by common consent in California, that measure is considered as exactly equivalent to thirty-three American inches. That officer then enclosed to us copy of a document he had obtained as being an extract of a treaty made by the Mexican government, from which it would seem that another length is given to the "vara," and by J.H. Alexander's (of Baltimore) Dictionary of Weights and Measures, the Mexican vara is stated to be equal to

92.741 of the American yard.

This office, however, has sanctioned the recognition, in California, of the Mexican vara, as being equivalent to thirty-three American inches.

The Mexican vara is the unit of all the measures of length, the pattern and size of which are taken from the Castilian vara of the mark of Burgos, and is the legal vara used in the Mexican republic. Fifty Mexican varas make a measure which is called cordel, which instrument is used in measuring lands.

The legal league contains 100 cordels, of 5,000 varas, which is found by multiplying by 100 the 50 varas contained in a cordel. The league is divided into two halves and four quarters, this being the only division made of it. Half a league contains 2,500 varas, and a quarter of a league 1,250 varas. Anciently, the Mexican league was divided into three miles, the mile into a thousand paces of Solomon, and one of these paces into five-thirds of a Mexican vara; consequently, the league had 3,000 paces of Solomon. This division is recognised in legal affairs, but has been a very long time in disuse—the same as the pace of Solomon, which in those days was called vara, and was used for measuring lands. The mark was equivalent to two varas and seven-eighths—that is, eight marks containing twenty-three varas—and was used for measuring lands.

LENGTH OF VARA,

Instructions to Deputies by U.S. Surveyor General for California L. Upson, dated June 1, 1864.

(Book Q, George Hansen Papers, Huntington Library)

In all cases you will consider the Judicial League equal to 5000 Spanish lineal varas or 4635 English yards or 210.6818 chs. and consequently the vara equal to 33.372 English inches and the Libro Mayor or Square League containing 4438.683 acres.

(The material on the following 14 pages is reprinted with permission. From an article by J.N. Bowman, "Weights and Measures of Provincial California," California Historical Society Quarterly, Vol. XXX, No. 4, December, 1951.)

LEAGUE

The juridical league was a measure both of distances and of areas. It was standardized at 5,000 varas, so its length depended on the length of the vara. The Mexican Law of 1857, establishing the metric system, gave the length of the league as 4.19 kilometers or 2.6035 miles.[22] In the *Alta* in October 1857, the length of the league in the province is given as 4,635 yards or 2.633 miles – evidently taken from Lee's *Tables* of 1849; and in 1861 Deputy Surveyor General Healy testified that the Spanish league was "2⅝ miles and a fraction of a chain over," or 2.625 miles.[57] Based on the 33-inch vara, it was 2.604 miles, while, on the 33.372-inch vara, it was 2.633 miles. For practical purposes in Alta California 2.6 miles can be used.

MILLA

The milla or mile was an old Spanish unit of lineal measurement and was somewhat in general use in provincial California. In the plan for colonization by foreigners in Upper and Lower California, as proposed by the California Junta de Fomento, 1825-27, provision is made that there shall be assigned, between the allotments, "lots of a square milla, or of 1666⅔ varas, which is the same thing. . . ." The milla occurs occasionally in Spanish testimony in the private land-grant cases; it was used in a land grant in the lower San Joaquin Valley, and J. J. Vioget used it in making his plat, now lost, and in his testimony regarding his survey of New Helvetia in 1840-1841.[58]

The Mexican milla was one third of a league,[59] and this also was the unit used by Vioget in his plat and in his testimony in the Sutter private land-grant case mentioned above.[60] This makes the milla about 0.87 of a mile.

The "Spanish Weights" in the Fitch documents states that the Spanish league is divided into three miles, but without indicating whether this was for the long or the short league.[25]

PULGADA

The pulgada or inch was the most used subdivision of the vara, which contained 36 pulgadas; the length of the pulgada, therefore, depended upon the length of the vara.

Where the 32.99206-inch vara was in use, the pulgada was 0.9164 of an inch, but the 33-inch vara made it 0.9166, and the 33.372-inch vara made it 0.927, of an inch. In any of these cases, the pulgada was a little less than an American inch.

In California the pulgada was rarely used in mission and governmental records. In one deed, in San Jose, it is found when the dimensions are given of the three rooms purchased by Juana Briones in 1852 from the Peñas in Santa Clara – the rooms adjoining the present Women's Club on the south.[61] These dimensions are given partly in varas, with eighths, sixths, and quarters; and partly in varas and pulgadas.

SITIO

Sitio was quite generally used to designate the square league. *See* "Square League" below.

SQUARE LEAGUE

The league, or square league, or sitio, or sitio de ganado mayor was the unit of the Alta California ranchos, as determined by the Law of 1824 and the Regulations of 1828. This stock rancho unit varies with the length of the vara. With the 33-inch vara it contained 4,340.28 acres, while with the 33.372-inch vara it was 4,438.68 acres, or a difference of 98.40 acres for each league. The former figure is quite close to the league as established by the Mexican Law of 1857 at 1755.61 hectares or 4,388.11 acres.[22] For reasons mentioned below under "Vara," the smaller of these figures can be taken as the one used in Alta California, and the latter figure in patenting land grants confirmed after 1855.

