EDIBILITY OF THE EGGS OF BIRDS

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IN a previous communication¹, a preliminary account was given of observations and experiments on the relative edibility of the flesh of birds. Full details of this research have now been published elsewhere². During the past two years, this work has been extended to an investigation of the relative edibility of birds' eggs. Final results of the inquiry, which is still in progress, will not be available for some time; but since, with the exception of a paper by C. F. M. Swynnerton published in 1916³, the subject appears hitherto to have remained almost unexplored, it would now seem appropriate to summarize the new observations and to indicate certain conclusions to be drawn from them.

The bulk production and purchase of various foodstuffs (including eggs) during the War led to a widespread use of tasting panels (together with other methods for the assessment of quality) for the purposes of standardization and grading. At the Low Temperature Research Station, Cambridge, a tasting panel was already in existence in 1936⁴; and I take this opportunity of expressing my indebtedness to the three members of this panel—Dr. J. Brooks, Mr. H. P. Hale and Dr. J. R. Hawthorne—whose skill and experience have made possible the reliable assessments of palatability which form the basis of the present inquiry. Sincere thanks are also due to the Superintendent of the Station for allowing me storage and many other facilities in his Department.

The method of assessment was similar to that used in routine examination of fowls' eggs. Each sample was tested in the form of a scramble, prepared over steam, a numerical score being awarded on a scale ranging from 10·0 (excellent flavour) to 2·0 (inedible). In general, seven or eight species were tested at one session. Members of the panel were in all cases unaware of the identity of the samples to be examined (except in the case of a fowl's egg used as a control); and they recorded their results independently. The majority of species listed below were examined on two occasions by each taster, so that in general the mean edibility rating for a species is based upon six independent assessments. Eggs of eighty-one species, belonging to eleven orders and thirty-five families, have now been examined. In the following list these are arranged in order of palatability.

GROUP A (RELATIVELY PALATABLE)

Domestic fowl	8·8
Coot (<i>Fulica a. atra</i> Linn.)	8·3
Moorhen (<i>Gallinula c. chloropus</i> (Linn.))	8·3
Lesser black-backed gull (<i>Larus fuscus grællsii</i> Brehm)	8·3
Kittiwake (<i>Rissa t. tridactyla</i> (Linn.))	8·2
Herring-gull (<i>Larus a. argentatus</i> Pont.)	7·9
Common tern (<i>Sterna h. hirundo</i> Linn.)	7·8
Fulmar petrel (<i>Fulmarus g. glacialis</i> (Linn.))	7·7
Greater black-backed gull (<i>Larus marinus</i> Linn.)	7·7
Guinea-fowl (<i>Numida m. meleagris</i> (Linn.))	7·6
Razorbill (<i>Alca torda britannica</i> Tiechurst)	7·6
White-naped crane (<i>Grus vipio</i> Pall.)	7·5
Chaffinch (<i>Pringilla caelebs genaleri</i> Kleinschmidt)	7·5
Hedge-sparrow (<i>Prunella modularis occidentalis</i> (Hart.))	7·5
Partridge (<i>Perdix p. perdix</i> Linn.)	7·3
Lapwing (<i>Vanellus vanellus</i> (Linn.))	7·3
Spur-winged plover (<i>Lobivanellus lobatus</i> Lath.)	7·3
Stock-dove (<i>Columba oenas</i> Linn.)	7·3
Jackdaw (<i>Corvus monedula spermologus</i> Vieill.)	7·3
Spotted flycatcher (<i>Muscicapa s. striata</i> (Fall.))	7·3
Domestic turkey	7·2

