International Journal of Biology; Vol. 15, No. 1; 2023
ISSN 1916-9671 E-ISSN 1916-968X
Published by Canadian Center of Science and Education

Toward a Synopsis of the Challenges Facing Mainstream Interpretations of Skin Pigmentation in Humans

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Received: February 25, 2022 Accepted: April 28, 2023 Online Published: May 31, 2023

doi:10.5539/ijb.v15n1p24 URL: https://doi.org/10.5539/ijb.v15n1p24

Abstract

When traditional or mainstream interpretations of skin pigmentation in humans were proposed, not much data were available about the anatomy of human skin in particular and pigment research in general. The most popular and influential thesis put forth to date to justify the evolution of skin pigmentation is the thesis that skin pigmentation grew out of a natural adaptation of *Homo sapiens* skin to scorching conditions of fiery heat faced with by *Homo sapiens* individuals in equatorial regions of Africa. It is thereby argued that peak UVR [ultraviolet rays] environments encountered in equatorial/savannah climate caused an eccrine gland production to offset the overheating of skin during the high physical activity of hunting exerted by *Homo sapiens* persons. However, with human anatomy increasingly becoming the object of scrutiny from various fronts of biology, newer insights have given rise to significant blind spots vis-à-vis traditional explanations of black skin pigmentation. The present paper takes stock of the major challenges afflicting existing characterizations of human skin evolution. Paths for future research of skin/pigment are suggested. The paper aims to lay out a follow-up on and/or synopsis of recurrent challenges that the space of pigment research has accumulated over the years, giving way to long due synergies. In a world supersensitive to racial equality and dignity, the paper furnishes concerned researchers and policy makers with a much-needed contribution to inquiry into dark- and black-skinned peoples.

Keywords: pigmentation, natural selection, black skin, feet, lips, melanin, deep-set eyes, spinal cord

1. Introduction

Pigment alternatively called colorant is a substance that imparts a specific hue to something. Pigment has existed since the beginning of matter. Pigmentation or coloration of tissues, cells, and organs in microorganisms, plants, animals, and humans typifies one of the characteristics of life production and growth. It is no accident that black pigment is irreversibly abundant in nature; among elements such as rivers, shores, rocks, sands, soils, chemicals, and even in (the skin of) living beings such as trees, fruits, leaves, flowers, roots, branches, seeds, fishes, insects, reptiles, birds, mammals, etc. Nevertheless, when applied to human skin black pigment is enormously misunderstood and mischaracterized (d'Ischia et al., 2013, 2015). Perhaps the biggest enigma of pigment research is that authors addressing the topic black skin pigment come from a mishmash of unrelated backgrounds. But no academic field has experts with a unique or unilateral background, either. Diversity of backgrounds provides authors with a richer and deeper set of perspectives on the topics tackled. A revealing example of diverse-perspective research can be encountered with Varpio and MacLeod (2020) reflections. Multidisciplinary or multi-perspective research is highly beneficial to all types of research.

Still, while reviews have been conducted on the topic (black) pigment (Brancalion, Haase, & Wade, 2022; Caro & Mallarino, 2020; Cibangu, 2022; Solano, 2014, d'Ischia, 2013, 2015; Jablonski, 2017, 2018, 2021; Jablonski & Chaplin, 2017), a follow-up for pigment research has been lacking and important materials along with the challenges leveled from the 19th century onward have gone unnoticed and unconnected, leaving authors with superficial and incorrect approaches toward the issues faced or posed. The most troubling part of the stigma surrounding black pigment is that the stigma is fueled and propagated by highly renowned scholars, with assumingly a (well-intended) given agenda behind. One reason behind the stigma attached to black color of human skin is that academic descriptions of human skin originated in the 18th and 19th centuries in Western Europe in a context of deep-rooted prejudice, remarkably devoid of needed relevant data and theories (details below). Up until the 18th and 19th centuries, black pigment found in human skin, like any pigment, was part of nature, and thus was hardly the object of social stigmas such as poverty, crime, uncivility, unemployment, diseases, homelessness, etc.

2. Significance

The significance of pigment studies has been rising to the fore from wide-ranging phenomena (Brancalion, Haase, &

Wade, 2022; d'Ischia et al., 2013, 2015) such as global, accelerated interactions between people of different color and backgrounds, acute awareness about ecology and its diversity (i.e., animals, plants, living species, landscapes, seascapes, etc.), healthcare policies ever upgraded in protecting human life, and advanced medical procedures. In the same vein, the spectacular development of modern-day industries such as sports, cosmetics, pharmaceuticals, anesthesia, lasers, zoos, microscopes, etc. have brought into question the mainstay of skin color understandings.[1] This development is also compounded on the one hand by mounting specializations of human biology such as sports medicine, zoology, cosmetology, pharmacology, pediatrics, plastic surgery, forest studies, quantum biology, etc., and on the other hand by the hubris about skin-related injustices (e.g., racism, ethnic conflict, civil war, etc.) and life-threatening hazards (e.g., environmental pollution, natural disasters, pandemics, etc.), many of which affecting swaths of populations around the globe for centuries. While challenges to pigment research accrue from newer fields and industries, a one-stop-shopping account of the challenges involved is lacking. This paper seeks to make a contribution by supplying researchers with a synoptic overview of the challenges faced to allow for better equipped inquiries. The paper aims to shed greater light on synergic efforts toward redressing the challenges posed to pigment research in our inextricably multiracial world.

3. Method

Method (Babbie, 2021; Bryman, 2016) represents the part of scholarly work that determines the manner in which data were collected and findings obtained. Since the present paper is one of a conceptual/review nature, its method did not involve experiment. Using Google Scholar, the paper took a deep dive into reviews carried out on pigment/melanin with an eye on common moves/themes traversing the reviews to pinpoint the interpretations/understandings of pigment. The paper did so in light of foundational readings of pigment literature and newer specialties of biology to locate the challenges caused.

4. Literature Review

Literature review (Babbie, 2021; Bryman, 2016) forms the core of scholarly activity. Literature review endeavors to survey prior inquiries achieved on a given topic of a field to take the pulse of that field. Pigmentation scholarship boasts exuberant literature, the rapid evolvement of which brings afresh the central concepts/themes engaged with, gaps/blind spots bypassed, positions/views complied with, arguments made, and issues done with. Although overly racist concepts and views held in fundamental texts/documents of pigmentation body of knowledge have been averted in modern-day pigmentation literature, the interpretations behind those documents have persisted and tend intentionally or unintentionally to obscure current understanding of pigmentation (details below). An interpretation deserving of note here is one in which northern hemisphere is portrayed to be the province of light-pigmented individuals (i.e., Western Europeans) while southern hemisphere represents the homestead of black-skinned peoples, wiping out altogether dark-skinned Innuits and similar Nordic populations. The interpretation is achingly discrepant with the well-documented existence of aboriginal, curled-haired, and black-skinned populations in the Caucasian Mountain (Cibangu, 2022), among others, let alone the marked diversity of peoples in Nordic regions of which Caucasians were/are nothing but a tiny minority.

4.1 Different Phenomena/Properties of the Same Chemical Products

A quick illustration is with two recent detailed reviews, one carried out by animal geneticists Brancalion, Haase, and Wade (2022) on pigmentation in dogs and the other realized by anthropologist Jablonski (2021) on pigmentation in humans. While both reviews delve into the exact same concepts, melanin and/or MC1R [melanocortin 1 receptor], to account for pigmentation, they offer completely different phenomena/properties of the same chemical products. In other words, when melanin and/or MC1R operate in humans they manifest properties that are completely different from the properties they manifest when operating in dogs. Remember that dogs and humans are all mammals, and that melanin is nothing but a chemical substance, more specifically an organic pigment (Pfaff, 2022). In addition, phenomena/ideas such as UVR, high physical activity, equatorial Africa, vitamin D, etc. vindicated beyond parallel by Jablonski (2021) to be key in the coloration of human skin, are not even insinuated in Brancalion, Haase, and Wade (2022) research on the pigmentation of dogs, nor alluded to along the markers of organic pigments (Pfaff, 2022). To give one example, it is like saying that in mangoes calcium does things totally different from those it does in papayas or that there is more calcium in equatorial regions than there is in polar regions. Yet, mangoes and papayas are all fruits. This is, as demonstrated in the present paper, a real thorn in the side of pigment literature. To little avail, previous reviews (d'Ischia et al., 2013, 2015) have bewailed a pronounced disparity among authors about what melanin/black pigment entails. Hence, this paper contribution is one of launching a synopsis of the challenges recurring over the years to allow for concerted effort/work on pigmentation. For ease of discussion, the present paper centers on the manner in which pigmentation is interpreted to take place in (human) nature/biology.

4.2 Foundational Writings/Teachings of Pigment Literature

Some figures, because of their stellar role, have left writings that can be deemed foundational writings/teachings of pigment research. As noted earlier, when academic characterizations of human pigment were first proposed in Western Europe in the 18th and 19th centuries they were purely and simply personal opinions of scholars – mainly because of the popularity commanded by these scholars. The first and perhaps the most leading scholar of black pigmentation in human skin is Swedish naturalist Carl Linnaeus (1707-1778), aka Carl von Linné, who presented one of, if not, the most prestigious categorizations of human species in 1758 in the first volume of his 10th-edition book entitled *Systema Naturae*. This book (Blunt, 1971/2001), first published in 1735, displayed a distinctly and unjustifiably denigrating characterization of Africans described as a negligent and lazy species -- using the Latin words *niger/nigri*, which means black, for Africans, and *albus*/*albi*, signifying white, for Europeans. For better or worse, Linnaeus (1735/1758, pp. 21-22) employed the Latin word *niger* to lump Africans altogether in the category black while denigrating the category. Most important for our discussion, black color of human skin was portrayed by Linnaeus (1735/1758) as equivalent to indecency and uncivility, with no proven, scientific theory or data to support such statements. Linnaeus attended Sweden top-tier University of Uppsala and held a professorship in biology at the University of Uppsala for over three decades, from 1741 until his death in 1778, during which his teachings about black skin gained unimaginably and perhaps ineffaceably wider acceptance.

