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Light and shadow: the status of Italian geology around 1807

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Abstract: The stratigraphical approach and geological mapping of William Smith in England and Georges Cuvier in France gave birth to modern geology. However, before 1815 neither used the word 'geology', a term first coined by Ulisse Aldrovandi in 1603. At the turn of the nineteenth century most leading geoscientists were based in France and Germany, but those in Britain were poised to take over the lead. After three centuries of dominance in science and geology, was Italian geology in decline? A review of the works of Italian geologists and the role these played in disseminating Italian geological research has been undertaken to examine this question. The French Revolution and the Napoleonic wars shocked the Italian states, disrupted the economic order and discontinued the progress of science. Nevertheless, from 1759 to 1859 over 40 classic papers in geology were published in Italy. Among them, Gian Battista Brocchi's *Conchiologia Fossile* is the most renowned for having inspired Charles Lyell's work. In the middle decades of the nineteenth century Italian geoscientists made up the majority of foreign members of both the French and English geological societies. The Italian Geological Society was not formed until 1881. This was largely due to the earlier political fragmentation of Italy into many small states.

Two different paths can be followed to assess the state of a discipline in a particular country or cultural area[1] at a given time. The first requires analysis of facts, documents and historiographical sources. The second focuses on one or several masterpieces of the discipline, possibly comparing them with equivalent works in other areas or countries. The aim of this paper, therefore, is to explore both paths looking for consistency and reliability of the results obtained. The work of excellence selected to represent the status of geological research in the Italian cultural area at the beginning of the nineteenth century is Gian Battista Brocchi's (1772–1826) *Conchiologia Fossile Subapennina* (1814). This work is not only a masterpiece, but it is also particularly relevant since it contains a famous section on the history of conchology – perhaps the first ever written in such detail – which coincides with the beginnings of modern history in palaeontology and, to a certain extent, geology.

After a detailed chronological review of the literature, Brocchi (1814) was able to make a clear assessment of the status of geology in Italy at the end of the eighteenth century:

> in particular, the Tuscan savants contributed to the advancement of natural history, in particular fossil conchology [palaeontology]: a study which deserves to be called the base of geology.
>
> (Brocchi 1814, p. LXVII)

At the same time, he also identified two peculiarly Italian flaws: self-criticism and xenophilia or an excessive compliance to foreign ideas and fashion (Brocchi 1814, LXVII). Brocchi's general conclusion was:

> My aim was to make a point about the history of Italian science that was not very well known. A wealth of writings came out during three centuries; they did not neglect a single branch of natural science. Since it is not convenient to claim the glory of past merits, I will quote a series of classic authors from the recent past or who are still alive (Olivi, Cavolini, Poli, Renieri, Marsili, Donati, Iano Planco, Breislak, Spallanzani, Targioni, Santi, Savi, Tenore, Viviani, Bertoloni, Brignole). Yet, there are still many gaps.
>
> (Brocchi 1814, pp. LXXIX–LXXX)

This well-documented, proud evaluation that Italian science had held a prominent position is not eulogistic, but shows a realistic picture of Italian geology and an awareness that, however successful they had been in the past, even more could be done.

Charles Lyell (1797–1875) gave full credit to Brocchi's work, directly translating or summarizing most of Brocchi's history of geology in his own history section in the first volume of his *Principles of Geology* (1830–1833). When discussing the status of geology and the role of Italian research in

[1] The term 'cultural area' is used in preference to the country name, since Italy and Germany as we know them today did not exist until the late nineteenth century.

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furthering its progress during the previous three centuries, Lyell says:

> It was not till the earlier part of the sixteenth century that geological phenomena began to attract the attention of the Christian nations. At that period a very animated controversy sprung up in Italy, concerning the true nature and origin of marine shells, and other organized fossils, found abundantly in the strata of the peninsula.
>
> (Lyell 1830, p. 23)

This work (Nicholas Steno's *De Solido* (1669)) attests to the priority of the Italian school in geological research (Lyell 1830, pp. 27–28):

> We return with pleasure to the geologists of Italy, who preceded, as we before saw, the naturalists of other countries in their investigations into the ancient history of the earth, and who still maintained a decided pre-eminence [during the eighteenth century].
>
> (Lyell 1830, p. 41)

MacCartney (1976), in a critical analysis of the two histories – Brocchi's and Lyell's – has argued that both have interpreted the sources based on their own geological paradigm. Although commonly true, such an attitude does not alter the validity of Brocchi's dataset, which has never been questioned by any scientist or historian, and certainly not by Lyell who had been able to check Brocchi's data and statements during his repeated visits to Italy.

But only 70 years later things had changed quite drastically, as demonstrated at the centenary celebration of the Geological Society of London in 1907. Sir Archibald Geikie (1835–1924), then President of both the Geological and the Royal Societies, gave a presidential address. He had chosen for his subject 'The State of Geology at the Time of the Foundation of the Geological Society'. In his speech (Geikie 1909), the Italian legacy and its early dominance in geology, so strongly asserted by Lyell, was almost forgotten despite Geikie being a good friend of the Italian geologist Giovanni Capellini (1833–1922) whose handwritten dedication to Capellini can be seen in a copy of Geikie's *Text-book of Geology* (1903)[2] (Fig. 1). The only Italian scientist quoted in Geikie's speech was Scipione Breislak (1748–1826) (Geikie 1909, p. 113, footnote 120). Geikie was an authority on the history of geology and had written a classic, if much-discussed, book on the subject (Geikie 1905) and reviewed others, making his omission even more striking.[3] His speech is notable for its British bias – this 'branch of science is not much older than the Geological Society itself' (Geikie 1909, p. 107) – the recognition of the French and Scottish schools, and the criticism of Werner's geognosy and Neptunism, and yet reference to Italian geology is almost completely absent. How can such a rapid change in the historiography of geology regarding the role of the Italian community be explained?

The obliteration of Italy's leading role in the history of geology by the end of the nineteenth century has both an 'external' and 'internal' rationale. The former is related to the changing approaches to geological sciences in the major European countries, while the latter can be explained by Italian individualism and provincialism, no longer compatible with the changing political and economical conditions in Europe. After three centuries of Italian dominance, the centres of development in the geosciences had moved to Germany and France by the end of the eighteenth century, and to Britain by the beginning of the nineteenth century (Ellenberger 1988, 1994; Oldroyd 1996; Vai & Cavazza 2003; Rudwick 2005; Vai & Caldwell 2006). In addition, the new geology of the nineteenth century, based on palaeontological stratigraphy, was developed mainly in France and Britain. The coincidence of these cultural areas with two long-standing and powerful nations favoured the awareness and popularization of a *national science* that could not be felt in nations such as Italy and Germany, which did not yet exist. At the same time, the international, interdisciplinary and broadly cultural approach to geoscience, culminating in a proliferation of theories of the Earth, came to an end.

After the original and pioneering historicist work done by Brocchi (1814), no new studies on the history of geology in Italy have been undertaken, neither by scientists nor historians, except perhaps for some research on Leonardo da Vinci and a few others.[4] Furthermore, recurrent articles on Italian primacy in geology by leading Italian geologists[5] mostly echoed Brocchi's and Lyell's histories, rather than presenting original historiographical research. Only in the last few decades has there been any attempt to fill this historiographical gap, but these studies mainly cover the golden age from the early sixteenth to late eighteenth centuries (Morello 1979, 1998; Vaccari 1993, 2003*a*; Vaccari & Curi 2003; Vai & Caldwell 2006). A

[2] This is now stored in the historical library of the Capellini Museum in Bologna (A, b, 91).

[3] See, also Vaccari 1993, pp. 5–6 and 16.

[4] See, for example, Baratta (1903), Gortani (1931, 1952, 1963) and Vai (1995*a*).

[5] For example, Bianconi (1862), Capellini (1897), Gemmellaro (1862), Meneghini (1866), Pilla (1840) and Stoppani (1862, 1881).

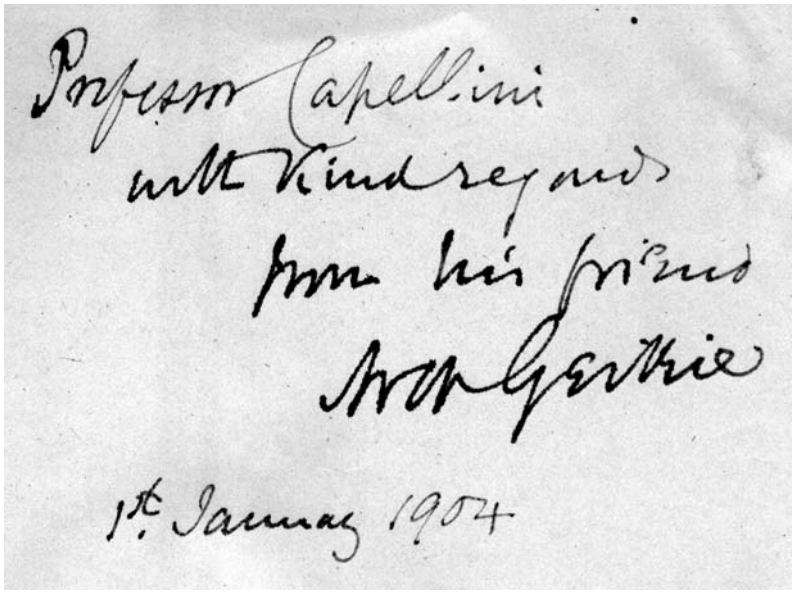

Fig. 1. Geikie's dedication to Capellini.

comprehensive picture of the scientific and cultural status of geology in Italy in the decades around the turn of the eighteenth to the nineteenth century is still not available.

The result of such oblivion for more than a century was silence or, at best, acceptance and propagation of a notion that, after a glorious past, Italian science (including geology) had suffered a decline since the eighteenth century (e.g. Cavazza 1990, 2002). But was this really the case for Italian geology in the crucial decades before and after the founding of the Geological Society in 1807? Factual evidence about the status of geological studies, results and publications in a broad time interval centred on the Geological Society's birth date will be discussed first. The results of this discussion will then be cross-checked, as a case history, by examining how far Lyell's *Principles* (1830–1833) was influenced by Brocchi's *Conchiologia* (1814).

