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## Health and Disease in Nineteenth-Century San Francisco: Skeletal Evidence from a Forgotten Cemetery

### ABSTRACT

Burials from the Legion of Honor cemetery provide osteological evidence of the living conditions experienced by economically disadvantaged people who died in San Francisco during the last half of the 19th century. Comparisons suggest their lives were similar to those of other lower-class 19th-century Americans. Rapid population growth, overcrowded housing, sanitation problems, and water contamination probably contributed to the shared disease patterns seen in urban areas throughout the United States in the mid-19th century. Some significant population differences, however, do exist. The relatively high frequency of enamel hypoplasia in the Legion of Honor population may be attributed to conditions unique to San Francisco's urban poor as well as to the stressful conditions the city's immigrants faced as children in their places of origin. The lower frequency of nasal fractures may be attributed to changing patterns of interpersonal violence associated with the commercialization of boxing during the early-20th century.

### Introduction

During the 1994 renovation of San Francisco's California Palace of the Legion of Honor, more than 900 burials were discovered in an area formerly occupied by the Golden Gate Cemetery. Archaeological data and historical records suggest that these people were interred between 1868 and circa 1906. Artifactual and skeletal evidence indicates that most of the burials are those of poor, working-class people of European ancestry. People of other ethnicities (Chinese and perhaps Native American) were also buried in the cemetery, and the associations of some of the burials suggest access to considerable wealth. These individuals, however, are not part of the sample studied. Some of the material recovered from the

cemetery consists of amputated body parts, fetuses, preserved medical specimens, and other remains that appear to be hospital waste (Chatten et al. 1997). Access to the Palace of the Legion of Honor skeletal collection for osteological analysis was limited to a few days immediately prior to its reburial. As a result, only a small fraction of the total sample was studied. In order to collect the maximum amount of data possible, the analysis, consequently, was limited to a subsample of 90 comparatively complete, non-commingled, adult skeletons with well-preserved crania.

Many researchers have noted the scarcity of non-Native American skeletal samples from the historic period of North America (Thomas et al. 1977; Owsley et al. 1987; Rathbun 1987; Scullin and Gramly 1989; Owsley 1990; Murray and Perzigian 1995). While several studies in recent years have contributed to understanding historic period health and living conditions, very few collections from the western United States have been analyzed. Although the group of 90 individuals studied is a small sample of the Legion of Honor cemetery burials, it is one of the largest collections of 19th-century skeletal remains from the western United States and provides important data on the health status of the 19th-century inhabitants of San Francisco.

### Cemetery History

In 1858, near Lands End in San Francisco, 200 acres of sand dunes were set aside for a cemetery; a few years later, this area was designated the Golden Gate Cemetery. This municipal cemetery received a high proportion of San Francisco's poor and indigent people (Ambro 1990) and thus was considered by many people to be a less desirable burial place than the city's many private cemeteries that were maintained by religious and fraternal groups. The cemetery is rarely mentioned in historical documents, suggesting that little importance was attached to it (Chatten et al. 1997). Golden Gate Cemetery is not listed in any of the early San Francisco directories, and city records concerning the cemetery were most likely burned in the fire following the 1906 earthquake (Lockwood 1978).

An 1879 National Park Service report states that the Golden Gate cemetery was used to bury smallpox victims, paupers, and people of Chinese ancestry (cited in Chatten et al. 1997). The medical examiner reported that 4,070 Chinese, 6,454 indigents, and 980 people from charitable organizations had been interred in Golden Gate Cemetery by 1887, along with 267 burials relocated from Yerba Buena Pioneer cemetery. In 1893, part of Golden Gate Cemetery was converted into the Fort Miley Military Reservation. By that time, it was estimated that about 18,000 people had been interred there (1995 Medical Examiner press release, cited in Chatten et al. 1997).

In 1900, a city ordinance banning burials within the city and county of San Francisco marked the end of the cemetery's active use and the beginning of attempts to relocate the bodies interred there. Although a city ordinance was passed stipulating that all the burials in the cemetery were to be moved to the neighboring city of Colma by 1911, this plan clearly was not successfully implemented. Surviving documents refer to the removal of fewer than 1,000 bodies, and the contractors hired to move the burials appear to have removed only the headstones in many cases (Rowlands 1998).

#### Excavations at the California Palace of the Legion of Honor

Originally built in 1915, the California Palace of the Legion of Honor, an art museum located in the area of the former Golden Gate Cemetery, was declared seismically unsound in the late 1980s, and plans were made to expand it as part of seismic retrofit work. These improvements included two subterranean levels beneath the courtyard and a service tunnel (Chatten et al. 1997). Testing in preparation for the retrofitting revealed that a large portion of the cemetery was still present beneath the museum complex, with burials just six inches under the existing lawn (Rowlands 1998).

The burials examined during our analysis (N=90) were excavated in several of the areas impacted by the construction. The majority (N=73) came from the exterior of the building in the courtyard area and the interior of the building in the west basement area (Figure 1). The remaining burials were discovered outside

of the building under the front lawn and along the west side. Eighty-seven of these people were buried in the same type of redwood coffin, which measured 6 feet long, 1 foot wide at head, 9 inches wide at the foot, 1 foot 6 inches at the widest point, and 10 inches deep. The three remaining individuals were buried together in a wooden box (Chatten et al. 1997).

