SCIENCE

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WHERE IS THE LITRE?—A MODERN SCIENTIFIC PUZZLE-PICTURE.

BY STEPHEN H. EMMENS, YOUNGWOOD, PA.

IN *Engineering News* of Oct. 20, 1892, appeared an article on Fuel-Gas Values, in which I gave a table entitled "Some Metric Constants," designed to show the variations of value to be found in the text-books even with regard to so fundamental a matter as the volume of the litre. The publication of this table has caused me to receive a letter of protest from my friend, Mr. Latimer Clark, F.R.S., who, as all the world knows, takes rank among the foremost living authorities on the subject of weights and measures; his "Dictionary of Metric and other Useful Measures" being a permanent masterpiece. This letter contains much that is interesting to the scientific world, as will be seen by the following quotations which include all the material passages:—

"I have looked over the varying list of values and it is not very difficult to account for the discrepancies. Many of them have taken the values as defined by Act of Parliament, and as published by the Board of Trade. But all the world has known for years past that this valuation is very far wrong, and therefore the more careful writers have endeavored to correct the error as far as they were able by using the best results they could obtain or hear of. Some of them, however, are not quite so easily explained (S A. Ford, for example).

"For the past thirty years no scientific writer or worker has used the Board of Trade official value of the cubic inch of water, viz., 252.458 grains. This is the simple cause of the discrepancies you point out. You have been a little hard on me in the matter, and your article would certainly lead any one to suppose that I had given three different values for the litre, which is very far from being the case. After the book was all printed ready for issue, the new Board of Trade measurements came out and I rewrote and reprinted a great part of it in order to make it conform to the new legal definition of the Board of Trade. Up to September, 1891, I had always assumed the cube decimetre and litre to be identical. . . . At page 57 I call especial attention to the change, in the footnote, and again in the article 'Water,' at page 90, and I give there a table of the volumes of the litre and cube decimetre. Then, again, at page 103, I give a special note on the capacity of the litre. I beg you to read these with care, for it is evident that you have read hastily and have never put your back into the question. If you had read carefully you would have found abundant warning against confounding the litre with the cube decimetre. They are practically the same, and can be differentiated only by means of the most costly apparatus used by the most skilful physicists and with extraordinary precautions; but then you were writing from a scientific point of view and you ought to have read carefully.

"Then in reference to the 'cube inches into litres,' page 47. You ignore the six places of decimals given in the first column, and pass on to the subsidiary column of reciprocals where only two are given, and by some process you expand them into five places of decimals, some of which are, of course, sure to be wrong. Strangely enough, too, while going to this trouble, you fail to notice that on this line and the one above it ('into cube decimetres') the two figures are given differently, viz., 61.04 and 61.0270. This would certainly have caught your eye if you had been really studying the question, but I fancy you were more intent upon writing a rattling article for the press.

"I hope you will find some opportunity of correcting the impression that my book is not trustworthy, for it is at the present day the *only* book that gives the English measures correctly.

"I note that in the constants you have adopted, you use 28.3127 as giving the number of 'litres in a cube foot.' I do not quite see what you take this from, but in England the number is 28.3110, while the number of cube decimetres is 28.3153.

"In the United States the metre is by law = 39.37 inches, but in England it is 39.37079 inches. From the latest measurements, however, the U. S. number is likely to turn out more accurate than the English number."

In order that this letter may be clearly understood it is desirable to quote the published statements to which it refers. These are as follows:—

1. The reference to Mr. Clark's book in my table appeared thus:—

"Authority.	Cu. inches in 1 litre.	Cu. feet in 100 litres.	Litres in 1 Cu. ft.
Dictionary of Metric Measures, by Latimer Clark, F.R.S.	61.0364	3.5322	28.3110
Ditto	61.04	3.5323	28.3093
Ditto (cube decimetre.)	61.0270	3.5316	28.3153"

2. After directing attention to some current arithmetical inaccuracies on the subject of the heat-value of natural gas, I remarked as follows, in the paper concerning which Mr. Clark has written me:—

"Considerations of space forbid my entering at further length into the correction of published errors. Every careful man who has ever consulted a text-book will grimly admit the justice of this remark; even though he may willingly agree with me in sincerely thanking the Trautwines and Haswells and Gmelins and Clarks and Thomsons and Favres and Regnaults and Berthelots, and all the brilliant compilers who have done so much good and worthy work in aiding the progress of knowledge."

