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INTER-SOCIETY COLOR COUNCIL

NEWS LETTER NO. 46

MARCH 1943

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NEW INDIVIDUAL MEMBERS At a meeting of the Executive Committee held just prior to the annual meeting of the Council on March 4, three new individual members were accepted. We are glad to welcome them to membership in the Council: Dr. Victoria K. Ball of Western Reserve University, whose interest is in art education; Dr. Ellis Freeman of the Bureau of Visual Science, American Optical Company, whose interest is psychological and psychophysiological; and Mr. Jos. P. Gaugler, president of Fiatelle, Inc., who is particularly interested in merchandising research.

CHANGES IN DELEGATES The Optical Society of America has recently added Professor Parry Moon and Dr. Elliot Q. Adams to their list of delegates. Dr. Balinkin has recently been made chairman of delegates from the American Ceramic Society, replacing Dr. Weyl who found it necessary to resign from this work. Mr. J. R. Bonnar is now a delegate from the Textile Color Card Association of the U. S. Inc.

REPORT CHANGE OF ADDRESS Several delegates and members have recently reported to the secretary that they have not received recent News Letters. In several of these cases there has been a change of address. This note is to remind you that Council publications are generally sent second-class mail and that therefore this material is not forwarded in the same manner as first-class mail. Therefore if you expect to get your News Letters and other Council reports, please supply changes in address to the secretary.

CHAIRMAN JUDD'S 1942 REPORT TO THE ANNUAL MEETING It is customary for the chairman to summarize briefly the achievements of the Council during the past year and to indicate the expected course of things to come. Foremost among the events of the past year was the first formal attempt by the Council to bring recent technical knowledge of color to bear on the problems of art. I refer to the Symposium on Color in Art Education and the attendant review of art-school teaching methods held with complete color exhibits at the Metropolitan Museum of Art. Published accounts of these papers have recently been distributed.

Development of a test for color aptitude has been continued and is apparently approaching successful conclusion under a committee of which Dr. Dimmick and Mr. Foss are co-chairmen. A subcommittee under Dr. Le Grand H. Hardy has meanwhile standardized a test for red-green discrimination based upon the materials prepared for the aptitude test, and has placed it at the disposal of the Armed Services as an aid in the selection of personnel to operate aircraft. The News Letter has been maintained at its pre-war levels of content and scope and in spite of heavy war-time demands on its editor-in-chief, Dr. Godlove, has reached you at a fairly close approximation to its bi-monthly schedule. New recognition has been gained for the ISCC-NBS method of designating color. The American War Standard for the Specification and Description of Color, Z44-1942, was approved last June 17th. This standard recommends the ISCC-NBS color names as the last of 4 provisions for color standardization.

A new privilege has been offered to the Council, that of naming one of the trustees of the Munsell Color Foundation recently established through the unselfish act of Mrs. Juliet E. O. Munsell, widow of the originator of the Munsell system, Mr. A. H. Munsell. This responsibility has been accepted and the Executive Committee has named our secretary, Miss Dorothy Nickerson, as this trustee. Another new responsibility of the Council has also been placed in Miss Nickerson's capable hands. My own member body, the Optical Society of America, has requested the Council to arrange a series of papers on color blindness. This series was arranged with the advice of the Executive Committee. It is scheduled for Saturday morning in the Keystone Room of this Hotel. All of you are cordially invited to this session as well as to the other sessions of the Optical Society, both of contributed and invited papers.

To peer even further than 2 days into the future, it is expected that Council policies will be more explicitly formulated in the near future than they are now in the Articles of Organization and Procedure. We expect to keep on the alert for ways to serve the war effort, to encourage the development of color knowledge, and to arrange for the effective use of that knowledge. This work will be carried on in spite of the loss of our Vice-chairman, Dr. Walter M. Scott, to the Chemical Warfare Service, and the loss of other valuable delegates and members to the urgent business of winning the war. I say with confidence, the work will be carried on, because I know from experience how well I can rely on the cooperation of those of you who are left.