The seeming discrepancy is not as important in practice as it is in mathematics. Even though the standard alcalde varas were used as a basis in land measurement, many factors entered to affect adversely the seeming exactness at this point. The cordel, or what is now called the surveyor's chain, was made of sisal, hemp, hair, or occasionally rawhide. The cordel was to be "well twisted and stretched," but the measuring was done by holding the vara measure and the cordel in the hands; also no allowance was made for the natural shrinking and stretching of the cordel. It was pulled along the ground by cord-bearers, usually on horseback when measuring the land, and on foot when measuring house lots. The marks on the ground, indicating cordel lengths, were made by the men on horseback, who struck the ground with sticks tied to the ends of the cordel. It was pulled in the general direction of a selected landmark but not necessarily in a straight line. Wide streams, swampy places, precipitous areas were not measured at all, but were estimated as being of a certain extent agreed upon by all the parties concerned, the number of leagues measured being expressed in terms of *poco mas ó menos*, a little more or less. With these factors present in rancho measurements, the difference between the two leagues becomes nullified. For the data on the change from the small or short league to the larger or long league, see the consideration of this question under "Vara" below. Not only in rancho but even in house-lot measurements the same discrepancy arose, owing to these factors. When the first 50-vara lot in Yerba Buena was granted to J. J. Vioget, the first modern land surveyor in California, that he might practice his profession there, he found by his measurement that the lot was short 8 varas. In 1847, in making his "swing" of the streets in Yerba Buena, Jasper O'Farrell found the 50-vara lots differed greatly in size.[62]

In dealing with the league of land in Alta California, from the point of view of those days and in relation to the events of those times the smaller area would be proper. When, however, land grants made in those days are viewed from the point of view of the later American surveyors, in making the patent plats for these grants, the larger area must be used.

VARA

The vara was the basic unit of lineal measure in Spain and in the Spanish colonies. On it was based the length of the league and the area of the sitio or square league, and it also determined the length of the milla.

In Alta California it was the most used of all the units, followed closely by the fanega. The vara was used in determining the length of the cordel in land measurement and in measuring the size of churches and buildings.

The original vara, as mentioned earlier, was cut on the outer wall of the cathedral of Burgos at an unknown date, and so became known as the vara de Burgos or vara de Castilla. In 1721 a standard unit of wood was made of the vara de Burgos, and later one was made of metal. A metal unit was also sent to Mexico in the eighteenth century. The length of the vara de Burgos has been placed at 32.90957 or 32.99206 inches. In Spain, however, variations from this standard became quite general locally and among the provinces, not only in Spain but also in the new world. In time its length ran from 31.496 inches in Colombia to 44.092 inches in Argentina; and in Portugal, which also used the vara as a unit, it was 48.28 inches.[12, 22-23, 30, 63]

In Mexico the generally accepted length was quite close to that of Burgos. With one exception which gives the length as 35.74 inches,[63] there is general agreement among metrologists that the length was about 33 inches, but usually a little less. Humboldt in 1803-1804 gave the length as 33.03143 inches in a note, while, in his text, his equivalent of 66 varas (or 171 feet of that day) is 31.09 inches, which the translator corrects from 171 to 180 feet, or 32.727 inches.[64] During the Mexican War, army engineers acquired a provincial vara standard in Mexico and brought it to Washington; it is now in the Bureau of Standards. It is a bar made of a sheet brass, inscribed "Vara Mexicana, Por Orden Suprema, Año de 1846," with an eagle seal. One side of it has marks indicating ⅛, 1/16, ¼ and ½ varas. At one end, one of the 1/12 varas is subdivided into three parts labeled pulgadas, or inches, and one of these parts in turn is divided into ten parts without indicating the name; at the other end, one of the ⅛ divisions is divided into 6 parts and named dedos, and one of these is further divided into 10 parts. The other side of the standard is divided into 10 parts with the first five marked, 10, 20, 30, 40, and 50; each part is divided into 10 numbered parts, and each of these into 10 parts and labeled centesimos. The length of the vara on one side, measured at 27°, is 837.41 mm or 32.9688 inches; and on the other side, measured at 28°, is 837.52 mm or 32.9731 inches, with a probable error of 0.01 mm.[65] In 1855 this same standard vara was measured by the U.S. superintendent of weights and measures, from various places in the division marks—valleys, inner and

outer edges of the valleys—at stated temperatures, with an average reading of 32.9682 inches.[66] J. H. Alexander in 1850 computed the Mexican vara length as 0.92741 yard or 33.3876 inches, and the Burgos or Castilian vara as 0.91319 yard or 32.87484 inches.[67]

On January 20, 1849, a report was written by the engineers who accompanied the U.S. army into Mexico in 1846; it was printed in 1850. In the account of the passage through Texas, a comparison of Mexican and English measures is given with the vara at 33⅓ inches.[68] On November 14, 1851, the new surveyor general for California wrote Washington his suggestion as to the length of the vara, 33 inches, for use in the surveys of the private land grants, and accompanied the letter with a copy of Article 20 of an agreement of the Mexican officials in London, in 1837, as to the ratio between British and Mexican measures: "In compliance of what is ordered by the seventh article of the preceding law, in the preceding agreement in regard to the holders of bonds deferred, it is declared that the act of which mention is made in said agreement answers to 4,840 English yards squared, equivalent to 5,762.403 Mexican varas square; in as much as the sitio de ganado mayor contains 4,338.464 acres, the Mexican vara having been found by exact measure equals to 837 French millimeters, and consequently to $\frac{916.469}{100,000}$ of the English yard. Reducing the ratio of 4,840 square yards and 5,762.403 yards the vara will be 32.99312.

Reducing the 4,338.464 acres 32.99311

Reducing the fraction $\frac{916.469}{100,000}$ 32.99288."

A note to the agreement corrects this fraction to $\frac{915.755}{100,000}$ 32.96718.