3. The foot-note at p. 57 of Mr. Clark's book is:—

"The litre was designed to be the volume of a cube decimetre of water in vacuo at maximum density, but is actually somewhat greater. It is now understood as the volume of one kilogram of water freed from air, at maximum density and weighed in vacuo. It is, therefore, dependent on the dimensions of the kilogram and not of the metre. The litre used in these tables has the capacity above defined; the equivalent weight of water employed is not the kilogram but the actual weight in air (see 'Water')."

4. The article "Water" at page 90 of Mr. Clark's book is:—

"The weight of the cube inch of water at 62° F., used in the following table and throughout the work, is not the old and well-known cubic inch of 252.458 grains, but the newer determination by the Standards Department of the Board of Trade, viz., 1 cubic inch of distilled water, freed from air, at 62° F., weighed in air against brass weights, barom. 30 inch = 252.28599 grains. This measure has already been legalized. It is distinguished by the date 1890. The old weight of the cubic inch was legalized by Act of Parliament in 1824, and when used it is distinguished by that date.

"The gramme of water is very commonly considered identical with the cubic centimetre, and the kilogram is similarly taken as equivalent to the cubic decimetre or litre, but these relations are only true when they are weighed in vacuo and at maximum density, 4° C. The litre of water (1 kilogram in vacuo at 4° C.) when weighed practically, that is, against brass weights in air, barom., 30 inches, loses 16.5 grains, owing to displacement of air, and then weighs at 4° C. only 998.93 grammes instead of 1,000. The difference is, of course, greater at ordinary temperatures. In addition to this, the kilogram, and therefore the litre, is supposed to be intrinsically heavier than the cubic decimetre of water in vacuo by about 120 milligrams or 1.85 grains, owing to slight errors in the original determination. Dr. O. J. Broch (International Committee of Weights and Measures. Annales de Chimie et Physique, tome X., February, 1887) remarks that the centimetre employed in fixing the dimensions of the original kilogram of water would appear to have been $\frac{1}{25000}$ longer than the present standards. The freedom from air was also a point which was not regarded at that period.

Weight of Distilled Water, Free from Air, Weighed against Brass Weights, Barom 30 Inch.

Volumes.	In grains		In grammes	
	62° F.	4° C.	62° F.	4° C.
Cube inch of 1824	252 458	252.741	16.3591	16.3773
" " " 1890	252.286	252.568	16.3479	16.3662
" " weighed in vacuo	252.556	252.839	16.3654	16 3837
Cube foot (62.2786 lbs.), 1890	435950.2	436438.2	28249.11	28280.73
Gallon (10 lbs)	70000.	70 78.3	4535.93	4541.0[illegible]
Litre (1 Kilog. in vacuo)	15398.6	15415.8	997.814	998 930
Cube decimetre	15396.3	15413.5	997.662	998.779
Cube centimetre	15.3963	15.4135	.9977	.9[illegible]88

"Water increases in volume from its maximum density at about 4° C. (or 39.2° F.) to that at $16\frac{2}{3}$° C. in the ratio of 1 to 1.001120 (log. 0.0004863). At the same time its density or specific gravity diminishes in the same ratio, or as 1 to .998881 (log. $\bar{1}.9995137$). These figures are taken from government reports. The true maximum density is said to be at 3.945° C., but 4° C. is the accepted standard."

5. The "Note on the capacity of the litre" at p. 103 of Mr. Clark's book is:—

"The relation between the British and Metric measures of capacity depends on the value which we assign to the litre.

"This value may be obtained as follows. The litre is the volume of one kilogram of water at 4° C. in vacuo. If we suppose the litre of water to be raised in temperature to 62° F., its weight will not change, but its volume will have expanded to 1.00112 litres (Chaney, Proc. Roy. Soc., No. 294, Sept., 1890). If 1.00112 litres at 62° F. weigh 1 kilogram, or 15432.35 grains, then 1 litre will weigh $\frac{15432.35}{1.00112} = 15415.08$ grains.