Artifacts found with the Legion of Honor burials included buttons, buckles, snaps, fasteners, and shroud pins. A few burials contained personal effects such as eyeglasses, shoes, and crutches. Items of jewelry included silver earrings, jade earrings, a ring, and jade bracelets. Several burials were associated with religious items such as crucifixes and rosaries. Although items suggesting Chinese ethnicity were found with some of the burials recovered from the cemetery, none of the burials examined were associated with such items.

#### Methods

To gain an understanding of the health and living conditions of San Francisco's 19th-century population, data on age, sex, osteometrics, and pathological conditions were collected on adult burials (Buikstra and Ubelaker 1994). A hierarchical approach was used to determine

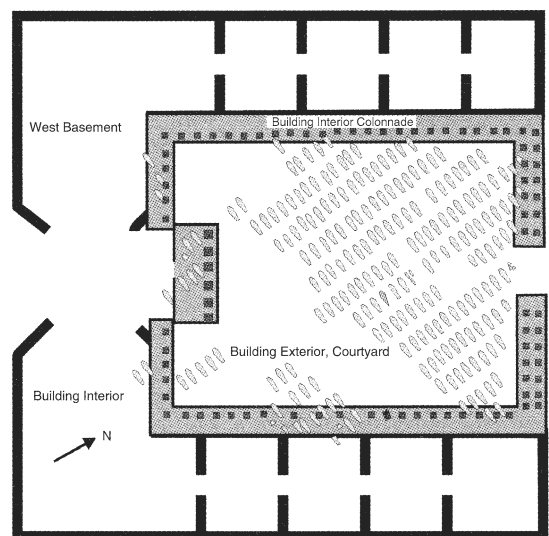


FIGURE 1. Map of the Palace of the Legion of Honor Excavation (adapted from Chatten et al. 1997).

the age at death of the people in this sample. As the pubic symphysis is considered the most reliable indicator of age for adults (Buikstra and Ubelaker 1994), age was preferentially assigned based on pubic symphysis morphology (Brooks and Suchey 1990). When the pubic symphysis was not preserved, which was often the case, tooth wear was used as the basis for age determination (Scott 1979). Because the analyses were limited to adult individuals, no conclusions about children in this population can be made. Analysis was also limited to well-preserved individuals, which may bias the sample against older, osteoporotic individuals.

Tooth wear on the mandibular and maxillary molars was scored using the Scott system (Scott 1979) in which each molar is divided into quadrants, and wear in each quadrant is scored on a scale of increasing severity from 1 to 10. When present, the molars on the left side were scored. If the left side was missing or unobservable, the right was used. A series of multiple regression equations were used to predict age based on the person's first and second molar wear scores. These equations were developed using the molar-wear scores of known-age individuals in the Terry Collection, an early-20th-century skeletal series that contains people whose socioeconomic status was similar to that of the people buried in the Legion of Honor Cemetery. The average error of the age estimates obtained using these equations was 7.43 years. Twenty-eight of the Legion of Honor burials were aged using this method. Most of the remaining individuals whose age could not be estimated based on pubic symphysis morphology or molar-wear scores could be placed in one of the following age groups based on age-related features such as cranial suture closure (Buikstra and Ubelaker 1994): Young Adult=17 years to 34 years; Middle Adult=35 years to 49 years; Old Adult=50 years or greater; Adult=adult individuals for which more precise age data are unavailable.

Sex determinations were also made using a hierarchical approach. As the most reliable indicator (Buikstra and Ubelaker 1994), sex was first assigned to individuals whose pubic bones and other pelvic remains gave clear indications of their sex. When pelvic indicators were not preserved, cranial traits were used. Sexually dimorphic pelvic traits were scored using

the protocol described in *Standards for Data Collection from Human Skeletal Remains* (Buikstra and Ubelaker 1994). If the ventral arc of the pubis and the subpubic concavity both indicated a sex of female, then a pelvic sex of female was assigned. If these same features indicated a sex of male, a pelvic sex of male was assigned. For most individuals, the greater sciatic notch was the only available sexually dimorphic pelvic feature. Burials with hyperfeminine (scores of 1 or 2) or hypermasculine (score 5) sciatic-notch morphologies were also assigned the appropriate sex, and os coxae with extremely large preauricular sulci (score of 1) were assigned a pelvic sex of female.

Since people with poorly preserved cranial remains were not included in the sample, most of the burials possessed several observable sexually dimorphic cranial traits that could be scored using the protocol outlined in *Standards for Data Collection from Human Skeletal Remains* (Buikstra and Ubelaker 1994). Observations of these cranial traits made on skeletons from people of known sex in the Terry Collection were used to generate a series of logistic regression equations for use in sex determination. Formulae that performed well in these tests were then used to assign sexes to burials lacking well-preserved pelvic remains. The following formulae were used: Formula 1, sex=glabella + mental eminence + mastoid process; Formula 2, sex=glabella + supra-orbital margin + mental eminence; Formula 3, sex=glabella + supra-orbital margin + mastoid process. Formulae 1, 2, and 3 correctly classified 90%, 85%, and 89%, respectively, of the Terry Collection individuals.

Owing to the limited time available for analysis, osteometric observations were only made on the humerus and femur. The measurements taken corresponded with those used by Richard Steckel and Jerome Rose (2002), as they are the most frequently present. For the humerus, the maximum length, the minimum circumference, and the midshaft mediolateral and anteroposterior diameters were recorded. For the femur, the maximum length, and the midshaft mediolateral and anteroposterior diameters were recorded. Stature estimates were calculated from long bone lengths using the Trotter equations for White individuals (1970).