A decline in geology or managerial delay during the Napoleonic turmoil?

The term 'geology' was first used in its modern sense in Bologna in 1603 by Ulisse Aldrovandi (1522–1605) (Vai 2003*a*; Vai & Cavazza 2006). He defined the new discipline as 'la Giologia ovvero de fossilibus' ('Geology, or about what is dug up from the Earth'). In particular, it made reference to his large scientific collection of rocks, fossil organisms and minerals that were to be displayed in a dedicated room bearing this name within his museum. It may be of interest and rather surprising to note here the remarkably similar quotation adopted for the Geological Society's logo; 'quicquid sub Terra est' ('whatever is under the Earth'). Thus, the circular recurrence of both concept and terminology, starting with Aldrovandi in 1603 and ending with the Geological Society in 1807, was closed. During those two centuries, terms such as lithology, petrology, oryctology and geognosy were used more commonly than geology and, when used, geology had several different meanings (Ellenberger 1994, pp. 250–251; Vai 2003*a*, pp. 73–74). In fact, it took almost two centuries of scattered use for the term geology to become accepted after Aldrovandi had introduced it, important examples being Arduino (1759–1760, 1774, p. 232), De Luc (1778), Targioni-Tozzetti (1779), De Saussure (1779–1796), Dolomieu (1794, p. 259) and Hutton (1795).

It is well known that Georges Cuvier's (1769–1832) and William Smith's (1769–1835) pioneering work in stratigraphy and geological mapping around the turn of the nineteenth century gave birth to modern geology. However, before 1815 neither used the term geology. Most of the Founding Fathers of the Geological Society would also not have called themselves 'geologists' before the Society was founded, despite having undertaken many geological activities (Lewis 2009), and its first President, George Bellas Greenough

(1778–1855), was, according to Geikie (1909, p. 112), 'a shrewd pupil of Werner' (but see also Kölbl-Ebert 2009). Geognosy – a knowledge of the Earth – had originated with Abraham Gottlob Werner (1749–1817) at the Freiberg Mining Academy in Germany in the middle of the eighteenth century (Guntau 2009) and its use soon spread all over Europe, including Italy (Morello 1983; Ciancio 1995; Vaccari 2000). Geognosy defined a science based on the recognition of the order, position and relation of the layers forming the Earth. On this basis, geognosists began to draw cross-sections that could represent the inclination of strata (geometry) in deformed areas, but which did not provide a reasonable lateral correlation of the same strata in order to understand their regional setting (structure). Furthermore, for geognosists, fossils were only lithic elements of the rocks and of no great consequence. Geologists, on the other hand, began quite early on to appreciate the time value of fossils, which were recognized as organisms that were independent from the encasing rock. Once this paradigm was established by Smith in 1799 (Smith 1815), Cuvier & Brongniart (1811) and Brocchi (1814), modern geology began its race. It is interesting to note that Cuvier & Brongniart when printing their *geological* map (1811) still used the conventional term *geognostical*, reflecting a still non-critical acceptance of the terminology received during their training. Smith, on the other hand, who had a less formal education, felt free to use the term 'geological' for his map (Smith 1815). Brocchi (1814) was the most critical and rigorous insofar as he desired to 'provide this work with a geognostical map' (Brocchi 1814, p. 56), while establishing his stratigraphical approach 'geologically speaking' (Brocchi 1814, p. 11; Vai 1995*b*, pp. 66–68). (See Table 1.)

But what about the status of Italian geology at this time? If the answer was to be based on the comparative founding dates of national geological societies, the Società Geologica Italiana would not occupy pole position; indeed, it comes behind most of the other European countries (Table 2). Obviously, there is not a direct causal link between the health of a geocommunity in a given country and the founding of its geological society. However, each late arrival in setting up basic geological institutions (such as societies, surveys, museums) has to be carefully assessed as to whether it indicates external constraints or the internal lack of potential. Why, then, did the Italian Geological Society appear 74 years after the founding of the Geological Society in London? Was the alleged Italian scientific and geological decline – suspected since Geikie's time – the reason for the delay? Was there really a true decline?

To answer these questions it is necessary to review the standard and number of naturalists active in 'geology' (geoscientists hereafter) during the eighteenth century, and to have some familiarity with their work – the number of publications they wrote and the questions they raised – as well as having an idea of how many of them took foreign correspondents into the field in Italy, and the ideas they exchanged and exported.

When analysed in this way, a true scientific decline during the period preceding the French Revolution, although commonly accepted and uncritically quoted, is difficult to prove – at least for geology. Works by Marsili, Vallisneri, Moro, Monti, Arduino, Targioni Tozzetti, Donati, Spallanzani and Soldani (Table 1), to name but a few, seem to testify to the contrary, as will be shown. In spite of recent attempts to revive the relevance and works of great Italian scientists,[6] what is still missing is a greater awareness of the wider body of knowledge regarding other Italian geoscientists, their writings and the role they played in the European forum at the time of the 'Italian tours' undertaken by many foreign scientists in the eighteenth century (Vaccari 2007; Wyse Jackson 2007).

A careful survey shows that within an interval of six decades around 1807, from 1777 to 1837, Italian geoscientists actively producing scientific papers exceeded 200 in number (Table 3). Half of these were devoted to the study of volcanoes and/or earthquakes, events of great interest to geoscientists in the second half of the eighteenth century, despite the dominance of Neptunism as a geological model. The works of many of these authors considerably influenced the views and works of the European and North American scientists undertaking the Italian tour. A typical example is the influence Giuseppe Recupero (1720–1778) had on Sir William Hamilton's (1730–1803) views on volcanology (Rudwick 2005).

In the middle of this period of activity came the French Revolution and the Napoleonic wars (1789–1814), which shocked the Italian states and disrupted their social and economic order, severely hampering and even halting, for a time, progress in science (Vai 2003*b*). However, there were local advantages brought by the Napoleonic reforms, such as reproducing French institutions strongly

[6] See, for example, publications on Aldrovandi (Vai & Cavazza 2006), Colonna and Scilla (Morello 2006*a*, *b*), Steno, Kircher and Marsili (Vaccari 2003*a*; Vai 2004*b*, 2006; Yamada 2006), Arduino (Vaccari 2006), Spallanzani (Spallanzani 1994; Vaccari 1998) and Fortis (Ciancio 1995).

Table 1. *A chronograph of leading natural historians from about 1200 to 1800, arranged by cultural and linguistic areas: Italian, German, French and British. Most of the prominent natural historians at the beginning of the nineteenth century were based in France and Germany, but those in Great Britain were poised to take over the lead in a few years time*

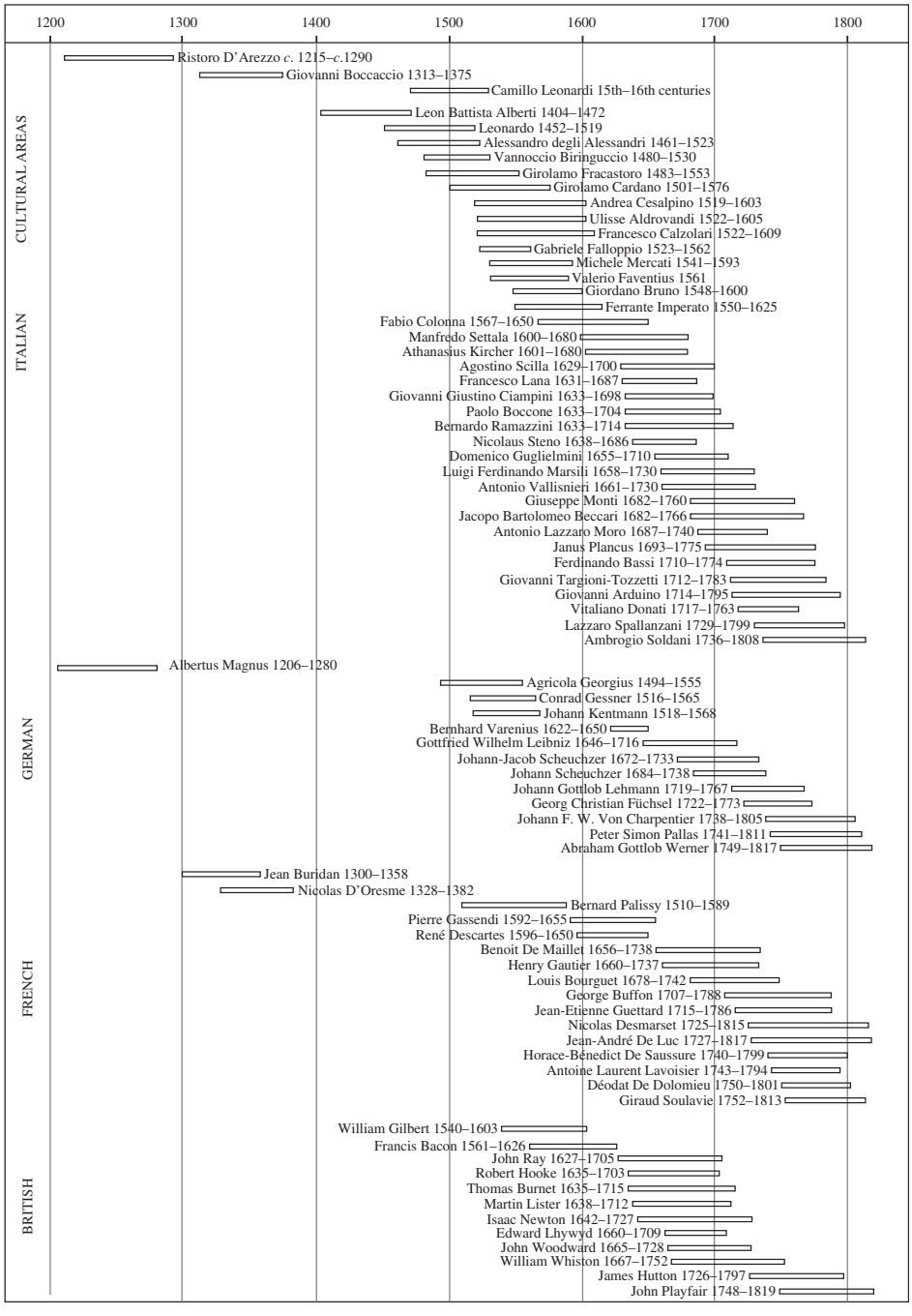

Table 2. *Foundation dates of national geological societies*

England (London)	1807
France	1830
Scotland (Edinburgh)	1834
Germany	1848
Hungary	1848
Sweden	1871
Belgium	1874
Italy	**1881**
Switzerland	1882
America	1888
Denmark	1893
Japan	1893
South Africa	1895
Norway	1905
Austria	1907
The Netherlands	1912
Spain	1985