Equally without complementary relevant data or theory, a student of Linnaeus, German biologist Johann Friedrich Blumenbach (1752-1840), introduced in the classification of Linnaeus (1735/1758) explained supra the now famous if not inerasable concept Caucasian species as White race (Rupke & Lauer, 2019). Blumenbach (1775/1795, p. 303) suggested the concept Caucasian in the 3rd edition of his book which resulted from his doctoral dissertation presented in 1775 at the University of Göttingen, Sweden, on the varieties of humans, and later published in 1795. Blumenbach acknowledged that the proposed concept was arbitrary (see Cibangu, 2022, for further arguments). Perhaps that was the reason why the category Caucasian was not inserted in the original dissertation text of Blumenbach. As an acclaimed professor, Blumenbach lectured at the University of Göttingen in the school of medicine for more than half a century, from 1778 until his death in 1840, propounding unwarranted assumptions about black pigment of human skin. For instance, the binary white/black and the category Caucasian were acknowledged by their respective founders to be arbitrary, with no imperial evidence supplied (Blumenbach, 1775/1795; Linnaeus, 1735/1758). To no purpose, these categories, like many others, and the views behind them have had a wider circulation in textbooks and manuals.

Another highly respected scholar to be noted about black pigment more precisely along the lines of the Linnean classification (Linnaeus, 1735/1758) is German philosopher Immanuel Kant (1724-1804). For over two decades, from 1756 to 1775, Kant taught powerful summer courses on the topic physical geography or human races at the University of Königsberg [in Polish Królewiec, and currently Kaliningrad, now part of Russia]. Entitled *On the Different Races of Humans* and published in 1775 (Kant, 1775), the courses delivered by Kant underlined the notion black race as a subpar race and white race as a race par excellence. Still another distinguished scholar with immense influence on the characterization of black color in human skin is Swiss-born American geologist and biologist Jean Louis Rodolphe Agassiz (1807-1873). For no less than two decades, Agassiz taught zoology and geology at US first-rate universities, namely University of Harvard (Cambridge, MA, USA) and to a lesser extent Connell University (Ithaca, NY, USA), from 1847 until his death in 1873 (Irmscher, 2013). During his research and teachings, Agassiz (1850, p. 143) was an intractable proponent of inferiority and uncivility as inherent to black-skinned species that he vehemently believed to be separate from white race or species. One of the foremost results observed with pigment research is that concepts and/or categories avowedly created or known (to be used) as arbitrary and unfounded have been given a de facto central role in pigment literature, thus eliminating or compromising the scholarly nature of pigment field.

4.3 Claimed Distribution of Pigment around the World

Because pigment is omnipresent in nature, an issue that has lavishly engaged the attention and more correctly the position of pigment authors regards the claimed distribution of pigment around the globe, for which two figures and their writings have remained seminal: Samuel Stanhope Smith (1751-1819), an American Presbyterian clergyman and the 7th president of Princeton University, Princeton, NJ, USA (Smith, 1787/1810) and Constantin Wilhelm Lambert Gloger (1803-1863), a German ornithologist (Gloger, 1833). Smith (1787/1810) was perhaps one of, if not, the most vocal defenders of ideas that Africa is the fieriest/hottest place on earth and that there is a latitude-driven gradation, called gradient in biology, of skin color with Whites being in northern regions and Blacks in equatorial regions. Smith (1787/1810) wrote, "something may be ascribed also to the excessive ardor of that region [Africa] of burning sand. *Africa is the hottest country on the globe* [emphasis added]" (pp. 95-96). Smith went on saying, "the whole interior [of Africa], as far as it has been explored, is represented to be a desert of burning sand which often rolls in waves before the winds" (1787/1810, p. 222). The gradation of skin color was/is believed to unfold from the equator toward the northern/polar regions. Most emphatically, Smith (1787/1810) stated,

> *In tracing the various climates of the globe, advancing from the arctic circle to the equator, we find them marked with considerable regularity by the colour of the inhabitants*. In the European continent, we meet, in the *highest*

> *temperate latitudes, with a ruddy, and sanguine [pink] complexion*, which is commonly conjoined with different shades of redness in the hair. We soon descend to a *clearer mixture of red in white*. And afterwards succeed the brown, the swarthy, and passing over into Africa, the tawny, increasing by darker and darker shades as we approach the hottest temperatures of the torrid zone. In the Asiatic continent we pass at once from the fair to the olive, and thence by various gradations in the darkness of the hue to the black colour which prevails in the southern provinces of the peninsulas of Arabia and India [emphasis added]. (pp. 35-36)

However, both the ideas of highest heat in Africa and latitudinal gradation of human pigment were met in the 19th century with stinging massive criticism (see Cibangu, 2022). Although Smith had to soften up his position, his ideas are still attractive to date, further obscuring pigment research/nature (details below). Gloger (1833) is most known for the idea, slightly adjacent to those of Smith recapped supra, that birds plumage becomes darker in warmer regions and whiter in colder regions. This idea is popularly designated as Gloger rule. It bears clarifying that as much as Gloger (1833) posed/premised the latitudinal coloration of birds, he did not find compelling, empirical evidence to sustain it. Thereby, Gloger (1833) became one of, if not, the staunchest opponents of highest temperatures in Africa and of latitudinal gradation of temperatures. Perhaps to the dismay of many authors, Gloger (1833) noted that average temperatures in equatorial Africa are much lower than those on the east coast of North America and that there is no such a thing as sunlight in equatorial forest, with day and night being alike (details below). These and similar ideas predispose authors to a different approach toward melanin/pigment.

With the inventions achieved in the Industrial Revolution (i.e., electricity, steam engine, telegraph, etc.), the 18th and 19th centuries underwent fantastic improvements of technology and infrastructure never seen before across Western Europe, which provided a considerable boost to slave trade of Blacks and further heightened the already ongoing stigmas regarding black color of human skin. As is now clear, when applied to human skin black pigment emerges in a scholarly community polluted by prejudice and divested of scientific rigor. Personal options held by scholars about black pigment of human skin were/are presented as science, with little to no rigor in the methods used. This has caused human skin color/pigment scholarship to be based on bad science. Existing scholarship concerned with the evolution/formation of pigment in human skin does not appear to have reversed the course of the 18th- and 19th-century stigmas ascribed to black color of human skin. Because prior work (e.g., d'Ischia et al., 2013, 2015) escapes pigment researchers, paths to move research forward evaporate. The foremost result is one of a vicious circle entangling pigment research. Synergic work requires continued follow-up to keep scholarly inquiry vibrant.

5. Discussion

Discussion (Babbie, 2021; Bryman, 2016) is the section of scholarly work that captures the impacts/take-aways of the inquiry accomplished. In discussion section researchers seek to drill deeper into the missing pieces/challenges encountered in the investigated topic of a field to unearth the lessons learned/take-home messages. Because this paper is a review/conceptual paper, a findings section was not necessary to engage the discussion, rather a perusal of the works looked at in literature review has laid bare the challenges amassed over the years. For the purpose of the present reflection, challenges crippling skin color materials have been broken down into ten most important levels.

5.1 Hunting of Hominins

The first level of challenge besetting skin color scholarship relates to hunting of hominins. Indeed, hunting of hominins constitutes one of the main arguments advanced by skin color scholars in justifying human skin evolution. Nonetheless, the thesis considering fire and cooked meat as processes much longer than traditional, narrow instances of *Homo sapiens* behavior (Chazan, 2017; Gowlett, 2016; Sandgathe, 2017; Wrangham, 2017) renders more problematic the thesis of hunting, and more so the mainstream thesis of human skin pigmentation. To refresh the memory, skin pigmentation of hominins was thought to have taken place around 1.2 million ago or sooner as a natural adaptation to hominins' high physical activity of hunting (Jablonski, 2017, 2018, 2021). High physical activity of hunting was believed to produce eccrine glands to avert the overheating of skin caused by UVR-flaming conditions of savannah/equatorial regions. Yet, the appearance of skin pigmentation wouldn't have to happen until a process leading to an entirely established behavior of fire and to that of cooked meat was complete. Equally, the thesis of fire and cooked meat as long processes brings home the idea of skin pigmentation as a long process by and of itself. Physical activity and resulting alleged argument of eccrine production were found to be impractical in and irrelevant to a savannah or forest setting (Cibangu, 2022).

In fact, in light of ichnological (i.e., fossil) data, Sussman and Hart (2015) noted hunting to be quite a late activity of *Homo sapiens* behavior, which occurred no sooner than 400, 000 years ago. One reason is that hunting could not be possible up until the advent of fire and metal in human civilization. More precisely, human teeth are poorly equipped/designed for cutting through and masticate raw meat of hunted preys, let alone human stomach cannot readily digest raw meat. Extensive fossil materials show early hominins to have had a vegetarian diet, with meat diet being related to fire advent and tool crafting (Andrews & Johnson 2020; De Meester et al., 2022). The point being, human teeth are nowhere near as meat-piercing as teeth of wild carnivores. Raw animal flesh, skin, and bones are tough to both unsharpened metal and unsharp human teeth. Even with the advent/use of metal, knives ought to be specifically regularly sharpened in order to be able to slice meat whereas intense, habitual cooking fire was needed to get meat as soft and chewable as possible for human teeth. One option for the stimulation of eccrine glands that might be thought of when considering the vegetarian diet of early hominins is that of high physical activity aimed at looking for fruits and seeds in trees. Yet, while monkeys/primates are adept climbers and quadrupedalists when looking for food (i.e., fruits and seeds), humans are neither of the two.