For each individual, the number of permanent teeth present, the number of teeth lost

antemortem, the number of teeth with carious lesions and/or fillings, and the number of teeth lost postmortem were recorded. The number of abscesses present and occurrences of enamel hypoplasia on the incisors and canines were also recorded. Enamel hypoplasia was recorded using the following system: 0=no observation possible, 1=no hypoplasias present, 2=one hypoplasia present, 3=two or more hypoplasias present.

All skeletal elements were examined for the presence of pathological conditions. Special attention was paid to the identification of cribra orbitalia, porotic hyperostosis, tibial periostitis, and traumatic injuries. These conditions were recorded using the methods described by Steckel and Rose (2002).

## Results

Archaeological records (Chatten et al. 1997) show that 578 adults and 173 infants were excavated during the renovation work at the Palace of the Legion of Honor (Table 1). During the excavation, 381 of the burials were sexed on site by the archaeologists, based on skeletal morphology and artifact associations. Of these, 33% (124) were judged in the field to be female and 67% (257) male (Chatten et al. 1997) (Table 1). The high percentage of males is consistent with the fact that pauper cemeteries usually contain more males than females (Higgins and Sirianni 1995; Murray and Perzigian 1995; Nawrocki 1995). The predominance of males is also consistent with a California Department of Public Health (1875)

report indicating that in 1874, males made up 62% of California's population.

Of the adults recovered from the cemetery, 16% (N=90) were studied. Owing to poor preservation, 50% (45/90) could not be aged more precisely than the determination that they were adult at the time of death. Of the remaining individuals, 22% (10/45) were young adults, 64% (29/45) were middle-aged adults, and 13% (6/45) were elderly people. Eighty-nine percent (80/90) of the burials could be sexed. Thirty percent (24/80) of these individuals were females, and 70% (56/80) were males (Table 1).

The mean femur length for the Legion of Honor sample was 460.0 mm for males (N=45, s.d.=27.0 mm) and 434.5mm for females (N=20, s.d.=31.9 mm). Using the equations of Mildred Trotter (1970) for White individuals, average adult height was estimated as 161.36 cm for the females (N=20, s.d.=7.9 cm) and 170.97 cm for the males (N=45, s.d.=4.6 cm).

The people buried in the Legion of Honor Cemetery suffered from poor oral health (Table 2). Forty-three percent (34/80) displayed at least one carious lesion, 80% (61/76) exhibited antemortem tooth loss, and 34% (27/80) have at least one abscess. Enamel hypoplasia was observed in 50% (29/58) of those who retained at least one of the teeth (incisors or canines) scored for this condition (Table 2). Hypoplastic lesions were present in 29% of the incisors and 46% of the canines examined. There are no statistically significant differences among the members of different age or sex groups in the frequency of these oral pathologies.

TABLE 1  
DISTRIBUTION OF THE LEGION OF HONOR BURIALS BY AGE AND SEX

|                            | This Study | Burials Excavated<br>(Chatten et al. 1997) |
|----------------------------|------------|--------------------------------------------|
| Total Individuals          | 90         | 751                                        |
| Young adult                | 10         |                                            |
| Middle adult               | 29         |                                            |
| Elderly adult              | 6          |                                            |
| Adult of indeterminate age | 45         | 578                                        |
| Subadults                  | 0          | 173                                        |
| Sexed Individuals          | 80         | 381                                        |
| Female                     | 24         | 124                                        |
| Male                       | 56         | 257                                        |