ASSOCIATION FOR COLOR RESEARCH

ACR held a regular meeting on January 27 at Art Center, Chicago, 32 West Randolph Street. At this meeting a three-man Board of Experts replied to questions about the new Chicago Subway, including such questions as the following proposed in the announcement: How can the color schemes of the new Chicago Subway stations speed up traffic and promote safety? Will advertisements in the new subway stations be "as junky-looking as those in the New York and Boston subways" or will some system of control be exercised? The experts were Alfred Shaw of the Chicago Planning Commission, member of the Board of Directors, Chicago Art Institute and Consulting Architect for the Chicago Subways (Mr. Shaw was architect of the Merchandise Mart, world's largest office building); E. V. Buchsbaum, Architectural Designer, Chicago Subways; and Walter Rasmus, Architectural Engineer, Chicago Subways.

The present officers of the Association, which is affiliated with Art Center, Chicago, are: President, Merle B. Sweet, Northern Pigment Co. Ltd.; Vice-president, Oliver J. Lunn, U. S. Color Card Co., Secretary, Albert E. Russell, Jewel Paint & Varnish Co.; Treasurer, Ben Heatherly, Metal & Glass Products Co.; Directors, E. D. McGlone, Wm. B. Ingram, Bruno Movrich, James Fruin and Tom Byron.

Art Center Chicago, in which ACR is associated along with five other organizations, in January sent out invitations to three shows. One was the work of Kenneth Waldemar Olson, including photographs both in monotones and full color, sketches, renderings, product designs, interiors, salesroom and office designs, convention displays and unusual water colors. The other shows were the Society of Typographic Art's War Printing Show and the Annual Chicago Photography Exhibition. Taylor Poor is President of Art Center Chicago. Another affiliate, the Art Directors Club of Chicago recently sent out invitations to the 1943 Annual Exhibition of Advertising Art, held during all of March at the Chicago Art Institute.

NEW TCCA DIRECTOR

At a recent meeting of the Board of Directors of the Textile Color Card Association of the U. S. Inc., John F. Warner, Director of Development of the Calco Chemical Division of the American Cyanamid Company was appointed a director of the Association to fill the vacancy caused by the death of William Hand. Before joining the Calco Chemical Company as vice-president in 1937, Mr. Warner was associated with Pacific Mills in the management of their textile, printing and finishing plants and in the merchandising of their cotton and rayon piece goods. A leader in the development of fast color dyeing and an authority on synthetic textiles, Mr. Warner has been at the forefront of many movements for the betterment of the textile industry. He is also a member of the Association's Dyestuffs Advisory Committee, appointed immediately after the declaration of war by the United States, to advise the organization on the colors it will produce for the duration. This committee also serves as a link between the Association and the Dyestuffs Division of the War Production Board, whose chief is Dr. Arnold Lippert.

In addition to Mr. Warner and the Association's President, Charles Pinnel of Merrimack Mfg. Co., the following now serve on the Association's Board of Directors: E. Irving Hanson, Sr., Stunzi Sons Silk Co.; Allan C. Jacobson, J. P. Stevens & Co.; Carl E. Kempf, Brewster Hat Co., Inc.; W. R. MacIntyre, Joseph Bancroft & Sons Co.; William B. Olsted, American Viscose Co.; Brainerd Pidgeon, Stunzi Sons Silk Co.; Armand Schwab, Armand Schwab & Co.; Alfred L. Simon, Alfred L. Simon & Co., and Roy E. Tilles, Gotham Hosiery Co., Inc.

MRS. REIMANN NEW TCCA RESEARCH ASSOCIATE AT THE NBS

It was recently announced by Mrs. Margaret Hayden Rorke, Managing Director of the Textile Color Card Association of the U. S. Inc., that Mrs. Genevieve Reimann, well known to many of our readers, has been appointed by the Association as Research Associate at the National Bureau of Standards under the supervision of our Chairman and NBS Physicist Dr. Deane B. Judd. It was stated that, as a phase of the Association's broad program of color identification and standardization, the project would include the spectrophotometric calibration of the 216 colors of the Ninth Edition of the Standard Color Card of America and the translation of these standards into the language of scientific specification and nomenclature. The spectral reflection curves of each of the standard colors will be measured on the Bureau's Recording Spectrophotometer. Then will follow the location of the colors in the ISCC-NBS system of color names and the assignment of the corresponding designations along with the visual comparison of the 216 colors with the Munsell standards and assignment of Munsell notations to the colors. When the entire data have been assembled they will be printed in booklet form and placed at the disposal of the Government and industry and will be a supplement to the Ninth Edition Standard Card.