5.2 Human Skin

The second level of challenge poisoning skin pigmentation circles revolves around human skin. Human skin represents one of, if not, the most conspicuous organs in the kingdom of the livings. Notwithstanding, from a biology vantage point, human skin figures prominently in vulnerable areas of anatomy. Quite strikingly, humans are the only species with particularly unwarrantedly swollen parts on their skin, namely, lips, breasts, belly, and buttocks. Protuberance on these parts of human body (i.e., lips, breasts, belly, and buttocks) completely defies the idea of evolution inasmuch it corresponds to no specific needed biological function. Individuals who, for example, have lips, breasts, or buttocks heavier than those of others are biologically no better than individuals who do not. Sitting position cannot fully account for fleshy buttocks because monkeys use buttocks for sitting purposes but their buttocks are no fatter than those of humans. Belly and to a lesser extent female breasts tend to become remarkably and often lethally protruding. One further dilemma of human skin is with groin, axilla, and cleft at the rear of ear lobe of infants (Kispotta et al., 2021; Shah & Sheth, 2021). Groin, axilla, and cleft at the back of ear lobe of infants are remarkably susceptible to infection, most of which being fatal. Unlike the young of other mammals, groin and axilla of human infants require regularly applied and specialized powder/product in lieu of soap or clean water. Taking into consideration recent zoological research (Ortiza, Batista, Blanco, & Gobello, 2022; Stasiukynas et al., 2022), hygiene taken by humans in rearing infants, for example, proves to be nowhere easier than that taken by wild cats caring for their cubs. This is utterly at odds with the natural evolution of human skin.

Sure enough, parasitic infestation often in times fatal can develop in human skin simply through contact with skin (Man, Price, & Hoskins, 2022). Human skin in areas around nails of toes and fingers as well as around groins and genitals frequently gets infested with colonies of parasites. Parasites can live deep in skin leaving toes and fingers achingly swollen and barely usable (Oranges et al., 2022; Modi, 2009). Lice and ticks easily hide and nest in hairy regions such as those around skulls and genitals. Ticks inherited from mammals can be lethal to humans. Lice and ticks also hide and nest in furniture, clothes, walls, and other human belongings only to feed on human skin during rest or sleep time. Even with the modern time mass production of repellents, sprays, and detergents, extra care is still needed to incessantly protect human skin from biting bugs such as mosquitoes, bees, wasps, spiders, etc. This is not to mention bites from animals such as snakes, wild cats, wild dogs, etc. against which human naked skin has no protection whatsoever. Human skin is also particularly vulnerable to saps dripping from trees and leaves. Most importantly, even in the absence of parasites and bites, human skin -- whether covered or not and regardless of the care taken or of an individual’s health, tends to flake, crack, blister, etc. and thus requires moisturization all the time (Abrutyn, 2022; Hollinger, Kindred, & Halder, 2022). One matter of concern to biology researchers and the general public is that human skin is prone to develop moles, blemishes, lesions, bruises, etc., all of which (if untreated) can lead to a person’s death. It follows that natural selection does not appear to have played a role in protecting human skin against the aforementioned numerous and nefarious parasites, bites, and damages. The complexity of human skin continues to be brought to the fore with the rising fragmentation of biology specialties (Moreau & Zhen, 2022; Sore & Lynch, 2022). No wonder recent research has determined that the mechanisms of natural selection could not and should not be reducible to melanin production that renders human skin dark/black.

Using dermatological data for over more than two decades across nations, dermatologists Elias, Williams, and Bikle (2016) asserted,

> Given its importance… natural selection surely would have evolved more efficient regulatory mechanisms than latitude-determined gradations in skin pigmentation… In fact, pigmentation did not lighten in a predictable fashion as humans emigrated out of Africa … Very fair pigmentation evolved solely in populations residing far to the north in Europe… long after they had migrated out of Africa… Consider also that melanin is a relatively inefficient UV-B filter in comparison to another endogenous mechanism that is much more efficient; that is, *transurocanic acid* (t-UCA), which intercepts well over 50% of incident UV-B, even in darkly pigmented skin. (p. 756)

More to the point, it was further elicited that “current theories for the development of epidermal pigmentation in hominins are problematic… Latitude-dependent pigment dilution to facilitate cutaneous vitamin D3 (VD3) synthesis is also problematic" (Elias & Williams, 2015, p. 273). As shown above, in more ways than one, human skin cannot be a mere product of natural selection due to UVR higher intensity in equatorial/savannah regions.

5.3 Human Lips

The third level of challenge corroding human pigmentation research and closely related to the second is human lips. Human lips are an integral part of human skin often forgotten in most accounts of human skin (Hollinger, Kindred, & Halder, 2022). Human lips were salient features used in the classifications of living beings, proposed by founding biologists Linnaeus (1735/1758) and Blumenbach (1775/1795). These classifications are now taken to be foundational for the study of species. For our discussion, however, what is most interesting with human lips is,

> As the lips have little cornified tissue or melanin, they are very sensitive to chemical, physical, or microbial damage. Their prolonged exposure to sunlight… may lead to the appearance of actinic cheilitis and even *spinocellular carcinoma*… Most lip cancers, considered as mouth cancers, are most common on the lower lip. (Houséle et al., 2022, p. 252)

The statement above clashes with the claim that human skin pigmentation evolved as a product of natural, latitudinal selection involving the multiplication of melanin as a protector against UVR. The idea that human lips are super-susceptible to exterior damage (i.e., physical, microbial, or chemical) interferes with the idea of natural selection for human skin. Most troublingly defeating the purpose of skin pigmentation is the fact that regardless of a person's health, human lips -- and more so than skin in general -- flake, crack, blister, and bleed, under the mere effect of ambient air. Even worse, regardless of races, ages, latitudes, and locations (i.e., outdoors or indoors), human lips require moisturization every minute or so. Just like human skin, moisturization of lips becomes a basic need of humans (Abrutyn, 2022; Hollinger, Kindred, & Halder, 2022). In *Homo sapiens* days, people didn't have a mass production of oil that human lips constantly require. Curiously enough, as Houséle et al. (2022) indicated, "the lipstick we know today is mainly a makeup product composed of anhydrous pastes such as oils and waxes in which are dispersed pigments and other coloring agents designed to accentuate the complexion of the lips" (p. 252). It all appears that lipsticks are composed of the very ingredients (i.e., pigment, wax, oil, etc.) that natural selection should have supplied to safeguard the skin of hominins, especially in equatorial/savannah regions.

5.4 Human Feet

The fourth level of challenge regards human feet. Human feet are one of the topics commonly referred to by authors when explaining skin pigmentation. Because of hominins' bipedalism, human feet play an essential role in the activity of running and walking. One point of merit here is that human feet (details below) are not fit for the purpose of running and walking as they provide no grip and show no protection against trip hazards and wild, untreated terrain. Most significantly, both in a savannah and forest, grass and leaves, whether dry or fresh, especially when decomposing, render the terrain unavoidably slippery to human feet. The thesis of hominins' hunting is further contradicted by the unfitness/vulnerability of human feet. This holds true for both shod and unshod runners and walkers. Studies conducted on unshod and shod runners signal inescapably rising injuries (Francis & Schofield, 2020). These studies rebut the natural selection of human feet for running or walking. Human feet, whether shod or not, present a high likelihood of injuries at ankles and toes during all positions (e.g., walking, running, standing, resting, etc.). Human knees are no better if not worse than human feet because human knees are highly vulnerable to shock, injury, and bruise. For example, birds and rodents can sleep for hours when peacefully seating/perching on their feet (jaws); and they can use their feet (jaws) to dig through dirt whereas humans cannot. In addition, ankles are sensitive to unclean, unsafe water common in paddles or pools spread throughout equatorial/savannah settings. This is because some parasites living in unclean water can enter a person's skin through ankles (Man, Price, & Hoskins, 2022; Oranges et al., 2022). Apart from the unfitness for running and walking, human feet just like human hands require moisturization all the time. This is in part because human feet and hands tend to flake, crack, blister, etc. (Weber et al., 2022), which makes them a perfect target of parasites and infection. Another area of human skin not always mentioned in most exposes of human skin is human eyes. Human eyes are part of skin as they are covered by skin. Most interesting for our reflection are the types of human eyes seen in human anatomy. One type of note is the Asian type of eyes called, for lack of a right word, deep-set eyes (Fakhro et al., 2015). Deep-set eyes represent by far the best form of eyes for inclement weather. Put differently, deep-set eyes are immeasurably naturally better designed and more protected against UVR, dust, pollen, wind, etc. than the eyes of Africans living in bug-crammed and UVR-blazing equatorial or savannah regions. Thus, the idea of skin pigmentation as emerging from natural selection is called into question.

5.5 Skin Areas over the Back or Spinal Cord

The fifth level of challenge bedeviling skin color research concerns skin areas over the back or spinal cord. Although particularly susceptible to cold, heat, and wind, spinal cord areas of humans remain troublingly bare and unprotected especially in the neck and heart regions. The point was raised in the 19th century by evolution biologist Wallace (1871), with more emphasis than Darwin (1859/1873, 1871/1889), remarking that "*man's naked skin could not have been produced by natural selection* [emphasis in original]" (p. 347). The back of humans is staggeringly unnecessarily hairless while it is the part of the body the most exposed to sunlight, heat, and wind. Wallace (1878) also decried heat as an evolutionary factor of human skin color, writing: "tropical light and heat can in no sense be considered the cause of colour" (p. 220). Wallace was a noted 19th-century evolution scholar, doing his research independently from and at times in disagreement with Darwin (1859/1873, 1871/1889). As much as Darwin (1859/1873, 1871/1889) conducted expansive work on evolution theory, he was paralleled by Wallace (1871, 1878). Evolution theory is a theory which pigment authors might advance to adduce reasons for the survival of humans through the evolution/adaption of skin/pigment. In effect, pigment literature displays Darwin to be the most mentioned authority of evolution theory while according little to no value to Wallace (Jablonski, 2017, 2018, 2021). Armed with luxuriant research, both Darwin and Wallace had unflinching aversion to the idea of skin pigment regarded as a product of and/or adaption to natural selection. Oddly enough, the buttock areas of humans, an important part of skin, have awfully more fat/cushion than the vertebrae areas of the human spinal cord that need protection/fat the most. As argued earlier, one reason for the cushion on buttock areas might be to accommodate the sitting position. Still, leaving the spinal cord meatless and unprotected is unbearably inconsistent with the process of natural selection. Even worse, the buttock areas of humans are by far fatter than those of primates, our ancestors. The challenges posed by the spinal cord areas and others bring in sharper relief the reservations voiced by Darwin (1859/1873, p. 4) saying that natural adaptation although essential is not the only means governing biological transformations. In this regard, the production of melanin and associated protection against UVR proves to be only a fraction of, if not a diversion from the myriad convoluted phenomena and processes involved in the intricate complexion of human skin.