TABLE 2  
FREQUENCY OF PATHOLOGICAL CONDITIONS BY AGE AND SEX

| Pathological Condition  | Young Adult<br>+N (%) |               |   | Middle Adult<br>+N (%) |               |                | Elderly Adult<br>+N (%) |                |   | Indeterminate Adult<br>+N (%) |                 |               | Total<br>+N (%) |                 |                |                 |
|-------------------------|-----------------------|---------------|---|------------------------|---------------|----------------|-------------------------|----------------|---|-------------------------------|-----------------|---------------|-----------------|-----------------|----------------|-----------------|
|                         | M                     | F             | I | M                      | F             | I              | M                       | F              | I | M                             | F               | I             | M               | F               | I              | Total           |
| Dental caries           | 1/6<br>(16.6)         | 1/4<br>(25.0) |   | 6/20<br>(30.0)         | 2/4<br>(50.0) | 2/4<br>(50.0)  | 3/5<br>(60.0)           | 0/1<br>(00.0)  |   | 13/24<br>(54.2)               | 6/11<br>(54.2)  | 0/1<br>(00.0) | 23/55<br>(41.8) | 9/20<br>(45.0)  | 2/5<br>(40.0)  | 34/80<br>(42.5) |
| Antemortem tooth loss   | 4/6<br>(66.7)         | 3/4<br>(75.0) |   | 14/19<br>(73.7)        | 3/4<br>(75.0) | 1/3<br>(33.3)  | 3/5<br>(60.0)           | 1/1<br>(100.0) |   | 22/23<br>(95.6)               | 10/11<br>(90.9) |               | 43/53<br>(81.1) | 17/20<br>(85.0) | 1/3<br>(33.3)  | 61/76<br>(80.3) |
| Dental abscesses        | 1/6<br>(16.6)         | 0/4<br>(00.0) |   | 7/20<br>(35.0)         | 1/5<br>(20.0) | 3/3<br>(100.0) | 0/5<br>(00.0)           | 0/1<br>(00.0)  |   | 11/24<br>(45.8)               | 4/12<br>(33.3)  |               | 19/55<br>(34.5) | 5/22<br>(22.7)  | 3/3<br>(100.0) | 27/80<br>(33.8) |
| Enamel hypoplasia       | 3/5<br>(60.0)         | 1/4<br>(25.0) |   | 7/16<br>(43.8)         | 2/4<br>(50.0) | 1/2<br>(50.0)  | 2/4<br>(50.0)           | 1/1<br>(100.0) |   | 7/16<br>(43.8)                | 5/6<br>(83.3)   |               | 19/41<br>(46.3) | 9/15<br>(60.0)  | 1/2<br>(50.0)  | 29/58<br>(50.0) |
| Porotic hyperostosis    | 0/6<br>(00.0)         | 0/4<br>(00.0) |   | 0/18<br>(00.0)         | 0/4<br>(00.0) | 0/2<br>(00.0)  | 0/5<br>(00.0)           | 0/1<br>(00.0)  |   | 1/23<br>(4.3)                 | 1/11<br>(9.1)   |               | 1/52<br>(1.9)   | 1/20<br>(5.0)   | 0/2<br>(00.0)  | 2/74<br>(2.7)   |
| Cribra orbitalia        | 0/5<br>(00.0)         | 0/4<br>(00.0) |   | 2/16<br>(12.5)         | 0/5<br>(00.0) | 1/2<br>(50.0)  | 0/4<br>(00.0)           | 0/1<br>(00.0)  |   | 3/24<br>(12.5)                | 0/10<br>(00.0)  |               | 5/49<br>(10.2)  | 0/20<br>(00.0)  | 1/2<br>(50.0)  | 6/71<br>(8.4)   |
| Tibial osteoperiostitis | 1/6<br>(16.6)         | 1/3<br>(33.3) |   | 4/17<br>(23.5)         | 1/5<br>(20.0) | 0/1<br>(00.0)  | 1/5<br>(20.0)           | 1/1<br>(100.0) |   | 4/21<br>(19.1)                | 2/13<br>(15.4)  | 0/4<br>(00.0) | 10/49<br>(20.4) | 5/22<br>(22.7)  | 0/5<br>(00.0)  | 15/76<br>(19.7) |
| Other osteoperiostitis  | 0/5<br>(00.0)         | 1/4<br>(25.0) |   | 1/20<br>(5.0)          | 0/5<br>(00.0) | 0/4<br>(00.0)  | 0/5<br>(00.0)           | 0/1<br>(00.0)  |   | 5/25<br>(20.0)                | 3/14<br>(21.4)  | 1/6<br>(16.7) | 6/55<br>(10.9)  | 4/24<br>(16.7)  | 1/10<br>(10.0) | 11/89<br>(12.4) |
| Traumatic injuries      | 2/6<br>(33.3)         | 2/4<br>(50.0) |   | 8/20<br>(40.0)         | 0/5<br>(00.0) | 0/4<br>(00.0)  | 1/5<br>(20.0)           | 1/1<br>(100.0) |   | 11/25<br>(44.0)               | 6/14<br>(42.9)  | 3/6<br>(50.0) | 22/56<br>(39.3) | 9/24<br>(37.5)  | 3/10<br>(30.0) | 34/90<br>(37.8) |

M=Male; F=Female; I=Indeterminate Sex

+ = number of individuals affected, N = number of individuals examined, % = percentage affected

Several other pathological conditions were observed in the Legion of Honor sample. Porotic hyperostosis was present in 3% (2/74) of the burials and cribra orbitalia in 8% (6/71). All of these lesions were remodeled. No individuals were observed to have both porotic hyperostosis and cribra orbitalia. Due to the small sample size, there are no significant differences in the rates of porotic hyperostosis and cribra orbitalia by sex. Periosteal reactions were common, with 21% (19/90) of the burials showing signs of osteoperiostitis on one or more skeletal elements. The legs were the most commonly affected area, 20% (15/76) had tibial lesions. Of these 15, mild to moderate lesions were exhibited by 6, and 9 had severe lesions. No statistically significant age or sex differences are present in the frequencies of these conditions (Table 2). One individual of indeterminate sex exhibited severe infection on the right tibia characteristic of venereal syphilis. No other diagnostic treponemal lesions (i.e., caries sicca) are present.

Healed fractures or other signs of traumatic injury were observed on 38% (34/90) of the burials. Weapon wounds were apparent in three individuals, with one male showing evidence of a fatal gunshot wound to the head, one showing possible evidence of a gunshot wound, and the other showing evidence of blunt force trauma to the face. Cranial vault injuries were more common in males (23%, 12/52) than in females (9%, 2/23). However, this difference is not statistically significant. Fractures of limb bones also do not differ significantly between males and females (Table 3).

### Comparisons with Other Historical Skeletal Samples

Owing to urban development and land-use regulations protecting archaeological resources, the excavation and analysis of historic cemeteries has become an important part of physical anthropology in North America. In recent years, many articles and reports on skeletal collections from historic cemeteries have been published (Grauer 1995; Saunders and Herring 1995; Owsley and Rose 1997). These historic-period skeletal collections often consist of the remains of people of low socioeconomic status buried in cemeteries whose locations were little noted and soon forgotten. Owing to the comparatively recent urbanization of most of the western United States, most opportunities to study skeletons from historic cemeteries have occurred in the eastern half of North America. Only a few collections of non-Native American historic-period skeletons have been analyzed from the western United States. Among these are a small mid-19th-century cemetery from Seccombe Lake Park in San Bernardino, California (Walker and Lambert 1991), the Santa Barbara Presidio (Costello and Walker 1987), a Mormon pioneer population from Salt Lake Valley, Utah (Tigner-Wise 1989), and the Freedman's cemetery in Dallas, Texas (Condon et al. 1998; Tiné 2000). The Legion of Honor cemetery thus provides an opportunity to study a large collection of burials from a population for which very little skeletal data are currently available.

