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## MEDICAL STATISTICS FROM GRAUNT TO FARR

BY MAJOR GREENWOOD

## INTRODUCTION

UNDER the Fitzpatrick Trust, a Fellow of the Royal College of Physicians of London is chosen annually by the President and Censors to deliver two lectures in the College on 'The History of Medicine'. I had the honour of being chosen for this office in 1940 but, for obvious reasons, the lectures were not delivered, and it may be safely assumed that some years will pass before a medical audience will have time to attend to the history of a subject the modern practice of which does not make a strong appeal to physicians.

The nature of the intended audience inclined me to stress the medical rather than the purely statistical aspects of the story and I have trodden ground over which a greater man passed some years ago. I hope that Karl Pearson's studies of some or all of these old heroes will eventually be printed, and I know that my slight essays can ill sustain a comparison. But, precisely because they are slight and linger over small traits and human oddities, they may, in these times, wile away an hour or two. I have eliminated some explanations which no statistician or biometrician needs and the medical technicalities are few. Perhaps a note on the London College of Physicians as it was in the days to which these studies relate should be added.

The College was more than a century old when John Graunt was born, and the corporation consisted wholly of physicians who were Doctors of Medicine of Oxford or Cambridge; these were the *Fellows*. Physicians not Doctors of Medicine of Oxford or Cambridge were admissible only to the grade of *Licentiate*, and it was not until the nineteenth century, when Farr was a young man, that the exclusive privilege of the senior universities was abolished. It was not until Farr was a middle-aged man that the College had any direct contact with general practitioners of medicine and began to examine persons who did not seek to practise solely as physicians. In modern usage the College licence, L.R.C.P. (now only granted jointly with the membership of the Royal College of Surgeons, M.R.C.S.), is a diploma obtained by a large proportion of general medical practitioners in the South of England. Down to Farr's time, the L.R.C.P. was a 'specialist' diploma and could not have been taken by a general practitioner (the apothecary of those days) at all. The old L.R.C.P. is represented by the M.R.C.P. of our own time but with this distinction. Now, Fellows (F.R.C.P.) are normally chosen from the body of M.R.C.P.'s. In the past only Doctors of Medicine of Oxford or Cambridge could be Fellows, and before election but after examination were known as 'candidates', not licentiates. The great physician

Sydenham was never more than a licentiate. He graduated M.B. at Oxford and, for some unknown reason, never proceeded M.D. until near the end of his life, when he took the higher degree not at Oxford but at Cambridge.

#### I. THE LIVES OF PETTY AND GRAUNT

It is always rash to assign an absolute beginning to any form of intellectual effort, to say that this or that man was the very first to fashion some organon which has proved valuable. All we are justified in saying is that this or that man's work can be shown to have so directly influenced the thought of his contemporaries or successors that from his day the method he used has never been forgotten. It may be that the lost works of the school of the Empirics Galen despised anticipated the numerical method of Louis—some words of Celsus are consistent with the hypothesis. It may be that in the long succession of parish clerks who for more than a century transcribed the London Bills of Mortality, one or two suggested that these figures might have some other use than that of warning His Highness of the need to move into Clean Air. But we do not know. We do know that out of the casual intercourse of two Englishmen in the seventeenth century was produced a method of scientific investigation which has never ceased to be applied and has influenced for good or ill the thought of all mankind. In that sense at least we may fairly hold that John Graunt and William Petty were the pioneers not only of medical statistics and vital statistics but of the numerical method as applied to the phenomena of human society.

John Graunt and William Petty were both of Hampshire stock. Petty was of Hampshire birth, born on Monday, 26 May 1623, and was three years younger than John Graunt, who was born at the Seven Stars in Birchin Lane on 24 April 1620.

Materials for writing Petty's life are abundant; indeed a good biography of him was written nearly fifty years ago by his descendant Lord Edmond Fitzmaurice, and since then much of the material used by Lord Edmond has been printed. Sources for Graunt's biography are scanty, the most valuable John Aubrey's brief life of him.\* Graunt and Petty became acquainted in or before 1650. The circumstances of that first acquaintance are interesting to those who meditate upon the perepeteia of human fate. It was the contact of client and patron.

John Graunt's early life and manhood were those of the Industrious Apprentice. His father was a city tradesman, who bred his son to the profession of haberdasher of small wares. John 'rose early in the morning to his study before shop-time' and learned Latin and French, but did not neglect his business. He was free of the Drapers' Company and went through the city offices as far as

\* *Brief Lives, chiefly of Contemporaries*, set down by John Aubrey, between the years 1669 and 1696, edited by Andrew Clark, Oxford, 1896, 1, 271 *et seq.*

common councilman; he was captain and then major of the trained bands (the ancestor of the Honourable Artillery Company). At the time of the Great Fire he is said to have been an opulent merchant. Even fifteen years earlier he—and no doubt his father (1592–1662)—had city influence. At that time a Gresham professorship was vacant and a young Dr Petty was anxious to obtain it. This young man's career had been unlike that of an industrious apprentice; it had been, even for the seventeenth century, romantic. His father was a clothier in Romsey, who 'did dye his owne cloathes' in a small way of business. When William was a child, 'his greatest delight was to be looking on the artificers—e.g. smythes, the watch-maker, carpenters, joyners etc.—and at twelve years old could have worked at any of these trades. Here he went to schoole, and learnt by 12 yeares a competent smattering of Latin, and was entred into Greek' (Aubrey, Clark's edition, 2, 140).

But the precocious lad did not find a patron in Romsey and was shipped for a cabin boy at the age of fourteen. His short sight earned him a taste of the rope's end, and after rather less than a year at sea he broke his leg and was set ashore in Caen to shift for himself. 'Le petit matelot anglois qui parle latin et grec' attracted sympathy and obtained instruction in Caen. Caen was not a famous seat of learning like Leyden or Montpellier, but the Fellows and licentiates of the College of Physicians admitted between 1640 and 1700 include the names of four persons who studied or graduated in Caen (Nicholas Lamy, Theophilus Garencières, John Peachi and Richard Griffiths). Petty, however, was not then thinking of medicine but mathematics and navigation and came home to join the navy. In what capacity he served is unknown; he merely says (in his Will) that his knowledge of arithmetic, geometry, astronomy conducing to navigation, etc., and his having been at the University of Caen, 'preferred me to the King's Navy where at the age of 20 years, I had gotten up about three score pounds, with as much mathematics as any of my age was known to have had'. His naval career was short, for in 1643 he was again on the continent. Here he wandered in the Netherlands and France and studied medicine or at least anatomy. He frequented the company of more eminent refugees, such as Pell and Hobbes, as well as that of the French mathematician Mersén. He was very poor and told Aubrey that he once lived for a week on three pennyworth of walnuts, but on his return to England the three score pounds had increased to seventy and he had also educated his brother Anthony.

At first Petty seems to have tried to make a living out of his father's business, but he soon went to London with a patented manifold letter writer and sundry other schemes of an educational character. These occupied him between 1643 and 1649 and made him acquainted with various men of science, among others Wallis and Wilkins, but were not remunerative, and in 1649 he migrated to Oxford.

Petty was created Doctor of Medicine on 7 March 1649 by virtue of a

dispensation from the delegates (no doubt the parliamentary equivalent of the Royal Mandate of later and earlier times). He was also made a Fellow of Brasenose and had already been appointed deputy to the Professor of Anatomy. He was admitted a candidate of the College of Physicians in June 1650 (he was not elected a Fellow until 1655 and was admitted on 25 June 1658). At Oxford he became something of a popular hero by resuscitating (on 14 December 1651) an inefficiently hanged criminal, who, condemned for the murder of an illegitimate child, is said to have survived to be the mother of lawfully begotten offspring.

Academically Petty rose to be full Professor of Anatomy and Vice-Principal of Brasenose. It is at this point (as usual the precise dates are dubious) that he became a candidate for a Gresham professorship and made contact with John Graunt.

Although, as I have said, the materials for a biography of Petty are abundant, all we know of his early years comes from himself or from friends of later life who knew no more than he told them. We have no independent means of judging the extent of his culture. There is good evidence that he knew more Latin than most Fellows of the College of Physicians know now; none that he was an exact scholar (indeed we have his own word, which I am not prepared to gainsay,\* to the contrary). He was certainly admitted to friendship by some men, such as Wallis and Pell, who were serious mathematicians, as by others, such as Hobbes, who were not. But whether he could fairly be called a mathematician is doubtful. Of his medical knowledge we know little. He left medical manuscripts, but these are still unpublished; of his clinical experience we know nothing.