Red-legged partridge (<i>Alectoris r. rufa</i> (Linn.))	7·2
Bullfinch (<i>Pyrrhula p. nesa</i> Math. and Ired.)	7·2
Southern guillemot (<i>Uria aalge albionis</i> With.)	7·1
Great skua (<i>Stercorarius s. skua</i> (Brünn))	7·1
Rock-dove (<i>Columba l. livia</i> Gmel.)	7·1
House-sparrow (<i>Passer d. domesticus</i> (Linn.))	7·1
Common gull (<i>Larus c. canus</i> Linn.)	7·0
Dipper (<i>Cinclus c. gularis</i> (Lath.))	7·0

GROUP B (INTERMEDIATE)

Hobby (<i>Falco s. subbuteo</i> Linn.)	6·9
Cirl bunting (<i>Emberiza c. cirilis</i> Linn.)	6·9
Black-headed gull (<i>Larus r. ridibundus</i> Linn.)	6·8
Wood-pigeon (<i>Columba p. palumbus</i> Linn.)	6·8
Little owl (<i>Athene noctua vidalii</i> Brehm)	6·8
Kestrel (<i>Falco t. tinnunculus</i> Linn.)	6·7
White-fronted goose (<i>Anser a. albifrons</i> Scop.)	6·7
Carrion-crow (<i>Corvus c. corone</i> Linn.)	6·7
Magpie (<i>Pica p. pica</i> (Linn.))	6·7
Pheasant (<i>Phasianus colchicus</i> Linn.)	6·6
Domestic duck	6·6
Robin (<i>Erithacus rubecula melophilus</i> Hart.)	6·5
Rook (<i>Corvus f. frugilegus</i> Linn.)	6·5
Skylark (<i>Alauda a. arvensis</i> Linn.)	6·3
Catbird (<i>Dumetella carolinensis</i> (Linn.))	6·3
Sparrow-hawk (<i>Accipiter n. nisus</i> (Linn.))	6·2
Little tern (<i>Sterna a. albifrons</i> Pall.)	6·1
Eider (<i>Somateria n. mollissima</i> (Linn.))	6·0
Red-backed shrike (<i>Lanius c. collurio</i> Linn.)	6·0
Swallow (<i>Hirundo r. rustica</i> Linn.)	6·0
British jay (<i>Garrulus glandarius rufitergum</i> Hart.)	5·8
Long-tailed tit (<i>Aegithalos caudatus rosaceus</i> Mathews)	5·8
Blackbird (<i>Turdus m. merula</i> Linn.)	5·8
Greenfinch (<i>Chloris c. chloris</i> (Linn.))	5·7
Chiffchaff (<i>Phylloscopus c. collybita</i> (Vieill.))	5·7
Meadow-pipit (<i>Anthus pratensis</i> (Linn.))	5·7
Sand-martin (<i>Riparia r. riparia</i> (Linn.))	5·7
Capercaillie (<i>Tetrao u. urogallus</i> Linn.)	5·5
Song-thrush (<i>Turdus e. ericetorum</i> Turton)	5·5
Cowbird (<i>Molothrus a. ater</i> (Bodd.))	5·4
Tree-sparrow (<i>Passer m. montanus</i> (Linn.))	5·3
Yellow bunting (<i>Emberiza c. citrinella</i> Linn.)	5·3
Gannet (<i>Sula bassana</i> (Linn.))	5·3
Oyster-catcher (<i>Haematopus ostralegus occidentalis</i> Neun)	5·2
Bar-headed goose (<i>Eulabeia indica</i> (Lath.))	5·2
Dabchick (<i>Podiceps r. ruficollis</i> (Pall.))	5·0
Turtle-dove (<i>Streptopelia t. turtur</i> (Linn.))	5·0

GROUP C (RELATIVELY UNPALATABLE)