"If we bring this new litre into the air, and weigh it against brass or bronze weights, it will sustain a further loss of weight, due to the buoyancy of the air. This will amount to 16.491 grains, as described below, and the weight of the litre in air at 62° F., Bar., 30 in., will then be:—

	15415.08 grains
Less loss by weighing in air	16.49
Weight of the litre in London at 62° F..	15398.6 grains

"The original litre has, therefore, lost 17.25 grains by its expansion in volume, and 16.49 grains by the buoyancy of the air acting on it and the weights which counterbalance it. Having thus ascertained that the litre of water at 62° F. weighs 15398.6 grains, and the cubic inch 252.286 grains, we easily find that the litre contains 61.0364 cubic inches.

"The loss of weight in air is thus calculated. Mr. H. J. Chaney, warden of the standards, who has recently re-determined the weight of the cubic inch of water (Chaney, Proc. Roy. Soc., No. 294, Sept., 1890), finds that one cubic inch of ordinary air, containing an average proportion of moisture and carbonic acid, weighs in London .3077 grains at normal pressure and temperature. 61.0364 cubic inches, therefore, weigh 18.781 grains. The weights, if of bronze, have a specific gravity of 8.4, and if of brass of about 8. Taking a mean density of 8.2 we get $\frac{18.78}{8.2} = 2.29$ grains due to the displacement of air by the brass weights. Deducting the 2.29 grains from 18.78, the displacement due to the water, we get 16.49 grains, the value used above.

"It would not be possible to measure the litre or the cubic decimetre strictly as defined by the French Statutes, for they prescribe that the water shall be weighed at 4° C. in measuring vessels which are to be correct at 0° C. There is a similar anomaly in the definition of the American gallon."

6. The values given at p 47 of Mr. Clark's book are:—

	Multiply.	Divide.	Log.
Cube inches into cube decimeters,	.016386	61.0270	$\bar{2}.21448$
" " " litres,	.016384	61.04	$\bar{2}.21441$

7. The values given at p. 57 of Mr. Clark's book are:—

	Multiply.	Divide.	Log.
Litres into cube feet,	.035322	28.3110	$\bar{2}.54804$
" " inches	61.0364	———	1.78559
" cube centimetres, or gram., water at 4° C.	1000	———	3.00000

8. The values given at p. 32 of Mr. Clark' oook are:—

	Multiply.	Divide.	Log.
Cube feet into cube metres,	.02832	35.3166	$\bar{2}.45202$
" " " decimeters,	28.3153	———	1.45202
" " litres or kilogs. of water 4° C.	28.3110	———	1.45196

9. The values given at p. 24 of Mr. Clark's book are:—

	Multiply.	Divide.	Log.
Cube decimetres into litres,	1	———	0.00000
" " " cube feet,	.03532	28.3153	$\bar{2}$ 54798
" " " " inches,	61.027	———	1.78552

10. The values given at p. 61 of Mr. Clark's book are:—

	Multiply.	Divide.	Log.
Cube metres into cube feet,	35.31658	———	1.54798
" " " " inches,	61027.05	———	4 78552

The foregoing quotations, together with Mr. Clark's letter, form a very excellent puzzle-picture, in which, presumably, the litre is somewhere to be found. Before, however, I adventure upon the search, let me clear away four small clouds that might otherwise befog the expedition.

First, Mr. Clark is mistaken in imagining that I had not read his book carefully and that I "confounded the litre with the cube decimetre." No. 1 of the foregoing quotations shows that in my table I specifically drew attention to the distinction between the two measures in question.

Second, Mr. Clark is mistaken in imagining that, with reference to the values given at p. 47 of his book, I "failed to notice that on this line and the one above it ('into cube decimetres') the two figures are given differently, viz., 61.04 and 61.0270." No. 1 of the foregoing quotations shows that the two figures in question must have "caught my eye"; for I duly included both of them in my table and took care to show that one referred to the litre and the other to the cube decimetre.