Petty told Aubrey that 'he hath read but little, that is to say, not since 25 aetat., and is of Mr. Hobbes his mind, that had he read much, as some men have, he had not known as much as he does, nor should have made such discoveries and improvements'. But it is at least certain that he made a favourable impression upon men who had read a good deal and that the young Dr Petty of 1650 was thought a promising man. Still it *had* been an odd career and one wonders what a steady business man in the city of London thought of it.

Why the anatomy professor who had resuscitated half-hanged Ann Green should be made a professor of music is not obvious, and if the Gresham appointments were jobs, why should the job be done for Petty? The modern imaginative historian might suggest various reasons. For instance, that Petty made a

\* If No. 88 of *The Petty Papers* (2, 36) is a typical example of Petty's Latin Prose style, there is not much to be said for it. Here is an example: 'An dulcius est humanae naturae permultos suam potestatem in unum quendam et in perpetuum transferre, id est pendis amittere quam ipso puel deindem servare, vel paulatium et in breve tempus irogare, a seipsis demo reformendam et disponendam alioquin pro ut, mutato tam rerum quam animi Indies suaserit?' Some of the gibberish may be due to the editor's failure to decipher the handwriting, but no emendation could twist this into unbarbaric prose.

conquest of Graunt, perhaps had Hampshire friends who were friends of the Graunt family, perhaps talked about political arithmetic. We have no evidence at all. If the Gresham Professor of Music *had* duties, Petty did not perform them; about the time of his appointment he obtained leave of absence from Brasenose and within a year (in 1652) had left for Ireland, where he was to be very busy for some time to come and to make, or found, his material fortunes.

Macaulay (chap. III) says that at the end of the Stuart period the greatest estates in the kingdom very little exceeded twenty thousand a year.

The Duke of Ormond had twenty-two thousand a year. The Duke of Buckingham, before his extravagance had impaired his great property, had nineteen thousand six hundred a year. George Monk, Duke of Albemarle, who had been rewarded for his eminent services with immense grants of crown land, and who had been notorious both for covetousness and for parsimony, left fifteen thousand a year of real estate, and sixty thousand pounds in money, which probably yielded seven per cent. These three Dukes were supposed to be three of the very richest subjects in England.

In 1685 Petty made his Will. This Will is a curiously interesting document, because it is also an autobiography. It is rich in arithmetical statements and, like much of Petty's arithmetic, the statements may be optimistic. Petty's final casting of his accounts is in this fashion: 'Whereupon I say in gross, that my reall estate or income may be £6,500 per ann. my personall estate about £45,000, my bad and desparate debts, 30 thousand pounds, and the improvements may be £4000 per ann., in all £15,000 per ann. *ut supra*.'

The details of the calculation are perplexing enough; still if the above cited dukes *were* the richest subjects of the king and if (Macaulay) 'the average income of a temporal peer was estimated by the best informed persons, at about three thousand a year', Sir William Petty, of the year 1685, had travelled as far from the young Oxford professor of 1650 as that budding physician from the little English cabin boy who spoke Latin and Greek, in Caen, in 1638. The details of the fortune-building are not our concern. The shortest account is Petty's own in his Will. He says that by the end of his Oxford career he had a stock of four hundred pounds and received an advance of one hundred more on setting out for Ireland.

Upon the tenth of September, 1652, I landed att Waterford, in Ireland, Phisitian to the army, who had suppressed the Rebellion began in the year 1641, and to the Generall of the same, and the Head Quarters, at the rate of 20s. per diem, at which I continued, till June, 1659, gaining by my practice about £400 per annum, above the said sallary. About September, 1654, I, perceiving that the admeasurement of the lands forfeited by the fore-mentioned Rebellion, and intended to regulate the satisfaction of the soldiers who had suppressed the same, was most insufficiently and absurdly managed, I obtained a contract, dated the 11th. of December, 1654, for making the said admeasurement, and by God's blessing so performed the same as that I gained about nine thousand pounds thereby, which with the £500 above mentioned, my sallary of 20s. per diem, the benefit of my practice, together with £600 given me for directing an after survey of the adventrs lands, and £800 more for 2 years sallary as Clerk of the Councell, raised me an estate of about thirteen thousand pounds in ready and reall money, at a time, when, without art, interest, or authority,

men bought as much lands for 10s, in reall money as in this year, 1685, yield 10s. per ann. rent above his *Maties* quitt rents (*The Life of Sir William Petty*, by Lord Edmond Fitzmaurice, London 1895, p. 319).

No one would willingly rake over the embers of Irish history—still glowing after nearly three hundred years. Petty believed himself to be a good man struggling against adversity and a public benefactor treated with gross injustice to the day of his death. Lecky (*History of Ireland*, vol. 1, chap. 1, p. 111 of popular edition) took a less favourable view. Even if the subject were relevant to my undertaking, which it is not, I have not the training in historical research to justify me in writing about it. There are, however, some points of psychological interest.

Petty did not, like his contemporary Thomas Sydenham, actually take up arms against the king, but he was even more plainly a protégé of the king's enemies. Sydenham's military career was unimportant; there is no reason to believe that he ever exchanged a word with a member of the Cromwell family. Petty was the confidential adviser and close personal friend of Henry Cromwell; his services to the Commonwealth authorities were the foundation of his fortune. Like many people who have social gifts he had the gentle art of making enemies.

Pepys, Aubrey and Evelyn concur in the judgment that Petty was a most entertaining companion. Evelyn says he was a wonderful mimic. He could speak 'now like a grave orthodox divine; then falling into the Presbyterian way; then to Fanatical, to Quaker, to Monk, and to Friar and to Popish Priest'. The gift he exercised among his friends.

My Lord D. of Ormond once obtained it of him, and was almost ravished with admiration; but by and by he fell upon a serious reprimand of the faults and miscarriages of some Princes and Governors, which, though he named none, did so sensibly touch the Duke, who was then Lieutenant of Ireland, that he began to be very uneasy, and wished the spirit layed, which he had raised; for he was neither able to endure such truths, nor could but be delighted. At last he turned his discourse to a ridiculous subject, and come down from the joint-stool on which he had stood, but my lord would not have him preach any more (Evelyn).

My lord Duke was not the first or last person to fail to relish a joke against himself.

In *The Londoners* a challenged party names garden hoes as the weapons. That was Mr Robert Hichens's fun. In real life, Petty, challenged to mortal combat by a Cromwellian soldier, pleaded his myopia and demanded that the duel should take place in a cellar and the weapons be axes.

A man like this makes friends or at least admirers, also enemies. Long before the king enjoyed his own again, Petty had a host of enemies. When the king returned, one might have expected that Petty's position would be critical. According to his own account he *did* lose something, but he was knighted and the losses, such as they were, did not seem to stay the growth of his fortune. At the Restoration he was already prosperous and he died wealthy. Perhaps the

explanation is that Petty was really as great a public benefactor as he thought he was. Perhaps the reason is personal. King Charles loved wits (in the old and new sense of the word) and Petty was a wit. The scanty specimens of what Petty's modern representative calls 'Rabelaisian' printed from the Petty papers would not have appealed to such a connoisseur in this genre as the king—we know from Halifax that the king liked to be the raconteur in this field and indeed repeated himself often—but he would have relished a good mimic. Still more important might have been their common virtuosity.

Charles was interested in experimental science, and although Petty certainly knew more than the king, he may not have known very much more. Neither Charles nor James would have been able to find more common ground with Isaac Newton than in a later age Bonaparte found with Laplace. But the ingenious Dr Petty, who had resuscitated half-hanged Ann Green (which would be a capital story if well told), invented an unsinkable ship, had a dozen plans for doubling the king's revenue, and knew something of everything, probably did more than Wilkins to interest the king in the new society of virtuosos (how the king must have relished the story of the planting of horns in Goa\*), and he may incidentally have interested the king in his business affairs. This is all speculation; what is sure is that when Petty was back in London and able to renew personal intercourse with John Graunt, their relation was no longer that of client and patron. For a few years more, Graunt was to be a solid merchant, but before long Petty was the patron and Graunt the client.

At this point it will be convenient to conclude the biographical facts relating to Graunt. I take them mainly from Aubrey.

Graunt continued to be a prosperous city tradesman for many years after his first meeting with Petty. 'He was', says Aubrey, 'a man generally beloved; a faithful friend. Often chosen for his prudence and justice to be an arbitrator; and he was a great peace-maker. He had an excellent working head, and was facetious and fluent in his conversation.' Pepys thought as well of Graunt as did Aubrey, admiring both his conversation and his collection of prints—'the best collection of anything almost that ever I saw'.