Puffin (<i>Fratercula arctica græbe</i> (Brehm))	4·8
Sedge-warbler (<i>Acrocephalus schoenobaenus</i> (Linn.))	4·7
Blackcap (<i>Sylvia a. atricapilla</i> (Linn.))	4·7
Lesser whitethroat (<i>Sylvia c. curruca</i> (Linn.))	4·5
Shag (<i>Phalacrocorax a. aristotelis</i> (Linn.))	4·4
Sandwich tern (<i>Sterna s. sandvicensis</i> Lath.)	4·3
Little crane (<i>Porzana parva</i> (Scop.))	4·0
Linnet (<i>Carduelis c. cannabina</i> (Linn.))	3·9
Ringed plover (<i>Charadrius h. hiaticula</i> Linn.)	3·8
Whitethroat (<i>Sylvia c. communis</i> Lath.)	3·8
Great tit (<i>Parus major newtoni</i> Prazak)	3·5
Reed-warbler (<i>Acrocephalus s. scirpaceus</i> (Herm.))	3·4
Blue tit (<i>Parus caeruleus obscurus</i> Prazak)	3·3
Eastern house-wren (<i>Troglodytes a. ædon</i> (Vieill.))	3·2
Wren (<i>Troglodytes t. troglodytes</i> (Linn.))	2·0

An extensive series of experiments has also been carried out to test the preferences of small egg-eating mammals such as the ferret, rat and hedgehog. In each test, the experimental animal was offered a choice as between two egg-samples. On the basis of 454 experiments with rats, it has been possible to arrange the eggs of thirty-five species in their approximate order of palatability for these animals. With hedgehogs, 230 tests have provided a basis for assessing eighteen egg-species. Only 17 tests have as yet been made with a ferret, on eleven egg-species.

From this work it is clear that the eggs of various birds differ very widely in palatability to egg-eating mammals, as they do to man—all these animals showing unmistakable preferences or aversions for particular eggs. It appears also that the assessments by experimental animals are in fair agreement with the human palatability rating. This general agreement is very close for the ferret, and tolerably so for the hedgehog. Rats show wider differences, especially in their rating of various species considered as palatable or intermediate by man. For example, rats appear to class chaffinch, spotted flycatcher and hedge-sparrow as relatively unpalatable, while the bar-headed goose, magpie, dabchick and eider are given a high place in the series.

Similar pairs of egg-species offered to the various experimental animals afford a means of comparison, and show the following agreement or disagreement with the human edibility rating:

Experimental animal	Number of paired samples		
	Agreement	Doubtful	Disagreement
Rat	55	19	30
Hedgehog	23	7	10
Ferret	9	3	0

It is perhaps significant that agreement is closest for eggs of low-grade edibility. Thus, among eleven species below 4.9 (Grade C), no fewer than eight, namely, great tit, sedge-warbler, lesser whitethroat, linnet, eastern house-wren, blue tit, whitethroat and blackcap, appear (in the order given) at the bottom of the sequence for rats. Similarly, three of the four Grade C eggs offered to hedgehogs, namely, sedge-warbler, linnet and whitethroat, appear to be the least edible of eighteen species offered to these animals: puffin, on the other hand, is given a high place.

We may here note that Swynnerton's experiments³, with a mongoose as taster, though not carried far enough to yield a graded sequence of egg-species, tend also to show some coincidence with the present ratings by man—where similar species are available for comparison. Thus, the eggs most acceptable to the mongoose included those of house-sparrow, bullfinch, greenfinch and moorhen; and those most repugnant, lesser whitethroat, great tit and wren. The above evidence on the preferences of four mammals therefore suggests that the sequence of palatability in terms of human preference may afford a provisional basis for the consideration of ecological and other aspects of the subject.