Third, Mr. Clark is mistaken in imagining that my "article would certainly lead any one to suppose that (he) had given three different values for the litre." Any careful reader of the table (vide quotation No. 1) would see that I cite Mr. Clark as having given two different values for the litre and a third value for the cube decimetre, which is, in very deed, the case.

Fourth, quotation No. 2 shows that I took some pains to preclude any impression that Mr. Clark's book is not trustworthy.

Coming now to the main question, let us commence our investigation by summarizing the statements in Mr. Clark's book and letter as to the various measures that all come under the common denomination of "litre." They are as follows:—

A.—"LITRES" PROPER.

1. "Litre = 1 cube decimeter, or $\frac{1}{1000}$ cube metre, very nearly The volume of 1 kilogram water at 4° C. . . . It is now understood as the volume of 1 kilogram of water, freed from air, at maximum density, and weighed in vacuo" (p. 57). The accepted temperature of maximum density is 4° C. (p. 91). The weight of 1 Kilog. of distilled water, free from air, in vacuo at 4° C., is 15432.35 grains (p. 103); and the weight of 1 cubic inch (of 1890) of water under the same condition is 252.839 grains (p. 91). Hence the volume of the standard litre is $\frac{15432.35}{252.839} = 61.036272$ cubic inches.

2. If a standard litre of distilled water, free from air, be weighed in London against brass weights in air at 62° F., barom. 30 in., the result will be 15398.6 grains (p. 103); and the weight of 1 cubic inch (of 1890) of water under the same conditions is 252.286 grains. Hence the volume of the "London" litre (of 1890) is $\frac{15398.6}{252.286} = 61.036284$ cubic inches.

3. The volume of the "London" litre (of 1824) is $\frac{15398.6}{252.458} =$ 60.9947 cubic inches.

4. The value of $\frac{15398.6}{252.286}$ adopted by Mr. Clark is 61.0364.

5. The weight of 1 kilogram of distilled water, free from air, in vacuo, at 62° F., is $\frac{15432.35}{1.00112} = 15415.0851$ grains, and the loss by weighing in air is 16.491 grains. The weight of the litre in London at 62° F., barom. 30 in., is thus 15398.594 grains; and this, divided by 252.286, gives 61.03626 cubic inches as the volume of the London litre (of 1890).

6. On the basis of 61.03626 cubic inches per litre, the number of litres in 1 cubic foot is $\frac{1728}{61.03626} = 28.31104$.

7. On the basis of 61.0364 cubic inches per litre, the number of litres in 1 cubic foot is 28.310975.

8. The value of $\frac{1728}{\text{Cu. in. per litre}}$ adopted by Mr. Clark is 28.3110.

B.—CUBE DECIMETRES.

1. The English metre is 39.37079 inches. Hence the English cube decimetre is 61.027051 cubic inches.

2. The weight of 1 cubic decimetre of distilled water, free from air, weighed in air against brass weights, at 4° C., bar. 30 in., is 15413.5 grains; and the weight of 1 cubic inch under similar conditions is 252.568 grains. Hence the volume of the standard cubic decimetre (English 1890) is $\frac{15413.5}{252.568} = 61.027129$ cubic inches.

3. The value of $(3.937079)^3$, adopted by Mr. Clark, is 61.0270 cubic inches.

4. The U. S. metre is 39.37 inches. Hence the U. S. cube decimetre is 61.023377953 cubic inches.

5. On the basis of 61.027051 cu. inches per cube decimetre, the number of cube decimetres in 1 cubic foot is $\frac{1728}{61.027051} =$ 28.31531.

6. The value of $\frac{1728}{\text{cu. in. per cu. dec.}}$, adopted by Mr. Clark, is 28.3153.

7. The number of U. S. cube decimetres per cubic foot is $\frac{1728}{61.023377953} = 28.31702$.

C.—CONVERSION VALUES.

1. "Cube centimetres into cube decimetres (litres)"—divide by 1000 (p. 17).

2. Cube centimetres "into litres"—divide by 1000.05 (p. 17).

3. Cube decimetres "into litres"—multiply by 1 (p. 24).

4. "Kilogram = 1000 grammes = 1 litre, or 1 cube decimetre water, 4° C. Miller, in 1856, found the kilogram = 15432.349 grains in vacuo. It was originally intended to be the weight of a cubic decimetre of water at maximum density in vacuo. It is now a definite mass of plat num and is slightly heavier than the cubic decimetre of water" (p. 50).