related to geomineralogical studies in Milan, which became the capital city of the new Napoleonic Repubblica Cisalpina and later the Kingdom of northern Italy. The Istituto Lombardo delle Scienze (1797–1803) and the Consiglio delle Miniere del Regno Italico (1808) were two such institutes (Vaccari 2003*b*). This happened, however, at the expense of the Istituto delle Scienze di Bologna, which had had an excellent reputation for geology since 1711 (Tega 1986). In general, the advantages were too localized and of too short a duration – they did not last beyond the Restoration of 1815 – to outweigh the disadvantages. In some regions, such as the Church States (from Rome to Bologna), Tuscany and southern Italy, the previous scientific and academic structures were damaged or destroyed when, for example, collections were despoiled. These had to be restored, where possible, during a time of contrasts between revolution and restoration, reform and conservation.

A major and long-lasting impact of all this upheaval was on the economy. From having been a rich industrial and trading area, the Italian states were forced to become agricultural satellite areas of France, which gradually induced an increasing state of poverty (Vai 2003*b*, pp. 247–248). The turmoil also weakened the position of research centres such as those in Bologna, Florence, Padua and Siena that had previously been leaders in geology and natural sciences, while the role of Milan, Turin, Genoa, Rome, Naples and especially Pisa, which became the principal geological school of Italy in the third and fourth decades of the nineteenth century, was reinforced. Although there were some benefits, seen in the administrative, technical and political modernization introduced by the Napoleonic reforms, they took decades to become effective. The earlier shift of the scientific lingua franca from Latin to French and later to English had already caused the number of leading Italian scientists with an international visibility to decrease, and this trend was exacerbated by the reforms and the turmoil in the early decades of the nineteenth century. The quite large number of geoscientists of the eighteenth century was facing a gradual contraction.

Alongside the picture of political and economic instability, it may be useful to briefly review the most relevant works of Italian geoscientists printed in the century encompassing the origin of the Geological Society in 1807 and the Napoleonic turmoil in order to have a broader field for unravelling a trend in science development. During the century from 1759 to 1859 more than 40 ‘classic’ papers on geology were published in Italy, with a dominance of authors born in the eighteenth century (Table 4).

The relevance and priority given by Arduino to both chronostratigraphy and lithostratigraphy is well recognized (Vaccari 1993, 2006; Vai 2007*a*). Nevertheless, his maps and geological cross-sections – among the first ever made – as well as his discovery of contact metamorphism in 1782, may come as a surprise to many. As shown in Table 4, there were several other geoscientists active in the Venetian region,[7] reflecting the strong tradition of Padua University and its school of geology. These geologists were well known in Britain and in France, even before Brocchi’s works were introduced, and their interests were wide ranging at both the academic and consultant level. Most of them (Arduino, Fortis, Marzari-Pencati, Da Rio) focused on one important area of research, namely the interfingering, and thus interaction, between sedimentary and volcanic strata, and other igneous bodies that are well exposed in the Berici and Euganean hills near Padua. Their recognition of these effects explains why Neptunism and Plutonism are rarely observed in the discussions and works of the Italian geoscientists, and if only these works had been more widely disseminated at the time it might have contributed to solving, or at least mitigating, the largely speculative controversy about the origins of basalt. As it was, this remained a controversial topic for another 100 years. In addition, these geologists were able to provide the first evidence of what we now know to be post-Triassic granitoid intrusion, thereby strengthening the evidence for non-Primitive granites provided by Arduino in 1782. Before this work, granites had

[7] The region a geologist came from is generally indicated by the location given in the titles of their papers.

Table 3. *List of Italian geoscientists active between 1777 and 1837, indicating the main subject or region they worked on*

1	Acerbi	Venetian area	1829*
	Alessi G.	Sicily	1820s*
	Alfano	Naples Kingdom	1823*
	Algarotti M. A.	Venetian	1809–1823*
	Allioni Carlo	Turin	(1728–1804)
	Alvino F.	Vesuvius	1830s*
	Amoretti Carlo	Lombardy	(1741–1816)
	Ancona (d') G.	Calabria	1791*
	Aracri G.	Calabria	1810*
10	Arduino Giovanni	Venetian	(1714–1795)
	Ascoli (d')	Earthquakes	1806*
	Attumonelli M.	Vesuvius	1779*
	Augusti M.	Earthquakes	1789*, 1780*
	Baccio A.	Sicily	1793*
	Balbo P.	Piedmont	1784–1785*
	Baldracco C.	Liguria	1840s*
	Balsamo Crivelli G.	Lombardy & Italy	(1800–1874)
	Barba A.	Vesuvius	1794*
	Barelli V.	Emilia	1827*
20	Bartalini B.	Tuscany	1776, 1781*
	Barzellotti G.	Tuscany	1813*
	Battini D.	Tuscany	1793*
	Beffa C.	Sicily	1828*
	Bellani A.	Vesuvius	1835*
	Bellenghi A.	Sardinia	1832*
	Bernardino F.	Vesuvius	1794*
	Bertoloni Antonio	Bologna	(1775–1869)
	Bonfiglioli Malvezzi A.	Bologna	1777*
	Bonvicino	Turin	1780s–1800s*
30	Borson S.	Turin	1810s–1830s*
	Bottis (de) G.	Naples volcan.	1761*
	Breislak Scipione	Naples Kd	(1748–1826)
	Brocchi Giambattista	Venetian	(1772–1826)
	Bruno G. D.	Turin	1836*
	Calindri G.	Umbria & Marche	1829*
	Camilli S.	Latium	1833*
	Capocci E.	Naples	1835, 1837*
	Cappello A.	Latium	1820s*
	Carena A. P.	Piedmont	1760–1761*
40	Carpi P.	Latium	1829*
	Catullo Tommaso Antonio	Venetian	(1782–1869)
	Cava (la) P.	Vesuvius	1820*
	Ceva Grimaldi G.	Naples K. dom	1821*
	Chiavetta B.	Etna	1809*
	Ciofi A.	Vesuvius	1794*
	Colaci (de) O.	Earthquakes	1783*
	Collegno (di) Giacinto	Turin	(1793–1856)
	Collini C. A.		1776*
	Colosimo V.	Earthquakes	1832*
50	Consigliere (di) C.	Vesuvius	1818*
	Corrao A.	Earthquakes	1783*
	Cortesi G.	Emilia	1809*
	Covelli Nicola	Naples	(1790–1829)
	Cristofori (de) I.	Tuscany	1832*
	Delfico O.	Apennines	1794*
	Donati E.	Vesuvius	1831*
	Donato G.	Earthquakes	1832*
	Dondi Orologio A. Carlo	Venetian	1780s*
	Fantonetti G. D.	Lombardy	1836*

(*Continued*)

Table 3. *Continued*

60	Fasano	Calabria	1788*
	Ferrara M.	Vesuvius	1794*
	Filippi (de) F.	Lombardy	1830s*
	Fortis Alberto	Venetian	(1741–1803)
	Fossombroni V.	Tuscany	1789*
	Galani P.	Earthquakes	1783*
	Galiani F.	Vesuvius	1770s*
	Gallo C. D.	Earthquakes	1783*
	Gallo M.	Vesuvius	1835*
	Galvani C.	Bologna	1780*
70	Gargiolli G.	Tuscany	1837*
	Gemmellaro Carlo	Sicily	(1787–1866)
	Gennaro (di) B. A.	Vesuvius	1779*
	Giannelli B.	Vesuvius	1779*
	Gioeni G.	Vesuvius	1790–1793*
	Gismondi C.	Latium	1817*
	Giuli G.	Tuscany	1835*
	Giusti D. G.	Etna	1819*
	Giustiniani L.	Naples volcanoes	1817*
	Gottardi G.	Emilia	1813*
80	Granata L.	Naples Kingdom	1831*
	Grimaldi F.	Earthquakes	1784*
	Grimaldi L.	Earthquakes	1835*
	Guarini G.	Vesuvius	1830s*
	Guerrazzi	Tuscany	1810s–1830s*
	Guidoni G.	Liguria	1820s–1830s*
	Gusta F.	Earthquakes	1783*
	Inghirami G.	Tuscany	1820s*
	Interlandi	Sicily	1830s*
	Ippolito di Catanzaro	Earthquakes	1783*
90	Jorio (di) A.	Naples	1820*
	Lamarmora A.	Piedmont & Sardinia	1810s–1830s*
	Lancellotti J.	Naples	1812*
	Lanzetta A.	Naples	1796*
	Lavaggiorosso S.	Liguria	1814*
	Lavini G.	Turin	1835*
	Lippi C.	Vesuvius	1816*
	Magalotti L.	Vesuvius	1779*
	Maironi da Ponte Giovanni	Lombardy	(1748–1833)
	Malacarne C. G.	Venetian	1818, 1821*
100	Maraschini P.	Venetian	1810s–1820s*
	Maravigna C.	Etna	1800s–1830s*
	Mascagni P.	Tuscany	1779*
	Mazza L.	Earthquakes	1832*
	Mecatti G. M.	Vesuvius	1777*
	Menabuoni G.	Tuscany	1796*
	Milano M.	Naples Kingdom	1820*
	Minasi G.	Earthquakes	1785*
	Minervino S. C.	Vesuvius	1779, 1794*
	Mirone G.	Earthquakes & Etna	1786, 1787*
110	Monticelli Teodoro	Naples	(1759–1845)
	Mojon G.	Liguria	1806*
	Mongiardini G. A.	Liguria	1809, 1814*
	Morichini Domenico	Latium	(1773–1836)
	Morozzo (de) C. L.	Piedmont	1780s–1790s*
	Napione Galleani G. F.	Piedmont	1780s–1790s*
	Negroni O.	Vesuvius	1779*
	Nesti Filippo	Tuscany	(1780–1847)
	Niccolini A.	Naples	1829*
	Nobili (de) G.	Vesuvius	1822*

