by the heaping up of the water by the winds; for any amount of power which could possibly be derived from such a source must fall enormously short of that required.

It may be noticed that we have here a means of making a somewhat rough estimate of the absolute amount of resistance offered to oceanic circulation, a rather obscure point. It shows that the resistance to motions arising from friction is far greater than was hitherto supposed. The amount of the work of the resistance to a pound of water passing from the equator to lat. 60° cannot be less than twice 9,025 foot-pounds.

It follows also that if the resistance to motion in the waters of the ocean be as great as it has thus been proved to be, then there is no warrant for the generally received opinion that a force such as that of the winds acting on the surface of the ocean cannot produce motion extending to any considerable depth. For if the resistance to motion be as great as the foregoing consideration shows it to be, it is impossible that the upper layers of the ocean can be constantly pushed forward in one direction without dragging the underlying layers after them.

The inadequacies of the gravitation theory may be shown in an even still more striking manner. Conceive a column of water in any part of the ocean extending from the surface to the bottom. Suppose the column to be a foot square, and the depths of the ocean to be four miles. We have in this case a column a foot in thickness, and four miles in height measured from its base. According to Dr. Carpenter's theory, gravity tends to move the water forming the upper part of the column in the direction from the equator to the pole, and the water forming the under part from the pole to the equator. What then is the amount of force exerted by gravity on the entire column? In the next part of my paper on Ocean Currents in the *Philosophical Magazine* I shall demonstrate by an exceedingly simple and obvious method, that the total amount of force exerted by gravity on the whole mass of water constituting the column is only $\frac{9}{16}$ of a grain. That is, $\frac{9}{16}$ of a grain on 600 tons of water.

Edinburgh, April 15 JAMES CROLL

THE FOSSIL MAMMALS OF AUSTRALIA

THE substance of this communication was given orally at the meeting of the Royal Society, April 18, 1872.

Prof. Owen commenced by alluding to the series of fossils brought in 1836 by the then Surveyor-General of Australia, Sir Thomas Mitchell, from the bone caves discovered by him in Wellington Valley, New South Wales. The determination of these remains required study of the osteology and dentition of the existing marsupial animals, which formed the subject of papers in the "Transactions of the Zoological Society" (vol. ii., 1838, and vol. iii., 1845).

In these papers indications were given of a second species of living wombat, distinct from the type peculiar to Tasmania, such indications being yielded by a skull sent from Australia. In 1853 the author published, in his "Osteological Catalogue of the Museum of the College of Surgeons," the cranial characters of a third living species of *Phascolomys*, also from a skull, which, like that of the second species, was from the continent of Australia. These materials seemed to some naturalists inadequate for the acceptance of a *Phascolomys latifrons* and a *Phascolomys platyrhinus*, in addition to the first discovered Tasmanian *Phascolomys vombatus;* and Gould in the part published in 1855 of his great work, "The Mammals of Australia," containing the fine figure of that species, hesitated to admit more, although a drawing which he had received of the head of a wombat killed in South Australia "afforded good reason for concluding that the continental animal is really distinct." In 1859 this distinguished naturalist was able to publish in Part XI. of his work a figure of a wombat from the southern parts of the continent of Australia, which he recognised as distinct from the small wombat of Tasmania, and referred to the *Phascolomys latifrons;* it was, however, the larger bare-nosed species, *Phascolomys platyrhinus*.

In 1865 and 1866 specimens were received at the Zoological Gardens of London, of both the continental Australian wombats, which the able Prosector, Dr. Murie, showed to have respectively the cranial characters of *Phascolomys latifrons* and *Phasc. platyrhinus*. The *Ph. latifrons* had the nose or muzzle clothed with hair. This confirmation greatly encouraged the speaker in the investigation and comparison of the cranial and dental characters of the fossil remains of the genus; and in November 1871, he felt that he had grounds for submitting to the Royal Society such characters of four other species of wombat, not exceeding in size the largest of the existing kinds, which four species appeared to have become extinct on the continent of Australia. The differentiation of the actual platyrhine and latifront species from some of the extinct forms was not the less interesting and instructive; though it seemed small in degree, it was, however, definite, in comparison with other fossil remains which could not be distinguished from the existing *Phascolomys platyrhinus* and *Ph. latifrons*.

The determination of the species propounded on cranial and dental characters in the present paper was much easier and more decisive, by reason of the marked superiority of size of the fossils. These large and gigantic wombats were differentiated, not only by bulk, but by modifications of the skull and proportions of certain teeth, notably the incisors and premolars.

On these grounds the author characterises a *Phascolomys medius*, which, although markedly larger than *Phascolomys platyrhinus*, was intermediate in bulk between the two now known extremes of size in the genus. Next followed a *Phascolomys magnus*, and finally a *Phascolomys gigas*. Of the latter species a restoration was given in a diagram of the natural size, which was that of a tapir or small ox. The dental and certain cranial characters were illustrated by highly finished drawings of the fossils.

