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PRECONCEIVED NOTIONS AND HYPOTHESIS TESTING: HOLES IN THE BLUE HOLE

Bruce M. Rothschild*

Reconciling reported frequencies of periosteal reaction has been compromised by variable "criteria" for its recognition. One of the most important aspects of paleopathologic diagnosis is logical consideration of data, while avoiding biases introduced by preconceived notions. Documentation that skeletal manifestations of the treponemal diseases (as a population phenomena) are sufficiently (and reproducibly) distinct would allow meaningful assessment of the course of invasion and spread of treponemal disease in the Western Hemisphere. Quantitative assessment of the nature of osseous impact of specific treponemal diseases has resulted in identification of reproducible discriminating characteristics. The osseous reaction to treponemal infection, although reproducible for each variety, is not uniform among them. Examination of population frequency, demographics, character, and skeletal distribution of osseous treponemal impact provides clear, reproducible clues to the identity of the underlying treponematoses and help to distinguish them from other periosteal/cortical disorders. Application of the standard for distinguishing among the treponematoses has revealed only four patterns of disease: Those categorized as syphilis, yaws, bejel and a null pattern. The apparently inviolate categorization allows confidence in distinguishing among them.

Key words: Treponematoses, paleopathology, differential diagnosis.

El ajuste de las frecuencias reportadas de reacción periosteal ha sido comprometido por el "criterio" variable de su identificación. Uno de los aspectos mas importantes del diagnóstico paleopatológico son las consideraciones lógicas de los datos, mientras se evitan prejuicios de nociones preconcebidas. La documentación relativa a que las manifestaciones esqueléticas de las treponematoses (como fenómeno poblacional) son suficientemente distintas permitiría la evaluación significativa del curso de la invasión de la treponematoses en el Hemisferio Occidental. La evaluación cuantitativa de la naturaleza del impacto óseo de las treponematoses específicas ha permitido la identificación de las características discriminantes. La reacción ósea a la infección por treponema, aunque repetitiva para cada variedad, no es uniforme entre ellas. El examen de la frecuencia poblacional, la demografía, el carácter y la distribución esquelética del impacto de la treponematoses provee de pistas claras para la identificación de la treponematoses y permite diferenciarlas de otras condiciones periosteales/corticales. Las aplicaciones del standard para distinguir entre las treponematoses ha revelado sólo cuatro patrones de la enfermedad: las categorizadas como sífilis, pián, bejel y un patrón nulo. La categorización aparentemente inviolada otorga un mayor grado de confianza para poder diferenciarlas.

Palabras claves: Treponematoses, paleopatología, diagnóstico diferencial.

Advancement of science is predicated upon testing of new ideas according to scientifically established information (Spodick 1975). The challenge is distinguishing between scientifically-established information and assumption. Much of what [Heathcote et al. \(1998\)](#) refer to as the "collective consciousness" of anthropology "on the etiology, evolutionary ecology and epidemiology of the treponematoses" seems to be predicated solely on assumption. Unfortunately, repetition of assumptions does not validate them. To paraphrase Will Rogers (Spodick 1975), it aint what we dont know that gets us into trouble, so much as what we think we know, that aint so.

Learning Curve

Variability in reported frequency of periosteal reaction (e.g., [Mack and Armelagos 1992](#); [Pietrusewsky et al. 1997](#)) must be addressed. Does this variation represent real differences or simply interobserver variation - not only in selection of criteria, but also in their application. There are many learning curves in paleopathology. One of the most challenging has been recognizing periosteal reaction and distinguishing it from diagenesis.

It is intriguing that the skeletal distribution of periosteal reaction in the treponematoses is independent of severity ([Rothschild and Rothschild 1994a,b, 1995a,b, 1996a,b, 1997a, Rothschild et al. 1995a](#)). Thus, overlooking subtle changes or confusing them with diagenesis may lead to the false perspective that periosteal reaction is limited in frequency or unilateral. It would seem useful for those individuals, who believe they have found variant populations, to share those cases. Collaborative examination might well resolve the apparent variation.

Similarly, failure to recognize diagenesis may lead to bizarre perspectives of almost total population occurrence. The enigma of the Blue Hole site perhaps exemplifies the problem. [Mack and Armelagos \(1992\)](#) submitted a site report suggesting a high frequency (7 of 9 individuals) of periosteal reaction, yet we found the bones to be absolutely smooth, with the exception of slight periosteal reaction in a single tibia. This appears to be an interobserver/learning curve/communication issue, rather than an occurrence issue. Thus, establishment within the general field of anthropology does not validate the assumption of advanced position on the periosteal reaction/treponemal disease learning curve.

Perhaps a fundamental problem is understanding the difference between pathology and anthropology. Perhaps this is best illustrated by a medical school experience. One pathology professor spilled his slides on the way into the lecture hall. He then picked up the pile of slides, replacing them in the slide carousel in random order. The slides were all photographs, without any text. He then gave the lecture. I subsequently learned that this was a yearly routine, "performed" to make the point that the *pathology speaks for itself*. Context is not the issue in pathology. Clinical case reports may appear to be context-based, until one realizes that a case report is simply a clinical guess/hypothesis. The pathology is the test of that hypothesis!