(*Continued*)

Table 3. *Continued*

120	Olivi G. B.	Venetian	(1769–1795)
	Onofrio (d') M. A.	Vesuvius	1790s*
	Ortolani G. E.	Sicily	1800s–1810s*
	Pacchi D.	Tuscany	1785*
	Palatino L.	Naples	1826*
	Pareto Lorenzo	Liguria	1830s*
	Pasini L.	Venetian	1820s–1830s*
	Passerini R.	Tuscany	1830*
	Perez Naro P.	Tuscany	1830s*
	Petagna L.	Calabria	1827*
130	Pianciani G. B.	Latium	1817*
	Piccoli Gregorio	Venetian	(1680–1755)
	Pilla Leopoldo	Volcanoes & Calabria	(1805–1848)
	Pini Ermenegildo	Milan	(1739–1825)
	Piombanti C.	Tuscany	1779*
	Picaro A.	Vesuvius	1794*
	Porta L.	Tuscany	1833*
	Procaccini Ricci V.	Volcanoes	1810s–1820s*
	Quattromani G.	Naples Kingdom	1827*
	Ragazzoni B.	Lombardy	1820s–1830s*
140	Ranzani Camillo	Bologna	(1775–1841)
	Re (del) G.	Naples Kingdom	1830*
	Reale S.	Piedmont	1788–1789*
	Recupero Giuseppe	Volcanoes	(1720–1778)
	Repetti E.	Tuscany	1830s*
	Ricca M.	Tuscany	1810*
	Ricci G.	Naples	1821*
	Riccomanni L.	Rome	1782*
	Ridolfi C.	Tuscany	1834*
	Rio (da) Nicolò	Venetian	(1765–1845)
150	Riso (de) B.	Calabria	1810*
	Risso A.	Alps	1810s–1820s*
	Robilant (di) Spirito B.	Turin	(1724–1801)
	Romanelli D.	Naples	1817*
	Sacco G.	Vesuvius	1794*
	Salvadori G. B.	Vesuvius	1823*
	Sanmartino d. Motta	Turin	1784–1785*
	S. Quintino (di) G.	Tuscany	1825*
	Sarconi M.	Earthquakes	1784*
	Sasso A.	Liguria	1827*
160	Savi Paolo	Pisa	1820s–1830s*
	Scacchi Angelo	Naples	1830s*
	Sciciliano A.	Etna	1831*
	Scinà D.	Sicily	1810s–1830s*
	Scortegagna F. O.	Venetian	1820s–1830s*
	Scotti E.	Vesuvius	1794, 1804*
	Serrao E.	Earthquakes	1785*
	Serristori L.	Tuscany	1818*
	Sirugo	Sicily	1835, 1837*
	Sismonda Angelo	Turin	(1807–1878)
170	Sobrero A.	Turin	1835*
	Soldani Ambrogio	Siena	(1736–1808)
	Spadoni P.	Bologna	1793*
	Spallanzani Lazzaro	Pavia	(1729–1799)
	Stoppa G.	Vesuvius	1806*
	Targioni Tozzetti Giovanni	Tuscany	(1712–1783)
	Targioni Tozzetti Ottaviano	Tuscany	1823*
	Tata D.	Vesuvius	1779*
	Tenore M.	Naples	1830s*
	Terzi P. B.	Venetian	1791*

(*Continued*)

Table 3. *Continued*

180	Testa D.	Venetian	1793*
	Tomasi (de) D.	Vesuvius	1794*
	Tondi Matteo	Naples	(1762–1835)
	Torcia M.	Earthquakes	1783*
	Torre (della) P. M.	Vesuvius	1780s–1800s*
	Tramontani L.	Tuscany	1800*
	Turriani	Earthquakes	1784*
	Vagliasindi P.	Etna	1833*
	Vagnone	Piedmont	1816*
	Valenziani M.	Vesuvius	1783*
190	Vasco	Turin	1790–1791*
	Vassalli Eandi	Turin	1805–1808*
	Verri V.	Milan	1830*
	Vetrani A.	Vesuvius	1780*
	Viscardi F.	Vesuvius	1794*
	Vivenzio Giovanni	Earthquakes	(174?–1819)
	Viviani V.	Liguria	1800s, 1814*
	Volta Alessandro	Milan	1784*
	Volta Giovanni S.	Venetian	1780s–1790s*
	Zorda G.	Vesuvius	1806, 1810*
200	Zuccaro A. M.	Earthquakes	1833*
	Zupo N.	Earthquakes	1784*

*Denotes date(s) of publications listed in the *Bibliographie Géologique et Paléontologique d'Italie* (Anon. 1881).

always been considered Primitive in age. An empirical and balanced approach recognizing the action of both fire and water in developing geological processes is also observed in the regional geomorphological and lithostratigraphical monographs of the Tuscan school (e.g. Targioni-Tozzetti, Giorgio Santi). The number of lithostratigraphical names introduced at this time and still used today in the geological literature is remarkably high (Vai 2007*a*).

Many of the works listed in Table 4 are among the first palaeontological and zoological monographs ever written on these subjects in the world. They were the result of the pioneering efforts made by the Bologna school of geology to assemble the first specialized palaeontological and micropalaeontological collections in the Istituto delle Scienze di Bologna in the first half of the eighteenth century (Gortani 1931, 1963; Sarti 1988; Vai & Cavazza 2006, pp. 55–60). These works are also ground-breaking for the early taxonomy and chronostratigraphy they contain (Arduino, Spallanzani, Soldani, Brocchi). As an example, one can quote Volta who, in 1796, was the first to make a complete taxonomic study of the famous Bolca fish fauna of the early Eocene that was to inspire Louis Agassiz's (1807–1873) later fossil fish classification. Innovative research in the field of mineral resources was also carried out by Targioni Tozzetti, Arduino, Di Robilant and Matteo Tondi in the second half of eighteenth century and continued until the beginning of the nineteenth (Vaccari 2003*b*, pp. 265–266). Of major importance were the first surveys of historical volcanic eruptions and earthquakes that were accompanied by geological mapping of these areas (Morello 1998). In addition, the Italian role (Spallanzani, Brocchi, Scarabelli) in developing the prehistorical archaeology and the population of early humans should be noted (Pacciarelli & Vai 1995; Franceschelli & Marabini 2006).

Many of the research highlights of the Italian geoscience community a few decades later, presented at the time of the Congressi degli Scienziati Italiani (1839–1875), have been recorded by Morello (1983). She particularly underlined the importance of the early geological mapping of Italy, which required updated stratigraphic and regional research, accompanied by an agreed set of criteria for the 'semiography' of geological maps and the setting up of a national commission for geological and mineralogical nomenclature by Angelo Sismonda (1807–1878) (Morello 1983, pp. 71–72). The legacy of the Bologna school – original fieldwork and systematic geological mapping of the Apennines – can be seen in the excellent relations that developed between the Museo di Storia Naturale in Bologna and the Muséum in Paris, through the likes of the Reverendo Camillo Ranzani (1775–1841) and Georges Cuvier. Ranzani was Professor of Natural History at Bologna University. Cuvier met him in Bologna in 1810 and was so impressed by the Bologna vertebrate collections that he invited Ranzani to Paris where he stayed for two years, improving comparison

Table 4. *'Classic' Italian papers on geology printed in the century between 1759 and 1859*

Author	Title and date of publication	Highlights
Giovanni Arduino (1714–1795)	1759–1760, *Due lettere del sig. Giovanni Arduino sopra varie sue osservazioni naturali al Cavalier Antonio Vallisnieri* 1769, *Alcune osservazioni Orittologiche fatte nei monti del Vicentino* 1774, *Saggio Fisico-Mineralogico di Lithogonia e Orognosia*	Foundation of stratigraphic chronology (chronostratigraphy and lithostratigraphy); discovery of contact metamorphism (1782); early statement on Actualism; mining maps, proto-geological maps and geological cross-sections among the first ever made; ancient volcanic rock interbedded within marine sedimentary strata
Jacopo Odoardi	1761, *Dei corpi marini che nel Feltrese distretto si trovano* plus French (1762) edn	Major climatic changes and polar shift used to explain marine ingressions; angular unconformity
Giovanni Targioni-Tozzetti (1712–1783)	1768–1779, *Relazione di alcuni viaggi fatti in diverse parti della Toscana*, 2nd edn plus German (1787) and French (1792) reduced edns 1779, *Dei Monti ignivomi della Toscana e del Vesuvio*	Large geomorphological and lithostratigraphical monograph with balanced empirical approach supporting action of both fire and water in geological processes
Giuseppe Recupero (1720–1778)	1755, *Discorso storico sopra l'aque vomitate dal Mongibello e i suoi ultimi fuochi avvenuti nel mese il marzo del corrente anno MDCCLV* 1815, *Storia naturale e generale dell'Etna*	Survey of the 1755 Etna eruption in the Valle del Bove including lahars. He guided several foreign scientists and travellers to visit the Etna volcano
Lazzaro Spallanzani (1729–1799)	1784, *Osservazioni e esperienze da me fatte l'anno 1784 nella laguna di Chioggia e mare vicino* 1792–1797, *Viaggi nelle Due Sicilie e in alcune parti dell'Appennino*, plus French (1795–1797) and English (1798) edns 1797, *Sur les Salses du Modénais*	Foundation of volcanology, water–melt interaction, geochemistry and experimental geology; relation of fossil to living molluscs; physiology of sponges
Spirito Benedetto Nicolis di Robilant (1724–1801)	1786, *Essai Géographique suivi d'une Topographie souterraine, minéralogique*	Inventory of mines and mineral resources
Ambrogio Soldani (1736–1808)	1780, *Saggio orittografico* 1789–1798, *Testaceographia ac Zoophytographia parva et microscopica*	Taxonomy of recent and fossil foraminifera; different species at different depths; pioneering remarks on meteorites
Giovanni Vivenzio 174?–1819	1788, *Istoria de' tremuoti in generale, ed in particolare quelli accaduti nella provincia della Calabria ulteriore e nella città di Messina nell'anno 1783*	Early seismology and seismometers