Eggs belonging to the few orders in which a considerable number of species has been examined show a very wide range of palatability. For example, Charadriiformes grade from 8.3 (lesser black-backed gull) to 3.8 (ringed plover); Passeriformes, from 7.5 (chaffinch) to 2.0 (wren). This wide intra-ordinal range appears to indicate that edibility in eggs may be largely independent of systematic status. A comparison of the various orders in this respect should be based upon a more extensive series than has at present been examined. Nevertheless, the following figures may give some indication of relative edibility within various groups:

Order	No. of species	Edibility range	Mean edibility
Procellariiformes	1	—	7.7
Galliformes	7	8.8 — 5.5	7.2
Gruliformes	4	8.3 — 4.0	7.0
Strigiformes	1	—	6.8
Charadriiformes	17	8.3 — 3.8	6.7
Columbiformes	4	7.3 — 5.0	6.6
Falconiformes	3	6.9 — 6.2	6.6
Anseriformes	4	6.7 — 5.2	6.1
Passeriformes	37	7.5 — 2.0	5.6
Columbiformes	1	—	5.0
Pelecaniformes	2	5.3 — 4.4	4.9

It might be expected, in the absence of contrary evidence, that the palatability of an egg would show some relation to that of the bird which laid it, and that an acceptable or repugnant flavour in the former might be a reflexion of palatable or distasteful properties of the parent. Indeed, it is true that some birds with high-grade flesh lay palatable eggs—as is notably the case with Galliformes, and with some Charadriiformes and Columbiformes. Similarly, in the oyster-catcher both eggs and flesh are unpalatable. Nevertheless, in general there is a wide discrepancy between the quality of the flesh and eggs of various species. Thus, the relatively distasteful common

tern, jackdaw, and bullfinch lay palatable eggs. Conversely, many of the species the eggs of which are bitter and repugnant, including turtle-dove, little crane, ringed plover, yellow bunting, tree-sparrow, sedge-warbler and reed-warbler, are themselves good or excellent as food. Such divergences no doubt follow from the fact that while there is a general correlation between coloration and palatability, both for eggs (see below) and for birds², the coloration of the egg itself has no relation to that of the parent bird.

We have also to note that there is no close or obvious relationship between the food-habits of a bird and the flavour of its egg. For example, the eggs of many maritime or shore-feeding species such as kittiwake, common gull, herring-gull, lesser and greater black-backed gulls, common tern, great skua, razorbill, guillemot and fulmar petrel, are good in flavour and free from 'fishiness'. The same is true of others outside the series examined. Thus, as I am informed by Mr. G. A. Gibson-Hill and Dr. L. Harrison Matthews, the eggs of king (*Aptenodytes p. patagonica*), gentoo (*Pygoscelis p. papua*), jackass (*Spheniscus demersus*), macaroni (*Eudyptes chrysolophus*) and rockhopper penguins (*E. c. cretatus*) are quite palatable and without any unpleasant or fishy flavour. The last-named is described by Earle (in Murphy⁴) as "particularly fine and delicate in flavour". Similarly, Gibson-Hill and Matthews considered the eggs of black-browed (*Diomedea melanophrys*) and wandering albatross (*D. exulans*) very good eating and nearly as palatable as those of domestic fowl. Conversely, the eggs of some species (see below) which do not eat fish or feed along the shore yet have a more or less pronounced and unpleasant fishy flavour. This apparent lack of correlation between edibility status of the egg and feeding-habits of the parent is again illustrated by insectivorous species, which may have high-grade (spotted fly-catcher, dipper), intermediate (sand-martin), or low-grade eggs (sedge-warbler, reed-warbler, wren). Similarly, the eggs of mixed (seed and insect) feeders may vary widely: thus we have the palatable chaffinch and hedge-sparrow; the intermediate greenfinch and yellow bunting; and the unpalatable linnet and blue tit. It appears, therefore, that no simple explanation of distastefulness, in terms of food-derived deterrents, is admissible.

There appears to be a broad relationship between relative edibility and egg-size. The shell-length of the species so far examined ranges from 104.0 mm. (white-naped crane) to 14.0 mm. (eastern house-wren). The five most distasteful eggs, those of the wren, eastern house-wren, blue tit, great tit and reed-warbler, are all among the smallest tested, and range from 14.0 to 18.3 mm. Conversely, the twelve species heading the list as most palatable are mostly large eggs, ranging from 41.0 (common tern) to 104.0 mm.—seven of these species laying an egg larger than the domestic fowl's. This general correlation is apparent from the accompanying graph (Fig. 1), which shows the mean shell-length for species within various palatability-groups.