Comparison of skeletal and clinical frequencies is useful. However, selection of the appropriate clinical comparison sample is essential. If a treatable disease is being studied, it is essential to select comparison populations from the pre-treatment era. Antibiotics have changed the dynamics of the treponematoses, precluding comparison with "naive" disease. Outbreaks under treatment also cannot be compared to untreated endemic disease ([Mills 1955](#)). Attention to detail is essential.

Distinguishing Treponematoses from Non-treponemal Disease

This is simple for the nonvenereal treponematoses. There are no other diseases that have population frequencies of periosteal reaction in the 20-40% range ([McCarty and Koopman 1993](#); [Rothschild 1982](#); [Resnick and Niwayama 1988](#); [Rothschild and Martin 1993](#)). The challenge is more complicated for venereal syphilis, as the osseous lesions have low population frequency ([Rothschild and Rothschild 1994a,b, 1995a,b, 1996a,b](#); [Rothschild et al. 1995a](#)). Its pauciarticular pattern and skeletal distribution can occasionally be mimicked by other forms of osteomyelitis, bone neoplasia, and perhaps by rickets, but trauma, leprosy and tropical ulcers are easily distinguished ([Moller-Christensen 1967](#); [Resnick and Niwayama 1988](#); [Rothschild and Martin 1993](#)).

Trauma represents an often repeated, but unsubstantiated speculation. Such trauma-induced focal bony overgrowths are rare and easily distinguished. The latter appears to derive from misunderstanding of the medical literature. This is exemplified by [Meese and Sebastianellis \(1996\)](#) claim of periostitis in athletes, in spite of normal x-rays. Their impression was based solely on radionuclide bone scans. However, the scans showed only very focal isotope uptake, surrounded by a zone of lesser uptake. While they diagnosed periostitis, the images are actually classic for stress fractures! Stress fractures are readily recognized and distinguished in the osseous record ([Resnick and Niwayama 1988](#); [Rothschild and Martin 1993](#)), even across species lines ([Rothschild 1988](#)).

One critique to recognizing specific diseases is clearly based on what might be considered "diagnostic nihilism". [Heathcote et al. \(1998\)](#) state that "Conventional wisdom has it that... most... bone lesions observed in prehistoric remains cannot be attributed to a specific etiologic agent". That comment might be validly applied to isolated examination of lesions in isolated bones. It might even have application to examination of individuals. However, it has been clearly demonstrated not to be true for population studies. If such perspective were valid, then why study paleopathology?

Populations studies have clearly demonstrated the reproducibility of osseous findings for a given disease, independent of geography and socioeconomic status. The skeletal distribution and character of a given disease are clearly indistinguishable for populations with rheumatoid arthritis and spondyloarthropathy ([Rothschild and Martin 1993](#); [Rothschild and Rothschild 1993](#); [Rothschild and Woods 1991](#); [Rothschild et al. 1992, 1993a](#)). The general reproducibility of osseous findings (for a given disease) is so substantial that it even crosses species lines ([Rothschild and Rothschild 1994c](#); [Rothschild and Woods 1992](#); [Rothschild et al. 1993b, 1994](#)). Thus, the osseous appearance of spondyloarthropathy in gorillas is no different in appearance than that noted in humans ([Rothschild and Woods 1989](#)).

Distinguishing among the Treponematoses

Unproven Speculation

Invalid Criteria: While cranial lesions have been considered, distinguishing among the treponematoses ([Ortner and Putschar 1981](#); [Steinbock 1975](#)), [Hackett \(1976\)](#) stated that he would not even attempt to distinguish among the treponematoses. He felt his skull samples were compromised by significant collection bias, and he did not have documented examples of the various treponemal diseases. Skull findings do not lend themselves to epidemiologic differentiation of the treponematoses.

Insensitive Criteria: Dental stigmata would seem to be a reasonable differential tool, but the various forms of yphillis-attributed hypoplasia are infrequently observed in any syphilis-affected population.

([El-Najjar et al. 1978](#); [Rothschild and Rothschild 1997a](#)). Because they represent hypoplastic teeth, the dental elements often do not survive (in recognizable form) into adulthood and through taphonomic influences ([Pinborg 1970](#); [Putkonen and Paatero 1961](#); [Sullivan 1986](#)). Osseous lesions of congenital or syphilis are a short-lived phenomenon ([Levin 1970](#)), typically resolving over the course of several months, usually precluding their recognition in subadult skeletons ([McLean 1931](#); [Rothschild and Rothschild 1997a](#)).