The Association believes that the compilation of this valuable data will provide an authoritative guide not only for the color-using industries, but also for the Quartermaster General's Office and its various Depots, the Navy Department and other branches of the Government. As the War Department has adopted the Spectrophotometer for measuring its colors and as this and other Departments of the Government also make wide use of the Ninth Edition Standard Card, the coordination of these specifications will be most valuable for war requirements. Mrs. Rorke, who has been working on this plan for two years, stated that the data will supplement and tie into the work of the American Standards Association and the Inter-Society Color Council, the Textile Color Card Association being a member of both these groups.

Mrs. Reimann, a former student of the Maryland Institute of Art and Johns Hopkins University and for many years associated with the Munsell Color Company, is especially

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well qualified to carry on this important research work. She had previously served as as Research Associate for the Cordage Institute at the National Bureau of Standards an and is well acquainted with the problems of spectrophotometry.

NEW ASTM STANDARDS — There has recently been announced the Third or December, 1942, edition of the A. S. T. M. Standards on Paint, Varnish, Lacquer and Related Products. This brings up to date 120 specifications, tests and definitions issued by the American Society for Testing Materials through the work of its Committee D-1, comprising more than 200 authorities representing consumers, producers and general interests. Some sections of special color interest in the chapter on Pigments include: Tinting Strength (White Pigments) and Tint-Strength and Mass Color (Color Pigments); in the chapter on Paint Tests, Putty are: Hiding Power (Relative Dry) of Paints, Spectral Characteristics and Color of Objects and Materials, Specular Gloss of Paint Finishes, and Definitions of Terms Relating to Paint, Varnish, Lacquer and Related Products. Other chapters include Drying Oils and Thinners; Driers, Shellac, Varnish and Varnish Materials; Lacquer and Lacquer Materials; and Paint Weathering Tests. The book contains 425 pages, 6 x 9 in., with heavy paper cover. It sells for $2.25 per copy, with reductions for more than 10 copies and to ASTM members. It may be purchased from the society at 260 S. Broad St., Philadelphia, Pa.

LUMINOUS AND FLUORESCENT PAINTS — We have received a copy of the National Bureau of Standards' Letter Circular LC 703 of this title, which replaces LC 678, and is dated September 9, 1942. It is a 9-page single-spaced mimeographed letter. Luminous Paint is divided and described under 2 headings: Phosphorescent type and Radioactive Type. About 3 pages are devoted to the description and properties of these. Two pages of references in this section are divided into Government Publications and Publications Other than Government. In the section on fluorescent paint, after the description follows a paragraph on its application and uses, then several references to articles by Demant and Petzold. The third main section gives a list of Sources of Supply, naming over 30 firms, with addresses.

DISTRIBUTION OF 1942 MATERIAL — It has been our custom to report the distribution of subject material in the News Letter each year at the subsequent meeting. During 1942 it was approximately as follows:

Strictly news	42.1 %
Bibliography (incl. patents)	33.4
"Feature" articles	14.9
Reviews of current literature	7.9
Index	1.7

The "features" included Birren's Color Trip, Dimmick's letter on Vitamin A and Color Blindness, Kelly's Color Poem, Farnsworth's letter on the Latitude and Longitude of Color (Use of Munsell System), Eaton's letter on the First Known Colorist; an article on Camouflage; Isobel Moore's lecture on the Psychology of Color, and Godlove's series "Color in Painting through the Ages." (Total of 14.9%).

STAMP COLOR — We have received printer's proof of William H. Beck's "A Study of the Colors of the 1861, 3¢ U.S. Design Stamp," to be published in "The Stamp Specialist." According to an Editor's Note, this "is undoubtedly one of the most thorough studies of color as applied to stamps that have ever been attempted." The paper includes eight figures. After an introduction explaining color in popular terms, the author next considers paper and gum analysis, ink analysis and design analysis as they affect color; effect of light sources; the attributes of colors; stamp classifications and psychological notations; spectrophotometric analysis of stamp colors; units of color-difference ("Judds") and a scale of quantitative Discriminative terms relating to these units; analysis of the colors of individual stamps "on" and "off cover," and deviations in "Judds," from a standard pink, of the colors corresponding to stamp-experts' color terms, as "dark red rose" or "pigeon blood." A strip of three stamps was used as preliminary standard. In order to determine the effect of a cover on the color of the stamp, one stamp was placed on the back or interior of a cut-open white 1863 cover. Another stamp projected from the cover, and from a third the gum was removed. Corresponding $1\frac{1}{2}$-mm.-square areas were examined with the G. E. Recording Spectrophotometer of the Electrical Testing Laboratories, New York City. Some experimental conclusions were as follows. Stamps on cover produce a greater percent of reflection in the red end of the spectrum than do any of the stamps off cover. All stamps "expertized" as "pink" exhibit an inflection in the reflection curves at 520-560 mu. Removal of the gum darkens the face of the stamp slightly and lightens the back of the stamp by 6 - 8 %. Adhering the stamp to a 74 %-reflecting cover lightens the face of the stamp by 3.5 %. The margin sheet, which is exposed to light more than the back, darkens with respect to the back by 7.5 - 9 %, whereas the back of the margin sheet compared with the back of the degummed stamp is 20 % darker.