To obtain an overview of the health status of the Legion of Honor population relative to that

TABLE 3  
TRAUMATIC INJURIES BY ELEMENT AND SEX

| Area of Body  | Male<br>+/N (%) | Female<br>+/N (%) | Indeterminate<br>+/N (%) | Total<br>+/N (%) |
|---------------|-----------------|-------------------|--------------------------|------------------|
| Arm           | 3/54 (5.6)      | 2/23 (8.7)        | 0/10 (0)                 | 5/87 (5.7)       |
| Leg           | 3/52 (5.8)      | 2/23 (8.7)        | 2/10 (20)                | 7/85 (8.2)       |
| Nose          | 2/48 (4.2)      | 0/22 (0)          | 0/10 (0)                 | 2/80 (2.5)       |
| Cranial vault | 12/52 (23.1)    | 2/23 (8.7)        | 0/10 (0)                 | 14/85 (16.5)     |
| Hand          | 4/53 (7.5)      | 1/22 (4.5)        | 0/10 (0)                 | 5/85 (5.9)       |
| Weapon        | 2/56 (3.6)      | 2/24 (8.3)        | 0/10 (0)                 | 4/90 (4.4)       |

+ = number of individuals affected, N = number of individuals examined, % = percentage affected

of other 19th-century Americans, comparisons were made with the sample of 31 non-Native American collections compiled as part of the Health and Nutrition in the Western Hemisphere project (Steckel and Rose 2002). Included in the Western Hemisphere sample are large historic-period North American collections such as the St. Thomas' Anglican Church Cemetery in Belleville, Ontario (Saunders et al. 1993, 1997; N=604), a combined sample from historic cemeteries in Texas (Condon et al. 1993; Hoffman et al. 1993; N=1,157), the Freedman's Cemetery in Dallas (Condon et al. 1998; Tiné 2000; N=1,157), the Highland Park Cemetery in Rochester, New York (Lanphear 1988; Higgins and Sirianni 1995; Higgins et al. 2002; N=296), and the First African Baptist Church Cemetery in Philadelphia (Blakey et al. 1994; Rankin-Hill 1997; N=90). Since the African American and European-American samples included in the Western Hemisphere database differ significantly in a number of respects, the Legion of Honor sample will be compared separately to the African American and Euroamerican subsets.

Comparisons were also made with data collected on the Terry Collection from the Smithsonian Institution National Museum of Natural History and Hamann-Todd Collection at the Cleveland Museum of Natural History. Anatomist Robert Terry acquired the Terry Collection primarily during the first half of this century. This material consists of the skeletal remains of 1,730 individuals of European and African descent whose bodies were obtained for medical research from the dissecting rooms of Washington University School of Medicine in St. Louis, Missouri. The Hamann-Todd Collection of more than 3,000 individuals is composed of mostly the unclaimed bodies from the Cuyahoga County Morgue and city hospitals in Cleveland, Ohio, that had been dissected by anatomy classes at Case Western Reserve University (Jones-Kern and Latimer 1996). Individuals used as cadavers during this time tended to be those of indigent people or the urban poor who could not afford to be buried. These collections are thus biased towards people with low socioeconomic status and individuals who probably had minimal health care. In this respect, they are similar to the poor people buried in the Legion of Honor cemetery. While overall the Legion of Honor sample appears similar to the

pooled samples of Euroamericans and African Americans in the Western Hemisphere database sample, some interesting differences are evident when site-specific comparisons are made.

### *Height*

The study of adult stature provides a nonspecific indicator of stress (Goodman and Martin 2002). The average estimated heights of the males (171 cm) and females (161 cm) do not differ significantly from those of people of European origin buried in other historical sites such as Uxbridge in Massachusetts (Wesolowsky 1991), the Oneida Burial site in New York (Nawrocki 1995), the Freedman's Cemetery in Dallas (Condon et al. 1998; Tiné 2000), the Harvie cemetery in Ontario (Saunders and Lazenby 1991), and the Monroe County Almshouse (Higgins et al. 2002). The males from the Snake Hill military cemetery (Saunders 1991; Sledzik and Sandberg 2002), in contrast, are on average about 6 cm taller than the Legion of Honor males ( $t=-3.47$ ,  $df=70$ ,  $p<0.005$ ). Military recruitment procedures favoring taller men probably account for this height difference (Saunders 1991).

### *Tooth Wear*

Tooth wear patterns can provide information on diet, food preparation techniques, habitual activities, and the age structure of a population. The average Scott (1979) wear scores for the Legion of Honor sample are 18.1 for the first molar and 15.6 for the second molar. The average difference between the mandibular M1 and M2 scores calculated on an individual basis is 2.7. This wear differential is similar to that seen in other 19th-century Americans such as the Terry collection (3.4; Buzon et al. 1999), Cedar Grove (2.5; Rose and Santeford 1985), and Elko Switch cemeteries in Arkansas and Alabama (2.2; Shogren et al. 1989) (Table 4). Yet, the total wear scores are higher for the people in the Legion of Honor sample. This difference probably reflects the low frequency of young adults in the Legion of Honor samples (Walker et al. 1991).