From the Restoration for several years Graunt figures in London intellectual society (he was elected F.R.S. in 1663), but a material calamity was at hand. The Fire of 1666 no doubt caused Graunt direct financial loss; this might have been repaired. But, although brought up in Puritan ways, 'he fell', to quote Aubrey, 'to buying and reading of the best Socinian bookes, and for severall

\* Sir Philiberto Vernatti, Resident in Batavia, had certain inquiries sent him by order of the Royal Society. The eighth question was: 'What ground there may be for that Relation, concerning Horns taking root, and growing about Goa?' This is Sir Philiberto's answer: 'Inquiring about this, a friend laughed, and told me it was a jeer put upon the Portuguese, because the women of Goa are counted much given to lechery' (Sprat's *History of the Royal Society of London*, 2nd ed. London 1702, p. 161).

years continued of that opinion. At least, about . . . he turned a Roman Catholic, of which religion he dyed a great zealot.'

Graunt's path to Rome was similar to that of young Edmund Gibbon, but the results on the career of a city tradesman in the days of Oates *triumphans* were more serious than a visit to Lausanne. Graunt became bankrupt. His name dropped out of the list of the Royal Society after 1666, and in 1674 he died. There is evidence that in these last years of worldly misfortune, when the wheel had come full circle since Graunt had secured the Gresham professorship for Petty, Petty helped Graunt. When Petty was in Ireland, Graunt acted in some sort as his London agent, and Petty conceived a plan of settling Graunt in Ireland. But (we have, of course, only Petty's word for this) Graunt was not an easy man to help; it is possible, of course, that he may have resented Petty's admonitions. 'You have done amiss in sundry particulars, which I need not mention because you yourself may easily conjecture my meanings. However we leave these things to God and be mindful of what is the sum of all religion, and of what is and ever was true religion all the world over.' This is an extract from a letter of January 1673 to Graunt (*The Petty-Southwell Correspondence*, p. xxix) printed by the late Marquis of Lansdowne. If Lord Lansdowne was right (the whole letter is not printed) in thinking this a reference to Graunt's conversion (or perversion) 'of which', says Lord Lansdowne, 'Petty seems to have disapproved on temporal rather than spiritual grounds', it might have hurt a sensitive man.

Graunt died on Easter Eve 1674 and was buried the Wednesday following in St Dunstan's church in Fleet Street. 'A great number of ingeniose persons attended him to his grave. Among others, with teares, was that ingeniose great virtuoso, Sir William Petty, his old and intimate acquaintance, who was sometime a student of Brasenose College.' Sir William outlived his friend thirteen years and lies in Romsey Abbey. Until a descendant in the nineteenth century (the third Marquis of Lansdowne) erected a monument, 'not even an inscription indicated that the founder of political economy lay in Rumsey Abbey' (Fitzmaurice, p. 315).

Graunt had a son who died in Persia and a daughter who, according to Aubrey, became a nun at Ghent. Nothing is known of descendants.

Petty's widow was raised to the peerage and her elder sons, Charles and Henry, died without issue. But the title was revived in favour of the grandson of John Fitzmaurice, the second surviving son of Thomas Fitzmaurice, Earl of Kerry, who, as the above-mentioned grandson remarked, had 'married luckily for me and mine, a very ugly woman who brought into his family whatever degree of sense may have appeared in it, or whatever wealth is likely to remain in it'. This ill-favoured woman was Petty's daughter Anne, to whom her father wrote:

My pretty little Pusling and my daughter Ann  
That shall bee a countesse, if her pappa can.

The cynical grandson was George III's prime minister and afterwards his *bête noire*, 'The Jesuit of Berkley Square' and first Marquis of Lansdowne.

Of the two friends, one has left an intellectual monument only; descendants of the other have been famous in English history.

Of these, best known are the first and third Marquises of Lansdowne, William (1737–1805) and Henry (1780–1863). Of the first marquis, much better known as Lord Shelburne (the title created for Lady Petty), every schoolboy—not only Macaulay's schoolboy—has heard; the quarrel between Charles Fox and Shelburne, the party split, the coalition ministry and so on. Schoolboys who have reached the sixth and Lecky's *History of England in the Eighteenth Century*, know a little more. Shelburne, who had much more than a tincture of his great-grandfather's ability and applied himself to economic studies, was one of the earliest to appreciate the importance of Adam Smith and was highly thought of by two good judges of scientific ability, Benjamin Franklin and Jeremy Bentham.

As a public man, no parliamentary statesman before or since obtained so universal a dislike, a positive hatred shared by those who knew him and those who did not.

There is certainly nothing in the actions of Shelburne to justify this extreme unpopularity. Much of it was, I believe, simply due to an artificial, overstrained, and affectedly obsequious manner, but much also to certain faults of character, which it is not difficult to detect. Most of the portraits that were drawn of him concur in representing him as a harsh, cynical, and sarcastic judge of the motives of others; extremely suspicious; jealous and reserved in his dealings with his colleagues; accustomed to pursue tenaciously ends of his own, which he did not frankly communicate, and frequently passing from a language of great superciliousness and arrogance to a strain of profuse flattery (Lecky, 5, 136).

How far some of these characteristics may be recognized in Shelburne's ancestor, we shall inquire in due course.

The contrast between Malagrida\* and his son Henry is shattering. It is *this* Marquis of Lansdowne of whom nearly everybody thinks when he sees the title in a book, and rightly so. Walter Bagehot wrote:

You may observe that when an ancient liberal, Lord John Russell, or any of the essential sect, has done anything very queer, the last thing you would imagine anybody would dream of doing, and is attacked for it, he always answers boldly, 'Lord Lansdowne said I *might*'; or if it is a ponderous day, the eloquence runs, 'A noble friend with whom I have had the inestimable advantage of being associated from the commencement (the infantile period I might say) of my political life, and to whose advice,' etc., etc., etc.—and a very cheerful existence it must be for 'my noble friend' to be expected to justify—(for they never say it except they have done something very odd)—and dignify every aberration. Still it must be a beautiful feeling to have a man like Lord John, to have a stiff, small man

\* Malagrida was an Italian Jesuit settled in Portugal who was burned in 1761. The supposed jesuitical propensities of Shelburne led to the name becoming his popular title. Hence Goldsmith's unintended *mot*: 'Do you know that I never could conceive the reason why they call you Malagrida, for Malagrida was a very good sort of man.'

bowing down before you. And a good judge (Sydney Smith) certainly suggested the conferring of this authority. 'Why do they not talk over the virtues and excellencies of Lansdowne? There is no man who performs the duties of life better, or fills a high station in a more becoming manner. He is full of knowledge, and eager for its acquisition. His remarkable politeness is the result of good nature, regulated by good sense. He looks for talents and qualities among all ranks of men, and adds them to his stock of society, as a botanist does his plants; and while other aristocrats are yawning among stars and garters, Lansdowne is refreshing his soul with the fancy and genius which he has found in odd places, and gathered to the marbles and pictures of his palace. Then he is an honest politician, a wise statesman, and has a philosophic mind', etc., etc. Here is devotion for a carping critic; and who ever heard before of *bonhomie* in an idol? (Bagehot, *Works*, 2, 64-5).

Of the father, Atticus (an alias of 'Junius') wrote:

The Earl of Shelburne had initiated himself in business by carrying messages between the Earl of Bute and Mr. Fox, and was for some time a favourite with both. Before he was an ensign he thought himself fit to be a general, and to be a leading minister before he ever saw a public office. The life of this young man is a satire on mankind. The treachery which deserts a friend, might be a virtue compared to the fawning baseness which attaches itself to a declared enemy (*Letters of Junius*, Wade's edition, 2, 248).

Naturally justice was no more to be expected in eighteenth-century newspaper diatribes than in the twentieth century, but a clever caricaturist does not represent Charles Fox as a living skeleton. Those who attacked the son—there were such people—took a different line, as Bagehot hints. Perhaps even in his very different character something of the ancestral Petty survives. We shall try to discover what this was.

Forty years ago Hull brought out an edition of Petty's tracts in which he included Graunt's work. In 1927 the fifth Marquis of Lansdowne printed a selection from the Petty papers and in 1928 the correspondence between Petty and his wife's cousin,\* Sir Robert Southwell (*The Petty-Southwell Correspondence*, edited by the Marquis of Lansdowne, London 1928).

We shall have to examine in detail both the 'works' and the 'papers', but, as a light upon the character of Petty, the Southwell correspondence is the strongest we have. Southwell himself was some generations farther away from adventuring than Petty. He came of an 'undertaker' stock—the adventurers in Ireland of Queen Elizabeth's time—and his father was vice-admiral of Munster before him. He was born in 1635 (died in 1702), regularly educated (Queen's College, Oxford and Lincoln's Inn), knighted in 1665, for some time Clerk of the Privy Council, in the diplomatic service, held other offices, was a member of parliament and eventually settled in a country house near Bath. He was President of the Royal Society 1690-5. He might be described as a lesser William Temple; better educated and less selfish, not so able, but with the same cool, cautious judgment; a psychological antithesis of his correspondent.