Using "Judd" (in analogy with electrical units, this should be uncapitalized - Ed.) for Dr. D. B. Judd's "NBS unit" of color-difference, the author defines a "trace" as 0.0-0.5, "slight" as 0.5-1.5, "noticeable" as 1.5-3.0, "appreciable" as 3.0-6.0, "much" as 6.0-12.0, and "very much" as more than 12 judds. Using a strip of three stamps with gum as standard, 7 "pink" stamps differed appreciably (4.90); 2 "red browns", appreciably (5.5); 3 "roses", much (8.36); 3 "pigeon bloods," 6 "not pinks," 2 "dark red roses" and one "lake" differed very much (13.10, 16.71, 17.54, and 39.04 judds, respectively). But the pinks and pigeon bloods were close in percentage reflection (32.80 and 31.28), while the others ranged down to 17.32 % for the "lake." It is recommended that the color, measured $1\frac{1}{2}$ mm. under the chin of the portrait, reflect more than 30 % for pinks and pigeon bloods.

To compare colors "on cover" and "off cover," the author lists three possible methods: (1) classify only stamps on cover; (2) correct spectral reflection curves of on-cover measurements to off-cover conditions; and (3) use either a stamp on-cover or off-cover and specify the judd differences between the two colors. The author uses the second method. He determines the "ink color" by a graphical method of subtracting "paper color" from "stamp color." He concludes that when 25% of the paper color is subtracted from the stamp color, the off-cover "pink" differs from standard by 13 judds or less. He next establishes a "Proposed Standard Pink," whose ICI specification is $x = .3678$, $y = .3279$, $Y = 33.84$, excitation purity = .184, and dominant wavelength = 598.2 mu. A certain "near pink" for example, differed from this by 1.86 judds toward the red-yellow-red. Final recommendations are: (1) that on-cover "pigeon blood" differs from the proposed Standard Pink no more than 7.50 judds, fall in the red-purple-red region, have a reflectance of over 30% and differ from the original color of the stamp no more than 13 judds when 25% of the paper color is subtracted from the stamp color; also that the correction for off-cover shall be no more than 4 judds from the original on-cover color; (2) that off-cover "pink" differ from proposed Standard Pink by no more than 3.5 judds within the red-purple to blue-green range, have a reflectance over 30%, and differ from the original color not more than 10 judds when 25% of the paper color is subtracted. The essential difference between pink and pigeon blood is that the hue range of the former is larger. The method is stated to be applicable to all stamps of all hues.

DOMINATOR-MODULATOR THEORY OF COLOR VISION

A new theory of color vision has been proposed by R. Granit of Stockholm under the title: "A physiological theory of color perception," Nature 151, 11-4 (January 2, 1943). The theory results from experiments utilizing a technique for which E. D. Adrian laid the basis; Hartline (1938) developed a method of micro-dissection around the blindspot for isolation of optic-nerve fibers, and Granit & Svaetichin (1939) a micro-electrode technique for picking up impulses from the fibers inside the anaesthetized animal eye with cornea and lens removed. Discharges of spikes of impulses are obtained; but there is no definite correlation between type of discharge and type of color sensitivity. To analyze the "color sensitivity" of the discharges, there were plotted as ordinates the reciprocal of the energy necessary for a threshold response at each wave length. These ordinates were expressed relative to the maximum after correcting to number of quanta (Dartnall & Goodeve, 1937). The results suggest a differentiation of sensations into two categories of brightness and chromaticness. The curves for different dark-adapted animal retinas (the simplest structure) reproduce the absorption curve for visual purple (Lythgoe, 1937), with maximum around 500 mu. On light adaption, the human curve shifts (Purkinje shift) to 560 mu; and the new curve determines the distribution of brightness in a spectrum strong enough to elicit sensations of color (photopic, cone, spectrum).