The relationship appears to hold even within the limits of several orders and families. Thus the gannet is rated at 5.3 as compared with the shag at 4.4 (the respective egg-lengths being 78.1 and 62.9 mm.); among Rallidæ, coot (8.3, 52.6 mm.) and moorhen (8.3, 44.4 mm.) are rated above the little crane (4.0, 30.4 mm.); among Ploceidæ, the house-sparrow (7.1, 22.5 mm.) is preferred to the tree-sparrow (5.4,

Fig. 1. MEAN SHELL-LENGTH WITHIN GRADED EDIBILITY GROUPS

19.3 mm.); among Hirundinidae, the swallow (6.0, 19.9 mm.) to the sand-martin (5.7, 18.0 mm.). In several other cases, where the correlation throughout the group is less clear, it is found that the smallest egg is also the least palatable within its systematic group. For example, among three auks tested, guillemot (7.1, 81.5 mm.) and razorbill (7.6, 73.1 mm.) are more palatable than the puffin (4.8, 61.0 mm.); among three plovers, spur-winged plover (7.3, 50.0 mm.) and lapwing (7.3, 47.1 mm.) are both considerably larger and more palatable than the ringed plover (3.8, 35.7 mm.); among six species of gulls, the black-headed gull (6.8, 52.0 mm.) is both the smallest in size and lowest in edibility; among four Columbidae, the turtle dove (5.0, 30.7 mm.) is again lowest for its group in both respects; while the same is true for six species of Corvidae and six Fringillidae, the jay (5.8, 31.7 mm.) in the former and linnet (3.9, 18.0 mm.) in the latter each showing the lowest figure for size and edibility within their respective families. In other groups, notably the terns and game birds, no such correlation is apparent; and on looking at the series as a whole, many outstanding exceptions are to be seen, both among the smaller and larger eggs. Thus, chaffinch, hedge-sparrow, spotted flycatcher, bullfinch and house-sparrow all lay small but palatable eggs graded between 7.5 and 7.1. Similarly, several relatively large eggs are outstanding as exceptions: the status of some of these, such as sandwich tern and bar-headed goose, is still subject to confirmation, since the freshness of the material available may have been in question. The remaining large unpalatable eggs are typically those of shore-living or maritime species such as puffin, shag, oyster-catcher and eider, in which the flavour of the egg is possibly tainted by the bird's diet.

There also appears to be a general correlation between the degree of conspicuousness of the egg and its palatability. Among nineteen species laying cryptic eggs in open situations, twelve occur in the palatable group (A) and five in the intermediate group (B), only two being recorded as unpalatable (C). Moreover, within Group A, cryptic eggs predominate at the head of the list, the first six species (omitting domestic fowl) all falling into this category. Twelve other species, in which non-cryptic eggs are covered by a cryptic parent on open nests, are also distributed (with one exception) in Groups A and B. Of the remaining fifty species, in which the eggs are more or less conspicuously coloured, and are not incubated by a cryptic parent, twelve are unpalatable, repre-

senting no less than 80 per cent of all species in Group C. The distribution of cryptic and non-cryptic eggs within graded palatability groups is shown in Fig. 2.

The various species rated as least palatable owe their distastefulness to a variety of unpleasant or foreign flavours: such terms as acid, rancid, soapy, sour, oily, salty, fishy, and bitter occurring in the reports of the panel. Eggs of the oyster-catcher (*Haematopus ostralegus occidentalis*) (5.2) are markedly different from those of all other eggs tested, being remarkable both for their strong aromatic odour and flavour, and for their wide individual variation: thus of three samples examined, the first was rated by the three observers at 4.0, 4.0, 5.0, each member of the panel recording a strong smell and taste of onions; the second, at 8.5, 7.5, 7.0, with normal or nutty flavour; the third, at 4.0, 4.0, 3.0, inedible, with a strong odour and flavour of hemp. Species rated as 'fishy' were numerous, those with a markedly rank and fishy smell and taste being shag (4.4), bar-headed goose (5.2), eider (6.0), sparrow-hawk (6.2), ringed plover (3.8), sandwich tern (4.3) and blue tit (3.3). It will be noted that some of these, such as the sparrow-hawk and blue tit, are not themselves fish-eaters.