(*Continued*)

Table 4. *Continued*

Author	Title and date of publication	Highlights
Carlo Ermenegildo Pini (1739–1825)	1790, *Saggio di una nuova teoria della terra* 1790–1792, *Sulle rivoluzioni del globo terrestre provenienti dall'azione dell'acque: memoria geologica* 1810, *Descrizione ed uso di uno stratimetro*	One of the many diluvian Earth's theories. New tools for assessing the amount of mineral resources; scientist-traveller
Giovanni Serafino Volta (2nd Part of 18th century)	1796*, Ittiologia Veronese del Museo Bozziano*	Fossil fishes from Monte Bolca
Giovanni Battista Alberto Fortis (1741–1803)	1774, *Viaggio in Dalmazia* + translations 1778, *Memoria orittografica nella valle di Roncà* 1784, *Viaggio mineralogico nella Calabria e nella Puglia* plus German (1788) edn 1802*, Mémoires pour servir à l'histoire naturelle et principalement à l'oryctographie de l'Italie et des pays adjacens*	First to describe marine shells cemented by a basaltic flow in the Venetian region; scientist-traveller
Carlo Amoretti (1741–1816)	1794, *Viaggio da Milano ai tre laghi, Maggiore, di Lugano e di Como, e dei monti che li circondano* 1811, Della *ricerca del carbon fossile*	Inventory of mines and mineral resources; scientist-traveller
Scipione Breislak (1748–1826)	1801, *Voyages physiques et lithologiques dans la Campanie; suivis d'une mémoire sur la constitution physique de Rome* plus German (1802) edn 1811, *Introduzione alla geologia* plus French (1812) and German (1819) edns and British (1816) review	Role of uplift to explain fossils in the hills; early author of a treatise on geology; magmatic origin of basalts; scientist-traveller
Giovanni Maironi Da Ponte (1748–1833)	1803, *Osservazioni sul Dipartimento del Serio* and *Aggiunta alle …*	Inventory of mines and mineral resources; origin of concretions
Giuseppe Gautieri (1769–1833)	1804, *Sulla necessità di stabilire una direzione generale per lo scavo delle miniere, e de' fossili e per le manifatture loro relative nella Repubblica Italiana*	Inventory of mines and mineral resources
Giambattista Brocchi (1772–1826)	1807–1808, *Trattato mineralogico e chimico sulle miniere di ferro del Dipartimento del Mella con l'esposizione della costituzione fisica delle montagne metallifere della Val Trompia*	Late Tertiary mollusc taxonomy and stratigraphy; pioneerin species extinction; pioneer in urban geology and urban geological maps and profiles; early attempt at

	1811, *Memoria mineralogica sulla Valle di Fassa in Tirolo* 1814, *Conchiologia fossile subapennina, con osservazioni geologiche sugli Apennini e sul suolo adiacente* 1820, *Dello stato fisico del suolo di Roma*	history of geology; inventory of mines and mineral resources and their origin
Giuseppe Marzari-Pencati (1779–1836)	1822, *Sur les granits dits tertiaires, observes dans le Tyrol* plus Italian (1820) edn	First evidence of post-Triassic granitoid intrusion by contact metamorphism
Teodoro Monticelli (1759–1845 and Nicola Covelli (1790–1829)	1823, *Storia dei fenomeni del Vesuvio avvenuti negli anni 1821, 1822 e parte del 1823* 1825, *Prodromo della mineralogia vesuviana. Orittognosia*	Volcanology and volcanic minerals; covellite was named after Covelli
Nicolò Da Rio (1765–1845)	1833, *Quelques observations sur le gisement des trachytes en general et des Trachytes des Monts Euganéennes en particulier*	Pioneering work on intra-sedimentary laccolithic intrusions
Tommaso Antonio Catullo (1782–1869)	1827, *Saggio di Zoologia Fossile*	Early Wernerian and Brongniartian stratigraphy in the Secondary of the Venetian Succession
Carlo Gemmellaro (1787–1866)	1833, *Sopra la morfologia delle montagne di Sicilia*	Early opponent to the 'crater of elevation' theory
Giovanni Giuseppe Bianconi (1809–1878)	1840, *Storia naturale dei terreni ardenti, dei vulcani fangosi, delle sorgenti infiammabili, dei pozzi idropinici e di altri fenomeni geologici operati dal gas idrogene e dell'origine di esso gas*	Discovered and named the argille scagliose (tectonosomes and olistostromes) in the Apennines; early critic of Darwinian natural selection
Leopoldo Pilla (1805–1848)	1845, *Saggio comparativo dei terreni che compongono il suolo d'Italia* 1847–1851, *Trattato di Geologia*	Contribution to chronostratigraphical classification and correlation of European terrains at the Cretaceous–Tertiary boundary; critical discussion and empirical mitigation of excessive gradualism (also of 'craters of elevation')
Angelo Sismonda (1807–1878)	1845, *Notizie e schiarimenti sulla costituzione delle Alpi Piemontesi*	Jurassic age of the metamorphic rocks in the Western Alps
Alberto Ferrero de Lamarmora (1789–1863)	1858, *Voyage en Sardaigne: troisième partie. Description géologique et paléontologique*	Regional monograph
Abramo Massalongo (1824–1860) and Giuseppe Scarabelli (1820–1905)	1859, *Studii sulla Flora Fossile e Geologia Stratigrafica del Senigalliese*	Foundation of late Tertiary Apennine palaeobotany and stratigraphy

and correlation of the collections. The friendship resulted in an extensive exchange of palaeontological material between the two museums, as indicated by the numerous original samples and casts of French and Italian species studied and donated by Cuvier who left his insignia on them. After having referenced the Italian material in his *Ossemens Fossiles* (Cuvier 1812), the collection is now preserved at the Capellini Museum in Bologna. This tradition of palaeontological studies and geological mapping was continued by the works of Bianconi and Scarabelli (Table 4) who discovered and named the 'argille scagliose' (including what we now call tectonosomes and olistostromes within mélanges), a term still in worldwide use and discussion today (Vai 1995*b*, pp. 91–92 and 98–100; Pacciarelli & Vai 1995, p. 205). A similar geological survey of the Western Alps characterized the works of Sismonda in 1845 (Table 4). It was the first such work to demonstrate the Jurassic age of large masses of metamorphic rocks in the Alps, thus opening the way to the nappes theory. In his 'fixistic' map of the Alps, Sismonda distinguished two units with different lithologies and degrees of metamorphism, using palaeontology; one contained many Jurassic fossils; the other, assumed to be much older or Primitive, finally yielded extremely rare and metamorphosed Jurassic ammonites after tireless fieldwork proving it was, in fact, from Secondary rocks.

Altogether, these works suggest a very active community, still keeping pace with its past, maintaining a critical mass able to produce new ideas and methods, and improving the new science and its applications to the needs of the society before and after 1807, in spite of the political instability. While some of these works were translated into French, German and, sometimes, English, most of these Italian ideas and discoveries were disseminated through personal contacts during guided visits to Italy of distinguished foreign savants. This allowed the foreign visitor an easy, almost effortless, appropriation of Italian geological knowledge. Some of the works listed in Table 4, about 20 percent, are still relevant and quoted today in a scientific context. The importance of the others becomes immediately apparent when they are studied in an historical perspective, which is still to be done for most of them.

A case history: Brocchi's *Conchiologia Fossile* and its influence on Lyell's *Principles of Geology* (1830–1833)

Among the leading scientists of the Italian geocommunity discussed earlier, Giambattista, or Gian Battista, Brocchi (Fig. 2a) (Marini 1987) has been the most continuously quoted, after Arduino. Brocchi's inspirational work, *Conchiologia Fossile* (1814) (Fig. 2b), and its subsequent importance in Lyell's works has already been recognized (MacCartney 1976; Rudwick 1998, 2005, pp. 522 and 583); however, the extent to which this work specifically influenced Lyell's *Principles of Geology* (1830–1833) and, in its turn, *Elements of Geology* (1838) has not previously been qualified or quantified.

Conchiologia is not only a modern palaeontological monograph, but also a treatise on regional geology based on palaeontological stratigraphy, like Cuvier & Brongniart's (1811) and Smith's (1815) memoirs and maps. With these three works, a revolution was achieved. Even the language used by Brocchi is succinct, notwithstanding the length of the work; the style is concise when compared to the convoluted baroque metaphors common in books of the eighteenth century. The full title of the work (Fig. 2b) highlights the contents of the first volume, which is devoted to the stratigraphy and geological interpretation of the entire Apennine mountain chain and adjoining foothills. The second volume is a monograph on the taxonomy, ecology and palaeogeography of late Tertiary molluscs. As with Cuvier and Smith, the aim of the work is not regional but general; it is not limited to description (examples), but looks for concepts and principles derived from new observations. An extract from Manilius' *Astronomica* (first century AD), quoted on page four of *Conchiologia*, indicates Brocchi's farsightedness: 'Emersere fretis montes, orbisque per undas exiliit, vasto clausus tamen undique ponto' (So, by degrees, mountains emerged from the deep, and the round world sprung forth from the waves, but closed in on every side by the vast ocean).

