

gently, "and don't talk again for a little while. Perhaps some experiences of my own make me guess at the nature of the grief you can share with no one. As soon as you feel better I will tell you something of my own story."

"I am better already. Tell me now; we shall have to go back soon; the sun is beginning to colour the rocks yonder; it will be too cold for you here, very soon."

"My home is in Cheshire, near Liverpool," he began.

Carita started as he said this, and looked at him with such a quick glance of increased interest, that Arundel stopped and said—

"No, it won't do, I see. I will tell you all about myself some other time."

"I want you to go on now, Edward."

"But why did you start so?"

"Because I know someone else who lives near Liverpool," answered Carita, flushing a little, and then turning pale.

"What is the name of that someone, Carrie?"

The hand went to the side again.

So the trouble lies in that direction, thought the young man.

"Never mind, you can tell me some other time. Let us think of something else. Do you know what lies over yonder, within those mountains just over the upright walls of rock standing out in the evening sun?"

"No, I have never been out so far from the Springs before," replied Carita, in a listless tone. She would rather have heard more about Cheshire just then.

"There is a lovely little natural park surrounded by mountains. They call it the Garden of the gods."

"What a name, Edward! Is it very beautiful?"

"So they say; I have not been there yet, though several camping parties have been got up since I came to the Temple to explore it. I have often looked at the entrance from yonder rise in the plains there; its name and the narrow gate formed by those huge rocks have a fascination for me. It makes me think of the hymn, 'O Paradise, O Paradise.' I know you read the Bible, Carrie; I have noticed that in my quiet way."

"Ah, I know," said Carita, quickly; "you think of 'The Lord God planted a garden in Eden.'"

"Yes, and the old Greek translation translates the word garden by Paradise. Well, I have often lain out here alone, and thought how beautiful it must be inside there; that perhaps a clear mountain stream runs through the garden, with trees on either side, which I imagine to be like those whose 'leaves are for the healing of the nations.' The high mountains you see shut the garden in on every side from the keen, piercing winds which are so dreadful to a poor sick chap like me; and no hurtful thing there."

"I see no way into it, though," said Carita. Her companion's expression of face, and his tones, as he talked of the river and the trees, moved her so that she forgot her personal griefs, and looked intently towards this "Garden of the

gods," a beautiful spot, well-known to all travellers in Colorado.

"The entrance is narrow and the rocks are straight, Carrie, like the way and the gate that lead to life. From here they seem almost to meet. And that makes me think of a Latin phrase which I learned in my school days, 'Per angustam ad augustam,' that means, 'Through the narrow to the beautiful.'"

The girl grasped all the meaning that lay in the man's thoughts and words. Did the way to the beautiful for both of them indeed lie in the narrow, painful path of difficulty, over which her feet had stumbled and bled?

A light in Edward's face, which was a reflection of that light which comes not from this earth's sun, was reflected also in her large, dark eyes, and lit up her pale face. She took hold of her friend's hand again, and gazing still towards the rocks, she said, "And look, do look at the dark red of one ridge of rocks and the pure white of the other. 'Red like crimson and white as snow,'" she added, in a low voice, as though speaking to herself.

(To be continued.)

THE ANILINE COLOURS.

By AN ANALYST.



It is only matter in the wrong place. There is nothing wasted, and nothing useless in the world; and at the present day there is very little even of the most inconvenient and offensive rubbish which man cannot transform into articles of utility, beauty, or pleasure. The refuse of a great city supplies the raw material for numerous industries, and the sewage itself is a thing valuable in the farmer's eye, and, where it can be conveniently conveyed to agricultural land, possesses a distinct commercial value. The same is the case with the exhausted materials and bye-products resulting from many manufacturing operations. Formerly these materials often accumulated so as to be a serious embarrassment to the manufacturer, and not unfrequently a terrible nuisance to his neighbours. To some extent this is still the case. But in not a few instances these waste products have been so utilised as to become more valuable than the original object of manufacture.