### *Dental Caries and Antemortem Tooth Loss*

Often associated with an increased consumption of processed sugar, a high

TABLE 4  
COMPARISON OF MEAN MANDIBULAR MOLAR WEAR

| Sample          |      | Tooth<br>M1 | M2   | M1-M2 wear<br>score difference | Source              |
|-----------------|------|-------------|------|--------------------------------|---------------------|
| Legion of Honor | Mean | 18.1        | 15.6 | 2.7                            | Present study       |
|                 | N    | 39          | 41   |                                |                     |
| Terry           | Mean | 13.6        | 10.3 | 3.4                            | Buzon et al. 1999   |
|                 | N    | 58          | 75   |                                |                     |
| Cedar Grove     | Mean | 12.4        | 9.9  | 2.5                            | Rose 1985           |
|                 | N    | 67          | 85   |                                |                     |
| Elko Switch     | Mean | 12.2        | 10.0 | 2.2                            | Shogren et al. 1989 |
|                 | N    | 47          | 67   |                                |                     |

proportion of individuals from historic-period North American samples typically have high caries rates: 47% of the Uxbridge Almshouse (Wesolowsky 1991), 51% of the Highland Park (Sutter 1995), and 100% of the Salt Lake Valley (Tigner-Wise 1989) burials have teeth with carious lesions (Table 5). While the Legion of Honor sample has a lower caries frequency (43% of individuals; 8% of teeth) than most other historic populations, 80% of the burials had antemortem tooth loss, and much of this is likely to be the result of carious lesions and overall poor dental health (Goodman and Martin 2002). No evidence of dental care (fillings, etc.) was found. Dental care during this time period was not widely available, and the low socioeconomic status of the population makes it unlikely that they could afford the service. When the proportion of individuals

with carious or missing teeth is calculated for the Legion of Honor collection, the rate is more comparable to that found for other 19th-century collections (Table 5). The fact that the Legion of Honor sample contained a relatively large proportion of older adults with antemortem tooth loss may thus explain their comparatively low caries rate.

#### *Enamel Hypoplasia*

Enamel hypoplasia is a deficiency in enamel thickness of a tooth resulting from a disruption in the secretory/matrix phase of amelogenesis. Although hypoplastic lesions frequently result from systemic metabolic stress (high fever, infectious agents, malnutrition, hormonal changes), local trauma, hereditary conditions, and other factors can also disrupt enamel

TABLE 5  
CARIES AND ANTEMORTEM TOOTH LOSS (ATML)

| Site             | Caries Lesions |               | ATML<br>Ind.<br>%(N) | Caries + ATML |               | Reference                                                                                                           |
|------------------|----------------|---------------|----------------------|---------------|---------------|---------------------------------------------------------------------------------------------------------------------|
|                  | Ind.<br>%(N)   | Teeth<br>%(N) |                      | Ind.<br>%(N)  | Teeth<br>%(N) |                                                                                                                     |
| Legion of Honor  | 43(80)         | 7.8(1,326)    | 80(76)               | 88(90)        | 32.9(1,820)   | Present Study<br>Wesolowsky 1991<br>Saunders et al. 1997<br>Tigner-Wise 1989<br>Higgins et al. 2002;<br>Sutter 1995 |
| Uxbridge         | 47(17)         |               | 91(23)               | 96(22)        |               |                                                                                                                     |
| Belleville       |                | 31(4,605)     |                      |               | 45.9(6,525)   |                                                                                                                     |
| Salt Lake Valley | 100(9)         | 32.2(202)     |                      |               |               |                                                                                                                     |
| Highland Park    | 51(204)        | 31.7(3,196)   |                      |               | 37.3(2,332)   |                                                                                                                     |
| Cedar Grove      | 45(44)         | 11.9(875)     |                      |               |               | Rose and Santeford<br>1985                                                                                          |

Ind.=Individuals affected; N=Number examined



formation (Goodman et al. 1980; Goodman and Armelagos 1985a,b; Dobney and Goodman 1991; Guatelli-Steinberg 2001; Goodman and Martin 2002). Hypoplastic lesions were found in the anterior teeth of 50% (29/58) of the Legion of Honor burials that retained one or more incisor or canine. This frequency is significantly higher (30%,  $X^2=9.7$ ,  $p<.001$ ) than that of the Americans of European origin in the Western Hemisphere database sample. The Legion of Honor individuals, however, are similar to African Americans in the Western Hemisphere sample, 60% of whom had lesions on their anterior teeth. When examining just incisors, 29% of the Legion of Honor population is affected, which is similar to the other samples. The frequency of individuals with hypoplastic canines (46%), though, is significantly higher than the Euroamerican Western Hemisphere database sample frequency (26%) and significantly lower than the African American Western Hemisphere sample (60%).

Intersite comparisons show that the frequency of individuals with hypoplastic anterior teeth is relatively high in the Legion of Honor sample (50%). For example, 4% (1/25) of the military sample from Snake Hill (Owsley et al. 1991), 6% (2/32) of the Uxbridge Almshouse sample (Wesolowsky 1991), 36% (91/253) of Belleville sample (Saunders and Keenleyside 1999), and 37% (18/49) of the adult Dunning cemetery sample (Grauer et al. 1999) have hypoplastic lesions on their teeth. It is important to note, however, that a few 19th-century North American cemeteries have higher rates of enamel hypoplasia than we observed in the Legion of Honor sample (84.5%, Highland Park Cemetery, Lanphear 1988; 68.5%, Freedman's Cemetery, Tiné 2000; 100%, First African Baptist Church Cemetery, Rankin-Hill 1997).