5.6 Equatorial Africa

The sixth level of challenge threatening skin color research is the concept equatorial Africa. This belief is one that states that early "humans evolved under the sun. The early evolution of the genus *Homo* occurred in equatorial Africa under conditions of high UVA and high UVB" (Jablonski, 2021, p. 722). The same statement was made by Jablonski recently in Jablonski (2018, p. 30) and previously in several other venues. While the belief is likely to enjoy a wide audience, it collides with available facts. The first outstanding fact is that there is no such a thing as the sun in equatorial forest simply because of thick and tall foliage proper to any forest situated on the equator or beyond. This is confirmed by recent forest research (Rafferty, 2011, Waide, 2019). The fact greatly refutes the belief that "UVR was the most important environmental determinant of skin pigmentation" (Jablonski, 2021, p. 710). A tropical savannah is no better or different either, because of its tall, thick bunches of rank grass and bushes. Even by giving the benefit of the doubt to the thesis that there is sunlight in equatorial forest, the argument is still unconvincing, which leads us to the second fact overriding the belief of equatorial Africa in the sense that the continent of Africa can only cover so much of the earth's surface, let alone of the earth's equatorial line or circumference.

According to a recent report issued by FAO [Food and Agriculture Organization] and UNEP [United Nations Environment Program] (2020), on the status of the world's forests, equatorial Africa, more precisely the equatorial area covered by the Democratic Republic of the Congo, which is the greatest of Africa's forests, represents only 3% of the world's forests (see FAO & UNEP, 2020, p. 10) while the other remaining huge 97% of forests are found outside Africa. Thus, it becomes unreasonably problematic that such a smattering of the world's forest is believed to consume and contain the highest intensity/rate of the earth's UVR or heat. The kind of nonsensical statements best exemplified by the two facts recollected above are disconcertingly most prevalent in the literature of human skin pigmentation. While, as one would quite pertinently caution, "we cannot assume that the appearance, genetic composition, sun exposure habits, or UVR skin reactions of humans today are the same as those of our ancestors in prehistory" (Jablonski, 2021, p. 709), narratives describing the evolution of black skin in UVR-aflame conditions of equatorial Africa do not provide nor hint to any specification. Africa's forest is only too tiny to be able to change and blacken once forever the pigment of human skin in *Homo sapiens* individuals. Appalled at the unfounded exaggeration about the extent of Africa's equatorial forest, American anthropologist George Peter Murdock rightfully lamented, "Popular opinion also greatly exaggerates the extent of tropical rainforest, or 'jungle', in Africa. Actually… it is less dense than in comparable regions in Southeast Asia or South America" (Murdock, 1959, p. 6). The deplored exaggeration is still popular among and in the mind of modern pigmentation authors, leading to gravely erroneous characterizations of human pigmentation and its evolution. Indeed, the belief rampant among celebrated skin color researchers has it that Africa covers the largest portion of the world's forests and thereby the highest rate of UVR that has triggered the formation of black skin in early *Homo sapiens* species.

A related illustration is with green color; while green color is indefinitely abundant in equatorial Africa and even more so than black color, it is by no means as associated with equatorial Africa as black color of skin is. This illustration showcases the arbitrariness of the link popularly placed between black color of skin and equatorial Africa.

5.7 Skin Color Generalization

The seventh level of challenge defiling the space of human pigmentation research, and perhaps one with the most consequence on research method applies to skin color generalization. Generalization is a concept central to and typical of scientific research. The fact that biology tends to rely on experiments undertaken in labs, more exactly, manipulated reality or phenomenon constitutes a no less serious challenge to research and its impact and validity in and for the world. This is the risk that comes with all experimentation, regardless of the field in or for which experiment is being performed and of the targeted phenomenon being simulated or represented. Generalization also dubbed scalability is that which demarcates scientific knowledge from any other type of knowledge (Babbie, 2021). Because most academic descriptions of human pigmentation are nothing but personal opinions of authors from the 18th and 19th centuries to date, they are not in any shape, form, or way generalizable or scalable from one part of human skin to another (i.e., lips, nipples, genitals, eyes, soles, etc.) or from one organ to another, and most importantly, from one biology (or science) field to another. For example, the soles of human feet figure among the least UVR-exposed parts of human skin, and yet they are even blacker than lips that are invariably exposed and sensitive to sunlight in some if not most African individuals leaving in equatorial Africa, not to mention that there is no sunlight or UVR in equatorial forest. Similarly, black pigmentation in nature (i.e., rivers, plants, birds, mammals, reptiles, fishes, chemicals, rocks, etc.) is not comparable with or generalizable to that of human skin, not in the slightest. The argument of naked human back raised above with Wallace (1871) poses the biggest threat to current literature regarding the evolution of human skin pigmentation. This is further complicated by the fact that human skin is so diverse and so broad that it cannot be cherrypicked, as is often the case with pigmentation literature, as a valid unit of analysis for accumulative/progressive knowledge proper to and required of scientific research. Owing to serious, extant lack of appropriate classification and tool for human skin types (see Dadzie et al., 2022) as well as the variability in laxity and extensibility of human skin from one area to another of the human body (Wong et al., 2016), human skin with its complexity does not qualify as a fine-grained and well-tuned unit of analysis.

5.8 Melanin

The eighth level of challenge closely related to the seventh stems from the concept melanin. Since its kickoff experiment, melanin pertains to one of the most misrepresented and misunderstood concepts across academia and industry, with its challenges being either ignored or simply unaccounted for. At the same time, melanin is largely considered to be the unit of analysis of human skin color by world-famous skin color researchers (Jablonski, 2017, 2018, 2021). The bottom-line argument here is that melanin is the substance believed to be the leading factor of human skin evolution by shielding human skin against the harmful effects of UVR in savannah/equatorial regions of Africa. While the argument might have merit, it faces nonnegligible challenges when the history of the concept melanin is brought to light.

The term melanin was arguably first used by Italian naturalist Bartolomeo Bizio (1791-1862) in an experiment done on mollusks in 1825. The word suggested for that matter was *melaina* in Italian, translated as melain in English. As Bizio (1825) wrote, "*cos ìmi tenni obligato a chiamarla di un nome che a lei sola appartenesse, dicendola melaina* [so I could not help but designated it [the substance] with an appellation that is only proper to it, by calling it melaina]" (p. 100). Incidentally, the reason for the appellation *melaina* seems to be that the substance *melaina* was found to be invariably black. Bizio (1825) explained,

> *questo principio animale partícolarissimo il fu chiamato così dal greco μελας, nero, ed άεὶ sempre, che vale materia sempre nera* [This very particular animal principle has been called according to the Greek word *μελας*, meaning black, and *άεὶ*, which stands for always, because it is always a black matter]. (p. 105)

In light of the above experiment, Bizio insisted that the ink of mollusks also called cuttlefish or cephalopods was continually black. This was largely because the ink was insoluble, and could not change color when diluted in acid and potassium hydroxide. As Bizio (1825) observed,

> *Infusa la materia negra a freddo in una forte soluzione di potassa pura... imperciocch è dopo pochi stanti d'infusione il liscivio fatto alquanto di colore oscuro, il quale ... dopo due o tres giorni riesce di una tinta negrissima* [When the substance is cold infused in a strong solution of potassium hydroxide... after instances of infusion a fairly dark lye is seen... which after two to three days regains a very black color]. (pp. 100-101)

In the experiment above, the substance/dye of mollusks changed from a mild to a strong black color when infused in a cold solution of potassium hydroxide. As is clear from the experiment, no light or heat was involved. It is also clear from the experiment that the persistence or intensity of black color was a reaction to and because of acid and potassium hydroxide in which the product *melaina* was being experimented with.

Even most particularly noteworthy is the fact that Aristotle (350BC/1970, 524a-b), who also performed research on mollusks in which he highlighted the presence of ink, did not use the Greek word *μελας* [melas] with which Bizio (1825) coined the word *melaina* (details below). Such an added if not arbitrary interpretation of mollusks ink, like many others seen infra, will have severely damaging and unnecessarily lasting repercussions on the understanding of melanin and its research.

