

every one of our birds been deemed of any great importance by ornithologists. Of late, owing to the discovery of numerous errors that had crept into our nomenclature, careful attention has been paid to a species from the time of its advent into the world to a period when beyond all doubt it has reached its maturity. To the collector who accumulates a series, it is only too apparent how great is the difference between individuals, and that his series is not complete until each and every phase of plumage from various widely separated localities is represented.

Late in the season, while the full migration is at its height, a bird is secured which for the life of him he cannot name; in vain he searches the literature, compares specimens, and puzzles and worries only to find it at last an old acquaintance flitting under new colors. I have in mind a young man who, although not an accomplished ornithologist, ought to have known better, and who essayed to publish a list of the birds of the locality in which he lived. One winter he secured a bird entirely unknown to him, and in his dilemma sent it to the Smithsonian for identification; on its return the label bore: "American Goldfinch in winter plumage." This may be a little foreign to the subject but it shows how necessary was a thorough knowledge of the life-history of the species. Nor was it so very long ago that the "Gray Eagle," which for years was accorded specific rank, was found to be but an immature phase of *Haliaeetus leucocephalus*, while *Oidemia perspicillata trowbridgii* was shown to be but a seasonal variation of *perspicillata* proper. Even to this day it appears not to be generally known that the Golden Eagle takes from three to five years to acquire its full plumage; that the Bald Eagle attains his highest plumage at the age of three, the various intermediate stages being known as the Black Eagle, Gray Eagle, etc., and that the Little Blue Heron is pure white the first year, mottled and variegated with blue in every conceivable manner the second, and attains the perfection of its plumage only at the age of three; yet such are the facts. These are but isolated cases, while any day may bring about the unification of some two forms which at present are considered at least sub-specifically distinct.

#### BOILING-POINT AND RADIUS OF MOLECULAR FORCE.

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WHEN a bubble of its own vapor exists in a liquid the pressure,  $P$ , upon it is the sum of the three pressures:—

$A$ , due to the air,

$W$ , due to the water above the bubble,

$C$ , due to molecular cohesion.

Let us suppose, for convenience, that the bubble is so close to the surface that  $W$  may be neglected. When the radius,  $r$ , of the bubble is large compared with  $R$ , the radius of molecular force (i. e., the distance at which a molecule ceases to exert a sensible attraction), the pressure,  $C$ , over its diametral plane is equal to the surface tension,  $T$ , across the circumference. That is to say,

$$\pi r^2 C = 2\pi r T$$

$$\text{or } C = 2T/r.$$

Then  $P = A + 2T/r$ ; and the temperature must be such that  $P$  is balanced by the molecular energy of the vapor if the bubble is to continue to exist. As  $r$  increases  $2T/r$  decreases, and for bubbles of ordinary size may be neglected in comparison with  $A$ , the ordinary pressure of the air. Hence the lowest possible boiling point of a liquid is such that the vapor pressure is just sufficient to overbalance the air pressure. But at one or more points in the liquid the temperature must be very much higher, or no bubbles of vapor could be formed. This condition occurs whenever a liquid is boiled in a rough vessel.

If a liquid be uniformly heated no bubbles can be formed until the temperature is such that  $P = A + C$  for the whole liquid when the bubbles are first formed. When this point is reached bubbles are formed everywhere, the pressure upon them decreases very rapidly as they increase in size, and the liquid explodes. The explosion point, like the boiling-point, depends in part upon the pressure of the air, but has a definite lower limit when  $A = 0$ .

Unfortunately the value of  $C$  in terms of the surface tension

cannot be calculated directly for the explosion point; but a probable value may be found as follows:—

When a U-shaped wire in an inverted position is drawn up from a liquid, in many cases a film is formed between the wire and the liquid surface. For a pure liquid the thickness,  $k$ , of the film is nearly constant, though it varies greatly in some solutions. The film has a measurable tension,  $2T$ , across every linear centimetre on its surface. In other words, a force of  $2T$  is drawing apart, against the forces of cohesion, a liquid whose section is  $(K \times 1)$  square centimetre. It seems probable, therefore, that the liquid will give way at every point when the expansive force opposing  $C$  becomes  $2T/k$  on each square centimetre; so that at the explosion point

$$P = A + 2T/k.$$

In 1861, Dufour (Comptes Rendus, 52, p. 986) succeeded in heating water to 175° C., and chloroform (which boils at 61°) to 98°, under ordinary air pressure, without explosion. Assuming that these are approximately the explosion points of water and chloroform, we may calculate, from the known values of the surface tensions and the vapor pressures at these temperatures, that the value of  $k$  for water is 123  $\mu\mu$  (1,000,000  $\mu\mu$  = 1 mm.), and for chloroform 200  $\mu\mu$ . From a solitary case, which may be only a coincidence, it would be rash to generalize; yet it is interesting to notice that the ratio of these two values of  $k$  is almost exactly the ratio of the molecular diameters of water and chloroform.

Now  $R$ , the radius of molecular force, is known to lie somewhere between  $k$  and  $k/2$  (see Jour. Chem. Soc., 1888, p. 222). Hence, if the preceding equality of ratios be found to hold for other liquids we shall have the theorem that the radius of molecular force is proportional to the diameter of the molecules.

Quincke (Pogg. Ann., 187, p. 402, 1869), by a method likely to give results a little too low, measured  $R$  and found for water 54  $\mu\mu$ , a value which is in close accord with that given above.

The experimental determination of the explosion points of different liquids requires no complicated apparatus and would have considerable scientific interest. I make the suggestion for the use of any one who has time and inclination for research without the advantages of a well-equipped laboratory.

#### DR. GEORGE VASEY.

DR. GEORGE VASEY, Botanist of the Department of Agriculture, died, in the City of Washington, March 4, 1893. He was born on Feb. 28, 1822, at Scarborough, Yorkshire, England, and came to America when a child. He graduated from Berkshire Medical College at Pittsfield, Mass., in 1848, and settled in Illinois, where he practised his profession for twenty years. He was appointed Botanist to the Department of Agriculture in April, 1872, and held the position until his death. As Botanist to the Department he was Honorary Curator of Botany in the U. S. National Museum, and it is largely from his efforts that the present herbarium of over 25,000 species has been accumulated and arranged. His main work has been upon grasses, and among other papers he has printed "Descriptive Catalogue of Native Forest Trees of the U. S.," 1876; "Grasses of the United States: A Synopsis of the Tribes with Descriptions of the Genera," 1883; "Agricultural Grasses of the United States," 1884; "Descriptive Catalogue of the Grasses of the United States," 1885; "Report of Investigations of Grasses of the Arid Regions," two parts, 1886-87; "Grasses of the South," 1887; "Agricultural Grasses and Forage Plants of the United States," a revised edition, with 114 plates of "Agricultural Grasses," 1889; "Illustrations of North American Grasses; Vol. I., Grasses of the Southwest," 100 plates with descriptions, 1891; Vol. II., Part 1 of the same, "Grasses of the Pacific Slope and Alaska," 1892; "Monograph of the Grasses of the United States and British America" (Vol. III., No. 1, Contributions from U. S. National Herbarium) 1892.

He was a delegate from the Department of Agriculture and the Smithsonian Institution to the Botanical Congress in Genoa, last September, returning immediately after the adjournment of the congress. He was a member of the Biological and Geographical Societies of Washington, and a Fellow of the American Association for the Advancement of Science. He was taken sick on Feb. 28, and died after a short illness on the morning of March 4, of constriction of the bowels.