All these figures were so close to 33 inches that the surveyor general recommended it for use in the California private land-grant surveys.[69]

On May 15, 1857, Mexico established the metric system, to be effective on January 1, 1861, and the publication of the law contained conversion tables. The vara before 1838 was given as equivalent to 837.31 mm or 32.96489 inches, but in that year it was made equivalent to 838 mm or 32.99206 inches.[22] Hall, in his *Mexican Laws*, gave the vara as equal to 837 mm.[70] The International Congress of Berlin in 1863 gave the length of the Mexican vara as 836.695 mm or 32.9507 inches, the Spanish vara as 835.905 mm or 32.8775 inches, and in the other South American states the vara as somewhat larger.[71] In 1891 the Bureau of American Republics made the vara of the South American states range from 33 inches to 38.874 inches.[20] In 1906, Chief Justice Fuller in his statement of the case of Ainsa *v.* U.S., gave the length of the vara as 32.9927 inches for Arizona.[72]

In California the first official notice of the vara measure is found in 1802 in the viceroy's letter to the California governor, which states that no vara

measure existed in the province and that he was ordering one sent; this standard arrived the following year and was put into effect, but nothing is known as to its length.[3] By 1833 and 1834 the lack of uniformity in the units was such that merchants made their own units, and, as mentioned above, this prompted the district assembly to urge the governor to provide and enforce standards.[6-7] A decade later the same condition arose again and prompted the Monterey pueblo council to appoint a committee for revision and regulation of standards. But nowhere in these official activities are any data given as to the length or other details of the vara measure; and it is not known whether the provincial standard, one of which army engineers brought from Mexico in 1846, was sent to California. It probably was sent, but no evidence has been found. Regarding the vara length, data must, then, be found in the reports of explorers, and in the statements of pioneers of those days.

In 1841, Duflot de Mofras gave it as 84 cm., or 32.07 inches.[73] In the Fitch documents, the "Spanish Weights" give the vara used in land measurements as equal to 33.384 inches.[25] Between 1846 and 1851, the length has been found in various writings. The *California Star* in 1847 gave the length as about 33⅓ inches and this figure was also given by Soulé in his *Annals of San Francisco*.[74] In 1847, J. Q. Thornton gave the length as about 33⅓ inches, which is also given later by Hall in his *History of San Jose*.[75] In October 1847, William B. Ide surveyed Hyacinth Farm on the Sacramento River, adjoining the Jimeno rancho on the north; the area given on the plat makes the vara equal to about 33.352 inches.[76] This length of the vara, 33⅓ inches, is also given in a government report.[68] In 1849 the instructions to W. C. Jones, for his special survey of California private land grants, give the area of a league based on the 33-inch vara, and in the same year General Percifer Smith found the "Mexican league is about 2⅞ of our mile," or the vara about 33.264 inches; while Bouchacourt, also in the same year, made ten varas equal to 8 meters and 50 cm. or 33.4645 inches.[77] In 1848, Jasper O'Farrell surveyed General Vallejo's Petaluma rancho; his plat scale indicates that he used the 33-inch vara.[78] In June 1850, William Eddy, the San Francisco surveyor, surveyed the Vallejo-Leese grant of two lots, at the foot of present Broadway, and used the 33-inch vara, as did also the San Jose engineers in local surveys in 1850 and 1851.[79] In January 1851, W. J. Lewis surveyed the Quito rancho in Santa Clara County and used this same length of the vara.[80] In three deeds in San Jose of 1850 and 1852, the dimensions given indicate also this same vara of 33 inches; but in 1847 another deed makes it equal to 33.382 inches.[81] In the Leese *v.* Clark case, George Hyde, former alcalde of San Francisco, testified that the length of the vara in use during the 1840's was 33 inches.[82] In 1868, Thomas Bodley gave the California 25-vara length as equaling 68.09 feet, or one vara as 32.683 inches.[83] In 1852, William B. Ide, mentioned above, testified in the Bosquejo private land-grant

case that when he surveyed this rancho on March 4, 1846, he "understood the Spanish vara to be 8% less than the English yard; that 108 varas are equal to 100 English yards; and not having any means of knowing at that time how many varas make a Spanish league I used the same number of varas for a Spanish league as there are yards in the English league, which according to my recollection gave 222 English chains, $\frac{222}{1,000}$." In his field notes for this survey he wrote, "The scale used in drawing this within map is 160 chains to the inch and in the survey (222.22 chains) 222 chains and 22 links make a Spanish league."[84] This means that he used the 33.33-inch vara.

There is a tradition in Sonoma that the vara is 2.78 feet in length, based on the surveyed length of the 109-vara lots of the pueblo. Unfortunately this must be questioned, since 109-vara lots were those authorized by the governor in 1835, but General Vallejo, in measuring them, failed in exactness, so that some lots are smaller and some larger than those authorized and the street lines are not in line, as can be seen on the official plat of the city, especially at the northwest corner of the Plaza.