Nearly two decades after Bizio (1825) definition in 1825, an account with attention-catching details was offered by Swedish chemist Jöns Jacob Berzelius (1779-1848) when Berzelius (1840) affirmed,

> *Das Sepia-Geschlecht beherbergt in einer Blase eine schleimige, schwarze Flüssigkeit, whelche von diesen Thieren, wenn sie verfolgt werden, ausgespritzt wird, wodurch sie das Wasser trübe machen und so ihrem Feinde entkommen. Nach Prout hinterliess diese Flüssigkeit, nach dem Eintrocknen in ihrer Blase, einer bräunliche-schwarze, harte und sprôde Materie, von muschligem Bruch und sammetschwarzem Pulver… Der schwarze Farbstoff darin ist von Bizio Melain (von μελας, schwarz) genannt worden* [The genitals of cuttlefish species harbor in a sac an unctuous black liquid produced by these animals when they are pursued, and with which they darken water in order to escape from predators. According to Prout, this liquid upon drying and by way of conchoidal fracturing leaves behind it a brownish, black, brittle, and hard matter and a purplish powder in the animals' sac… The black dye was called *melain* (from [the Greek word] *μελας* [melas], black) by Bizio]. (pp. 776-777)

Melain is/was a dye that cuttlefish species secrete to render water black/murky to prevent predators from seeing them. One point of consideration here is that *melain* had nothing to do with human skin. What is most interesting is that in his book, cited above, Berzelius (1840), under the heading *Die Haut und iher Fortsetzungen und Aussonderungen* [skin and its features and components] (pp. 367-397), devoted extensive, detailed attention to the concept human skin, with no reference whatsoever to *melain*. Although unknown or uncited in existing human pigment research, Berzelius (1840) explanation of skin and its components amounts to one of the best and comprehensive descriptions of human skin. Clearly, *melain* was not exclusively about human skin as currently seen in conversations and research about human skin.

Indeed, the research referred to by Berzelius was a type of research undertaken about cuttlefish by British chemist and physician William Prout (1785-1850), details below, and Bizio. The English word cuttlefish might be misleading. As Berzelius (1840) specified, "*Dinte von Dintenfisch. Sie ist von Prout und Bizio untersucht worden* [Ink from cuttlefish was researched by Prout and Bizio] (p. 776). Without question, the original German word used supra by Berzelius is *Dintenfisch*, or now spelled as *Tinte* (see *Duden* https://www.duden.de), literally meaning, ink-fish, and the substance being alluded to was a dye or ink. Melanin is a substance, just like any dye, with no connotation of human black skin alongside the association with and reduction to heat and/or equator. *Dintenfische* or *Tintenfische* (see Balss, 1943, p. 55), are noted for secreting a black/dark dye. The dye secreted by cuttlefish was known since ancient times. As indicated earlier, Aristotle did not use the word μελας [melas], rather Aristotle (350BC/1970, 524a-b) referred to the Greek word *θολός* [tholos], *θολόν* [tholon] (see also Balss, 1943, pp. 120-122), meaning ink (of cuttlefish), to describe the ink discharged by sepia. The meaning of the Greek word *θολός* [tholos] is of significance here.

The Greek word *θολός* [tholos] has the primary meaning of dirt, mud (Liddell & Scott, 1843/1996). It is also quite refreshing that the Greek word *σηπία* [sēpia], *σηπίή* [sēpiē] encountered in Aristotle text (Aristotle, 350BC/1970, 524a-b; Balss, 1943, pp. 120-122) comes from the Greek verb σήπω [sêpô] which has the principal sense of hide, corrupt, soak, get rotten, etc. From the Greek verb σήπω [sêpô] is derived the Greek noun *σήπων* [sēpōn] or *σάπων* [sapōn], which stands for soap, cleaner, and to which the English word soap traces back. Equally from the Greek verb σήπω [sêpô] stems the Greek adjective *σηπτικός* [sēptikos], meaning septic, putrefactive (Liddell & Scott, 1843/1996), in which originates the English adjective septic. Beyond a shadow of a doubt, both the Greek words *θολός* [tholos], meaning ink or dirt, as well as *σηπία* [sēpia], simply transliterated in English as sepia, authenticate the notion dye for the substance produced by sepia. This is the notion that results from Aristotle (350BC/1970) description. On no account did cuttlefish dye in ancient times have a connotation of and connection with heat, light, equator, etc. Cuttlefish dye is not uniquely black, either. One point of foremost concern sits in the idea black with which melanin and its properties tend to be identified. While black color can be associated with melanin, it is only a smidgen of and indeed a deviation from it, much less the colors that characterize (the skin of) living organisms.

Perhaps of most relevance to our discussion is that relatively at the close of the 1800s, the terminology melanin was found to have an established usage across Europe. Still, just like in ancient times, the 19th-century established usage of melanin had no clichéd interpretation of something produced by equator, heat, and light. What is most curious and challenging, is that, in 1873, French biologist Charles-Philippe Robin (1821-1885) defined melanin as a product to be found in anatomy in general, with no pejorative connotation of and/or reduction to a specific location or body part. Robin description of melanin (Littré, Baillière, & Robin, 1873) is one of the best and most instructive of its kind, yet unknown and unmentioned among pigment researchers. The association of the term *melain* described earlier with the current term melanin can be found with Robin description. The shift from the terminology *melain* proposed by Bizio (1825) to that of melanin seems to be established in the second half of the 19th century with Littré, Baillière, and Robin (1873) description of melanin.

As noted supra, melanin is simply a dye/ink secreted by nature in the body of mollusks species. Littré, Baillière, and

Robin (1873) indicated,

> *Mélanine… de μελας, noir; Allemand Melanin, Anglais melanine, Italien et Espagnol melanina … Pigment noir de l'oeil, de la peau, etc.… Substance organique demi-solide, caractérisée par sa couleur, pouvant varier du noir au brun roussâtre ou pourpre foncé sous le microscope* [Mélanine… from *μελας*, black; German Melanin, English melanine, Italian and Spanish melanina … Black pigment of the eye, skin, etc. … Organic, semi-solid substance whose color changes from black to reddish brown or dark purple, through the microscope… It is found more or less abundantly, according to body parts or animal species]. (p. 940)

The nature/distribution of melanin is determined to be universally located in anatomy and/or biology. Synonyms given for melanin are *melain*, cutaneous pigment, pigment of the eye, black pigment, etc. (Littré, Baillière, & Robin, 1873). Described in greater details, black pigment is shown to be found in Whites, Blacks, and red individuals. As Littré, Baillière, and Robin (1873) elicited,

> *Dans l'homme blanc… il arrive souvent que certains points doivent une teinte permanente ou temporaire à du pigment dont la couleur perce à travers l'épiderme: tels sont particulièrment les pourtours du mamelon… la peau de la verge et du scrotum, celle de grandes lèvres et de l'anus* [In White individuals... it often happens that some body parts have a permanent or temporary color due to pigment whose color breaks through the epidermis. Those body parts are particularly: nipple surroundings, penis skin, scrotum skin, labia majora skin, and anus skin]. (p. 1193)

The body parts drenched with melanin in White individuals clearly belie the idea of heat and sun exposure for human skin evolution because those body parts (i.e., labia majora, scrotum, anus, etc.) are the most sun-shielded parts of human anatomy. The idea was confirmed by Cibangu (2015) showcasing the darkness/blackness of female genitals in unmixed White women to contradict equatorial/UVR exposure as grounds for skin evolution. The claimed photoprotective role of melanin against UVR was also demonstrated not to be the only role of melanin (Solano, 2014). In other words, UVR can be something more of a diversion from than a reflection of melanin.

Littré, Baillière, and Robin (1873) further clarified black pigment, saying,

> *Pigment cutané, noir, ou oculaire… est composé d'une substance organique particulière dont la teinte varie du fauve pâle au brun noir ou au noir roux… laquelle… se présente à l'état de granulations… Ces granulations … dans la peau sont déposées… soit par places… soit dans les parties déterminées… ou bien on les trouve dans toute l'étendue de la peau (nègres, peaux-rouges, etc., et quelques espèces animales)* [Skin pigment, black pigment, or eye pigment… is composed of a particular, organic substance whose color varies from palish fawn to blackish brown to reddish black… which… manifests itself in the form of granulations… These granulations… are deposited in skin according to body areas… to given organs… or are found on all skin (i.e., Blacks, red-skinned individuals, and some animals species)]. (p. 1193)

The challenge raised in the above explanation of melanin is that there is no such a thing as an entirely black melanin substance. This means that black color is neither the best indication of melanin nor the best definition/ingredient of black skin nor the best protection of skin against UVR in equatorial regions. One additional challenge is with the existence of melanin on all skin of not only Blacks but on that of red-skinned people. Red-skinned people are found across all races and latitudes. The real point is that red-skinned people are barely mentioned and/or researched in studies of human skin evolution, which leads to skewed/erroneous views and interpretations of what melanin entails. The challenge concerning a lack of research on red-skinned individuals was leveled by Cibangu (2015). Red skin cannot be accounted for by equator or UVR because it covers all latitudes, races, individuals, let alone all species of plants and animals.

One of the greatest benefits of Littré, Baillière, and Robin (1873) description is when Littré, Baillière, and Robin characterized the distribution of melanin, noting,

> *Chez les reptiles, les poissons, les crustacés, etc., on trouve les granulations pigmentaires dans le névrilème, les muscles, à la surface de la peau, sous la péritoine, etc.* [In reptiles, fish, and crustaceans, etc. granulations of melanin pigments are found in nerves, muscles, on skin surface, under the peritoneum, etc.]. (p. 1194)

Melanin is described to exist throughout the body of reptiles, fish, and crustaceans. What is most suggestive for our discussion is that melanin is found on skin surface of reptiles, fish, and crustaceans, most, if not, all of which live farther away from sun light and from equator. To illustrate, reptiles, fish, and crustaceans in lakes such as Great Bear Lake, 66°6′ N, in Northwest Territories, Canada, Great Slave Lake, 61°4′ N, in Northwest Territories, Canada, Wollaston Lake, 58°2′ N, in Saskatchewan, Canada, Reindeer Lake, 57°5′ N, in Saskatchewan and Manitoba, Canada, Lake Baikal, 53°5′ N, in Siberia, Russia, and Uvs Lake, 50°3′ N, in Uvs, Mongolia, to name a few, are definitely too far away from equator 0°0′. Evidently, melanin distribution/nature is neither dependent on equator and sun light nor on skin of species. This aspect of melanin is essential to keep in mind to avoid the continual challenges besetting current black pigment research. In a word, Littré, Baillière, and Robin (1873) described melanin to be preeminently present in the skin of not only Black individuals, but rather red-skinned people, shellfish, fish, and reptiles, and more interestingly for humans in the skin of nipples, penis, scrotum, outer lips, and anus. Clitoris also is found to be strongly black-pigmented among a majority of unmixed White races (Cibangu, 2015).