Brocchi's aim was clear and immediate: 'to elucidate the ancient history of the globe' (Brocchi 1814, p. 7), following Arduino's chronological paradigm (four time periods for the history of the Earth), and breaking out of the restrictions caused by 'theories of the Earth'. He strove to unravel the history of the tangible Earth, starting 'from organic remains' and complementing them with 'observations on their setting, the state in which they are formed, the features of the sediments in which they are buried' (Brocchi 1814, p. 7). As equally ambitious as the preceding 'theorists', but taking a different approach, Brocchi expounds the history of the Earth. Using today's terminology, the meaning of which was already clear to him and a few of his contemporaries, he outlines the stratigraphy of the late Tertiary based on the distribution of mollusc (and other) fossils in the Subapennine clay formation, using their palaeoecology and

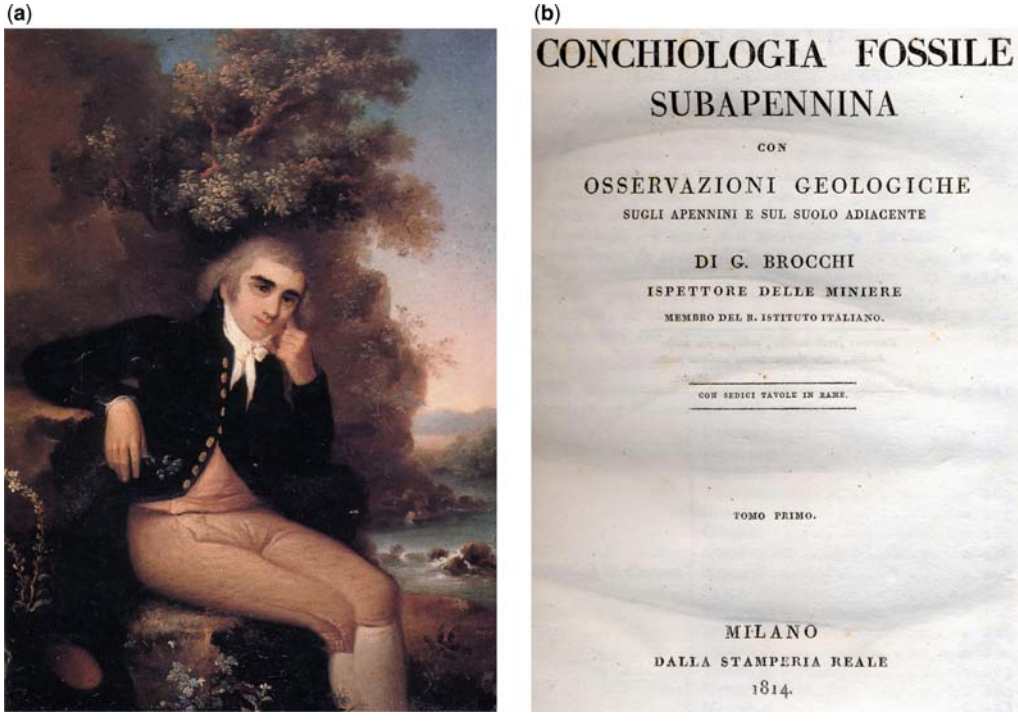

Fig. 2. (**a**) Gian Battista Brocchi. (**b**) The frontispiece of Brocchi's *Conchiologia Fossile*.

taphonomy, as well as the lithogenesis and diagenesis of the encasing formation (Fig. 3).

Brocchi's basic methodology was to ascertain 'whether we are able to compare with the present what others tell us of the past' (Brocchi 1814, p. 7). It is a much less dogmatic statement than Geikie's equivalent Lyellian aphorism 'the present is the key to the past'. Brocchi was thus calling for a more realistic, not always gradualistic, even partly catastrophic, uniformitarianism, giving no priority either to the present (e.g. Lyell) nor to the past (perhaps Cuvier); he follows a balanced pragmatic rule: 'I have always developed concurrently and relied similarly upon the study of fossil shells and present-day marine molluscs' (Brocchi 1814, p. 8). The difference between the fossil (past) and the living (present) shells is his starting point: 'I did not start this enterprise until I recognized the shells which are dug from underground are totally different from those settling in the present seas' (Brocchi 1814, p. 8).

Brocchi proceeds in a very modern way, providing information on both fossil and living faunal assemblages, and comparing them in both time (biostratigraphy) and space (palaeoecology). He is even aware that palaeontological research can predict results that could be tested by ongoing research (as, for example, trends in global climate change). This is a reverse interpretation of uniformitarianism: that is, the past is a key to the present (Valentine 1973, pp. 14–16) and future. By comparing the very low numbers of living species in Lamark's list of fossils from the Paris Basin to the high species content in the Subapennine fauna, Brocchi establishes the use of the percentage of living forms in a fossil assemblage as a criterion of relative dating of the encasing formations. This approach was later expanded upon in the palaeontological lists and works of Paul Gerhard Deshayes (1797–1875) and adopted in Lyell's chronostratigraphy (Vai 2007*a*). In this way 'fossil conchology becomes a scale for geology' (Brocchi 1814, p. 13), a statement succinctly describing how Werner's geognostic dream died out, being replaced by the stratigraphic paradigm of geology. Unlike Cuvier, who was strongly influenced by his Wernerian education in Germany, Brocchi's scientific consistency and semantic freedom is reflected in the early and well-defined use of the term 'geological' v. 'geognostical' (Brocchi 1814, pp. 11 and 56; see also Vai 1995*b*, p. 68).

Brocchi expressed the concept of a relatively long timescale by comparing the 'much more recent incoherent Tertiary Subapennine formation' with the 'older cemented calcareous Apennine mountains',

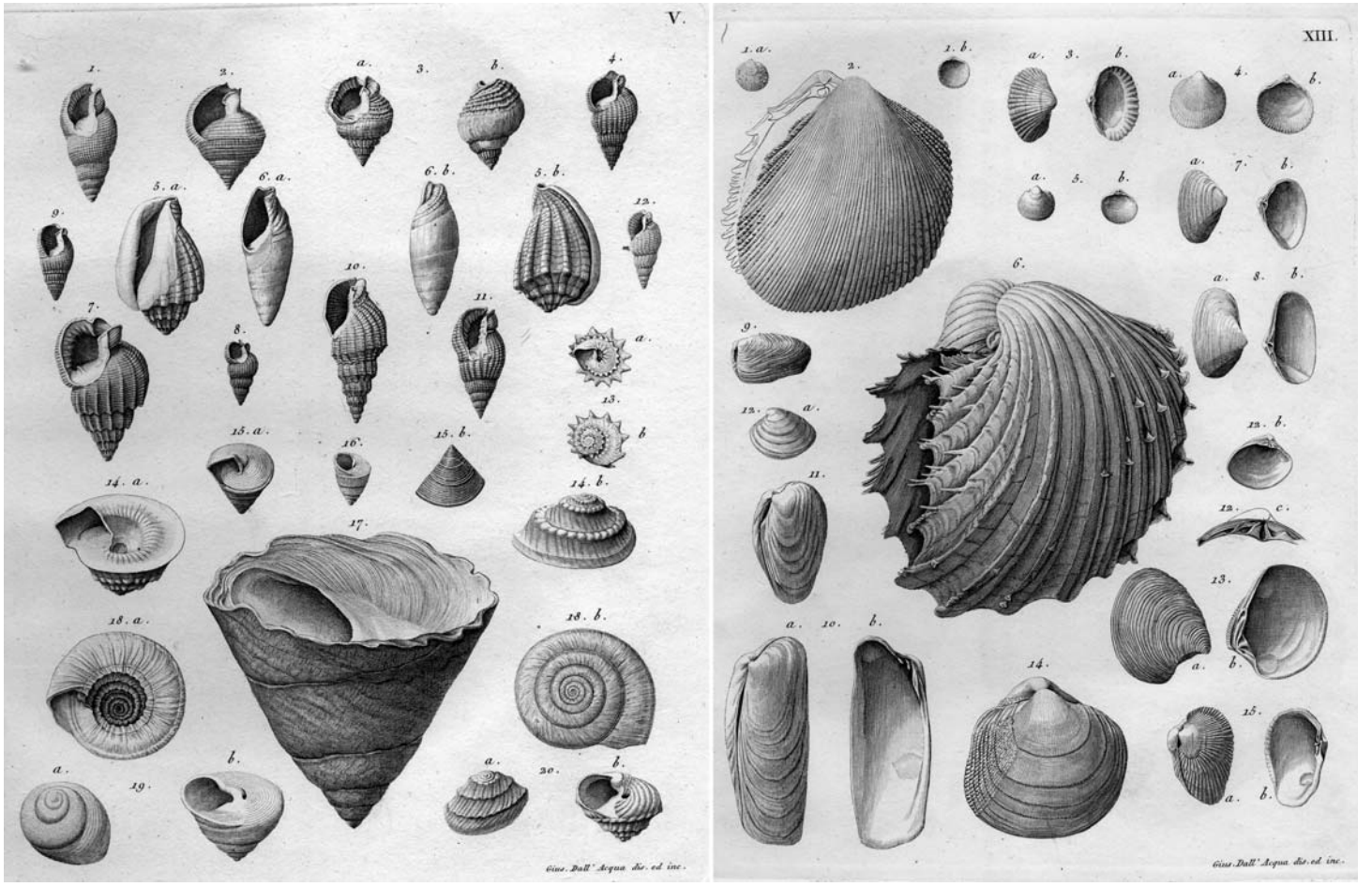

Fig. 3. Plates V and XIII from Brocchi's *Conchiologia Fossile*.

and spoke about 'excavated sites of the Lombardy plain hosting bodies buried for many centuries' (Brocchi 1814, p. 25). With his understanding of the distribution of different fossils in formations of different ages, he was confident in formulating a natural law that 'species perish like individuals' (Brocchi 1814, p. 30) (i.e. the 'law of species disappearance' or species senescence), introducing his own view on the evolution of fossil organisms (Corsi 1983; Pancaldi 1983*b*; Berti 1987). Although the concept of species disappearance did not originate with him, Brocchi was the first to elaborate and demonstrate this theory. Brocchi's evolutionary view, although accepting the geological relevance of catastrophes, is based on a general and constant law. However, the rate of disappearance (and, thus, of existence) is different among the various species in a teleological view of 'creation' and 'Nature' (Brocchi 1814, pp. 227–228): 'Species approach their end slowly and gradually as individuals do' (Brocchi 1814, p. 229). Similarly, he was aware that the face of the Earth had undergone changes and catastrophes in very recent times 'compared to the first origin of things'. This applied to the age of emersion of the Subapennine hills (Tertiary), expected to be in the order of thousands of years, and not the thousands of centuries he imagined for the Apennine mountain core (Secondary).