No industry perhaps furnishes a better illustration of this than gas-making. In its early days the accumulation of tar, and other ugly and evil-smelling refuse, threatened to prevent its development, and in several instances led to the summary suppression of gas-works as public nuisances. But enormous as has been the progress of this industry, the utilisation of its waste products has been even more rapid, and the tar and other bye-products are now actually more valuable than the gas itself. Paradoxical as it may seem, it is nevertheless true, that in certain localities gas companies might give away their gas for nothing, and

still make a good profit from their gasworks. Even taking the country as a whole, the tar and other residual products are at least equal in value to the whole of the coal consumed in the process; and from these "waste products" substances are manufactured of nearly twice this value.

These secondary products are numerous and varied, including thousands of tons of ammoniacal substances used in manufactures and for manures; smelling salts; sweet essences and flavours; solid and liquid paraffins; asphalt; and, most important of all, aniline, alizarin, and other coal-tar colours.

In manufacturing gas the coal is put into large iron or fire-clay cylinders, which are strongly heated in fiery furnaces. Abundant fumes and gases are given off, but a large proportion of these are soon condensed in the pipes through which they are led, and are collected in great tanks, forming the ammoniacal liquors and the tar—a black, syrupy, stinking compound. It is from this latter that the aniline colours are prepared.

The invention of the colours is due to several chemical discoveries, having at first little relation to each other. Early in the century some chemists in Lisbon while examining indigo—Portuguese *anil*—found on distilling it a brownish liquid which produced an intense mauve colour when treated with certain chemicals. Little more was heard of the matter for years. But when the tarry mixture of the gasworks came to be examined, and it was found possible to separate its different constituents, the same liquid was discovered among them. Even this did not advance matters much, as aniline only exists in coal-tar in very small quantities. But another substance—benzol or benzine—can be extracted in large quantities. This liquid is now well known and much used for removing grease stains, etc., from articles of dress; and still better in the form of nitrobenzol as a perfume for soaps, pomades, and other toilet requisites, and also as artificial almond flavouring for confectionery, etc. It was soon discovered that by a little further chemical treatment the nitrobenzol could be readily transformed into aniline. With large quantities of this liquid at their disposal, chemists again turned their attention to the fine colours already referred to, and in 1856 Mr. Perkins was able to patent a practical method of preparing the now familiar aniline mauve in considerable quantities. In a few years this was followed by the beautiful red or crimson magenta, or rosaniline. Mauve is, perhaps, a finer colour, and it is certainly more durable than magenta, but the latter is of greater importance, as it can be produced more easily, and it also forms the starting point of the extensive series of colours now so common. Very beautiful violets and blues of almost all shades are easily produced from it; and with somewhat more difficulty yellows and greens, and also some very fine blacks. In fact, there is hardly a tint in the rainbow not represented among these colours, and seldom a season passes but some new shade or combination is brought into fashionable notice; the "crushed strawberry" and others of the present season being good examples.

The brilliant and pleasing tints produced by these colours rendered them at once popular. The extremely pretty mauve, having no competitor of a similar shade among dyestuffs, speedily became fashionable. But what contributed even more than their fine tints to their extensive employment in dyeing and calico-printing is the extreme simplicity of their application to these operations. For most other dyes tedious and complicated processes, and the help of auxiliary bodies named mordants, are required to produce "fast" colours; and even then the result is not always satisfactory. To dye

silk and woollen fabrics with the aniline colours nothing of the kind is necessary. A little of the dye is dissolved in a large quantity of warm water, and the goods or yarn are simply placed in the solution for a short time. The fibres of these materials have so strong an attraction for the dye that it is speedily absorbed, and so firmly "fixed," that no subsequent washing will remove it.

With magenta, and some of the others, the dye proceeds so energetically, that precautions must be taken to secure uniformity throughout the material. With strong solutions the short time necessary to manipulate the goods is sufficient to give those portions that remain a few instants longer in the bath deeper tints. To avoid this several baths of varying degrees of strength are used, the goods being removed to stronger and stronger solutions till the required tint is obtained. Printing is just as easy. The dye is made into a thick ink with strong vinegar and gum-water, and with this the figures are stamped on the cloth; which is then steamed for a short time, and afterwards thoroughly washed and dried.