Perhaps one of, if not, the most deciding articles that has crystallized the current understanding and indeed misunderstanding of melanin was the article published by Pathak, Riley, and Fitzpatrick (1962) wherein they concluded,

> The familiar pigmentation which follows exposure to solar radiation or to ultraviolet light from artificial sources is known to involve two distinct photobiological processes. The first, generally called "primary melanization", consists of an erythemal response ("sunburn") followed by the formation of new pigment (melanogenesis) and the migration of melanin granules; it is initiated by wavelengths shorter than 320 mμ (i.e., the so-called erythemal spectrum) with maximal efficiency at 297 and 254 mμ. The second, which has been referred to as "immediate pigment-darkening" (IPD), is evoked by wavelengths greater than those which induce primary melanization. (p. 435, see the same statement in Pathak, Riley, Fitzpatrick, & Curwen, 1962, pp. 148-149)

The artificial infusion of wavelengths into skin is believed to have caused a melanization of human skin. The word melanization was clearly used. In order to get a better picture of Pathak, Riley, and Fitzpatrick (1962) experiment, it is helpful to keep in mind the participants and the unit of analysis considered as well as the (parts of) skin investigated in the study. As avowed in the article,

> Six fair-skinned and six dark-skinned (Japanese, East Indian and Negro) subjects were irradiated with long-wave ultra-violet light (wave-lengths 360, 400, 440 and 460 mμ) on the inner aspect of the forearm for between 20 and 30 min. and received approximately 150 x 107 ergs at each wave-length. The light used in this work was obtained from a high-intensity monochromator constructed in this laboratory. (Pathak, Riley, & Fitzpatrick, 1962, p. 149)

The study had a sample of six participants, and the part of (human) skin examined was the inner part of the forearm. As can be imagined, despite its widespread credence across scientific disciplines, the study suffers from no small methodological shortcomings, of which four most preponderant are looked at below. First the study is not generalizable, as pointed out above, to other parts of human body such as nipples, anus, elbows, penis, eyes, clitoris, etc. most of which are least exposed to the sun and yet rich in melanin (see Littré, Baillière, & Robin, 1873). Second, the study cannot be generalized/applied to other species such as mammals, reptiles, fish, crabs, not to mention plants and myriad microorganisms. Third, the study did not reflect/involve latitudinal diversity in which melanin is said to be present. Fourth and last, the study did not attend to the diversity of individuals within races (i.e., White, Black, and Yellow), much less red-skinned people that exist across races. Despite these and many other unknown and uncovered aspects of melanin, Pathak, Riley, and Fitzpatrick (1962) article is being intentionally and unintentionally universally applied to the concept pigment, causing melanin research to become fundamentally flawed. In effect, Pathak, Riley, and Fitzpatrick (1962) experiment was unquestionably uninformed of and inconsistent with the minute description of melanin given by Littré, Baillière, and Robin (1873). This description opens a researcher's eyes to the ubiquity and/or intensity of melanin on skin of reptiles, fish, crustaceans, red-skinned people, and some parts of human skin (e.g., penis, scrotum, labia majora, nipples, etc.). An awareness of Pathak, Riley, and Fitzpatrick (1962) and indeed of any skin color researcher about this primary feature of melanin would have led to a more nuanced understanding of and experiment on the phenomenon melanin. An argument can be made that language barrier did not allow Pathak, Riley, and Fitzpatrick (1962) to be aware of Littré, Baillière, and Robin (1873) description of melanin, which is in French. But, language barrier is implausible because Pathak, Riley, and Fitzpatrick (1962) made an extensive use of research published in German in the 1930s on the topic human skin and UVR, in the then journal of *Strahlentherapie* [Radiation therapy], currently known as *Strahlentherapie und Onkologie* [Radiation therapy and oncology].

Pathak, Riley, and Fitzpatrick (1962) shortcomings have yet to be redressed by subsequent biology research. In light of the detailed characterization of melanin seen with Littré, Baillière, and Robin (1873), the understanding of melanin by Pathak, Riley, and Fitzpatrick (1962) was/is embarrassingly entirely inaccurate and unrepresentative. Existing melanin research has not done better, either. The afore-deplored shortcomings have been posing enormous challenges to research on melanin. Recently, Fajuyigbe and Verschoore (2021) warned,

> Black skin, compared with white skin, is generally assumed to be more resistant to the consequences of sun exposure due to its epidermal melanin content. However, recent scientific evidence shows that black skin is not completely impervious to sunlight. Both clinical and experimental data have reported sun-induced effects on black skin. Black skin can warm, burn and peel when exposed to the sun. Exposure to the sun can also cause hyperpigmentation and photoaging manifestations. (p. 62)

The above research abundantly bespeaks the still-unresolved shortcomings of melanin research, stretching back to Aristotle research on mollusks in the 4th century BC.

When applied to other species, melanin proves to be a matter of hazard. One example of note here is with ultra-black or the blackest fish, *Betta splendens*, which are found to be living in the Gulf of Mexico (see Davis et al., 2020), away and independently from the equator. The skin of ultra-black fish is to date the blackest skin, the least sun-exposed, and often the most naked (i.e., scaleless) kin among animals, yet unreported and unrecognized in skin color research. What warrants most attention here is that crypsis variedly termed camouflage from predators, the most popular explanation of melanin encountered in ultra-black fish, is repudiated by the fact that other species, more importantly, fish living in the same setting and at the same depth of the sea, are not any black or dark, and indeed display a variety of colors from white to pink to grey, etc. Camouflage constitutes a less convincing argument because the depth/bottom of the sea is intensely dark/black (Davis et al., 2020). Perhaps of greatest attention is the fact that although scaleless, ultra-black fish, *Betta splendens*, live and develop in all types of waters, such as shallow, fresh, salty, etc. (Valderrama, 2023), so do lobsters, *Nephropidae*, shrimps, *Caridea*, and crabs, *Brachyura*, among many others, while displaying a vast variety of colors. Interestingly, among *Betta splendens* fish there exist a wide range of colors as well. Even in contexts with light seen and present to the fullest extent such as the sky, camouflage becomes more challenging if not inconclusive. To explain, black birds, *Turdus merula*, are black while passenger pigeons, *Ectopistes migratorius*, flying and living in the same conditions and even more so than black birds are not as black as black birds. The same is true for seeds on account of which the argument of camouflage from birds can be made (Glagoleva, Shoeva, & Khlestkina, 2020). However, corn, *Zea mays* and rice, *Oryza sativa*, are predominantly white, making the argument of camouflage less relevant. As is now evident from this paper review, melanin, more precisely pigment, represents a hazard of nature.

The fact that, as noted above, Aristotle (350BC/1970) himself did not employ the Greek word μελας when depicting the dye produced by cuttlefish, from which the English word melanin has been first derived by Bizio in 1825 (Bizio, 1825) is significantly important. Moreover, the experiment of Bizio was done in a cold, strong solution of potassium hydroxide, under the effect of which the dye of mollusks became much blacker. Also important is the fact that the German word for cuttlefish is *Dintenfisch* (Balss, 1943; Berzelius, 1840), meaning ink-fish, as discussed supra. The idea dye/ink presupposes an understanding of distribution made across and free from latitudes. One telling illustration here is with paint.

To give a quick example, imagine that the concept paint had been identified primarily with black pigment, paint would have been conceived of as a black substance according to equatorial latitude where black color is believed to be profuse. It would follow from this reasoning that painted products (i.e., wood, metal, plastic, etc.) and their uses are determined as blacker and more abundant in equatorial regions and brighter and more abundant in northern regions. While the example might seem somewhat fictional, it conveys the reality of melanin/black pigment. Perhaps in lieu of melanin, the right, neutral terminology could be *tholonin*, from the Greek term *θολός*, used by Aristotle (350BC/1970, 524a-b) or another word could be *pigmentin* from the Latin *pigmentum* the word employed by Littré, Baillière, and Robin (1873). The whole point here is to dispel the engrained bias sitting behind the term melanin. Melanin is/was a chemical product since the early research of Bizio (1825), and its association with equator, heat/UVR, and accompanying narratives is nothing short of late/weak addition dating from the second half of the 20th century (Jablonski, 2017, 2018, 2021). Melanin is perhaps the only chemical product to be surrounded with entrenched, unfounded interpretations about its properties.

5.9 Shape and Movement of the Earth

The nineth level of challenge, after that of melanin, rattling human pigment researchers is with the shape and movement of the earth. From the shape and movement of the earth comes the argument of UVR and heat highest intensity in Africa (details below). One of the best characterizations of the earth shape and movement is with 19th century British chemist and physician William Prout (1785-1850) afore-portrayed.

As Prout (1836) recounted,

> The distance of the earth from the sun is such, that the solar rays may be supposed to arrive at the earth’s surface in a state of parallelism. Now, when parallel rays fall upon a globe, it is obvious that any number of such rays falling perpendicularly, as at the equator of our earth, will occupy a very different portion of the surface of the globe, from what an equal number of the same rays will occupy when they fall obliquely, as in our polar regions. Hence, as we recede from the equator towards each pole, heat and light are diffused over gradually increasing portions of the earth’s surface, and thus the intensity of both decreases in like manner… For our present purpose, it is sufficient to observe, that among the natural causes affecting the distribution of heat and light in different latitudes, the globular figure of the earth is the principal. (p. 115)

The point is that with sun rays believed to be falling upon the earth in a parallel position, equator receives the highest intensity of heat and light while polar regions obtain merely obliquely deflected or reduced sun rays. The reason for this is that sun rays are oblique on polar regions and perpendicular on equator because of the earth being a globe.