\* Petty married in 1667 Lady Fenton, widow of Sir Maurice Fenton and daughter of Sir Hardress Waller who, knighted in 1629, fought for the Parliament and was one of the King's judges; he was a major general in Ireland in 1650-1 and a patron of Petty there.

The correspondence covers the eleven years 1676–87. Both men were, even by modern standards, middle aged. They write one to another with complete frankness; there is a remarkable absence of the elaborate verbal formalities which in seventeenth-century and even eighteenth-century letters are so wearisome.

Petty's side of the correspondence consists roughly of domesticities 10 parts, eager accounts of his quarrels and law suits concerning money 40 parts, discussion of papers or projected papers 40 parts, add autobiographical boasting to make up the 100.

In the purely domestic part of the correspondence, Petty is seen as a kind, good-natured father interested in the doings of his relations by marriage, also as a very bad judge of others' feelings. I remember to have read an unpublished letter by the famous Edwin Chadwick, the great and very unpopular sanitarian of a century ago. It was written to a friend whose wife had just died of puerperal fever. Chadwick expressed regret in the shortest possible formula and assured his correspondent that the best solace he could have would be to assist in pushing forward a bill (which I think he enclosed) to promote some sanitary reform which would have the effect of making it less likely that other men would lose their wives in childbed. I remember thinking that, however sensible the recommendation, the man who gave it was not likely to bring much comfort to his friend.

Petty was very much like Chadwick here. Southwell lost his wife in 1681 and Petty condoled with him as follows:

When your good father dyed, I told you that hee was full of years and ripe fruit, and that you had no reason to wish him longer in the paines of this world. But I cannot use the same Argument in this Case for your Lady is taken away somewhat within half the ordinary age of Man and soon after you have been perfectly married to her; for I cannot believe your perfect union and assimulacon was made till many years after the Ceremonies at Kinsington.

What I have hitherto said tends to aggravate rather than mitigate your sorrow. But as the sun shining strongly upon burning Coles doth quench them, so perhaps the sadder Sentiments that I beget in you may extinguish those which now afflict you. The next Thing I shall say is, That when I myself married, I was scarce a year younger then you are now, and consequently do apprehend That you have a second Crop of Contentment and as much yet to come as ever I have had.

This remark, curiously enough, was not well received.

You doe not onely condole the great loss I have sustained in a wife, but you seeme to think it reparable. . . . But when by 19 yeares conversation I knew the great vertues of her mind, and discover since her death a more secrett correspondence with Heaven in Acts of Pietye and devotion (which before I knew not of), you will allow me, at least for my Children's sake, to lament that they have too early lost their guide.

Petty could not, it seems, understand that Southwell was wounded and returned to the charge in a letter which is lost. That letter provoked a reply

which even Petty could not misunderstand and elicited an apology (*Correspondence*, p. 90).

Petty was quite incorrigible. A few years later Southwell had another family bereavement and is condoled with in the following terms:

That by the death of your Father, Mother and Sister, of Sir Edward Deering and your three nephews, you are the Head and Governor of both Familyes. That by the death of Rupe, Ingenious Neddy culminates; and by that of your Excellent Lady you are entitled to that million I mentioned of unmarried teeming Ladyes.

Once again, Southwell was not comforted. 'Cousin, you doe wipe off Teares at a very strange rate, but why did nature furnish Them if there must be no Sorrow?'

Petty had a very quick perception of when and where *his* shoe pinched, but no imaginative sympathy.

Passing to Petty's financial affairs and lawsuits, the position was this. By original grants, by purchase and in various ways, Petty had widely scattered Irish interests. Questions of the validity of the original grants, of rent charges due to the crown or to other grantees, of matters of fact and matters of law were endless. Petty saw himself steadily as a great public benefactor harassed by scoundrels, and it never occurred to him even as a theoretical possibility that others had rights. Of his manner of proceeding the editor of the correspondence gives a typical example (*Correspondence*, p. 90). In 1681 Petty gave evidence before Lord Chief Baron Hen as to 'Soldier's land' which he had bought in Kerry and, it seems, the court decided against him.

Petty gave vent to his chagrin in a long and scurrilous lampoon against the offending judge, entitled: 'HENEALOGIE or the legend of Hen-Hene and Pen-Hene', in two parts. Whereof the first doth in 24 chapters of Raillery, contain the enchantments, metamorphoses and merry conceits relating to them. The second part contayning (in good earnest) the foolish, erroneous, absurd, malicious and ridiculous 'JUDGEMENTS OF HEN-HENE'. Fortunately perhaps for the repute of its author, this diatribe was never made public.

Fortunately, also, for a more material reason; it would probably have led to a *second* incarceration for contempt of court.

Southwell evidently viewed his good cousin's proceedings with a mixture of gentlemanlike annoyance and practical minded contempt. He expressed these feelings more than once; the following extract from a letter of 1677 is typical; the particular suit in progress to which reference is made was a claim for £5000 in respect of a sum of £2500 actually advanced by Petty to the Farmers of Revenue.

And suffer from me this expostulation, who wish your prosperity as much as any man living; and having opportunities to see and heare what the temper of the world is towards you, I cannot but wish you well in Port, or rather upon the firm Land, and to have very little or nothing at all left to the mercy and good will of others. For there is generally imbibed such an opinion and dread of your superiority and reach over other men in the wayes of dealing, that they hate what they feare, and find wayes to make him feare that is

fear'd. I doe the more freely open my soul to you in this matter, because tis not for the vitells that you contend, but for outward Limbs and accessions, without which you can subsist with Plenty and Honour. And therefore to throw what you have quite away, or at least to put it in dayly hazard onely to make it a little more than it is, Is what you would condemne a thousand times over in another. And you would not think the Reply sufficient that there was plain Right in the Cause and Justice of their side, for iniquities will abound and the world will never be reformed.

After all this is said, I mean not that you should relinquish the pursute of your 2500£, which is money out of your Pockett and for which you are a Debtor unto your Family. But for other pretensions, lett them goe for Heaven's Sake, as you would a hott coale out of your hand: and strive to retire to your home in this Place, where you had the respect of all, and as much quiet as could be in this life, before your meddling with that pernicious business of the Farme.

There is no reason to suppose that Petty ever took such sensible advice. Yet, somehow, he kept his head well above water.

In the later part of the correspondence Petty indulges in that complacent financial retrospect which he inserted in his Will and I have, perhaps too harshly, described as autobiographical boasting. It is possible that Southwell had heard of these financial triumphs rather often; at least there is a hint of this in the following:

I will onely note that since you are soe Indulgent as to think me worthy of being your Depositary in this great Audit, and expect by the Course of Nature that I should speake when you are Silent, you must allow me liberty without blame to aske questions when you seeme defitient or Redundant.

That you are defitient may be suggested when, on the fortunate syde, I find noe Item for my Lady or of the hopefull stock she has brought you (p. 227).

The shrewd thrust of the last sentence was deadly. The subject does not recur.

I have indicated the character of the non-scientific part of the correspondence because we must examine Petty's scientific writings in greater detail. I think, however, we have enough to justify a provisional diagnosis of Petty's psychological type.

In literature and in life the perennial boy is often encountered. But while Peter Pan and Mr Reginald Fortune make far more friends than foes, that is not so true of their living counterparts. The exuberant flow of ideas and schemes, the intense and restless interest in *everything* which is characteristic of the clever child, often is extraordinarily attractive when it is associated with and controlled by the trained intelligence of a man. But the bad as well as the good points of a childlike or adolescent soul\* are to be brought into the account. The

\* The first Marquis of Halifax said of King Charles that 'his inclinations to love were the effects of health and a good constitution, with as little mixture of the *seraphic* part as ever man had', and Petty held that the King was typical. In *The Petty Papers* (no. 93 of vol. 2) there is a memorandum headed 'Californian Marriages with the Reasons thereof'. 'In California', says Petty, '6 men were conjugerted to 6 women in order to beget many and well conditioned children, and for the greatest venereall pleasure, in manner following, viz.'

He then sets out the plan. One man 'excelling in strength, nimbleness, beauty, wit, courage

clever child is often naïvely and intensely selfish, and so remains as the eternal boy; his quite crude and unashamed egoism, his inability to understand that others have feelings and even rights, repel as strongly as his intellectual freshness attracts. How far he is a success in life depends on which way the balance turns.