Circular Reasoning: Time course perspectives of disease epidemiology are dependent on modern distribution, the historical record, and paleopathologic evidence (Cockburn 1963). The preconceived notion of climate determination ([Powell 1995](#)) does not seem to fit with the paleo-epidemiologic findings ([Bogdan and Weaver 1992](#); [Bullen 1972](#); [Neuman 1975](#); Parramore 1970; [Powell 1995](#); [Rothschild and Rothschild 1994a,b, 1995a,b, 1996a,b](#); [Rothschild et al. 1995a](#); [Schermer et al. 1994](#)). It seems appropriate to explore other explanations for the current catchment areas, "islands" where non-venereal treponematoses still exist. Perhaps if we understand the timing of their eradication in other areas of the world, we may have a tool to understand their contemporary persistence patterns. Such would be in keeping with Cockburns (1963) cogent observations. [Heathcote et al. \(1998\)](#) confuse the hypothesis of climate as a significant cofactor in treponemal disease manifestation with evolution. That seems somewhat Lamarckian ([Gould 1998](#)). If climate determines manifestation of a single organism, this would be phenotype, not genotype.

Unitarian Hypothesis

[Heathcote et al. \(1998\)](#) suggest that contemporary anthropologic thinking assumes bejel, yaws and syphilis are simply manifestations of the same disease. Differential animal sensitivity to the different treponemes provides unequivocal evidence that they are different species ([Larsen et al. 1995](#); [Schell et al. 1981](#)). Manifestations of the different treponematoses differed from each other through repetitive passage, while strains of a given treponematoses produced identical findings ([Chacko 1966](#); [Turner and Hollander 1957](#)).

Documented Criteria

Distinguishing syphilis, yaws, and bejel among the treponemal diseases was made possible because of validation ([Rothschild and Rothschild 1994a, 1995a, 1996a](#); [Rothschild et al. 1995b](#)) of criteria ([Rothschild and](#)

[Rothschild 1994a,b](#), [1995b](#), [1996a,b](#); [Rothschild et al. 1995a](#)) for distinguishing among them. These skeletal findings are also indistinguishable from those derived from clinical/radiologic observation ([Csonka 1953](#); [Hackett 1946](#); [Helfet 1944](#); [Hudson 1958](#); [Hunt and Johnson 1923](#); [Jostes and Roche 1929](#); [Moss 1922](#)).

Examined as population phenomenon in *over 100* archaeological sites, only three patterns of disease were observed. Review of over 100 skeletal populations revealed no population with syphilis affecting more than 14% of the population and no population with yaws or bejel affecting less than 20% ([HersHKovitz et al. 1995](#); [Rothschild and Rothschild 1994a,b](#), [1995a,b](#), [1996a,b](#); [Rothschild et al. 1995a](#)). Unilateral tibial involvement and/or total sabre shin remodeling was found only in populations with syphilis. Subadults were affected in yaws and bejel at the same frequency as adults, while less than 5% (usually less than 1%) of subadults were affected in any population with syphilis. Hand and foot involvement was essentially limited to yaws, present in less than 5% of individuals with bejel or syphilis. Average number of bone groups affected was always less than 3 in populations with syphilis and bejel, with the converse noted in yaws. The skeletal impact of these patterns (representing syphilis, yaws and bejel) were sufficiently disparate to allow their individual recognition.

Use of Criteria to Validate Previous Speculation

[Baker and Armelagos \(1988\)](#) speculated that venereal transmission was a post-Columbian event in North America. Others have not been so certain, instead identifying non-venereal treponemal disease ([Bullen 1972](#); [Neuman 1975](#); [Powell 1995](#); [Schermer et al. 1994](#)). Such studies have speculated (on the basis of examination of "classic cases" that treponemal infection in North America was likely yaws or bejel. [Saint-Hoyme \(1969\)](#) specifically reported on yaws-like changes in the midwest of North America. Validated criteria ([Rothschild and Rothschild 1995b](#)) allowed verification of their perspective ([Rothschild and Rothschild 1994a,b](#), [1995a](#); [Rothschild et al. 1995a](#)).

Summary

Critical examination of assumptions/speculations and data clarifies ability to recognize and distinguish among the treponematoses. Interobserver error and misconceptions contribute significantly to confusion. Challenges seem to have been predicated upon untested assumptions and misconceptions. Speculation (that bejel, yaws and syphilis are a single disease, that yaws is always tropical, and that bejel is solely a desert phenomenon) are exposed for what they are - untested or rebutted hypotheses.

Conventional wisdom has suggested that the world is flat at that giraffes developed long necks so they could reach trees. Is anthropology a science or a philosophy? Should anthropology be "Descartian" - I think, therefore I publish - or should it be predicated on the scientific method? Do the "Lamarckian" and "flat-earther" aspects and history of conventional wisdom really represent concepts helpful in understanding the treponematoses or are do they represent pseudoscience often attributed to creationist defenses?

The prepared mind sometimes sees only what it is prepared to see. It is not what we don't know that gets us into trouble, so much as what we think we know, that simply isn't so. Is it not time to allow the data to speak for itself? That data-based approach forms the basis for this symposium.

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