Feathers, fur, hair, and other animal substances can be treated in a similar manner. No corroding liquids nor high temperatures are necessary; and thus the most delicate materials can be beautifully dyed without the slightest risk of injury.

With cotton, linen, and other fabrics prepared from vegetable sources, the process is not quite so simple. The dye will not fix itself to these fibres; and they must, therefore, be previously treated with some gummy albuminous matter as a "mordant," or fixing agent. In calico-printing the mordant and dye are usually mixed together, but the operations are not at all difficult.

Some of these dyes are exceedingly brilliant and striking, but the majority of them are characterised rather by a subdued and pleasing softness of tone, and when freshly dyed are very beautiful. Most of them, however, are not very durable. They are not affected by wet or damp, and they stand washing even with soap and soda very well. But on exposure to light, and especially to bright sunlight, they fade more or less quickly, and sometimes gradually change to a different tint. Even a few hours under a bright sun is sometimes sufficient to ruin a fine dress or a pretty feather. Mauve is more permanent than most of the others yet produced, and all are less easily impaired in silk and woollen material than in cotton goods. Considerable controversy has arisen as to whether these dyes are, or are not, injurious.

A number of instances have been brought forward tending to show that they produce irritating effects on the skin. With regard to the great majority of them, however, there seems little reason to doubt that such effects are due to arsenical or other impurities arising from imperfection or carelessness during their manufacture.

Aniline yellow, and one or two others, are decidedly poisonous, and will inflame delicate skins, and produce painful effects where the skin is in the least broken. It is highly inadvisable, however, to wear dyed or coloured materials of any kind next the skin. Whatever may be the best colour for the outer garments, the underclothing, and more especially that of young children, whose skins are peculiarly tender, should invariably be white.

A word may be said regarding amateur dyeing with these colours. It is useless to attempt cotton or linen materials, and no very satisfactory results need be expected if articles or garments of large size be tried. But there need be no difficulty with ribbons, feathers, fancy wool work, and such like. The articles should be first washed in warm water containing a little soda; then in cold water to remove all traces of the soda. A white

porcelain or earthenware basin, large enough to easily hold the articles, is then nearly filled with water, and just distinctly coloured with the dye desired. It is important not to use too much of the dye. This is, perhaps, the most common cause of failures, as it prevents a good uniform tint being obtained.

The articles while wet are placed in the basin, which is covered to keep out dust, and then the whole should be put into the kitchen oven, and left there for an hour or so. The articles are then removed, dipped two or three times into a basin of boiling hot water, and finally washed carefully in abundance of cold water. By limiting the time in the bath the shade can be altered very greatly, and if small pieces of white Berlin wool be put in the bath along with the other articles these can be from time to time removed and the progress of the dyeing watched. For very delicate or valuable articles the washing with soda may be dispensed with, and boiling water need not be used in the final washing. Judson's dyes yield very good results in this way, and other kinds can be purchased at almost any chemist's. But the amateur should not depend entirely on the appearance or even the names given to these dyes. There are numerous aniline blues and violets, for instance, all with some peculiarity of shade; and the colour of the dyestuff is often nearly the opposite of the dye it will give. The best way is to test them with a little Berlin wool as above.

The minute quantity of material required to give intense colours is quite remarkable, and enables the dyes to be used quite safely in articles of food. Less than a third of a grain of magenta will turn a gallon of water into a fine red solution, sufficient to tint confectionery, sweets, and similar articles; and a slightly stronger solution made into a paste with chalk or some similar material is the basis of many children's colour boxes, etc. These colours have also been employed in painting but not with great success. Their sensibility to the influence of light, which is of secondary importance with materials not intended or expected to last more than a few weeks or months, or a year or two at the outside, is fatal to their use in high class painting, where even a very small change of shade might entirely destroy the best effects of the painter's skill.