Petty seems to me a good example of this psychological type; its good points, the restless energy and exuberant flow of ideas, were sources of strength in such a time as that of the Civil War and Restoration, which, particularly the Restoration period, was in virtues and vices an age of grown-up children. Indeed his emotional adolescence may have shielded him from the deadly enmity of real men. Its bad points made him enemies, but they were children like himself. Nearly a century later, in a time of adults, these same characteristics, restless intellectual energy and vanity, exhibited by one no longer a rollicking adventurer but a great landowner, produced an unfavourable balance and we have 'Malagrida'. In Malagrida's son, one has a change; the attractive traits, the eager interest in all sorts of things is still there, but the childish hungry vanity has been softened or sublimed. The cynic may say that it was easy for a great Whig lord 150 years ago to be agreeable, to keep himself *hors concours*; perhaps it was, although the *Dropmore Papers* raise doubts. The fact, however, is certain. In the third Lord Lansdowne one sees the good and in the first the bad effects of the perennial boyishness of the ancestor. The ancestor lived in a state of society where the good points outweighed the bad points. That is why, although he made enemies and was often vexed, he was able to view his career with complacency and to bequeath a great fortune. But it is not Petty as a man but Petty as a scientific worker who is the proper object of my study.

How far does the psychological make-up which, as I think, characterized Petty conduce to scientific investigation? We might expect that it would be an immense stimulus to pioneering, that such a man would direct attention to a number of problems which deserved study, but that it would not lead to the production of any solid contribution to knowledge. Our task is to examine in some detail Petty's scientific work.

and good sense' subsequently called the Hero, is allowed four women for his sole use. One Great Rich Woman is allowed five men who are to serve her when she pleases, but another woman is allotted to the five men for use in common by the five.

It may be said this fable is only an after dinner jest—perhaps that *is* the whole explanation. But Petty does go to the trouble of financial calculations, and does seem to suggest a serious consideration. ('The encrease of children will be great and good.' 'No controversy about joynture, dower, maintenance, portion etc.') Nobody emotionally adult would be likely to make Californian Marriages a basis for practical statecraft.

## II. PETTY'S SCIENTIFIC WORK

It is no part of my undertaking to survey the whole of Petty's scientific activities, but to speak only of his medical and vital statistical work.

In Hull's edition of Petty's writings, the editor discusses Petty's status as an economist and remarks that Petty's view that value depended upon labour was probably derived from Hobbes. The corn rent of agricultural lands was in Petty's view determined by the excess of their produce over the expenses of cultivation, paid in corn, and the money value of the excess will be measured by the amount of silver which a miner, working for the same time as the cultivator of the corn land, will have left after meeting his expenses with a part of the silver he secures (Hull, p. lxxiii). Why there should be any surplus, he explains by density of population.

Prof. Hull refrained from attempting to assess Petty's work in terms of modern economic theory. A mere medical statistician will naturally follow this example. More than a century ago, Mr Chainmail had learned from Mr MacQuedy that the essence of a safe and economical currency was an interminable series of broken promises and added: 'There seems to be a difference among the learned as to the way in which the promises ought to be broken; but I am not deep enough in their casuistry to enter into such nice distinctions.' Medical statisticians may well adopt Mr Chainmail's modest attitude towards the whole field of economic theory. Confining ourselves to statistics, we must consider what Petty thought should be done and what he actually did himself.

Under the first heading, praise can be unstinted. More than 150 years before the establishment of the General Register Office, Petty specifically proposed the organization of a central statistical department the scope of which was wider than that of our existing General Register Office. It was to deal not only with births, marriages, burials, houses, the ages, sexes and occupations of the people, but with statistics of revenue, education and trade (see *The Petty Papers*, 1, 171-2). He did not confine himself to vague recommendations, but drew up an enumeration schedule to be used for each parish. On this was to be entered: The number of housekeepers and of houses; the number of hearths; the number of statute acres; the number of people by sex and in age groups, viz. under 10, between 10 and 70, over 70; for males those aged 16 to 60, and for females those between 16 and 48 and how many of these latter were married; how many persons were incurable impotents and how many lived upon alms. This, it will be noted, is a better enumeration schedule than any used in England before the census of 1821. Further in his notes (printed in *The Petty Papers*) are various suggestions for the utilization of data collected in this way.

The most striking is this: 'The numbers of people that are of every yeare old from one to 100, and the number of them that dye at every such yeare's age, do shew to how many yeare's value the life of any person of any age is equivalent

and consequently makes a Par between the value of Estates for life and for years' (*The Petty Papers*, 1, 193).

This is, I think, the most remarkable thing Petty ever wrote, for it *suggests* that he had grasped the principle of an accurate life table, viz. a survivorship table based upon a knowledge of rates or mortality in age groups. No such table was constructed from population data until the end of the eighteenth century, because until then data of the age distribution of the *living* population were not obtained. Whether Petty also realized that under certain conditions a life table could be constructed without knowledge of the ages of the living population is a controversial matter which I shall discuss later on.

Then he makes suggestions which are relevant enough to modern demographic problems.

By the proportion between marriages and births, and of mothers to births, may be learnt what hindrance abortions and long suckling of children is to the speedier propagation of mankind; as also the difference of soyles and ayres to this foecundity of women.

By the proportion between maryd and unmaryd teeming women, may be found in what number of yeeres the present stock of people may bee encreased to any number assigned answerable to the defect of the peopling of the nation for strength or trade.

There are not wanting some suggestions which imply that even if Petty's opinion of the Faculty were higher than that of Sydenham (whom we honoured *posthumously*) it was tinged with scepticism.

Whether they [viz. fellows and licentiates of the College of Physicians] take as much medicine and remedies as the like number of any other society.

Whether of 1000 patients to the best physicians, aged of any decade, there do not die as many as out of the inhabitants of places where there dwell no physicians.

Whether of 100 sick of acute diseases who use physicians, as many die and in misery, as where no art is used, or only chance. (*The Petty Papers*, 2, 169-70.)

This statistical experiment has not yet been performed and indeed might be hardly so conclusive as Petty implied.

When one passes from what Petty suggested to what he actually did himself, our praise must be qualified. As Prof. Hull said, he was 'more than once misled into fancying that his conclusions were accurate because their form was definite'.

In judging Petty it is but fair to contrast him with College contemporaries whose names are more honoured by us. Among his contemporaries in the College were Thomas Browne and Thomas Sydenham. Browne was a much older man than Petty, Sydenham almost his coeval. Of Browne's quality as a physician we know nothing; but his literary influence indirectly—through Samuel Johnson—and directly upon generations of readers has been greater than that of any other practising medical man. Browne, like Petty, had an enormous range of interests and his book learning was greater. But, as we shall see, when

he tackles a problem of demography, Petty's rashest guesses seem by comparison as soberly scientific as an annual report of the Registrar-General.

Sydenham was an iconoclast in clinical practice and believed himself to be emancipated from the rule of ancient authority. No fantastic arithmetical calculations are to be found in *his* writings. In fact, with a single exception (*Observations Medicae*, 2, i), no arithmetic at all. It never seems to have entered his mind, although his greatest work purports to give the history of the diseases in London through a generation, that the arithmetical statements of the London Bills of Mortality were of any value whatever.

Sydenham was too wise a man for us to think that he rejected the evidence because the data were compiled by illiterate old women. He would have known that the sworn searchers had the loquacity of their sex and rank and were likely to ask what 'the doctor said'. He rejected it, because counting and measuring things did not come within his purview, just as the first beginnings of pathology and medical chemistry seemed to him irrelevant.

For the most part, Petty's statistical work was severely practical, but there is one excursion into theory which is interesting. It is to be found in a section of his tract on the use of what he calls Duplicate Proportion and is reprinted by Hull (pp. 622-3).

Petty states that there are more persons living between the ages of 16 and 26 than in any other decade of life. The statement is not true for modern populations and was probably not true for the English population of Petty's time. In 1861-71 (before the fall in the birth rate and infant mortality rate) there were 5.4 millions living under 10, and 4.0 between 15 and 25). But perhaps Petty meant that there were more living in the decade 16 to 26 than in any *later* decade, in which case his statement was of course right unless the birth rate was falling.

He then asserts that the

Roots of every number of Men's Ages under 16 (whose Root is 4) compared with the said number 4, doth show the proportion of the likelihood of such men reaching 70 years of Age. As for example: 'Tis 4 times more likely that one of 16 years old should live to 70, than a new born Babe. 'Tis three times more likely, that one of 9 years old should attain the age of 70, than the said infant. Moreover, 'tis twice as likely, that one of 16 should reach that Age, as that one of four years old should do it; and one third more likely, than for one of nine.

