observer. In spite of the much-lauded simplicity of metric measures, we find that the "litre" has as many meanings as the "pound," that it is addicted to the reprehensible habit of impersonating its fellow-measures, that the virtue of its mother centimetre is open to grave suspicion, and that its own constancy is no better than it should be. What, then, are we to do? The answer to this question appears to me to be plain enough, and, indeed, constitutes the object I have had in view in originating and pursuing the discussion. The lesson of the litre teaches us the importance of a duty that is too often neglected, namely, the prefixing (or affixing) to every scientific paper, or treatise, a table, or other statement, setting forth the values assigned to the constants employed by the author. If this be done, it matters not one whit whether the values chosen are in accordance with the most rigorous determinations or depart therefrom. If any reader choose to attach different values he can then do so; whereas under the present system of every man being a hidden law unto himself, the perusal of a scientific work is not a process to which the phrase "emollit mores" can be justly applied.

Another lesson that we may learn from the litre is the futility of a besetting scientific sin, namely, the Affectation of Accuracy. The owner of that holy and hosannâd thing, the "scientific conscience," is apt to deem himself "not as other men" and smiles complacently at the thought that he has expended long years and a fortune in determining, for example, that a cubic inch of water under certain conditions weighs 252.28599 rather than 252.28598 grains. And yet the same gentleman will, from his lofty pedestal of physics, look down with much pity, if not with absolute contempt, upon the equally conscientious entomologist who (vide *Nature*, Nov. 17, 1892) wears away a thinking and working lifetime in determining whether a certain insect walks upon more than three legs at once. The results of the most refined investigations are but approximations to the truth, after all; and in most cases of scientific work an approximation sufficiently close to the truth to serve all practically useful purposes can be arrived at easily and expeditiously. Accuracy, therefore, may often be, in the true sense of the term, excessive, even if intrinsically trustworthy; but when we consider that what appears accurate to one generation is regarded as inaccurate by the next, we must surely deem it but a poor thing to boast of. Take, for example, Mr. Clark's confession that up to September, 1891, he "had always assumed the cube decimetre and litre to be identical"; a confession which, coming from so distinguished an authority, is tantamount to a demonstration that most other physicists shared the same erroneous impression, and therefore that the much-vaunted accuracy of modern work in physical science has not existed to the full extent claimed. And yet we all know that the work has been really magnificent and solid, both in its contributions to the world's store of knowledge and in its advancement of the welfare of mankind. This certainly teaches us that reasonable care in scientific measurement is sufficient care, and that extreme care is, by the very nature of things, doomed to fail of its object.

A PRESUMABLY NEW FACT RELATIVE TO THE CEDAR WAXWING (*AMPELIS CEDRORUM*), WITH REMARKS UPON THE IMPORTANCE OF A THOROUGH KNOWLEDGE OF FIRST PLUMAGES.

BY EDWIN M. HASBROUCK, WASHINGTON, D. C.

IT is considered by every one that the individual waxwing possessing wax tips on both secondaries and rectrices is in the highest development of plumage, while a high development of plumage in any species whatever is usually accorded to the older birds.

Coues states that, "Specimens apparently mature and full-feathered frequently lack the wax-tips"; that "their normal appearance is unknown," and that "birds in the earliest known plumage may possess one or more." Beyond this little appears to be known.

In a somewhat extensive series of waxwings in the National Museum, in my own and other collections, appendages on the wings were developed in forty-five, fifteen displayed the ornaments on both wings and tail, while the remainder, apparently adult birds, were entirely unadorned. (It might be well to state that the females as well as the males possess these tips, although less frequently, while some specimens examined showed the ornaments on both wings and tail.) Now, the natural conclusion from this would be that those birds possessing wing-tips only were older than those having none at all, while the fifteen on which both wings and tail were adorned were even older and were in the highest perfection of plumage. This is disproved by the fact that four birds of the year still in the striated plumage, taken in August, September, and October, respectively, display very distinct tips on the secondaries; and if on the secondaries at this early age when older birds possess none at all, why should they not also appear on the tail-feathers? The supposition of older birds only being adorned being disposed of, the question arises, When do these horny appendages appear? and on this I am able to throw considerable light.

It was in the summer of 1884 that I was spending a month at Port Byron, N. Y., when I ran across a nest of the waxwing, containing four young, every one of which had the wax tips on tail and wings perfectly developed. These birds were nearly fledged, although unable to fly, and I had good opportunity to observe them. Not being interested in collecting birds at that time they were not preserved, a circumstance to be regretted, but the full import of these appendages being developed in nestlings was appreciated.

The following table for the calendar year shows the conditions of specimens examined. So regularly and so nearly is it completely filled that it is evident that an examination of a larger series would undoubtedly fill the gaps.[1]

Month.	Wings.	Both.	None.
Jan.	♂		♂ ♀
Feb.	♂	♂	♂ ♀
Mar.	♂ ♀		♀
Apr.	♂ ♀	♂	♂
May	♂ ♀	♂	♂ ♀
June	♀	♀	♂ ♀
July	♂	♂	♂
Aug.	♂ ♀ ♂ im	♂	♂ ♀
Sept.	♂ ♂ im		♂ ♀
Oct.	? ♂ im		♀
Nov.	♂		♂ ♀
Dec.	♂		♂

With this evidence it is apparent that these handsome ornaments are by no means a sign of age, but are, on the contrary, a purely individual development, appearing sometimes in their highest perfection in the nestling, while in an adult they may be entirely absent or barely beginning to appear; or again, appearing a few months after attaining first plumage, to go through a regular course of growth and development. Inasmuch as an individual with wax on both tail and wings is exceedingly rare, and the August and September birds are just beginning to acquire the tips it would be interesting to know just how often this development in the nest occurs, and this is published mainly with the hope of eliciting further information on the subject, and of prompting those in the field to be on the watch the coming season.

The importance of thus studying the first plumages cannot be too highly estimated, for not until comparatively recent years has a careful and thorough study of the life-history of each and

[1] In this table an attempt has been made to show merely that both sexes are adorned for each month in the respective columns. In a number of instances several individuals were found for each.

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 *Haliœetus 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.

BY T. PROCTOR HALL, CLARK UNIVERSITY, WORCESTER, MASS.

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 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., 137, 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.