On June 19, 1851, Samuel D. King arrived in San Francisco as the first surveyor general for California. Within a very short time, the question of surveys of the private land grants arose with its problem of the length of the vara. From the data listed above, it is noted that surveyors like Eddy, O'Farrell, and officials like Hyde, understood and used the vara as 33 inches, while travelers and Americans, recently arrived in the province, placed the length between 33 and 33½ inches. On inquiry, presumably among the engineers and officials, King found that the vara was quite generally recognized as equivalent to 33 inches, and this was further substantiated by the London agreement of 1837, a copy of which he sent to Washington with his recommendation of the 33-inch vara. This recommendation was made on November 14, 1851, as mentioned above. On the following February 12, King replied to a question of the state legislature that he could not set the length of the vara until he heard from Washington regarding his recommendation.[85] Washington wrote its reply on March 5, 1852, approving the recommendation of the 33-inch vara, and on December 16, 1852, King informed the Board of Land Commissioners, then about to begin its work of hearing the private land-grant claims, that the league adopted contained 4,340.27 acres – this indicates the 33-inch vara.[86]

This was the official vara length used from 1852 to 1855. Much testimony is found in the private land-grant cases that this was the length used in the rancho surveys of those years.[87] On February 20, 1855, the U.S. land commissioner stated that this was still the official length.[88] The next evidence found in the private land-grant cases as to the official length is the testimony, early in 1858, and the instructions to the deputy surveyor general, dated September 1, 1858, giving the length of the vara as 33.372 inches.[89] On October 12, 1857, the *Alta California* gave the length as 33.372 inches and the league as 4,635 yards. So, between February 20, 1855, and September 1, 1858, or October 12, 1857, if the *Alta California* were correct, a change in the length of the vara had been made.

No direct evidence has been found as to the date of, or the reason for, the change in the vara length between 1855 and 1858; nothing has been discovered in the private land-grant cases themselves; the correspondence and the files of the California surveyor general were burned in the 1906 San Francisco fire, and a search has failed to uncover any documents bearing on the question in the General Land Office in Washington or in its files in the National Archives. Without direct available evidence, reliance must be placed on data from which inferences may be drawn.[90]

Two facts were discovered in the National Archives bearing on the problem. The instructions of John C. Hays, the surveyor general in San Francisco, dated June 11, 1855, for the survey of rancho Suisun, state that "5,000 lineal varas is the judicial league, equal to 4635 English yards, which would make the Spanish vara equal to 33.372 inches." And in the field notes of the survey of rancho Mariposa, approved by Hays on July 31 of the same year, is a note reading: "The calculations for the quantity are made in accordance with the length of the 'vara' as adopted in Lee's Tables, and decisions of the Supreme Court in several cases making the league equal to 4635 English yards."[91] The change, then, had been made on or before June 11, 1855, and had been based on Lee's Tables and in accordance with Supreme Court decisions.

First, as to the court decisions. Up to this date, June 11, 1855, only three decisions had been delivered by the Supreme Court on California private land grants. One, the Cervantes case, related to procedure. The Suisun and Mariposa cases were both decided on March 10, 1855, and only the latter has anything remotely related to the question of the lineal length of the measure: "... the survey must now be made under the authority of the United States, and in the form and divisions prescribed by law for surveys in California, embracing the entire grant in one tract."[92] This placed the survey problem in the hands of the administrative division of the government, and nothing has been found in the legislative actions or in judicial decisions up to 1855 bearing on the length of the vara or league.

The opinion and the mandate in the Mariposa case were both filed in the District Court in San Francisco on June 4, 1855. And since this is the only decision found which possibly affects the problem, it, together with the Suisun decision whose mandate alone was filed in the San Francisco District Court on May 2, 1855, must be accepted as the ones referred to by Hays on June 11.[93] On June 15, 1855, Hays issued his general instructions to his deputies, containing, undoubtedly, the new vara length.[94]

As to Lee's Tables, the Library of Congress and the General Land Office know of only one set of Lee's Tables, that of Capt. Thomas Jefferson Lee, issued in 1849, a second edition in 1853 and a third in 1873.[95]

In the three editions the figures change but little: the 1849 edition alone gives the 4635 yards for the league by using only three figures of the decimals of the foot, which is corrected in the 1853 edition to 4637. The 1849-edition figure, 4635 yards, makes the vara 33.372 inches while the correction of the later editions, 4637, gives the length as 33.3852 inches; in a league of land this makes a difference of 3.83 acres.

How Lee arrived at the length of his Castilian units is unknown, and also unknown is why the conversion tables of the Mexican Law of 1857, which established the metric system, were not used in the 1873 edition. Lee also apparently did not use in the 1849 edition the figures of the 1837 Mexican London agreement, nor in the later edition did he use the Bache computation, mentioned above, of the length of the standard vara secured from Mexico by army engineers in 1846. Lee's work sheet, notes and papers are not found in the General Land Office, in the National Archives, or in the Library of Congress.[96]

From these facts the following inferences may be drawn. The change was not made in Washington, where such a change, or at least the approval of a change, would be expected. Lee's second edition had been published two years before 1855; it is not understandable how the General Land Office could use the 1849 edition instead of that of 1853. Also Hays' note to the field notes of the Suisun and Mariposa surveys gives the basis of the measure rather than states that the measure is in accordance with instructions from Washington. The change appears to have been made by Hays between June fourth, the date of the filing of the mandate and the opinion in the San Francisco District Court, and June eleventh, when the instructions for the Suisun survey were written and issued. The opinion threw the details of the measurement upon the surveyor general; action was expected immediately. Hays knew and had used the 33-inch vara in California surveys, and no doubt knew the correspondence of King relative to its adoption. But Hays was from Texas where he had been a surveyor, and he had also done surveying in Mississippi. He knew the Texas vara was generally accepted as about 33⅓ inches, while in California the length was reported to be from 33 to 33½ inches. No doubt King or someone had brought from Washington a copy of the 1849 edition of Lee's Tables, but the 1853 edition was not available; very probably Hays knew the book, and, since its vara length was close to the one he knew in Texas and within the range of the lengths used in California, he selected it as the official length.[97] Time did not permit correspondence with Washington. The opinion and the mandate as read and understood placed the responsibility on the California surveyor general; Hays took the official figures compiled by a government official and published in an official governmental publication, and, in the note to the field notes of the first two patent surveys, gave the basis of the length of the league, thereby informing Washington of the change made. Until such time as documentary evidence may be found bearing on the question, the change of the length of the vara may be placed between June 4 and 11, 1855, probably toward the end of that week, and it may also be assumed that Hays took the length of the league from the 1849 edition of Lee's Tables.