Further in detail, Prout (1836) reflected,

> There is also another circumstance connected with the earth's motion in its orbit… The earth's orbit is not a circle, but an ellipse, of which the sun occupies one of the *foci*. Now, it has been so arranged that, in the middle of our winter, the earth is in that part of its orbit which is nearest to the sun. The earth, therefore, is at Christmas actually about three millions of miles nearer to the sun than at midsummer. (p. 116)

It is claimed above that owing to the elliptic shape of the earth when it is winter in Western Europe and North America (i.e., Christmas), the earth is tilted closer toward the sun on the other side of the globe (i.e., equatorial Africa) than it is during that same period of the year. It is thereby concluded that sun rays are found to be at their highest point in equatorial Africa.

While there appears to be some sense to the statements made on the shape and movement of the earth, Prout (1836) was quick at warning authors that

> The sun is the most obvious and unvarying source from which both heat and light are communicated to our earth. *The nature of the sun, however, and the mode in which that wonderful supply of heat and light is maintained are quite unknown to us, and will probably always remain so* [emphasis added]. (p. 50)

The nature of the sun and the mode in which light and heat emanate from the sun are completely beyond our reach. To bolster his caution about the earth and sun, Prout showed our flimsy knowledge about or rather our cursory glimpse into the sun to be amplified by three most dominant factors.

First, the northern polar region is not the coldest place on earth. Prout (1836) clarified,

> Hence it has been inferred that there are two points or poles of greatest cold situated in about the latitude of 80 º, and longitudes of 95 º east, and 100 º west; and consequently that the geographical pole of the globe is not the coldest point of the Arctic hemisphere. (p. 110)

(p. 110)

The stated-above factor fully contradicts the idea of gradient skin color from equator to the northern pole. The factor is a stark derision of torrid zone theory and its corollary "gradient of human skin color" (Jablonski, 2017, p. 6). One reason for this might be that the southern polar region contains more land than the northern polar region. The factor afore-referred is confirmed by existing data identifying the southern polar region to be the coldest place on earth rather than the northern polar region (see Post et al., 2019). The second most dominant factor is that, unlike the massive popular belief relayed by a great number of skin color outlets (Jablonski, 2017, 2021), the temperature in the African equatorial region is demonstrated to be much lower than commonly claimed. Prout (1836) asserted,

> Since at the equator, only about *one-sixth of the whole circumference of the globe is dry land*, the general equatorial temperature, as actually found to exist, is perhaps lower than upon theoretical principles it ought to be; and *certainly much below* what it ought to be [emphasis added]. (p. 111)

As depicted earlier, equatorial temperature is found to be much lower that usually believed by a no small number of pigment authors.

As misconceptions on equatorial temperature continued to spike up, Prout (1836) maintained,

> The mean annual temperature of the equatorial, like that of the polar regions, is a meteorological problem of considerable interest. Humboldt, from a very extensive generalization, fixed the mean equatorial temperature at 81½ º; and the same temperature has been adopted by others. Attempts, however, have been recently made to show that this temperature is 3 º or 4 º below the truth; but Humboldt, in reply still maintains his former opinion. (p. 111)

As explained above, Humboldt, the founder of latitudinal gradient diversity and of most instruments for the measurement of latitude and longitude (see more details in Cibangu, 2022), had to repeatedly repudiate misconceptions about equatorial temperatures. One figure of great value for pigment research to be recalled here is German naturalist Constantin Wilhelm Lambert Gloger (1803-1863), who, using data-supported materials, demonstrated the temperatures of equatorial Africa to be much lower than those of North America. As an illustration, Gloger (1833, p. 59) posited the annual temperature in equatorial Africa to be around 20 ℃ [68 ℉] while that of North America reaches up to 40 ℃ -- 50 ℃ [104 ℉-- 122 ℉] and that "*in der Äquatorialzone ist da selten Sonnenschein; Tag und Nacht sind gleich* [in the equatorial zone, sunshine is rare, day and night look alike]" (Gloger, 1833, p. 47). Regardless of how a forest can be (mis)conceived, a forest presents features that are fundamentally incompatible with the idea of highest heat and/or UVR. In more ways than one, as noted earlier, recent research on forests has repudiated the misconceptions about temperatures in equatorial Africa (Rafferty, 2011; Waide, 2019; FAO & UNEP, 2020), with the idea, for instance, that thick barks constitute a definite barrier against heat and light or that Africa's equatorial forest only covers less than 3% of the world's forest, with the remaining 97% being outside of Africa. If Africa only spans less than 3% of the world's forest (FAO & UNEP, 2020) and (not to mention) that as shown above by Prout (1836) only one-sixth of the equatorial region of Africa is dry land, then the claim of highest intensity of heat and UVR in Africa is nothing short of plain, unfounded prejudice, further obscuring research on pigment.

The third and last most dominant factor sits in the nature of human skin, this is in light of Prout (1836) detailed reflections about thermodynamics. Prout (1836) reasoned,

> The conduction of heat is chiefly confined to solid bodies; and as solids exist of every degree of consistency and density, from perfect fluidity up to perfect hardness, the conducting power varies in like manner. Hence the laws of conduction and those of radiation have a mutual dependence; and, in fact, the laws of conduction may be considered as only extreme cases of the laws of radiation. In general the densest bodies, as metals, stones, hard woods, &c., have the greatest conducting power, though these differ exceedingly among one another. (p. 44)

Prout (1836) went on, narrating,

> Porous bodies in general are bad conductors; and of such bodies charcoal may be considered as one of the worst conductors. Among substances employed as articles of dress, hare's fur and eider down are the worst conductors, and flax the best. The relative conducting powers of substances of this class seem to depend much upon the quantity of air enclosed within their interstices, and the power of attraction by which this air is retained or confined. (p. 44)

One point to be borne in mind here in light of the account laid above is that human skin figures among the most porous bodies in nature, along the lines of animal fur/skin. The fact that human skin is one of the worst conductors of heat and light makes it the least likely and indeed the worst unit of analysis for research on heat and UVR.

What is perhaps worthiest noting is that porous bodies are among the worst conductors regardless of their color. Despite being rebutted by data-proven research from the 19th century onward, misconceptions about temperatures in equatorial Africa have persisted and crippled pigment research unabatedly. Current melanin research (d'Ischia et al., 2013, 2015; Glagoleva, Shoeva, & Khlestkina, 2020) all but fiercely rubber-stamps the challenges pinpointed in the past about skin and melanin.

5.10 Quantum Biology

The tenth and last challenge, after that of melanin, chipping away at pigment research, springs from the concept called quantum biology. Quantum biology can be said to be one of the most forgotten or unknown domains of pigment research. Some of, if not, the earliest exposés of quantum biology were with German physicist Ernst Pascual Jordan (1902-1980) and Austrian physicist Erwin Schrödinger (1887-1961). However, Jordan proven affiliation with the Nazi party and the use thereof to justify quantum biology (see Beyler, 1996, p. 248; Howard, 2013, p. 265) have nearly irreparably diverted researchers' attention from Jordan writings on and implementations of quantum biology (Jordan, 1932, 1934, 1941; Franck & Jordan, 1926). This is in sharp contrast to Schrödinger (1944/2021) who relinquished a famous faculty position at the University of Berlin and left Germany in blatant defiance of Nazism, thereby rising rapidly to fame as a staunch opponent of Jewish persecution. Jewish persecution was/is no different from the state of black-skinned populations, the underlying rationale behind the present paper. Sharp contrast can also be seen with French physicist Louis Victor Pierre Raymond de Broglie (1892-1987) who led a withdrawn and yet scholarly productive life. In his PhD dissertation defended at the then University of Paris[2] in 1924 and published a year later in 1925 (de Broglie, 1925), de Broglie made substantial contributions to quantum theory. Thus, it needs to be underscored that quantum mechanics was/is not the same as Nazism or the Nazi state. Interest in quantum biology can be found with newer or more objective implementations of quantum mechanics (Freire Jr, 2015; Freire Jr et al., 2022; Laloë, 2022; Myrvold, 2022). While fascinating areas for implementations of quantum mechanics have been identified in general biology by a growing number of studies (Guan et al., 2022; Marais et al., 2018; Scholes et al., 2017; Xu et al., 2021), areas for pigment quantum biology have yet to be fleshed out and investigated. Consequently, the challenges discussed supra stand out in relief and serve as signposts for future pigment quantum research. Arndt, Juffmann, and Vedral (2009) supplied one of the most informative introductions to quantum biology. Pigment quantum research has enormous growth potentials.

As de Broglie (1925) summed up,

> *Bref, le moment semblait venu de tenter un effort dans le but d'unifier les points de vue corpusculaire et ondulatoire et d'approfondir un peu le sens véritable des quanta. C'est ce que nous avons fait récemment et la présente thèse a pour principal objet de présenter un exposé plus complet des idées nouvelles que nous avons proposées* [In a word, time seems appropriate for an effort toward bridging the perspectives of particle and of wave, and delving a bit into the key feature of quantum theory. That is what we did recently and the present [PhD] thesis aims to present a fuller account of the new ideas that we suggested]. (p. 33)

In tandem with the claim looked at above, one of the most captivating interests of quantum mechanics for pigment research resides in the idea of phenomenon (i.e., light, UVR, forest, skin, earth, etc.) seen as matter and particle at the same time, all of which goes past the mere, traditional idea of linearity (i.e., parallelism of sun rays, cause-effect description of skin, gradient of human skin, etc.). Pigment quantum research constitutes an open affront to traditional interpretations/theories of skin evolution such as gradient of human skin, torrid zone theory, equatorial highest heat and UVR, melanin seen as the strongest shield from UVR, melanin believed to be the blackest substance, etc. Perhaps the real bane of pigment research is a continued neglect of the challenges posed over the years.