In light-adapted animals, the curves are of two types: (1) broad (absorption) bands, called "dominators;" (2) narrow bands, called "modulators." The dominator is located at about 560 mu (frog, snake or cat, but not guinea-pig or rat). It is identical with the average curve from mass receptors of light-adapted eyes of the same species; thus it is the carrier of the Purkinje shift. As it also corresponds to the human scotopic luminosity curve, the dominator is regarded as responsible for brightness. Color broadly is thought to be due to modulation of the dominant (and most frequent) impression of brightness by the much rarer modulators, which occupy very narrow bands of sensitivity in 3 preferred regions around 580-600, 520-40 and 450-70 mu. In some eyes with 1% or less of cones (rat, guinea pig), there is also a narrow band at 500 mu, where the absorption maximum of visual purple is located. With these there is no Purkinje shift on light adaptation but instead a change of visual-purple type of curve to modulator type; that is, light-adapted rods serve as cones. The most frequent modulator is the "red" one at 600 mu. In the cone-eye of the snake it is generally (but not always) connected to a "green" hump at 520 mu, suggesting a "green" modulator that failed of isolation. But in guinea pigs and frogs the green modulators were at 530 mu, the "blue" at 450-65 mu; the frog has modulators also at 580 and 600 mu. "As rods and cones may converge towards a common ganglion cell (Polyak, 1936), and as many other factors antagonize isolation, it is clear that all atempts to interpret complex curves as well as to understand the nature of the sensory message as a whole must begin by emphasizing the positive character of the evidence for the existence of curves as simple as the modulators."

Work with the snake suggested that the dominator itself is composed of modulators joined together in such a fashion - either photochemically or by connections in the retinal synapses - as to operate as a functional unit. But this assumption is not essential to the theory based on the experiments. It would explain why stimulation of all modulators together also causes perception of white, and not of all hues confused. The modulators would in this case merely add to the effect of the dominator. Alternatively, the modulators could be coupled in antagonistic pairs which neutralize each other. In fact, in eyes having both "red" and "green" modulators, they are very difficult to separate. The author examines the consequences of experimental subdivision of receptors into a great number of narrow modulators varying somewhat in shape, locus, sensitivity and number within 3 preferred spectral regions. The dominator mediates the domenant sensation of brightness and is modulated by the modulators so as to give the higher centers a cue for the integration of "color." (1) the greater the wave length distance from the center of the dominator, the darker the color. This we know to be true. (2) W. D. Wright (1934) has shown that selective adaptation of the human eye to any color causes chiefly a large general reduction of brightness and an insignificant selective effect on the fatiguing color. This is also a direct consequence of a dominator for the perception of brightness. Classical theories require not only a much larger selective effect on the fatiguing color but also a considerable shift of the luminosity curve. (3) As it is improbable that all receptors would be of exactly the same threshold, a diminution of intensity should, on classical theories, lead to a perception of chromatic spots. Instead it leads to the spectrum becoming colorless, with the brightness distribution of the dominator, as required by the presence of this most common receptor. (4) Similarly, a reduction of area of the visual object, known to lead to disappearance of its color with maintained brightness distribution, must do so because the "small" stimulus has merely a chance of hitting upon the common dominator. (5) color-blindness need not, but can be possible without parallel change of the photopic luminosity curve. A color-blindness of this type would be the common form of red-green blindness (deuteranopia), to be interpreted as absence of the "red" and "green" modulators, with the remaining dominator alone giving the normal luminosity curve. Without a separate structure for the perception of brightness as distinct from chromaticness, no theory can ever hope to explain color-blindness unaccompanied by considerable "luminosity-blindness" to light from the "blind" region of the spectrum. Considered in relation to the complete color sense of man, many of the animals represent different types of color-blindness. The guinea pig comes very near the totally color-blind (but has modulators in the short wave region); the cat near the deuteranope.