In New Mexico the same difficulty was encountered as to the length of the vara. On August 21, 1854, the California length was adopted.[98] In the opinion of the Supreme Court case of U.S. *v.* Perot, on October 28, 1879, a table of various lengths is given – all under 33 inches – with a statement that the length in Texas was 33⅓ inches, and also quotes a letter from the land commissioner dated February 20, 1855, which gives the California vara as 33 inches. The court in 1879 was unaware that California had changed its length to 33.372 inches in the middle of 1855.

From 1855 to the present, the long vara has been used in California in the surveys of all private land grants confirmed. In the Glendale U.S. public survey office are letters from Washington regarding the survey of Potrero Chico, one of which is dated November 19, 1919, and states that "33.372 inches seems to be the length generally accepted at the present time."

During the provincial days, the alcaldes' staffs of office had etched on them the standard vara length, stamped as such, and regarded as official; it was the standard for each alcalde's jurisdiction. It was used by the alcaldes in measuring the cordel or chain in land measurement. Among the people were vara sticks (yardsticks of the present day), governed in length by the alcalde's staff or Barra del Autoridad or Barra de Justicia, and used for home purposes and perhaps occasionally for measuring the cordel in land measurement. The exact length of the vara as measured from the alcalde's staff would depend upon whether the valley or the edges of the etchings or some combination of these were used in measuring the length of the vara. In the surveyor general's office in San Francisco in 1906, the late Miss Bailey recalled that during her employment in the office there was a vara stick of wood, about one inch square, without metal ends, but she did not recall the markings or stamps on the stick. A search since 1935 in all possible or likely places in the state and in the west and Mexico has not revealed the existence of one of the old California vara sticks or alcalde staffs; it is possible that one may still be found in the attic of some old pioneer home, and, if discovered, it is hoped that it may be preserved in some appropriate institution. The late Prof. Gilmore of Davis secured a vara stick from San Salvador, which was in actual use by a carpenter when secured; it is now in the Bancroft Library. The present writer secured in 1941, through the kindness of F. W. McBryde

of Ohio State University, an alcalde staff from an Indian alcalde in a village in northern Guatemala; it was in actual use in land measurement when McBryde acquired it. McBryde also secured a vara stick from a young Indian weaver in a village in the state of Oaxaca, Mexico; the weaver was using it in measuring cloth woven on his loom; this one, very likely, is very similar to those used in California. Both of these sticks have been placed in the Bancroft Library. Recently a Sonora vara stick from Arizpe has been acquired by the Los Angeles County Museum and is fully described by R. M. Ariss in the Museum *Quarterly*.[99] It was used by an Arizpe merchant and his heirs from the early 1800's to 1895. It is made of lignum vitae; its tips have been lost, and it now measures 32⅞ inches in length; it is divided by inlaid bone on one side into thirds and on the other into quarters, all of unequal lengths, with some shorter markings apparently indicated. It is also marked with M A (Municipality of Arizpe) and with a series of years, as they can be deciphered, from 1838 to 1852 and possibly 1862, indicating the resealing by the Oficiana del Fiel Contracte. The vara stick was very probably quite similar to those used in Alta California.

From these facts it appears that the California vara length varied in three periods with some local variations. In the Spanish-Mexican period the length was slightly under 33 inches but with some variations. During the transition period from the late 1840's to 1852 it was regarded by many pioneers, especially engineers and officials, as 33 inches, and this was made official in 1852 and used until 1855 by the surveyor general. From somewhere between June 4 and 11, 1855, to the present the length has been 33.372 inches, and has been used in all the surveys of the Spanish and Mexican private land grants in the state. In any use of the vara, in terms of inches, it is well to regard the length as the short vara slightly under 33 inches, for all studies in the Spanish and Mexican periods; as 33 inches for all studies involving the late 1840's and early 1850's, and as 33.372 for all studies since 1855. For all practical and general use the 33-inch vara may be used.

NOTES

1. *See* notes 12, 22, 23, 30, 63 below.
2. *See* note 26 below.
3. "Archivo de California" (manuscript, Bancroft Library), State Papers, Sacramento, III, 18.
4. *Ibid.*, Provincial State Papers, XVIII, 321 ff.
5. *Ibid.*, Departmental Records, VI, 148.
6. *Ibid.*, State Papers, Missions and Colonization, II, 234 ff, 237.
7. *Ibid.*, Legislative Records, II, 72 ff.
8. "Archivo de Monterey" (manuscript, Bancroft Library), V, 31.
9. "Archivo de California" (note 3 above), Departmental State Papers, Angeles, VIII, 19.
10. *Idem*, p. 72.