6. Paths forward for Newer Research

Highlighted by newer research, ten levels of challenges have been garnered to appraise the interpretations needed to best understand and research (black) pigment (in humans): from hunting of hominins to human skin to lips to feet to the back/areas the spinal cord back/spinal cord areas to equatorial Africa to the earth's shape and movement to quantum biology. The challenges are designed to help authors forge paths forward for newer research into (human) pigment. Unresolved flaws inherited from the past in the understanding of melanin continue to gnaw at existing pigment research. As d'Ischia et al. (2015) lamented, "despite considerable advances, applied research on melanins and melanogenesis is still far from being mature" (p. 520). Perhaps, with an awareness about the challenges and/or descriptions formulated in the 19th century, research on melanin would have taken a much different direction (details below). In effect, d'Ischia et al. (2015) went on, expounding, "Until very recently no consensus has been reached on the precise nature of melanins' physical structure" (p. 528). The fixation on equator and heat has done and still does a great deal of damage to both a proper understanding of and research into melanin and its distribution. Technological advances do not make a difference, either. As d'Ischia et al. (2015) insisted, "Despite considerable advances, however, several challenges must be met before melanin-based technology becomes a mature field" (p. 536). The point was made clearer in a previous remark. Not without reason, d'Ischia et al. (2013) cautioned that

> there still remains today a lack of general consensus what actually melanin is. A variety of definitions and models are found in the literature, which reflect, however, an arbitrary use of terminology as well as several assumptions and speculations that have never been proven on experimental grounds. (p. 616)

The statement above confirms the key concern/contribution of the present paper for more synergies/concerted awareness about pigment. Disconnected and unproven interpretations of pigment stem from a lack of concerted work/effort and the limited/reductionist nature of lab-situated existence of melanin and corresponding products. Repeated experiment in diversified settings might help circumvent reductionism seen with lab-driven accessibility of investigated pigment. Due to misconceptions associated with melanin since its inception, a different terminology such as *tholonin* taken from the Greek work *θολός* suggested by Aristotle (350BC/1970, 524a-b) or *pigmentin* borrowed from the Latin word *pigmentum* (see Littré, Baillière, & Robin, 1873) might be more accurate and neutral for future research. Arbitrary interpretations of melanin very well trace back to unaddressed challenges of the 19th century sketched above. To explain, d'Ischia et al. (2013) averred, "Despite considerable advances in the past decade, melanin research still suffers from the lack of universally accepted and shared nomenclature, methodologies, and structural models" (p. 616). The nature of melanin is definitely part of the puzzle. This is partly because, as Glagoleva, Shoeva, and Khlestkina (2020) reminded researchers, "The poor solubility of melanin in particular solvents and its complex polymeric nature significantly constrain its study" (p. 1). It is helpful to recall that melanin is found in nature, without limitation to a particular species or location. In this respect, Glagoleva, Shoeva, and Khlestkina (2020) recently stated, "This pigment [i.e., melanin] is present in all kingdoms of living organisms, but it remains the most enigmatic pigment in plants" (p. 1). The fact that melanin cannot be found in its natural habitat or living complexity renders its study inherently deficient, not counting that melanin is nothing more than a chemical product.

One idea might be to replicate a lab-manipulated experiment of pigment in as much diverse/different setting as possible to provide a broader look into the researched product. Another idea to move pigment research forward, which is a requirement of any scholarly work, is a recognition of and emphasis on the limitations inherent to the research done, in the hopes of warning concerned researchers against potentially uncalled-for, unfounded narratives/interpretations. Lab-led interpretations remain unfounded until they are fully corroborated by in-situ or real-world unaltered phenomena/circumstances. This is the biggest threat to most life science research, enmeshed with social consequences such as pigment research.

7. Limitations

While the paper was able to produce a synopsis of the challenges posed to the understandings of pigmentation by probing Google Scholar, it did not focus on individual reviews. Rather the paper looked at the common themes/ideas threading through collected reviews. By focusing on individual reviews, the paper would have uncovered discipline-specific deficiencies. For example, what is problematic in animal genetics might not be so in plant science. However, because the topic pigment spans an increasing variety of disciplines, concerted efforts/works have the potential to spawn firmer/broader views on the topic researched.

8. Conclusion

Experimenting with a phenomenon in a lab vs in the real world is a challenge to be borne in mind when proposed research regards humans in particular or (social) reality in general. Similarly, working in silos does not farewell for anybody, from industry to academia to entertainment to career to life and to nature itself. On more than one account, melanin, or pigment to use a more precise term, corresponds to no less than a hazard of nature. Thus, pigment researchers are urged to keep their finger on the pulse of past challenges magnified by newer industries and ensuing skin-related specialties. Just like any chemical product, melanin, to call it so by lack of a right word, requires unfettered approaches toward its (real) properties to allow for fresher synergic research free from unwarrantedly deep-set, biased narratives and concepts. Indeed, the diversity of backgrounds among pigment-centered or skin color researchers along with the augmenting advancement of modern-day industries and subspecialties of biology continue to thrust (skin) pigment into the spotlight. This is further compounded by the fact that humans have body parts (i.e., lips, breasts, belly, and buttocks) that can be naturally groundlessly heavier than those of other species.

Challenges to (black) pigment research have been raised and soaring since the 19th century, and invaluable materials along with efforts toward mending matters have remained disturbingly widely dispersed, unacknowledged, and perhaps ignored or unknown. This has left pigment research on a heap of ruins or, to put it mildly, of undone works. Yet, pigment (or skin color) research is just as old and evident as skin itself. As is apparent above, the wide-ranging diversity of backgrounds from and with which authors come to grips with the concept black pigment is a potent boon to research rather than a disservice. One way or the other, the afore-stated and similar challenges ought to be redressed in order for a discourse on the evolution and/or formation of human pigmentation to amount to a generalizable, scientific, and prejudice-free discourse. Perhaps a key in addressing the challenges faced by human skin evolution lies in an important warning issued not long ago by paleoanthropologists Smith and Wood (2017) that narratives of evolution – and those of human skin evolution are no exception -- are being proposed while at the same time relevant data are lacking. With newer materials, traditional interpretations of human skin pigmentation have further come into question. A skin color researcher is thus urged to have their works borne out by and engaged with data of new emerging subfields of biology concerned with human skin. For example, considering fire as a longer process of *Homo sapiens* behavior in high physical activity of hunting/cooking leads to a rethink of human skin formation and its timing. The fact that melanin is a dye which is not entirely or uniquely black poses a dilemma to traditional understanding of black skin. Quantum pigment research comes to be a complete reversal of traditional interpretations of (human) pigment alongside its natural setting and proposed units of analysis (i.e., melanin, skin, UVR, vitamin D, heat, forest, savannah, etc.).

Part of the challenge is that there was no rhyme or reason for humans to be hunters of meat only to have dull, unsharp teeth unable to munch and digest raw meat and bones. Nor for human lips to be meatier/fleshier than any lips in the kingdom of the livings only to become considerably depleted under the mere effect of ambient air. Nor for humans to exhibit high physical activity as runners and/or walkers only to have feet with no grip on objects and the ground. Nor for humans to be UVR-protected or melanin-shielded in their skin only to have a skin that is a typical haven for colonies of parasites/bugs (e.g., mosquitoes, bees, wasps, spiders, etc.). Nor for humans to have a naturally UVR-adapted skin that is all naked, hairless especially in the back, and nearly unavoidably cracks, blisters, hurts, and/or itches any time, even with the greatest care and best body lotion. Nor for humans to have skulls, toes, fingers, genitals, groins, etc. with areas specifically prone to the proliferation of parasites. Nor for *Homo sapiens* individuals residing in equatorial Africa and before their dispersals out of Africa to be naturally unequipped with or deprived from the deep-set type of eyes common among Asians, and which are yet best designed for and protected against equatorial conditions awash with bugs, straws, or pollens and (alleged to be) flaming with the earth's most intense UVR. Vulnerable skin areas such as groin and axilla of human infants and even adults call for specialized products rather than regular soap and plain clean water. Skin color literature greatly underestimates the innate vulnerability of human naked skin in equatorial/savannah conditions and beyond. The natural vulnerability of human naked skin needs to be emphasized by skin color scholarship to help dark- and black-skinned individuals to properly take care of their skin as best as possible. It is proposed that future research of human skin color dovetail with the complexity of human skin and the attendant growing biology specialties (i.e., cosmetics, zoology, dermatology, pediatrics, sports, plastic surgery, forests, pharmaceuticals, quantum biology, etc.) rather than being narrowed on a single mechanism/hypothesis of *Homo sapiens* behavior and anatomy thereof. A multifaceted view of (human) skin as one arising from quantum theory has the potential to cast a fresher, broader look into traditional interpretations of skin evolution and existing data.

Acknowledgements

Special thanks are extended to Alessandra Lenzi --- Head of Library and Archives, at Museo Galileo, Institute and Museum of History of Science, Firenze, Italy --- for supplying the paper with Bizio (1825) article. Not least to be warmly thanked is Joseph Katembwe for helpful translations and suggestions made on the article received.

Notes

1 The present paper is focused on the evolution of human skin, and thus it does not cover the challenges involved in understanding the evolution of modern humans or human species, authors interested in the taxonomy/evolution of modern humans are referred to Wood (2010, 2017), Smith and Wood (2017), and Faith et al. (2021) works, among others. Equally, the arguments and theories of skin pigmentation fall beyond the compass of this reflection, authors with an interest in these matters can be directed to Cibangu (2022) in-depth review of black skin research.

2 Founded in the late 1100s (Leutrat, 1997), the University of Paris, was commonly referred to by metonymy as Sorbonne, from the 13th century onward, because of the buildings called College of Sorbonne in which some University of Paris faculties were housed. Since the 1970s, however, due to a rapid growth, the University of Paris has been divided into thirteen separate institutions scattered across the city of Paris, from University of Paris I (or Paris I) to University of Paris XIII (or Paris XIII), three of which have kept the appellation Sorbonne ascribed to them: namely Paris I (Panthéon-Sorbonne University), Paris III (Sorbonne Nouvelle University), and Paris IV (Paris-Sorbonne University).

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