But by far the most widespread and important distasteful quality is bitterness. This is a frequent attribute of eggs in the lowest palatability grades. In nineteen species this flavour was more or less pronounced (being noted in at least 50 per cent of tests on the species concerned). Fifteen of these bitter-tasting eggs were those of passerine birds: greenfinch, linnet, yellow bunting, tree-sparrow, meadow-pipit, long-tailed tit, red-backed shrike, sedge-warbler, reed-warbler, chiffchaff, common and lesser whitethroats, eastern house-wren, swallow and sand-martin. It will be noted that all these are small species, laying eggs between 23.0 and 14.0 mm. long. Moreover, the remaining four species recognized as markedly bitter, namely, ringed plover, little tern, little crane and turtle-dove, are in each case the smallest eggs examined within their respective orders or families. To this we may add that the two smallest eggs of Corvidae (jay and magpie) were both recorded (in two observations out of six for each species) as bitter; the same being true of the puffin—the smallest of three auks examined.

Fig. 2. PERCENTAGES, IN GRADED EDIBILITY GROUPS, OF SPECIES IN WHICH (a) THE EGGS ARE CRYPTIC, (b) NON-CRYPTIC EGGS ARE COVERED BY A CRYPTIC PARENT, (c) NEITHER EGGS NOR PARENTS ARE CRYPTIC

This incidence of bitterness among the smaller eggs laid by members of four different orders, Passeriformes, Charadriiformes, Gruiformes and Columbiformes, raises an interesting ecological question, and suggests that this quality may have been developed as a deterrent to attack by potential egg-eating predators. Obviously, the point requires further investigation, especially in the light of field observations, but the suggestion appears to be supported by three types of evidence.

In the first place, while distasteful properties of the egg appear to be neither directly related to the feeding-habits nor to the palatability of the parent bird, they are, on the other hand, often associated with small size and with conspicuousness. Size is an important factor in the vulnerability of a species in Nature. In the absence of compensating adaptations, smaller birds are liable to attack by a wider range of predators, and are less able to protect themselves and their eggs during the incubation period than larger species. Consequently any deterrent property such as relative distastefulness in the eggs of such birds is likely to be of selective value in the interspecific struggle for existence—especially if it is associated with conspicuous coloration easily recognized and remembered by potential predators.

Secondly, Rensch⁶ has shown, in his work on the sensitivity of birds to various tastes, that the lower limit of (externally ascertainable) taste perception is not markedly different from that of man; and that while relative insensitivity to bitterness is characteristic of birds feeding on seeds or insects which often have a sharp or bitter flavour, other species, and in particular birds of prey, such as the goshawk (*Accipiter gentilis*) and tawny owl (*Strix aluco*), are especially sensitive to bitterness.

A third approach to the question is through feeding experiments with egg-eating predators. We have already noted that there is a fair agreement between the palatability ratings of man and the apparent preferences of the ferret, rat, hedgehog and mongoose, and that this agreement is closest for the eggs rated as least edible by man. The series of thirty-five egg-species used in the rat tests includes eleven species rated as bitter, and all these occur in the lower half of the palatability sequence. Among eighteen species used in the hedgehog experiments, the three which appear at the end of the list as least palatable to these animals are the only three markedly bitter eggs offered.