### *Osteoperiostitis*

Osteoperiostitis, a nonspecific stress indicator with a variety of causes including trauma, pathogenic organisms, and nutritional deficiencies (Ortner and Putschar 1985; Goodman and Martin 2002), is present on the tibia in 20% of the individuals in the Legion of Honor sample. This frequency is comparable to that of other Americans of European origin in the Western Hemisphere database (22%). Individual sites

show similar frequencies as well, such as Uxbridge (Wesolowsky 1991), in which 25% (6/24) display tibial osteoperiostitis; combined military samples (Sledzik and Sandberg 2002), in which 11% (8/71) have the condition; and the St. Thomas cemetery population (Sledzik and Sandberg 2002), noted in 10% (13/135) of the adults. The Legion of Honor database is lower than that found in the adult skeletons at the Monroe County Poorhouse (Higgins et al. 2002), which finds that 39% (74/194) show signs of tibial infection.

The frequency of lesions in the Legion of Honor sample is significantly lower than the African American subset of the Western Hemisphere sample (59%,  $X^2=47.3$ ,  $p<0.001$ ), which includes two large collections from Cedar Grove (54% of adults, Davidson et al. 2002) and the Freedman's Cemeteries (52% of adults, Davidson et al. 2002) with exceptionally high tibial osteoperiostitis rates.

### *Porotic Hyperostosis and Cribra Orbitalia*

Porotic hyperostosis and cribra orbitalia are thought to be manifestations of marrow hyperplasia in response to childhood episodes of iron deficiency anemia. These conditions have been associated with systemic infection, especially diarrheal disease (Walker 1985, 1986), and adaptation to infection by microorganisms (Lallo et al. 1977; Kent 1986; Stuart-Macadam 1992). Six of the individuals with preserved orbits (8%) show cribra orbitalia, and porotic hyperostosis of the cranial vault was observed in 3% (2) of the individuals with the requisite cranial bones. These frequencies do not differ significantly from the Western Hemisphere database sample as a whole. The collection from the Monroe County Almshouse (Higgins et al. 2002) shows a comparable rate of cribra orbitalia (9.8%, 18/183) and porotic hyperostosis (1.6%, 3/193), as do the combined military samples (Sledzik and Sandberg 2002), which show 3.2% (2/63) affected by cribra orbitalia and 5.7% (4/70) affected by porotic hyperostosis. The Cedar Grove (Rose and Santeford 1985) and First African Baptist Church samples (Rankin-Hill 1997), in contrast, show a significantly higher frequency of porotic hyperostosis with 26% (21/80) and 53% (40/75), respectively, of the adults exhibiting lesions.

### *Traumatic Injuries*

The study of traumatic injuries in archaeological populations can shed light on patterns of violence and aggression as well as daily behavior (Goodman and Martin 2002). The frequency of individuals with traumatic injuries in the Legion of Honor sample (38%), which includes one gunshot victim, is higher than the Euroamerican (20%) and the African American (9%) subsets of the Western Hemisphere sample. While similar to some civilian collections, such as that from the Dunning Cemetery (Grauer et al. 1999) where 24% of the burials had evidence of trauma, the frequency of lesions in the Legion of Honor sample is, as would be expected, lower than that of trauma victims (56%) among the Snake Hill military cemetery burials (Owsley et al. 1991).

When comparisons are made of the distribution of injuries within the body (Table 3: arm, hand, leg, cranial vault, face, nose), the relative frequencies of injuries in the Legion of Honor collection does not differ significantly from the Western Hemisphere database sample. The frequency of nasal injuries (2.8%) is significantly lower ( $X^2=22.07$ ,  $p<.001$ ) than the Terry Collection frequency (27.8%, Walker 1997).

### Discussion

According to the California Board of Health report for 1874–75, most diseases afflicting the people of San Francisco (such as tuberculosis, cholera, diphtheria, scarlet fever, typhoid, and malaria) were prevalent in other areas of the United States at the time. Although epidemic-related mortality had an irregular spatial and temporal distribution in the United States, mortality rates were similar for most major cities during the second half of the 19th century. At this time, most of the United States, especially more densely populated urban areas, experienced rapid growth, accompanied by overcrowded, substandard living conditions, poor sanitation, and contaminated water supplies (CA Dept of Public Health 1875). The similar conditions in many urban areas probably contributed to the comparable disease patterns seen throughout the widely distributed 19th-century urban American populations.

This spatial homogeneity is consistent with our comparisons of 19th-century North American skeletal collections. For example, the frequency of osteoperiostitis and porotic hyperostosis in the Legion of Honor sample is similar to that found in skeletal samples from urban areas. Enamel hypoplasia, however, is clearly higher in the Legion of Honor cemetery in comparison to other historic samples. How can we account for this difference?

There is evidence that the environment in San Francisco in the latter half of the 19th century was conducive to the growth disruption from malnutrition and acute systemic infection that is often associated with enamel hypoplasia. The Gold Rush of 1849 had a dramatic effect on the population of California. Vast numbers of people began to arrive during this time. San Francisco suddenly changed from a small pueblo to an international city. Unlike other gold rush areas (such as Alaska), the masses of people who came to California stayed, even when gold discoveries declined. This large population influx formed the basis for the development of other urban centers in California. San Francisco, with the largest population and the port of entry for supplies and people, was the most important of these. The growth of the state's agricultural economy insured the city's preeminence as the state's doorway for import and export goods, even after the Gold Rush waned (Asbury 1933; Chartkoff and Chartkoff 1984).