11. Henry D. and Josefa C. Fitch, "Documentos para la Historia de California" (manuscript, Bancroft Library), pp. 980 ff.
12. G. Rodríguez, *Pesos y Medias del Mundo* (Habaña, 1922); Institut d' Agriculture, *Recueil de Coefficients et d'Equivalences* (Rome, 1922).
13. M. Velásquez, *Diccionario . . . de la Lengua Española* (New York, 1900).
14. *Enciclopedia Sopena* (Barcelona, 1925).
15. Academia Española, *Diccionario de la Lengua Española* (Madrid, 1933); Arturo Masriera Colomer, *Diccionario de Diccionarios* (Barcelona, 1917); *Nuevo Diccionario de la Lengua Castillana* (Paris, 1869).
16. Land case No. 92 ND, in U. S. District Court, San Francisco.
17. *See also* H. E. Bolton, tr., Palou's *New California* (Berkeley, 1926), I, 51, note.
18. *H. Ex. Docs.*, 38th Cong., 1st sess., IX (49), 24.
19. Bur. Am. Republics, *Bulletin*, No. 4, 1891, "Moneys, Weights and Measures of the American Republics."
20. I. D. A. Johnson, *Modern Metrology* (London, 1882).
21. R. J. Kerr, *Handbook of Mexican Law* (Chicago, 1909), p. 225. The sitio he gives as 4,338.464 acres, and the vara as 835.019 mm or 2.73956 feet. His two figures for the vara are not quite equivalent, and the league based on vara-footage equals 4,307.386 acres.
22. *Sistema Metrico-Decimal* (Mexico, 1857). This Law of March 15, 1857, established the metric system in Mexico, to be put into effect on Jan. 1, 1861; the publication gives full conversion tables. The arroba is equivalent to 11.501563 kilograms or 25.356 pounds.
23. A. E. Kennelly, *Vestiges of Pre-Metric Weights and Measures* (New York, 1928).
24. Land case No. 192 ND. *The Californian*, Nov. 11, 1846; P. Tikhmeneff, *Historical Review of the Origin of the Russian-American Company* (St. Petersberg, 1861), p. 287, note 31. Here the arroba is given as equal to 28 pounds or 25.2 pounds avoirdupois.
25. *S. Ex. Docs.*, 31st Cong., 2nd sess., III (18), 30. In the Fitch documentos (note 11 above), is a short paper on "Spanish Weights." The arroba equals 25.36 pounds; the fanega (dry) equals 1.599 bushels; fanega (area) of corn equals 1.1313 acres. The vara, for the measure of cloth, linen, and silk, equals 33.384 inches. The league, divided into 3 millas, equals, for roads since 1766, 4.291 miles, while the "judicial league" equals 2.682 miles. The bushel is that of Winchester and equals 2,150.42 cubic inches. In the same documentos, p. 158, is a Fitch bill of sale, giving cloth measures in yards and the equivalent varas; here the vara equals 33.33 inches. This document is undated and unsigned, and there is no indication that it applied to California.
26. Bolton, *op. cit.*, pp. 28, 46, 53; "Documentos para la Historia da California" (manuscript, Bancroft Library), IV, 19, sec. 24.
27. Departmental State Papers, Angeles (as in note 9 above).
28. *See* note 66 below.
29. *H. Ex. Docs.* (as in note 18 above).
30. F. W. Clarke, *Weights and Measures* (New York, 1891).
31. *Boletín de la Sociedad Mexicana de Geografía y Estadística* (Mexico, 1863).
32. J. H. Alexander, *Universal Dictionary of Weights and Measures* (New York, 1867), written in 1850; G. B. Griffin, in a note to his translation of a Serra letter, gives about 1¼ bushels for the fanega (Hist. Soc. So. Calif., *Publs.*, II, 79).
33. *S. Ex. Docs.*, 31st Cong., 1st sess., X (32), 32, 46.
34. P. Meigs, "Dominican Mission Frontier of Lower California," *Univ. Calif. Publs. Geog.*, VII (1935).
35. *S. Ex. Docs.*, 34th Cong., 3rd sess., VI (27), 83. This is a report of the secretary of the treasury on weights and measures, 1857.

36. Otto von Kotzebue, *New Voyage* (London, 1830), II, 99; A. Forbes, *California* (London, 1839), p. 260.

37. Frank Soulé *et al*, *Annals of San Francisco* (San Francisco, 1855), pp. 62, 163; H. H. Bancroft, *California Pastoral* (San Francisco, 1888), pp. 350, 795; Theodore H. Hittell, *California* (San Francisco, 1885), I, 534. In his *History of California*, Bancroft interchanges fanegas and bushels in presenting mission and other statistics.

38. Alfred Robinson, *Life in California* (New York, 1846), p. 61.

39. Bayard Taylor, *Eldorado* (New York, 1861), p. 65.

40. W. P. Garner, "Letters from California," in *Magazine of History*, extra no. 103 (1924), p. 174.

41. Patrick McChristian, "Narrative . . ." (manuscript, Bancroft Library).

42. Land case No. 2 ND; San Francisco District Court, case No. 0084, Smith *v.* Dorland; *The Northern Crown*, June 1911.

43. Anson S. Blake, "The Hudson's Bay Company in San Francisco," this QUARTERLY, XXVIII (June 1949), 109; F. W. Beechey, *Voyage to the Pacific* (London, 1831), II, 37.

44. Land case No. 192 ND. Zapeda stated that he was a carpenter and not an agriculture man; he gave 11 almuds for an arroba. *S. Ex. Docs.*, as in note 35 above.

45. W. H. Davis, *Seventy-five Years in California* (San Francisco, 1929), p. 136.

46. P. Tikhmeneff, *op. cit.*, p. 287; K. T. Khlebnikov, in "Russian America" (manuscript, Bancroft Library), III, 121; *see also ibid.*, III, part 4, p. 126, where Captain Lutke, who sailed to the colonies in 1826-29, states that the "Fanega is a measure nearly equal to the Russian chetvert; the arroba is a weight of 28 Russian pounds." In the Russian text the word chetvert is used, so the question of translation does not arise. The arroba equivalent given by Lutke is very close, but his meaning of chetvert is unknown. This measure, chetvert, usually given as a little under 6 bushels, varied, however, in different times and places. The word chetvert, however, may have been written, copied, or printed for chetvertka, which Prof. O. A. Maslenikov, of the Russian department of the University of California, states is one quarter of a chetvert. In the light of Hagemeister's arrangement, the usual chetvert is out of the question. The captain's statement, therefore, throws no light on the matter of the capacity of the fanega. *See also* K. T. Khlebnikov, "Memoirs of California," in *Pac. Hist. Rev.*, IX (Sept. 1940), 326.