We have no life table for England in 1674. Perhaps the nearest modern experience might be the Liverpool Table calculated by Farr seventy years ago. According to that table the chance of a new-born child living to be 65 was 0.0976 and the chance of a person of 15 living to 65 was 0.202, which is about double the infant's chance, not four times as large. For the Healthy Districts, the chances are 0.4246 and 0.54585; that is, in a ratio of 1.28 to 1.

Petty's statements are wildly wrong. The interesting point is how did he reach them? The only figures he had were printed by Graunt.

This 'Life Table' gives  $l_x$  as follows:

$l_0$	100	$l_{46}$	10
$l_6$	64	$l_{56}$	6
$l_{16}$	40	$l_{66}$	3
$l_{26}$	25	$l_{76}$	1
$l_{36}$	16		

Now if we take 2 as the survivors to 70 (it does not of course matter what the numerator is for comparative purposes), then the infant's chance of surviving to 70 is 0.02 and the person of 16 has the chance  $1/20 = 0.05$ , a ratio of 2.5, not wildly different from the Liverpool Table figure and very different from 4.0.

*A fortiori* when Petty, having passed above age 16, asserts that 'it is five to four, that one of 26 years old will die before one of 16; and 6 to 5 that one of 36 will die before one of 26', we are in a region of pure fantasy because, even if he had had the statistical data, Petty would not have had the technical knowledge to solve the problem involved, viz. to find the probability that of two lives aged respectively  $x$  and  $y$ , the former will fall before the latter.

If we keep within the range of the simple arithmetic which Petty used, the result cannot be obtained.

He then passes to this statement:

To prove all which I can produce the accompts of every Man, Woman, and Child, within a certain Parish of above 330 Souls; all which particular Ages being cast up, and added together, and the Sum divided by the whole number of Souls, made the Quotient between 15 and 16; which I call (if it be Constant or Uniform) the Age of that Parish, or *Numerus Index* of Longaevity there. Many of which Indexes for several times and places, would make a useful Scale of Salubrity for those places, and a better Judg of Ayers than the conjectural Notions we commonly read and talk of. And such a Scale the *King* might as easily make for all his Dominions, as I did for this one Parish.

The puzzle is to discover why Petty thought this statistical experiment proved his point and why he regarded the mean age of the population of a parish its index of longevity. The first question I cannot answer at all; about the second I can make a guess. *If* the parish population were supported solely by births and there was no migration, then, if the death rates at ages did not vary, the population would be a stationary population and both the mean age of the living and the mean age at death would be constant. The expectation of life is greater than the mean age of the living unless the rates of mortality at early ages are very high and the more favourable the rates of mortality the greater will be the difference. In Petty's day, when mortality at early ages was very high, the two constants were probably not far apart, but it is certain that both expectation of life and mean age of a life table population were greater than 16; probably of order 28 to 32.

I think we may be sure that the parish Petty counted was not stationary in the statistical sense, but had an excess of births over deaths, and that his average threw no light upon the rates of mortality.

Passing to practical statistics, it will be convenient first to note rapidly statistical observations which are incidental in treatises of primarily financial or economic interest. In the *Verbum sapienti*, which although not printed until 1691 was written as early as 1665, Petty attempts to reckon what a man is worth. Here is the method. He concludes from financial data that the annual proceed of the Stock or Wealth of the nation yields 15 millions, but that the expenses of the nation are 40 millions. So the balance of 25 millions must be derived from the labour of the people. He assumes that the population is 6 millions and that half of these can work, and earn £8. 6s. 8d. a head per annum. This would be 7d. a day, abating 52 Sundays and half as many other days for sickness, holidays, etc. 'Whereas the Stock of Kingdom, yielding but 15 Millions of proceed, is worth 250 Millions; then the People who yield 25, are worth 416  $\frac{2}{3}$  Millions. For although the Individuums of Mankind be reckoned at about 8 years purchase; the Species of them is worth as many as Land, being in its nature as perpetual, for ought we know.'

Why an individual's working life is worth only 8 years' purchase is not clear. One would be inclined to put it as the average number of years lived in the working period of life. Perhaps Petty took Graunt's table and worked out the average number of years of life lived between the ages of 16 and 56; it *is* nearly 8.

He then calculates the money loss due to 100,000 dying of the plague and makes it nearly 7 millions, adding that £70,000 would have been well disposed in preventing this 'centuple loss'. Perhaps this is the first printed statement of the neglected truth that public health measures pay.

Since Petty's day, others, including Farr himself, have done sums of this kind; it is a popular occupation in the United States of America.

Farr went to work more elaborately, making out a balance sheet of a man from the cradle to the grave. But the principle was much the same. We cannot say it is a *wholly* useless pastime. There is of course the difficulty that if more lives are saved the price of labour might fall. But to Petty that would have been no difficulty, because he held that wealth is *purely* relative, viz. that if the income of each person in a community is halved, everybody is as well off as before.

In the *Political Anatomy of Ireland*, Petty seeks to determine war losses in Ireland.

The number of the People being now *Anno* 1672 about 1,100,000 and *Anno* 1652 about 850 M. Because I conceive that 80 M. of them have in 20 years encreased by generation 70 M. by return of banished and expelled *English*; as also by the access of new ones, 80 M. of New *Scots*, and 20 M. of returned *Irish*, being all 250 M.

Now if it could be known what number of people were in *Ireland* Ann. 1641, then the difference between the said number, and 850, adding unto it the increase by generation in 11 years will shew the destruction of people made by the Wars, viz. by the Sword, Plague and Famine occasioned thereby.

I find by comparing superfluous and spare Oxen, Sheep, Butter and Beef that there was exported above  $\frac{1}{3}$  more *Ann.* 1664 than in 1641, which shews there were  $\frac{1}{3}$  more of

people, *viz.* 1,466,000. Out of which Sum take what were left Ann. 1652, there will remain 616,000 destroyed by the Rebellion.

Whereas the present proportion of the *British* is as 3 to 11; But before the Wars the proportion was less, *viz.* as 2 to 11 and then it follows that the number of *British* slain in 11 years was 112 thousand Souls; of which I guess  $\frac{2}{3}$  to have perished by War, Plague and Famine. So as it follows that 37,000 were massacred in the first year of Tumults: So as those who think 154,000 were so destroyed, ought to review the grounds of their Opinions.

It follows also, that about 504 M. of the *Irish* perished, and were wasted by the Sword, Plague and Famine, Hardship and Banishment, between the 23 of *October* 1641 and the same day 1652. Wherefore those who say, That not  $\frac{1}{8}$  of them remained at the end of the Wars, must also review their opinions; there being by this Computation near  $\frac{2}{3}$  of them; which Opinion I also submit.

Assuming, which is rash, that the estimates of population in 1672 and 1652 are correct, the assumption that population varied inversely as exportation of cattle seems bold. Might it not be that shipping facilities were better in 1664 than in 1641? Had there been no exportation we could not infer the population to be infinite.

Again Petty has multiplied the estimate for 1672 by 1.333. But he needed the population of 1664, which presumably was smaller than that of 1672. If his estimate is right, the population was increasing at the rate of about 12.5 thousands per annum, so he should have multiplied 1,000,000 not 1,100,000 by 1.333 and has overestimated the 1641 population by 133,330, and therefore the number destroyed by the same amount, an overstatement of 20%. But this is not all. If we assign the decrement of population between 1652 and 1641 wholly to sword, plague and famine, we must assume that births continued at the peacetime rate; not a likely assumption. Lastly, it seems unreasonable to assign the casualties to the two races in precise proportion to their estimated numerical strength in the population of 1641.

*How* it follows that 37,000 were massacred in the first year of tumults I do not know.

In a later work (*Treatise of Ireland*, pp. 610–11) Petty has another shot at this problem.

He now assumes that Graunt's deduction from a Hampshire parish register, *viz.* that christenings are to burials in the ratio of 5 to 4, applies to Ireland, and that the death rate is 1 in 30, *i.e.* about what Graunt estimated for London and much higher than his estimate for the country. He then proceeds in this way. He estimates the population of 1653 to be 900,000 and that of 1687, 1,300,000. Then taking  $\frac{1}{30}$  for the death rate and  $\frac{1}{24}$  for birth rate, he makes the population of 1652, 985,000. He does not comment on the great decrease between 1652 and 1653; but there was still war in Ireland in 1652.

He now says that the population of 1641 was greater than that of 1687, 'as appears by the Exportations, Importations, Tyths, Grist-Mills and the Judgment of Intelligent Persons'. This time he takes the population to be 1,400,000—a little less than in the earlier estimate—and by the same kind of reasoning

again makes the war losses to be about 600,000. One is reminded of Hull's remark that Petty confused the accurate with the definite. Also one notes the inevitable tendency of a polemical writer—which Petty very decidedly was—to maintain his original assertion. Those of us who have *never* yielded to this temptation may cast stones at him. It is not I believe too cynical to say that *any* calculation Petty made would have made the war losses around 600,000.