The aniline colours are not the only dyes obtained from coal-tar. Turkey red and other alizarin dyes used to be obtained from madder-root, and many thousands of acres of this plant were grown solely for the purpose of supplying this dyestuff. From the marvellous gas refuse, however, not many years ago a substance was extracted from which alizarin could be readily prepared in large quantities, and now the anthracene or "artificial alizarin" colours have practically driven the natural madder product out of the market. The artificial dyes are, indeed, better and cheaper by a long way than the madder. These colours are much more durable than the aniline dyes, but the processes of dyeing and printing with them are more difficult and complicated. To painters, alizarin is indispensable, for it is from it that most of those pigments called "lakes" are prepared, pigments which are second only to the best metallic colours in permanency and resistance to destructive agents.

Many other dyes besides these are obtained from coal-tar. Quite recently indigo itself has been prepared from one of these tar products, and there can be no doubt that in a few years the cultivation of the indigo plant will become as rare as that of madder at the present day. Indeed, gas tar and similar "waste products" seem capable of furnishing all manner of dyestuffs in quantities far surpassing the practical needs of the world for

many generations to come. The industrial effects of these new sources of supply have already been very great, and will be greater still in the future. In India alone more than six millions worth of indigo is prepared from the plant, and our textile manufacturers still import cochineal from Mexico, safflower from China, and many expensive dye-woods from South America and other regions. But the supply of all these is more or less limited, and without the aniline and other coal-tar colours their prices must have years ago reached fabulous figures. As it is, dyes more splendid than the ancients had any conception of are prepared in abundance at a very trifling cost, and instead of canvassing the world for her colours England will soon be able to supply all nations. At present, curiously enough, France, Germany, and Switzerland, although drawing their supplies of tar and other crude products mainly from England, have almost a monopoly of the manufacture of these colours. This is not likely to last long. It is only a deficiency in chemical and technical education, which is being rapidly repaired, that has allowed a manufacture already worth seven or eight millions annually, and for which we supply the raw materials, to be carried on abroad.

The tendency to look to mineral sources instead of animal or vegetable products is not confined to these colouring matters. It is common in all chemical manufactures, and it is not at all impossible that the next generation or the one after will see the active principles of tea, coffee, opium, quinine, and many similar articles and drugs extracted from sources just as uninviting as the stinking coal-tar. Large tracts of land will thus be set free for the primary purpose of growing the staple articles of food. Many people who appear to be dreadfully alarmed about overpopulation seem entirely to have overlooked this tendency. As her population grows, England will have to depend more and more on the foreigner for her food supplies, but every invention and discovery renders these more abundant and accessible, and enables her to produce something to give in exchange for them.

ANSWERS TO CORRESPONDENTS.

COOKERY.

HEBE sends us a recipe for a quickly-made pudding:—

Take one tablespoonful of flour and one of sugar, a teaspoonful of baking-powder, and one egg. Place the mixture in a small long dripping-pan, and bake lightly. When removed from the tin, spread either stewed apples or preserved fruit over it, and roll it up like a bolster. It is described as a "three minutes' pudding." The sofa which has a musty smell should be taken to pieces and the hair or flock inside baked. You should send it to an upholsterer.

YOUNG WIFE.—The recipe is a patent, and the property of the firm manufacturing the article.

A SCHOLAR.—You will find a recipe for oat cakes on page 510, vol. iii.

TINY ROBINNA.—Dry herbs and leaves in the kitchen in a warm place; put them in paper bags when half done to finish, and when quite dry powder and keep in bottles. We should advise you to go to a shop and see a mantle or jacket that you may like. The cloths are multi-coloured this year, and in coarse weaving. You might use racoon undyed, black or coloured velvet bands or feather trimming for the border and trimmings. All are fashionable, and not very expensive.

LAVENDER.—If you have no thick or thin captains' biscuits, you might serve "pulled bread" with the cheese course; or, if you have no new loaf, you can make rusks of the stale. See "Broken Bread, and What to Do with It," page 391, vol. iv.

PEARL and KATHLEEN.—All good grocers keep "desiccated cocoanut." The directions for making cocoanut icing or cake were given at page 255, vol. i. "Pearl" writes that the former makes a distinction between the m and n and the u and v more decidedly; sometimes "Kathleen" forgets to do so.