47. W. Halley, *Centennial Yearbook* (Oakland, 1876), p. 559.

48. *Emeric v. Alvarado*, transcript (San Francisco, 1878), p. 720.

49. According to a letter from A. W. Adler, Sonoma, the inventory of the estate of Bartolome Tapia, April 28, 1828, included "1 half fanega measure." Land case No. 147 SD.

50. J. A. Rockwell, *Spanish and Mexican Laws* (New York, 1851), I, 664. His square vara of the fanega should read 276 x 184, instead of 376 x 184, and 50,784 instead of 56,784.

51. Land case No. 386 SD.

52. F. Hall, *Laws of Mexico* (San Francisco, 1885), p. 87.

53. M. Galvan, *Ordenanzas de Tierras y Aguas* (Paris, 1855), p. 177; G. H. McBride, *Land Systems of Mexico* (New York, 1923), p. 51. The data given by McBride indicate that the fanega of wheat was 0.03 acre, and the fanega of corn 3 acres.

54. M. G. Vallejo, "Documentos" (manuscript, Bancroft Library), X, 229; Clarence John DuFour, "The Russian Withdrawal from California," this QUARTERLY, XII (Sept. 1933), 258-59. The Sutter inventory of Fort Ross is in the possession of Edwin Grabhorn, San Francisco.

55. *S. Ex. Docs.*, 31st Cong., 2nd sess., III (18), 30.

56. Sena *v. U. S.*, 189 U.S. 235; 47 Law Ed. 789. This grant was petitioned for in 1728.

57. *Alta California*, Oct. 12, 1857; Land case No. 233 ND.

58. "Principal Actions of the California Junta De Fomento of 1825-1827," *transl. and ed. by* Keld J. Reynolds, this QUARTERLY, XXIV (Dec. 1945), 310, 318-19; Fitch "Documentos," *loc. cit.*; Miguel Costansó, "Diary," *ed. by* Frederick J. Teggart, Acad. Pac. Coast History, *Publs.*, II, no. 4 (Aug. 1911), pp. 150, 310; "Archivo de Santa Barbara" (manuscript, Bancroft Library), III, 228 ff; Z. Engelhardt, *Mission of Santa Inés* (Santa Barbara, 1932), p. 24; Land case No. 424 ND.

59. L. Hamilton, *Mexican Laws* (San Francisco, 1882), p. 103.

60. Land case No. 319 ND.

61. San Jose, county recorder, Deeds, E, 231.

62. Land case No. 424 ND; Cal. Supreme Court, Lestrade *v.* Barth, in State Archives at Sacramento. In Ainsa *v.* U. S., 161 U.S., 219; 40 Law Ed., 677, the league is given as 4,338.464 acres.

63. *Enciclopedia Sopena* (as in note 14 above).

64. A. von Humboldt, *Essay* . . . (London, 1814), II, 82; J. Wheless, *Compendium of the Laws of Mexico* (St. Louis, 1910), II, 803.

65. Letters from Bureau of Standards.

66. As in note 35 above, pp. 19, 180.

67. Alexander, *op. cit.*, p. 118.

68. As in note 33 above, p. 11.

69. *H. Ex. Docs.*, 33rd Cong., 2nd sess., I, part 1, 95 ff; Thomas Corwin Donaldson, *Public Domain* (Washington, 1884), pp. 396, 399. Hamilton, *op. cit.*, p. 106; M. Galvan, *op. cit.*, pp. 149, 177. The state surveyor general evidently had these figures in mind when he wrote to a county surveyor, E. B. Kellogg, on Sept. 5, 1850: "I have no table of Spanish measures and all the information I can give you at present is that the Spanish vara is 32.993 inches. . . ." (State Archives, Sacramento.)

70. Hall, *op. cit.*, p. 82.

71. As in note 18 above, pp. 18, 24.

72. Ainsa *v.* U. S. (as in note 62 above). The statement also gives the cordel (50 varas) as 137.05 feet. This, however, means a vara of 33.109 inches.

73. E. Duflot de Mofras, *Exploration de l'Oregon* . . . (Paris, 1844), I, 289. His statements are not overly exact.

74. *The Star*, Aug. 28, 1847; Soulé *et al*, *op. cit.*, p. 182.

75. J. Q. Thornton, *Oregon and California* (New York, 1849), II, 73. F. Hall, *History of San Jose* (San Francisco, 1871), p. 130, says the vara is "within a fraction of 33⅓ inches."

76. U. S. Circuit Court, case No. 67, Rogers *v.* Day, in San Francisco.

77. *H. Ex. Docs.*, 31st Cong., 1st sess., IX (18), 115; C. Bouchacourt, *Notice Industrielle sur Californie* (Lyon, 1849), p. 23; *see also* note 33 above, p. 100; and Thornton, *op. cit.*, II, 73.

78. O'Farrell's plat of Petaluma, wall map, recorder's office, Santa Rosa.

79. Land case No. 421 ND; Santa Clara County engineer, Maps A, 21, 73, 86.

80. Land case No. 226 ND.

81. San Jose, county recorder, Deeds, A, 21, 73, 86; 3:66.

82. Cal. Supreme Court, case No. 10,577, Leese *v.* Clark, State Archives, Sacramento.

83. U. S. Circuit Court, case No. 563, Luco *v.* Hare, in San Francisco.

84. Land case No. 367 ND. This figure, 108 varas equalling 100 yards, was also given in Jan. 1849 in the engineer's report of the Mexican War. It gives 1 foot as equal to 11⅓ inches; 1 vara equal to 33⅓ inches; or 108 varas equal to 100 yards. These figures are for Mexico. *See also* note 33 above, p. 11.