Returning to the *Political Anatomy of Ireland*, we find here a distinct claim that the mean age at death (not the mean age of the living) measures longevity.

As to Longaevity, inquiry must be made into some good old Register of (suppose) 20 persons, who were all born and buried in the same Parish, and having cast up the time which they all lived as one man, the Total divided by 20 is the life of each one with another; which compared with the like Observation in several other places, will show the difference of Longaevity, due allowance being made for extraordinary contingencies and Epidemical Diseases happening respectively within the period of each Observation (p. 172).

Apart from what we should think the absurdity of basing important conclusions upon an average of 20—and Petty only gives 20 as a figure—the mean ages at death of different populations are not comparable unless in each place the population is stationary in the sense described above. But, since so acute a man as Edwin Chadwick made the same mistake in the nineteenth century as Petty in the seventeenth century and it continues to be made in various places in the twentieth century, we need not be superior.

We now come to Petty's purely statistical work which is concerned with the growth of population; before examining this in detail, it will be convenient to consider the methods available in the seventeenth century for estimating population and notions then current on what may be called the theory of population growth.

It is hard to believe that in the ancient world nobody studied demography arithmetically. There is evidence that the Romans enumerated citizens—the word census is pure Latin—and it has been suggested that the Romans made life tables. Gouraud, cited by Todhunter (*History of the Mathematical Theory of Probability*, p. 14), refers to a passage cited from Ulpian in the *Digest* which I have discussed elsewhere.\* The question was of the value of annuities and the conclusion I reached was that Ulpian had no vital statistical basis whatever for his figures, that he simply began with the capital value the law gave for *any* usufruct and then, realizing that people do die eventually, made some subtractions, ending with the absurd (vital-statistically speaking) conclusion that after the age of 60 the rate of mortality was independent of age.

There is not, I think, any reason to believe that the practical Romans had anticipated Graunt and Petty.

That is not to say that nobody studied any demographical problems arithmetically. Indeed one fellow of the College of Physicians who has had—and will

\* *Journ. Roy. Stat. Soc.* 103 (1940), 246.

continue to have—a hundred readers for every one reader of Graunt and Petty, made an elaborate demographical calculation. This was Sir Thomas Browne. Sir Thomas devoted the sixth chapter of the sixth book of *Pseudodoxia* to the vulgar opinion that the earth was slenderly peopled before the Flood.

This vulgar opinion Sir Thomas found to be very wide of the mark. Indeed, far from the earth being slenderly peopled, 'we shall rather admire how the earth contained its inhabitants, than doubt its inhabitation: and might conceive the deluge not simply penall, but in some way also necessary, as many have conceived of translations, if *Adam* had not sinned, and the race of man had remained upon earth immortal'. Indeed Sir Thomas estimates that by the seventh century of the world's history its population amounted to 1,347,368,420. He reaches this result in the following way:

Having thus declared how powerfully the length of lives conduced unto populosity of those times, it will yet be easier acknowledged if we descend to particularities, and consider how many in seven hundred years might descend from one man; wherein considering the length of their dayes, we may conceive the greatest number to have been alive together. And this that no reasonable spirit may contradict, we will declare with manifest disadvantage; for whereas the duration of the world unto the flood was about 1,600 years, we will make our compute in less than half that time. Nor will we begin with the first man, but allow the earth to be provided of women fit for marriage the second or third first centuries; and will only take as granted, that they might beget children at sixty, and at an hundred years have twenty, allowing for that number forty years. Nor will we herein single out *Methuselah*, or account from the longest livers, but make choice of the shortest of any we find recorded in the Text, excepting *Enoch*: who after he had lived as many years as there be days in the year was translated at 365. And thus from one stock of seven hundred years, multiplying still by twenty, we shall find the product to be one thousand, three hundred forty seven millions, three hundred sixty eight thousand, four hundred and twenty.

	1.	20.
	2.	400.
	3.	8,000.
	4.	160,000.
Century.	5.	3,200,000.
	6.	64,000,000.
	7.	1,280,000,000.
		<hr/> 1,347,368,420.

Simply as a sum, there are difficulties about this result. If our 20 are equal numbers of males and females, it is not 20 which should be multiplied by 20 but 10. If they are all males, then women are left out of the reckoning. But, perhaps, as the Text does not record the ages of women, Sir Thomas esteemed them as ephemerids, sufficiently plentiful however to provide a wife for every husband. But then I think he should have said that the 20 to be begotten between 60 and 100 were all males. Anyhow the sum must be wrong because *some* of the 64,000,000 short-lived women of the sixth century should survive into the seventh. Indeed Sir Thomas uses his data a trifle capriciously.

We must surely play a game according to the rules. We are to accept the

Text word for word as it stands. But, omitting Adam, whose age at his begetting of Cain is not recorded, and Noah, who seems to have reached middle age—500 years—before becoming a father, the reproductive habits of eight fathers are recorded. Two begat males at the age of 65, one at 70, one at 90, one at 105, one at 162, one at 182 and one at 187. When this primary business was over, they are all recorded to have begotten an unspecified number of sons and daughters. So, if we are to be faithful to the Text, a very much more complicated arithmetical problem presents itself. A male begets another male at an average age of about 100, he then begets males and females at an unspecified rate for say another 600 years, required the law of increase. The Text does *not* authorize Sir Thomas to start pre-diluvian breeding at 65 or to stop it at 100. His ‘manifest disadvantage’ is breaking the rules of the game.

Further, the Text does not entitle him to predicate of the other males the lengths of days and procreative exploits of the recorded eight.

All this, it may be said, is breaking a butterfly upon the wheel. Nobody now takes the statistics of the Authorized Version literally. The point is that Sir Thomas Browne *did*, but used them improperly. As Lord Chesterfield said to a Garter King at Arms of his day who had not followed the rules of heraldry, ‘You foolish man, you don’t know your own foolish business’.

Petty did not tackle pre-diluvian demography, but he did try his hand at an estimate of the world’s population after the flood, ‘To justify the *Scriptures* and all other good *Histories* concerning the *Number* of the People in Ancient Time’ (p. 465).

As Petty was not going to allow the population of ancient times to be greater than in the seventeenth century, but to make it increase regularly from the time of Noah’s Ark, common sense saved him from fantastic figures, but not from physiological difficulties. The rules of the game obliged him to start with eight landed from the Ark, so he thought it best to make them increase and multiply very fast indeed at first and progressively more slowly. At first he doubled the population every ten years, but by the birth of Christ has brought the period up to 1000 years. But doubling every ten years (in the first century from the Flood) leads one into difficulties.

We can allow the possibility of the four pairs emerged from the Ark producing 8 offspring in ten years and so becoming 16 in year 10, without too great difficulty. But ten years later they must number 32 and this *is* a difficulty. If the fecundity of the first settlers remains the same they will contribute 8 more children, giving us a population of 24, the balance of 8 must come from the four couples of children all of whom must be under 20, and this *is* a little difficult.

But at least we may say that there is nothing wholly fantastic in Petty’s procedure. Petty does belong to a different arithmetical world from that of Browne. Here we may leave purely speculative demography.

To estimate the people of an area without counting them, we must count

something which has a connexion with the number of the people. We may count the tax-payers, the houses, the burials, the christenings or the acreage under corn—all or any of these items vary with the number of people.

I wish to keep separate the discussions of Petty's and Graunt's statistical researches, but in the matter now to be examined Petty used some of Graunt's methods and results, so these must be considered.

Graunt used three methods of estimation. In the first place, he surmised that the number of child-bearing women in a community might be about double the number of annual births 'forasmuch as such women, one with another, have scarce more than one child in two years'. Then he surmised that families were twice as numerous as women of child-bearing age. His reasoning was that women between 16 and 76 might be twice as numerous as women between 16 and 40 or 20 and 44 (i.e. of child-bearing age), and he thought of a family as centred round a married couple. Finally, he thought that the average family would consist of eight persons, the husband and wife, three children and three servants or lodgers. So, starting with 12,000 christenings, which he thought a fair measure of annual births, he reaches 24,000 women of fertile age, then 48,000 families and lastly 384,000 persons.