Brocchi's and Lyell's views about many aspects of geology did not coincide. In spite of this, Brocchi's influence on Lyell's work was impressive. Table 5 is a qualitative summary, by chapter, of items in Lyell's *Principles of Geology* (first edition) that have a direct source in Brocchi's *Conchiologia*. Out of a total of 1765 pages in Lyell's *Principles*, 70 are a direct translation or a

Table 5. *Brocchi's (1814)* Conchiologia *as a source for Lyell's (1830–1833)* Principles of Geology, *showing the corresponding pages where the same subject matter or quotation occurred in both**

Lyell 1830–1833 *Principles*	Items considered	Brocchi 1814 *Conchiologia*
Vol. I		**Vol. 1**
Ch. I, p. 1	**Definition of geology**	p. 7; p. I
Ch. I, pp. 1 and 3	**Actualistic approach**	p. 7
Ch. I, p. 4	**Werner**	p. I
Ch. I, p. 4	**Cosmogony**	p. III
Ch. II, p. 16	**Theory of equivocal generation**	p. V
Ch. II, p. 17	**Quotation of Fortis [1802]**	p. LXXII
Ch. II, p. 20	**The ancient authors had 'no purpose of interpreting the monuments left by nature of ancient changes'**	p. I, II
Ch. II, p. 23	**Account of history of geology**. Same title, same approach, same chronologic method, wider scope in Lyell (geology in general), narrower in Brocchi (fossil Subapennine conchology and geology)	p. I, title
Ch. III–V	**History of geology**. According to Lyell, his Ch. III is a shortened version of'Brocchi's Discourse'. More than half the chapter is a literal translation or a summary of Brocchi's text. Additional inserts from Brocchi are in Chs IV and V	part 2
Ch. VI, pp. 92–95	**Organic remains from the Italian strata prove climate formerly hotter**. The point is discussed by Lyell making reference to his visits to Italian collections and outcrops led by Costa (Naples), Guidotti (Parma) and Bonelli (Turin)	p. 14
Ch. VI, p. 100	**Assemblage of fossils in the Secondary rocks are very distinct from those of the Tertiary**	pp. 21–22
Ch. VIII, pp. 135–136	**Rise of the Apennines above the level of the Mediterranean and Adriatic seas**	pp. 52–55 and 78–79
Ch. IX, p. 151	**'State of preservation of fossils in the younger rocks very different than in the older'**	p. 20
Ch. IX, p. 160	**Begins by studying the most modern periods of the Earth's history, attempting afterwards to decipher the monuments of more ancient changes**	p. 22

(*Continued*)

Table 5. *Continued*

Lyell 1830–1833 *Principles*	Items considered	Brocchi 1814 *Conchiologia*
Vol. II		**Vol. 1**
Ch. I, p. 1	**'Duration of each species'**	§ 6, pp. 219–240
Ch. 2, p. 18	**'Constancy of species, Amount of transformation'**	§ 6, pp. 219–240
Ch. 2, p. 20	**'Approach to present system gradual'**	§ 6, pp. 219–240
Ch. 2, p. 23	**'Each species shall endure for a considerable period of time'**	§ 6, pp. 219–240
Ch. VIII, pp. 128–30	**Brocchi on 'the loss of species'**	§ 6, pp. 219–240
Ch. IX, p. 178	**Recent addition of land to both sides of the Italian peninsula**	p. 35
Vol. III		**Vol. 1**
Preface p. viii Ch. II, p. 19	**Proportion of recent species in different Tertiary groups** Brocchi's idea transferred to Lyell through Bonelli, Guidotti, Costa and Deshayes	p. 11
Ch. V, p. 49	**'Necessity of accurately determining species'**	pp. 30–31 ff.
Ch. V, p. 55	**'Recent species found in older tertiary strata are inhabitants of warmer climates'**	p. 14
Ch. V, p. 58	**'Numerical proportion of recent shells in the different tertiary periods'**	p. 11
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Ch. VI, p. 62	**'Reverse the natural order of historical research' or 'retrospective order of inquiry'**	p. 22
Ch. VIII, pp. 97–101	**'Quantity of past time' much greater than our historical/ human periods**	pp. 22, 32–48, 121, 199–200, 212–214
Ch. XII, pp. 155–157 and 159	**Synthesis of Subapennine formations and Brocchi's opinions**	pp. 82, 143, 147, 148 and 166
Ch. XII, p. 163	**Excellent preservation of shells (pearly lustre, external colour, ligament)**	pp. 26–27

*Ch., Chapter; §, Paragraph.

summary of sections in Brocchi's *Conchiologia* (44, 10 and 16 pages in volumes I, II and III of *Principles*, respectively). More generally, *Principles* deals with Italian geological features and matters compiled by Lyell from both Italian and foreign sources, or derived from his own trips to Italy with local guides, in the following: volume I, 159 pages out of 479; volume II, 20 pages out of 301; volume III, 111 pages out of 385. Although remarkable, this is not surprising. Lyell was fascinated by all aspects of the Italian natural environment and culture. The final decision to write the *Principles* came from his second Italian tour in 1828–1829 (Fig. 4), which overlapped with his honeymoon. Lyell was so excited by his Italian experience that he quoted from Dante's *Divine Comedy* (Lyell 1830, vol. I, p. 63), selecting the verse 'Dinanzi a me non fur cose create se non eterne' ('Before me no things were created unless eternal'). This shows the level of his proficiency in the Italian language and its literature (Rudwick 1998, p. 6), and his intention to benefit from the potential of Italian geological writings of his time. Rudwick (1998, pp. 4–6) in particular stressed the role of Brocchi's works, among others, as 'resources for the *Principles*' and says Lyell was influenced by Brocchi's model of piecemeal faunal change and by his geohistorical thinking (Rudwick 2005, p. 523).

To summarize, Lyell's *Principles* borrowed extensively from Brocchi's *Conchiologia* the ideas of:

- organic remains showing that the climate was formerly hotter;
- state of preservation of fossils in the younger rocks different to that in older rocks;
- assemblage of fossils in the Secondary rocks as distinct from those in the Tertiary;

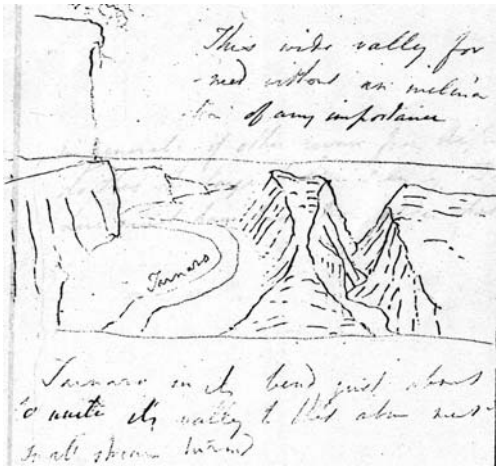

Fig. 4. A page of Lyell's field notes of northern Italy, 1828. Notebook 14, Kinnordy MSS. Reproduced by courtesy of Lord Lyell of Kinnordy.

- studying the most recent periods of the Earth's history and subsequently attempting to interpret more ancient changes (retrospective order of enquiry);
- proportion of recent species in fossil assemblages;
- increase in percentage of existing species from older to newer formations;
- accurately determining species;
- recent species found in older Tertiary strata are inhabitants of warm climates.

Thus, even the most fundamental tool of Lyell's chronostratigraphic division of the Tertiary into Eocene, Miocene, Pliocene (1833) and Pleistocene (1839) – the percentage of existing or extinct taxa – was borrowed from Brocchi (1814), although Lyell implemented Deshayes' (1830, 1831) faunal lists, updating those originated by Brocchi (1814). Rudwick's (1998, p. 6) statement 'Lyell appropriated a massive and mature body of contemporary geological literature' seems to be especially the case for Brocchi's *Conchiologia*, but there was an additional, perhaps less scientific and more personal, reason for Lyell to have been captivated by it.

Conchiologia reached the British Isles following the Italian tour made by William Buckland (1784–1856) and George Greenough in 1816. Buckland had met Brocchi in Milan where he was given a complimentary copy, which perhaps became the one used by Leonard Horner (1816) for his enthusiastic review and translation of excerpts (Rudwick 2005, p. 604).[8] In fact, the review was a much extended summary and translation of most of the first volume, which is devoted to the geological history of the Apennines – as underlined by the running title of the review: *Geology of the Apennines* (Horner 1816). Most of the translation is excellent and often exhaustive, except for a section (p. 169) dealing with the origin of coarse-grained deposits of the northern Po Plain. Here Brocchi's text is difficult to interpret and the translation fails to understand his idea of the 'catastrophic irruption of the sea'. What Brocchi meant by this is the power of the sea to effect the erosion and re-deposition of large amounts of material to build new sedimentary bodies, but in Horner's summary this concept is lost. Horner's review concluded: 'The description of the shells are illustrated by plates, which we cannot praise too highly; for they are more beautifully executed than any thing of the kind we have ever seen before' (Horner 1816, p. 180) (Fig. 3). However, it is quite surprising that no mention is made by Horner of Brocchi's final chapter on the 'loss of species'. Instead, this concept was popularized by Lyell, crept into Charles Darwin's notebooks and became a constant feature of controversies at the Société Géologique de France, although the name of Brocchi was rarely associated with the idea. Nevertheless, occasional events such as Buckland's and Greenough's Italian tour, and Horner's review and translation, acted as powerful advertisements for Brocchi's work, despite the fact that it was written in Italian. Brocchi was lucky. But he was also aware of having written an unprecedentedly important work. Against friendly advice to publish in French, he preferred to compensate for the limited access to his work, derived from writing in Italian, by having its excellence recognized and extolled by the Italian community. More generally, one has to admit that reception in Europe of a large part of the classic works listed in Table 4 was severely limited due to them being written in Italian. Brocchi's work was also well received in continental Europe. It immediately became a reference in taxonomy for Tertiary and more recent molluscs, and led to the standard recognition of the Subapennine Clay Formation for stratigraphic correlations throughout the Mediterranean countries. In addition, Brocchi's works, although in Italian, were appreciated because his scientific language was consistent with the new European ecumenical language of Cuvier and von Humboldt (Vaccari 1998).