85. U. S. *v.* Perot, 98 U.S. 428 ff; 25 Law Ed. 251 ff; *Journal*, Cal. Legisl., 3rd sess., p. 620.

86. U. S. *v.* Perot, as in preceding note; Land case No. 403 ND. Other estimates found: Jones, *op. cit.*, in his report in 1850, gave the square league as 4,428.402 acres, which means a vara of 33.33 inches; A. Wheeler, *Land Titles in San Francisco* (San Francisco, 1852), p. 7, note, gives the vara as 32.4 inches. *See also* 49 Texas 235.

87. Andrés Castillero *v.* U. S., 2 Black 17 ff; 17 Law Ed. 380 ff. *See also* the New Almaden private land-grant case (San Francisco, 1860), II, 1099; Black survey, 388 SD and 425 ND; Land case No. 92 ND, distances given; Land cases nos. 298 ND, 232 ND, 233 ND, 380 ND, 403 SD; report, General Land Office, Nov. 30, 1854.

88. U.S. *v.* Perot, *op. cit.*, letter of land commissioner to Justice Catron.

89. Land cases nos. 233 ND, 380 ND. Mandeville's instructions and references to them, in Land cases nos. 29 ND, 35 SD, 298 ND, 300 ND, 318 ND, 339 ND, 342 ND.

90. Letters from W. H. Richards, T. C. Howell, Elizabeth B. Drewry, and J. D. Wolfsohn.

91. Letters from Herman Kahn of National Archives.

92. 16 Howard 619; 14 Law Ed. 1080. 17 Howard 524; 15 Law Ed. 236. 17 Howard 541; 15 Law Ed. 241.

93. Leander Ransom, who was deputy surveyor general and chief clerk in the office of the surveyor general in San Francisco during this period, testified in 1866 in the Laguna de Merced private land-grant case (No. 380 ND) that the vara was 2 feet 9 inches in the early surveys, but "at a subsequent period the length was made to correspond with the decision of the U.S. Supreme Court which made a difference in the two measurements of 98 acres to the league." And A. W. von Schmidt, the deputy surveyor general who made the Mariposa survey, testified in the same Laguna de Merced case, that at first the vara was 33 inches but "it was afterwards ascertained that the measure was too short and was corrected to 33.372 inches." Most of Ransom's papers and documents were burned in the 1906 San Francisco fire. G. B. Ashcroft, *compiler*, "Col. Leander Ransom" (miscellaneous materials, in Bancroft Library). Only three letters of Von Schmidt are available, and these contain nothing relative to the length of the vara. California State Library, Sacramento. The extant Hays papers are scattered from California to New York. Prof. J. K. Greer of Texas, who is writing the biography of Hays, states that there is nothing in the papers and documents bearing on the length of the vara or the change in its length. Nor has anything been found on this problem in the Hays papers, newly acquired by the Calif. Hist. Society.

94. Land case No. 382 ND, Hays' letter to Deputy Surveyor General Green for the survey of Cañada de Capay. (Copy also in Hays papers, Calif. Hist. Society.)

95. Letters from W. H. Richards, and Robert C. Gooch. The 1849 edition of Lee's *Tables* is in the office of naval records and library, Washington; the 1853 edition is in the Library of Congress.

96. Letters from Elizabeth B. Drewry.

97. A note in a notebook of John Clar, who was connected with the Spanish archives and with the surveyor's office as an engineer during the Hays administration, has several references to Lee's *Tables* of 1849 but no mention of the later edition. It mentions that Hays "took charge of the office on July 15, 1853"; and notes the change of the length of the vara to the longer length but without giving the date of the change. The notebook is in the possession of a grandson, C. Raymond Clar, chief deputy state forester, Sacramento.

98. Donaldson, *op. cit.*, p. 396; *H. Ex. Docs.*, 32nd Cong., 2nd sess., I, part 1, p. 90.

99. Los Angeles County Museum, *Quarterly*, VI (Fall, 1947), p. 7.

Appendix O

U.S. SURVEYORS GENERAL—CALIFORNIA

Date of Appointment	
12 Mar. 1851	Samuel D. King
17 Mar. 1853	John C. Hays
13 July. 1857	James W. Mandeville
15 Apr. 1861	Edward F. Beale
23 Feb. 1864	Lauren Upson
20 Apr. 1868	Minard H. Farley
1 Jul. 1868	Andrew J. Moulder
18 Jul. 1868	Sherman Day
16 Jan. 1871	James R. Hardenbergh
19 Dec. 1873	James Thompson Stratton
12 Jan 1876	Henry George Rollins
27 Sep. 1877	John W. Ames
22 May 1878	Theodore Wagner
22 May 1882	William H. Brown
20 Nov. 1885	Richard P. Hammond, Jr.
4 Mar. 1890	William H. Pratt
24 Mar. 1894	William S. Green
24 Mar. 1898	James M. Gleaves
9 Jan. 1902	William S. Graham
7 Mar. 1910	Edward H. Archer
1 Mar. 1914	Frank H. Gould
21 Mar. 1918	Louis H. Mooser
15 Oct. 1921	John Plover

Office abolished 1 July 1925

Note: In a few instances, signatures of incumbent Surveyors General appearing on official township plats are dated after the indicated effective date of the successor's appointment.