With the three preferred regions for the modulators, the theory can do what the trichromatic theory does and "also demonstrates the essential correctness of Thomas Young's great generalization," although it is necessary to assume a greater or lesser number of somewhat different modulators within these regions. The main crux of the classical theories is the lack of precision in the concepts accounting for the perception of white as a separate entity, which, nevertheless, somehow is intimately connected with the perception of chromaticness. The trichromatic theory regards white as due to the summed effects of, chiefly, the red and green sensitivity curves. This forces the theory to accept the consequence that removal of "red" or "green" or both should cause removal of perception of brightness in the same region of the spectrum. Hence there could be no color-blindness without profound changes in the form and locus of the luminosity curve. It is an admission of failure to have to explain so important a phenomenon as deuteranopis by pushing it aside to be taken care of by the "higher centers." Many of the phenomena to which the trichromatic theory has directed attention need not be discussed, for the dominator-modulator theory does not necessarily exclude the explanations already available. Thus for example the fineness of hue discrimination in different regions of the spectrum may be explained in the classical way, or else by the assumption that the number of slightly different modulators is particularly great in the region of maximum hue discrimination. In its present form, the theory gives no explanation of "contrast color," though certain alternatives seem reasonable in view of the fact that different elements are so often coupled together and that the retina contains a large number of coupling synapses. If a certain percentage of the "red" and "green" modulators are coupled in such a manner that both discharge when either is stimulated, the natural result to expect from the asymmetry caused by fatiguing either of them is that the other one should predominate in the neighboring region as well as in the off-effect. The experiments themselves have not yet dealt with situations calculated to bring forth contrast phonomena.

It is impossible in a brief review to deal with the available evidence concerning the nature of the color-sensitive substances. The hypothesis the author prefers is that visual purple (the dominator of the scotopic eye) is the parent substance for the photopic dominator and the modulators. Its molecule consists of a protein nucleus serving as carrier for about 10 chromophoric groups (see Broda, Goodeve and Lythgoe, 1940). The different color-sensitive substances may be due to changes in the linkage between carrier and chromophores.

The Editor ventures to suggest that this theory has certain attractive features which may provoke interest and criticism; and invites our readers to comment in these pages. It may be pointed out that one type of "coupling" between modulators may be the fusion of chromophores by resonance or other interaction to form a composite chromophore with the effects of the original ones disappearing. It is known that in other cases, chromophores joined by non-resonating or inert atomic groups (which "insulate" the chromophores from each other) exhibit the separate effects of each one. The effects of absorption might profitably be examined in the light of "Stengel's Principle," (Lesbre, 1932) a special manifestation of a broader principle, according to which tendencies toward growth of particles (in the colloid range of sizes) are accompanied by an increase of the amount of light absorbed; and this is likewise true when simply related molecules are compared. Recent work on absorption of light at one point in the molecule and decomposition at another (weaker) point, as well as redistribution of energy in large molecules among the several degrees of freedom without decomposition (Norrish, Crone and Saltmarsh, 1934) ought also to be kept in mind. Finally, it must be pointed out that, although the author's reasoning bears the natural imprint of a bias from comparisons with human vision, he has not isolated modulators in the human visual system.

COLOR IN PAINTING THROUGH THE AGES XV.

Crete, the Cyclades and Greece. In Crete, about 2750 B.C., began the Early Minoan II period; and soon after, in Greece, Early Helladic II, while the passage from the first to the second Early Cycladic culture was not clearly marked. During Early Minoan II, the single-bladed axe was replaced by the two-edged axe, also known to the Sumerians, and became a fetish or symbol of divine power. Dark self-colored burnished pottery, like the early Anatolian and Cycladic Wares, continued; but in East Crete the potter covered her vessels with a red ferruginous wash which she relieved with dark (blackish) blotches deliberately produced by the reducing action of glowing charcoal. There was also a clear buff ware; and a lustrous red to black glaze paint was used to simulate the old burnished ware, while both white-on-dark and dark-on-light patterns came into use. In Central Greece, the Early Helladic II population, though living by farming, fishing and grape culture, was urban in character; and trade, industry and metal mining were well developed. A buff pottery was covered with a lustrous red to black glaze paint as on Crete. A distinctive shape was the "sauce boat." Leg amulets, tubes, "frying pans," marble idols and palettes and double-spiral pins were articles of commerce.

The Vardar-Morava culture of Vinca was continued at Starcevo on the middle Danube River. Here and at other sites in or near West Rumania, the potters' clay fired brown or red; and darker browns and black were used for designs. They were often red on black at Vinca, sepia on black at a moravian site; and black, red, brown, buff or even white or red at Starcevo. Pedestalled bowls with basketry (angular and crisscross) or spiral patterns were common. This painted ware derived through Thessaly from Southern Asia Minor, having its root ultimately in the Tell Halaf culture. In the West Rumanian sites, decoration by painting replaced ornament by incision; but the patterns remained essentially European. The great development of curvilinear designs was probably due to a mesolithic element in the population. Another Rumanian site, Tordos, previously described along with Vinca had red designs painted on a white-slip ground as well as red or brown on the natural buff-fired surface.