In conclusion, it may be noted that previous work on the relative edibility of the flesh of birds affords a series of facts parallel in many respects to those here considered. Thus cryptic coloration, whether of plumage or egg-shell, appears to be correlated with palatability; and conspicuousness, in otherwise vulnerable species, often to be associated with a distasteful or deterrent property. I hope to continue the present investigation next season, and should be glad to hear from anyone (a) who has tasted eggs of tropical or other species not usually eaten by man, or (b) who might be willing to submit newly laid eggs (of species not included in the above series) for examination.

¹ Cott, H. B., *Nature*, 156, 736 (1945).

² Cott, H. B., *Proc. Zool. Soc. London*, 116, 371 (1946).

³ Swynnerton, C. F. M., *Ibis*, (10), 4, 529 (1918).

⁴ Davies, G., Report of the Food Investigation Board for the Year 1936, 51 (1936).

⁵ Murphy, R. C., "Oceanic Birds of South America" (New York, 1936).

⁶ Rensch, B., *J. Ornith.*, 73, 633 (1925).

SCIENTIFIC CENTENARIES IN 1948

By ENG.-CAPT. EDGAR C. SMITH, O.B.E., R.N.

THE past year has seen the commemoration of the centenaries of many men and institutions, and thus homage has been paid, memories recalled, interest aroused and history enriched. Notable among commemorations in the realm of science and technology were those associated with the Chemical Society, the Institution of Mechanical Engineers, the Royal Netherlands Institution of Engineers, King's College Engineering Society, and with Edison, Graham Bell and Denis Papin. Papin's work (see *Nature*, Sept. 27, 1947, p. 422) belonged mainly to the seventeenth century, which saw the foundation of the Royal Society in 1660 and of the Paris Academy of Sciences in 1666. Both these bodies sprang from earlier meetings of men with scientific leanings, and the meetings in France are recalled by the tercentenary of the death of Marin Mersenne, who carried on a large correspondence with men of science and joined with Mydorge, Roberval, Pascal and others in friendly discussions. Born at Soutière (Sarthe) on September 8, 1588, he was educated at La Flèche, where for a time Descartes was his school-fellow, studied at the Sorbonne and entered the priesthood. He became the superior of a convent of his order in Paris, and he died there on September 1, 1648. An amiable and conciliatory man, he was given to experimenting, translated Galileo's mechanics, contributed to mathematics and was much devoted to music.

Turning back to the later part of the Renaissance, the year 1548 saw the birth of Simon Stevin, the Dutch mathematician, a friend of Prince Maurice of Orange, by whom he was made quartermaster-general of the Dutch Army. His best work was done in fortification and military engineering; but he is remembered for his invention of decimal fractions and as one of the first to revive the study of statics. Cajori wrote of him as "a man remarkable for attainments in science, independence of thought and extreme lack of respect for authority". His statue was erected at Bruges in 1847.

It was such men as Stevin and Mersenne, whose lives overlapped those of Kepler, Galileo and Newton, who helped to pave the way for the great discoveries and advances made in the eighteenth century, so rich in the names of famous men, of whom the first to be mentioned is John Bernoulli, who died at Basle on January 1, 1748. No fewer than eight members of the Bernoulli family achieved fame as mathematicians, John being the eldest. His equally distinguished brother James died in 1705 at the early age of fifty, but John lived to be eighty years of age, leaving two sons, Daniel and John, and a grandson, another John, to maintain the family traditions. Especially remembered for his work on the calculus, John the first had a temperament in marked contrast to that of the priestly Mersenne; but, said Ball, "he was, however, the most successful teacher of his age and had the faculty of inspiring his pupils with almost as passionate a zeal for mathematics as he felt himself". Born at Basle on August 7, 1667, from 1695 to 1705 he held a chair of mathematics at Groningen and then returned home to fill the chair left vacant by his brother's death. For twenty years he corresponded with Leibniz. He was a foreign associate for forty years of the Paris Academy of Sciences, and D'Alembert declared that whatever he