Discussion

At the beginning of the nineteenth century there was still a quite large Italian geoscience community very

[8] Horner (1785–1864) was to become Lyell's father-in-law.

active in the academic theoretical and experimental fieldwork, as well as in the applications of mining and soil science. In general, Italians kept up rather well with the pace of research in Europe. The standard of Italian authors in regional geology, stratigraphy, volcanology and seismology was not less than their French, British and German counterparts, but their visibility was reduced because their works were mostly written in Italian. However, about 10 percent were translated into French and/or German, and, more rarely, into English, signifying their relevance. Only about 15 percent were originally published in French, and less than five percent (mostly taxonomic works) in Latin. All this, plus the successful Congressi degli Scienziati Italiani,[9] would suggest that, at least until the end of the eighteenth century, there was not a decline of interest in geology per se in Italy where the discipline had blossomed in scientific, cultural, institutional and social terms.

Although the potential to establish an Italian geological society was available at about the same time as the Société Géologique de France was set up (in 1830), the political fragmentation of Italy did not facilitate it until the two stages of Italian Unity occurred in 1860 and 1871. Before that, an Italian nation, and even less an Italian state, was only a dream that was fostered by many Italian geologists (Corsi 1995, 1998; D'Argenio 2006). So, the easiest way for the Italian geoscience community to maintain contacts and exchanges with their European counterparts and test their competitive potential was to turn to established disciplinary organizations and to join to the geological societies already active. Paris was near, French the closest language, and France the country of science, culture, progress and vitality, in spite of its ambiguous position towards the challenge of the Italian Unity. In addition, there was a long tradition of exchanges between the Italian academies (e.g. the Istituto delle Scienze di Bologna) and the Académie des Sciences, which was reinforced at the geological and museum level by the action of Cuvier who was one of the supervisors during Napoleon's plundering (Vai 2003*b*). As a result, the best Italian geoscientists transferred their main activities to the geological societies of Paris and London. They used these opportunities not only for scientific but also for political purposes, as shown for example in the cases of Matteo Tondi (1762–1835) – a refugee in Paris during the Revolution and founder of the Royal Mineralogical Museum of Naples in 1801 – and Giuseppe Scarabelli – an active member of the Société since 1846 (Pacciarelli & Vai 1995; D'Argenio 2006). The enforced delay in establishing national scientific institutions that were able to stimulate advancement and competition was an additional problem confronting a fragmented Italy, following the economic crisis caused by the Napoleon turmoil. The total number of scientists decreased as well as the resources available to them for doing research. In addition, the most innovative programmes, such as the Geological Map of Italy that by the early 1860s only was just starting to become a possibility, could not progress (Corsi 2003, 2007). The Italian geological community began to loose confidence and had to wait another two decades, until 1881, before the Società Geologica Italiana was set up. This was due largely to reasons of economic crisis and institutional fragility within the new Italian state. The opportunity was provided by Italy hosting the second International Geological Congress in Bologna. The Congress's Presidents, Giovanni Capellini and Quintino Sella (1827–1884), were also the formal founders of the Società (Vai 2007*b*).

It is worth noting that Italian geoscientists made up the majority of the foreign members in both the Geological Society and the Société Géologique de France in the middle of the nineteenth century, owing to the relatively large size of the Italian geocommunity and, perhaps, a growing interest by European geoscientists wanting to know more about Italian geology. Out of a total membership of 1432 in the Geological Society of London in 1880, there were 40 Foreign Correspondents: eight were from Italy, eight from France, five from Germany, five from the USA, four from Austria, three from Belgium, two from Sweden, two from Switzerland, two from The Netherlands and one from Hungary. Out of a total of 577 members in the Société Géologique in 1883, 99 were Foreign Members: 24 Italians, 18 Belgians, 18 Spaniards, 14 Germans, 13 British and 12 from the USA. The distribution of the Italian members over time in the Société is shown in Table 6. A peak of 10 percent of the total Société Géologique membership was reached by Italians in 1846, with Sismonda and Scarabelli being the leading Italian geologists active in the Alps and the Apennines, respectively.

So it was only when the political conditions of the new Italian state seemed to be favourable, and an opportunity such as the second International Geological Congress Bologna in 1881 provided an ideal launch pad (Vai 2002, 2004*a*), that the Società Geologica Italiana became established; later than in many important countries such as the UK, France, Germany, Hungary, but prior to many

[9] The geology sessions were particularly successful, being joined by renowned foreign geoscientists such as Leopold von Buch, Adolphe Brongniart, Charpentier, Omalius d'Halloy (Morello 1983; Pancaldi 1983*a*).

Table 6. *Number of Italian members at various times within the Société Géologique de France*

Year of election	Italian members	Total members
1838	15	386
1844	25	437
1846	50	500
1859	42	
1868	32	
1880	25	
1883	24	577
1908	12	
1923	9	

others (Table 2). However, it was too late to prevent a major decline in the international relevance of the Italian geological community that had started after the Napoleonic wars and continued for some decades. The decline was felt in the reduction in size of the community, its scientific role and international visibility (except for some prominent individuals), and financial support from government for institutions and major programmes. A good example, derived from ineffective political and institutional support, is the history of the Italian Geological Survey and the Geological Map of Italy well described by Corsi (1995, 2003, 2007) and Brianta & Laureti (2006).

Conclusions and final remarks two centuries later

At the time of the founding of the Geological Society, the Italian geological community was still in good shape, able to supply Lyell with a lot of ideas, and through him many other leading geoscientists such as Charles Darwin. The relatively late founding of the Società Geologica Italiana, seven decades after the Geological Society and half a century after the Société Géologique de France, was not the consequence of a decline in scientific excellence or support from interested participants, but was initiated owing to the turmoil caused by the Napoleonic wars and enforced because an Italian state did not exist prior to 1860. All scientific requirements for establishing an Italian geological society at the time of the foundation of the Société Géologique were in place: there was a reasonably large geological community, trained and equipped with a tradition of discoveries; innovative research blossomed in most aspects of geology; and the leading scientists of this community were active, visible and respected at an international level. This is clearly demonstrated by the fact that the Italian geoscientists were the majority of the foreign members of both the Société Géologique and the Geological Society in the middle decades of the century. The disadvantages were the political fragmentation of Italy into many small states, making it difficult to reach a critical mass for interaction in both field and indoor activity. International visibility was limited by the increasing use of Italian in the publications instead of Latin or French; and the impact of the Napoleonic reforms on the economic and social frame of the country and its scientific structures was only locally compensated for by modernization and the rearrangement of institutions. But even the establishment of the Società Geologica Italiana could not prevent a decline in the international relevance of the Italian geological community that began to be evident in the second half of the nineteenth century and peaked in the first half of the twentieth, in spite of some individuals such as Sismonda, Scarabelli, Capellini, Seguenza, Sacco and Gortani playing an important role at the scientific and organizational level (Vai 2002, 2004*a*, 2007*b*). A recovery began during the second half of the last century.

The fascinating history that started two centuries ago with the founding of the Geological Society is still ongoing. It is partly reflected, and may be represented, in a graph comparing the membership over time of some of the major geological societies (Fig. 5). It stimulates a final remark. In spite of their different ages, the Geological Society, the Société Géologique de France and the Società Geologica Italiana show a relatively similar early development and evolutionary trend through the previous

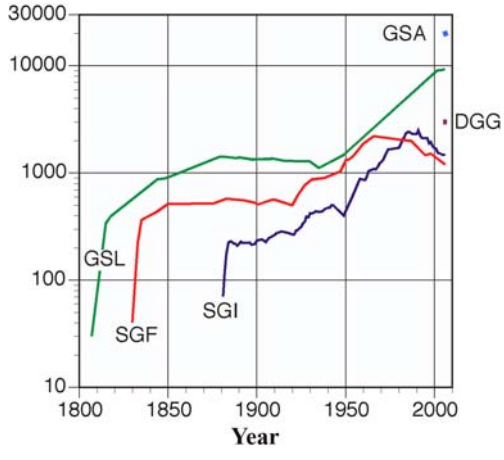

Fig. 5. Changing membership over time for the Geological Society of London (GSL), the Société Géologique de France (SGF) and the Società Geologica Italiana (SGI), compared with total membership of the Deutsche Geologische Gesellschaft (DGG) and the Geological Society of America (GSA) in 2006 (after Vai 2007*b*).

century. However, in the last two or three decades there is a sharp divergence between the still-growing Geological Society of London and the falling Société Géologique France and Società Geologica Italiana. Is this a dangerous side-effect of the 'impact factor', a policy that – as the President of the Société Géologique believes (Brun 2006) – favours papers and publications written in English, or should we be prepared for a major decline in our national geological societies?

I am indebted to the volume editors, to Andrea Candela and to an anonymous reviewer for their useful comments, and to Pietro Corsi, Gilbert Kelling, Giuliano Pancaldi, Hugh Torrens, Ezio Vaccari, the late Steve Walsh and Wendy Cawthorne, the Librarian at the Geological Society of London, for kindly providing information. Figure 4 was passed to me by S. Walsh through L. Wilson. This information is courtesy of Lord Lyell of Kinnordy.

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