Central Europe. Farther north, Danubian I peasants mixed with surviving Tardenoisian, Maglemosian and other mesolithic food-gathering peoples, while Danubians still spread down the German rivers. The mixed peoples formed several local groups, distinguishable chiefly by their pottery. One group, marked by its "stroke-ornamented" ware, arose in Bohemia and spread into Moravia, Macedonia, Bavaria and Central and East Germany. The pots were round-bottomed, decorated with skeuomorphic zigzag patterns made up of ribbons executed by a series of distinct jabs instead of continuous lines. Over a large area the earliest ware was the monochrome linear-decorated pottery, with spiral and meander "ribbons," a free rambling style suited to the simple Danubian peasantry. The tool-point stroke ornament, a planned design, was a development. This progress may be seen in the four successive settlements recently excavated at Lindenthal near Cologne, and also at Flomborn near Mainz on the Middle Rhine. A similar fusion of Danubians with forest folk explains the Rössen culture which grew up in Germany about 2600 B.C. The competition for land is indicated by fortification of their settlements and by weapons. Their hemispherical or globular pots were decorated with linear patterns of basketry model executed by using a tool in a "stab-and-drag" technique and filled with white inlay. Other local "mixed"cultures in Germany filled the period to about 2400 B.C. In Hungary, the Bükk culture continued. It has been mentioned that, in its second and third stages, linear ornament was supplemented by bands of dark red or white paint. This tradition was fused with that of the Körös group and the linear Danubian, to emerge in Hungary as a new culture known from the Hungarian river Tisza. This culture is represented by the second stages at Vinca and Tordos; it spread over all the middle Danube country and replaced that of stroke ornament in Moravia, Bohemia, Silesia, Austria and West Hungary. It acquired Aegean and Anatolian elements by contact with the Vardar-Morava culture of Macedonia and Thessaly. On the east were the "painted-pottery" cultures. Beside the Tisza, Rössen, and stroke-ornamented ware cultures, built in part on that of the Danubians, in the period from about 2600 to 2400 or 2300 B.C., the latter culture itself persisted also in the Middle Danube basin. Then for dwellings, rectangular houses instead of the old wattle-and-daub pits were used. In the first phase, the black-polished vases were decorated with patterns, incised and painted after firing ("crusted ware") in white, red and yellow. In the second phase, a fine burnished red ware was painted with white paint only, or with red painted on a white slip before burnishing and firing, as in the first Thessalian culture. In a third phase, colored decoration was no longer used. On the "Moravian painted pottery" just described, the patterns were spirals, meanders and basketry designs; in Hungary there were no spirals, but meanders, circles and conventionalized faces were employed.

The Alps and the West. In Switzerland and the Alpine region, the Western Neolithic whose appearance in Spain we have already discussed, spread from that country, as evidenced by fortified hill-top camps or lake-dwellings. The "bag-ware" took the form of dark-faced, undecorated, round-bottomed or carinated vases. Explorations at Lake Neuchatel reveal four occupation levels. The oldest is that of the neolithic Cortaillod culture. The farmers lived in rectangular houses in small clusters along shores and raised on piles above the lake waters. Horned cattle, pigs, sheep and goats were bred. Their smooth, dark, pots were of simple Western leather forms with lugs but no true handles. The people were long-heads (Mediterraneans). Their culture derived from Spain; but there were influences from the older mesolithic folk and the Danubians. The route from Spain no doubt passed through Southern France, where there are caves (from 2600 B.C.) in which have been found the Western culture. Palettes were made for grinding paints, and vases were decorated in three styles without special color interest. The neolithic adventures pressed on to the uplands of

Central France, where at Camp de Chassey they fortified a hill top, and produced a distinctive pottery decorated with knobs and fine incisions; then into the downlands of Northern France, where a camp site is known as Fort Harrouard. The old plain pottery was then enhanced with triangle and zigzag patterns in fine-hatched and pointille work inlaid with red and white paint. Other settlements in France point the way to Switzerland and the Cortaillod culture; while other colonists passed to Southern Britain, where their culture, exhibited at Windmill Hill, will be described in another issue.

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