This population growth was not without its consequences. Of the more than 25,000 people living in San Francisco in 1850, the vast majority were adult males under the age of 40. There were not nearly enough dwellings to shelter these newcomers. Most lived in leaky canvas tents or shanties. Insects and rats were prevalent. In addition, nutritious sources of food, like vegetables, were very expensive—a luxury only for the rich (Lewis Publishing Company 1892; Asbury 1933). According to the *Annual Report from the Board of Health of California in 1874–5* (CA Dept. of Public Health 1875), although the climate should have been most salubrious without extremes of heat or cold, in many places the water was full of sewage and constantly emitted noxious vapors. In San Francisco, sewage drained into the bay at the edge of the low tide zone, and by 1875

water pollution had become a tremendous health problem (CA Dept. of Public Health 1875). Drainage was faulty, and supplies of good potable water were scarce (Lewis Publishing Company 1892). The same municipal government, drainage system, water supply, and haphazard mode of multiplying buildings, originally created for a town of 50,000, was being forced to support a city of 250,000 in 1875 and nearly 300,000 in 1890 (Lockwood 1978). While the town was filled with tales of a few fortunate miners, there were thousands of hard-working men who were on the verge of starvation, living in squalor and destitution (Asbury 1933). As the poor are most often affected by contaminated air and impure drinking water, these problems likely affected those who were eventually buried in the Legion of Honor cemetery. These factors undoubtedly contributed to the poor living conditions often associated with enamel hypoplasia (Goodman and Rose 1991).

While it may be expected to also see higher rates of porotic hyperostosis and cribra orbitalia associated with the poor living conditions, the small sample size as well as the lack of children in the population may contribute to the lower observed frequency. Research has suggested that iron deficiency anemia, a major cause of porotic hyperostosis, may produce bone changes only in young children (Walker 1985; Stuart-Macadam 1992).

Not everyone who died in San Francisco was born and/or raised there. In 1874, only 38% of the deaths were of individuals born on the West Coast (CA Dept. of Public Health 1875). The frequency of enamel hypoplasia reveals factors affecting the health of children living in a variety of localities. The high frequency of enamel hypoplasia in the Legion of Honor collection may, therefore, reflect the Gold Rush era immigration into the city of people searching for prosperity they could not find in places (such as the eastern United States, Mexico, Portugal, Italy, France, and China) from which they came (Asbury 1933; Chartkoff and Chartkoff 1984).

A second interesting difference between the Legion of Honor sample and other historical samples is in the frequency of some traumatic injuries. Although the number of people with

traumatic injuries does not differ significantly from the Western Hemisphere database sample as a whole, the number of weapon wounds in the Legion of Honor collection suggests that interpersonal violence was a frequent cause of death in 19th-century San Francisco. This reinforces the image of Gold Rush San Francisco as a rough and tumble, comparatively lawless “boom town.” As a result of the thousands of restless, turbulent, gold-hungry men who arrived, the city was transformed from “the once peaceful hamlet of San Francisco into a bawdy, bustling bedlam of mud holes and shanties” (Asbury 1933:18). A total disregard for life prevailed during the Gold Rush times. Drunken brawls were frequent, many men carried arms that were used at the slightest provocations, bloody duels were a daily occurrence, and shooting on site was a common practice. All of this violence occurred in the absence of real judicial authorities (Lewis Publishing Company 1892). The Gold Rush attracted money seekers and felons from which arose “a unique criminal district that for almost 70 years was the stew of more viciousness and depravity” (Asbury 1933:1). Robberies and assaults too numerous to count in addition to an average of two murders a day resulted in the formation of the Vigilance Committee in the early 1850s. While this group of residents organized to tame crime created a safer city for a few years, by the mid-1850s San Francisco “was again a hell-roaring swirl of crime and debauchery” and within months conditions were at least as bad as they were in the early gold rush days (Asbury 1933:82).

In addition to revealing the violent nature of life in San Francisco, the patterns of traumatic injuries also give us some insight into the cultural nuances of violence during these times. For instance, the frequency of nasal fractures in the Legion of Honor sample is much lower than that of the Hamann-Todd and Terry collections (27.3%)—Americans who lived during the first part of the 20th century. Although nasal injuries are fairly common in antiquity (Roberts and Manchester 1995), the low frequency of nasal fractures in the Legion of Honor cemetery suggests that fist fighting was uncommon (2.5% of observable crania) among the people buried there (Walker 1997).

Why does the Terry Collection show significantly higher frequencies of nasal fractures than the Legion of Honor sample? Phillip Walker (1997) proposes that the high frequency of nasal fractures in the Hamann-Todd and Terry Collections relative to collections dating earlier in the 19th century, such as the Legion of Honor sample, reflects changes in the cultural patterning of violence associated with the rise of professional boxing. In contrast to the Hamann-Todd and Terry Collections, the lower frequency of nasal fractures in the Legion of Honor sample may be explained by the fact that most of these people lived during the mid-19th century, before the popularization of boxing by the mass media in the United States.

### Conclusion

The Legion of Honor burials provide an opportunity to examine osteological evidence of the living conditions experienced by people who lived in San Francisco during the last half of the 19th century. Overall, comparisons with other North American samples suggest that these individuals experienced living conditions broadly similar to those of contemporaneous economically disadvantaged Americans. The widespread presence of unfavorable living conditions associated with rapid population growth, overcrowded housing, and contaminated water supplies in urban areas undoubtedly contributed to the similar disease patterns seen in many areas of the United States. A closer look at their health status, however, reveals some differences between populations, including a higher level of enamel hypoplasia and a lower level of nasal fractures.

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