It is quite certain that Graunt's estimate of an annual fertility rate of 500 per 1000 was an enormous overstatement. In London in 1851, the ratio of legitimate births to married women aged 15–45 was 251·8 per 1000. There is no reason to believe that nuptial fertility changed appreciably between 1660 and 1860. But an error of this kind would lead him to an understatement of families. Now, however, another error saves him. We cannot be so positive that eight to the family is a great overstatement as we can that the marital fertility was not 500 per 1000, but it is much higher than any nineteenth-century finding. Using *this* multiplier saves Graunt in this sense, that his quaint rule gives almost precisely the right answer for the population of London nearly 200 years after his time.

The legitimate births registered in London in 1851 were 75,097. This, according to Graunt's rule, is to be multiplied by 32. The result is 2,403,104. The enumerated population was 2,363,236; the conjecture is only 1·7% out. *Sic me servavit Apollo.*

Graunt's next method was experimental and very briefly described. He counted the numbers of families in certain parishes within the walls and found that '3 out of 11 Families per annum have died'. He then multiplies the burials for the year (13,000) by 11/3, and proceeds as before.

Finally, he took Newcourt's map of London and

guessed that in 100 Yards square there might be about 54 Families, supposing every House to be 20 Foot in the front: for on two sides of the said square there will be 100 Yards of Housing in each, and in the two other sides 80 each; in all 360 Yards: that is 54 Families in each square, of which there are 220 within the Walls, making in all 11880 Families within

the Walls. But forasmuch as there die within the Walls about 3200 per *Annum*, and in the whole 13,000, it follows that the Housing within the Walls is  $\frac{1}{4}$  part of the whole, and consequently, that there are 47,520 Families in and about *London*, which agrees well enough with all my former computations (p. 385).

These conjectures led Graunt to think that the rate of mortality in London was about 1 in 32. In his first essay on the growth of London (pp. 458–75) Petty bases himself upon that estimate, and in the series of papers (pp. 505–44) this remains the fundamental method, but Petty allows himself to modify the multiplier, not altogether without suspicion of bias. At a quite early stage he had satisfied himself that London was the largest city in the world and much larger than Paris. This is the kind of argument. For the three years 1682–84, the average of burials in London was 22,337 and for Paris 19,887. So if the rates of mortality were the same, London was larger than Paris.\* If the rate of mortality in Paris were higher than in London then the population of London must be larger still. According to Petty (*a*) a larger proportion of the Paris population died in hospital, (*b*) the mortality in hospital was heavier in Paris than in London. So it follows that the general death rate of Paris was higher.

That at *London* the *Hospitals* are better and more desirable than those of *Paris*, for that in the best at *Paris* there die 2 out of 15, whereas at *London* there die out of the worst scarce 2 of 16, and yet but a fiftieth part of the whole die out of the *Hospitals* at *London*, and  $\frac{2}{5}$  or 20 times that proportion die out of the *Paris Hospitals* which are of the same kind; that is to say, the number of those at *London* who chuse to lie sick in *Hospitals* rather than in their own Houses, are to the like People of *Paris* as one to twenty; which shows the greater Poverty or want of Means in the People of *Paris* than those of *London*. We infer from the premisses, viz. the dying scarce 2 of 16 out of the *London Hospitals*, and about 2 of 15 in the best of *Paris* (to say nothing of *l'hostel Dieu*) that either the *Physicians* and *Chirurgions* of *London* are better than those of *Paris*, or that the *Air* of *London* is more wholesome (p. 508).

These, however, are only logical deductions if the user of the hospitals in London and Paris is identical. If, as implied in the first part of the quotation, we think of hospitals in the sense which our elder contemporaries think of the old-fashioned poor law infirmaries, viz. as refuges for the sick poor, it would mean that in Paris more of the aged indigent died in institutions than in London and heavy mortality might well have nothing to do with the skill or lack of skill of the medical staff. If we think of hospitals in the modern sense, then heavy mortality might be a mere reflection of the resort to these hospitals of persons suffering from illnesses which needed special treatment. In any case, Petty can hardly have it both ways. In another essay (pp. 510–11) he contrasts the higher ratio of deaths to admissions at *l'hostel Dieu* of Paris with that of *la Charité*, argues that the excess in *l'hostel Dieu* is unnecessary and proceeds to calculate

\* It should be remembered that the London of Petty's calculations is the whole area within the Bills. The calculations of Graunt described above did not include Westminster or the six out-parishes of Surrey and Middlesex which were within the Bills: Islington, Lambeth, Stepney, Newington, Hackney, Redriff.

what the French nation would gain by saving this excess. But he has not inquired whether the patients of the two institutions were *in pari materia*.

Here is an historical problem which might be solved by those familiar with the literature of the period. Its discussion would not be relevant here. It is, however, only just to Petty to say that, unless conditions deteriorated seriously in the following century, his strictures on l'hostel Dieu were justified. In Franklin's work (*La Vie Privée d'autrefois. L'Hygiène* (Paris 1890), pp. 177 *et seq.*) an appalling account of this hospital from the pen of the eminent surgeon Tenon, printed in 1788, is quoted. Tenon's description of the routine of this great hospital compares, unfavourably, with the story of the wounded in the Mesopotamian campaign which horrified England in the war of 1914-18. He remarks, *inter alia*, 'on ne guérissent point de trépanés autrefois à l'Hôtel-Dieu, comme on n'en guérit pas encore aujourd'hui', and cites a court surgeon of the time of Louis XIV, i.e. a contemporary of Petty, to that effect. His account of the treatment of lying-in women is grotesquely horrible.

In another essay (pp. 533-6) Petty discusses methods of estimation more carefully than in his other papers.

He proposes to show that the population of London (within the Bills) in or about 1685 was approximately 696,000.

There are, he says, three methods: (1) From houses and families. (2) From an estimated death rate. (3) From the ratio of those who die of the plague to those who escape.

This last we may deal with at once. Petty asserts that Graunt had proved that one-fifth of the people died of the plague. But in 1665, 98,000 died of the plague; therefore the population was 490,000, and allowing an increase of one-third between 1665 and 1686 we reach 653,000.

Graunt could not have proved that one-fifth of the population died of the plague unless he knew what the population was, and he never claimed to have done so.

The other methods (which Graunt used) are rational.

To estimate houses, Petty used three methods. He says that in the Fire of 1666, 13,200 houses were burned and that deaths from these houses were one-fifth of total deaths, so he reckons the houses to have been 66,000. Then as burials in 1686 were to burials in 1666 as 4 to 3, he makes the houses of 1686, 88,000. He does not, however, say upon what basis the estimate of one-fifth of the deaths in 1666 stands.

Next, he gives an estimate of the houses in 1682 given him by those employed upon a map said to have been made in that year. This map has not been identified.

Lastly, he uses the return of hearths. In Dublin in 1685 the hearths were 29,325 and the houses 6400. In London the hearths were 388,000; so the houses on the Dublin ratio should be 87,000. In Bristol he says there were 5307 houses

and 16,752 hearths, which give 123,000 houses for London; the mean of the calculations is 105,000. The Hearth Office itself, he says, certified the number to be 105,315. He must now have a multiplier. He accepts Graunt's multiplier of 8 as valid for tradesmen's families, but allows for smaller families among the poor and larger among the rich, finally choosing 6. He then allows for double families in houses by adding 10,531 to his 105,315, and multiplying the sum by 6 has 695,076 for the population.

Petty's second way was from an estimated death rate.

Petty multiplies the average of the burials in 1684 and 1685 (23,212) by 30, which makes the population 696,360.

He now essays to prove that the death rate in *London* was 1 in 30. He uses four arguments, of which only one is strictly to the point, viz. Graunt's direct observation that three deaths occur annually in eleven families—which however involves the assumption of eight persons to the families observed. Two others are relevant, viz. observations, apparently direct, that in 'healthful places' the mortality is 1 in 50 and in nine country parishes 1 in 37. The fourth partly rests upon a statement which Graunt did *not* make, viz. that one of 20 children under 10 dies annually. This fictitious value Petty averages with the statement of a M. Auzout to the effect that the rate of mortality of adults in *Rome* is 1 in 40. It will be clear that Petty has proved nothing at all. What he has done is to make it unlikely that the rate of mortality was less than 1 in 30. That, perhaps, was enough. One has a certain sympathy with his round statement: 'Till I see another round number, grounded upon many observations, nearer than 30, I hope to have done pretty well in multiplying our Burials by 30 to find the number of the People.'

With this I may conclude the analysis of Petty's statistical work. It will, I think, soon be clear enough that it is not of the calibre of Graunt's. Yet I cannot take leave of it without something of an *ave*. Careless, happy-go-lucky, tendentious; yes, all that. But anybody who has felt the exhilaration, to which Francis Galton owned, in the doing of sums concerning biological problems, feels his heart warmed by the arithmetical knight errant who had so many statistical adventures.

(*To be continued*)