5. "Cube metres or steres (= 1000 litres very nearly) into litres"—multiply by 1000 (p. 61).

"Cube metres or steres into cube decimetres"—multiply by 1000 (p. 61).

"Cube metres or steres into cube feet"—multiply by 35.31658 (p. 61).

"Cube metres or steres into cube inches"—multiply by 61027.05 (p. 61).

6. "Kilograms (or litres) of water into cube inches"—multiply by 61.170 (p. 92).

"Cube feet of water into litres, 62° F."—multiply by 28.311 (p. 93).

"Cube feet of water into kilograms 62° F."—multiply by 28.249 (p. 93).

From this summary it will be seen that Mr. Clark's book and letter present us with quite an extended range of choice for the value of a litre, viz.:—

Standard litre (1890)	61.036272	cu. inches.
" decimetre	61.027051	" "
" " (weighed in air)	61.027129	" "
London litre (1890)	61.03626	" "
" " (1824)	60.9947	" "
Clark " (1890)	61.036284	" "
" " "	61.0364	" "
" decimetre	61.0270	" "
" "	61 02705	" "
U. S. "	61.023377953	" "
"kilogram" (in vacuo, 4° C., 1890)	61.104666	" "
" (in air 62° F.)	61.170	" "

and, in addition to these, I may quote the following from Table 1 of the before-mentioned article on "Fuel-Gas Values," viz.:—

Authority.	Cu. ins. in litre.
U. S. Dispensatory, 16th ed.	61.0280
G. Gore, LL.D, F.R.S.	61.024
Professor V. B. Lewes, F.C.S.	61.024
Professor J. D Everett, F.R.S.	61.022
Trautwine (said to be U. S. Standard)	61.0254
"	61.024425
Haswell (said to be by Act of Congress)	61.022
"	61.02524
Gmelin	61.0267
W. Crookes, F.R S.	61.02709
Thomson and Tait	61.02432
S. A Ford	64.99008

The suggestion made by Mr. Clark that these discrepancies may for the most part be explained by the difference between the 1824 and 1890 standards is obviously insufficient if the difference he refers to be that of the cube inch value; for as the 1824 value is 60.9947 it clearly was not adopted by the authorities above quoted. Some other explanation is, therefore, required; and as so consummate an authority as Mr. Clark appears unable to advance one, I may perhaps be allowed to hint that the cause of the varying values is to be found in sheer laxity of calculation. I know that so commonplace a theory is rather shocking, and I duly blush as I advance it; but, really, when I find Mr. Clark himself deliberately adopting the value 61.0364 as the quotient of $\frac{15398.6}{252.286}$ and adopting it as the basis of his book, whereas the true quotient is 61.036284, or, if four places of decimals be used, 61.0363, I may plead for pardon with some assurance of the same being accorded. The example here cited is even still more to the point; for the value 15398.6 is adopted by Mr. Clark as the result of the calculation $\frac{15432.35}{1.00112} - 16.491$, whereas the true result is 15398.594 and this divided by 252.286 gives 61.03626.

But let it not be imagined that I make these remarks in any fault-finding or critical spirit. I am too conscious of my own short-comings to be willing to sit in the seat of judgment. In the before-mentioned table, for example, I derived Mr. Clark's second value of "cubic feet in 100 litres" from his figure of 61.04 cubic inches per litre. The calculation was, of course, $\frac{6104}{1728} = 3.5324$; and yet, when I corrected the proof of the article, I inadvertently allowed the value to appear as 3.5323. So I must ask my scientific brethren to understand that my observations are not intended as any disparagement of the "Dictionary of Metric Measures" or as casting any adverse reflection upon the other text-books I have quoted, all of which I regard as admirable examples of scientific work and as trustworthy as reasonable mortals can expect them to be.

And so we come back once more to our question, Where, after all, is the litre? Our puzzle-picture turns out to be of a kaleidoscopic variety and appears in a different aspect to every 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.