With respect to the large extinct wombats described in his present paper, the author remarked that it was not likely they could have escaped detection if still existing in any of the explored parts of the Australian Continent. The knowledge that such species have existed may excite to research and help to their discovery, if any of them should still be in life, in the vast tracts of the northern and warmer latitudes of Australia.

The author exhibited in a tabular view the localities of the known existing and extinct Australian wombats as follows:—

Where found	By whom found	Species of Phascolomys.
Breccia Cave, Wellington Valley, N. S. Wales	Sir Thomas Mitchell, C.B., 1836	*Mitchelli*
Lacustrine Bed, Victoria	E. C. Hobson, M.D., 1845	*Gigas*
Drift Deposits, Queensland	Geo. Bennett, M.D., F.L.S., 1861	*Mitchelli*
Ib. King's Creek, Darling Downs	S. Turner, 1847	*Parvus, Medius*
Ib. Gowrie, *Ib.*	Fred. Neville Isaac, 1861	*Mitchelli*
Ib. Eton Vale, *Ib.*	Ed. S. Hill, 1865	*Platyrhinus, Medius, Magnus, Gigas*
Ib. St. Jean Station, *Ib.*	M. Satche St. Jean, 1864	*Gigas*
Ib. Drayton, Queensland	Sir Danl. Cooper, Bt., 1865	*Thomsoni, Medius Magnus, Gigas*
Freshwater Beds, Clifton Plains, *Ib.*	F. Nicholson, 1866	*Gigas*
Caves, Wellington Valley, N.S. Wales	Professor Thomson, G. Krefft, 1867	*Mitchelli, Krefftt, Latifrons*

The author then touched upon some generalisations suggested by the present stage of discovery. The disappearance of the larger species was explicable on the principle of the "contest of existence," as applied by him to the problem of the extinction of the fossil birds of

* "On the Fossil Mammals of Australia," No. VIII.: Genus *Phascolomys;* species exceeding the present in size, by Prof. Owen, F.R.S.

New Zealand (Trans. Zool. Soc., vol. iv., 1850), and subsequently by Darwin to the incoming of new species, as "the battle of life." He next entered upon the relation of the present discoveries in Australia to the law of Geographical Distribution in the new Tertiary or Quaternary periods of extinct and existing animals.

The wombat was a more characteristic Australian form of mammal than the kangaroo, for the latter is represented by species in New Guinea; and species of *Phalanger* range farther from Australia, though still bound to the same great natural, and mainly submerged, division of the earth's surface. But no kind of wombat, recent or fossil, has been detected out of Australia and Tasmania. The present Continental kinds, and species near akin to them, existed in Australia during a very long period, reckoned by the terms of historical time, if we may judge from the state of petrifaction of the fossils, and the great depths at which some have been met with in well-digging; where, after 30 ft. or 40 ft. of black rich soil have been bored through, such fossils occur at 100 ft. lower down in sandy drift, which has been accumulated to that or greater vertical thickness beneath the loam. On the assumption that air-breathing animals perished in a general deluge some 5,000 years ago, and that their dispersion then began anew from the exceptional few individuals preserved in the Ark, we must suppose the wombats then living in Australia to have contributed miraculously their pair or pairs to the Asiatic menagerie, and to have been as miraculously restored to their proper continent on the subsidence of the Noachian flood.

It is neither creditable nor excusable that so great a divergence should still be maintained, chiefly through theological teaching, in the ideas of the majority of men "of ordinary culture" as to the cause and conditions of the distribution of living species over the globe, from those suggested by the clear and multiplied demonstrations of Science. On this topic the author referred to a paper in "Annals and Magazine of Natural History," 1850, "On the Gigantic Birds of New Zealand, and on the Geographical Distribution of Animals."

*THE CONNECTION BETWEEN COLLIERY EXPLOSIONS AND WEATHER**

AFTER a preliminary reference to previous papers on the subject, and especially to the diagrams published by Mr. Joseph Dickinson, and by Mr. Bunning, of Newcastle-on-Tyne, the authors of the paper referred specially to Mr. Dobson's paper, published in the reports of the British Association. They showed that the periodicity alleged by him to exist in these explosions had no real foundation in fact; for, on plotting the dates of the explosions for the last twenty years in two ten-year periods, very slight resemblance was seen between the two curves. The number of accidents (all fatal ones) on which the statement was based was 1,369.

In the progress of this inquiry it had come out that the number of serious accidents, involving the loss of ten lives or more, had materially increased during the last five years, the numbers being:—

1851-55 . .	13.	1856-60 . .	15.
1861-65 . .	12.	1866-70 . .	21.

These numbers appear to be well worthy of remark.

For the special purpose of the paper, the continuous records from Stonyhurst, one of the observatories in connection with the Meteorological Office, were taken, and the curves for the barometer and thermometer were plotted for the three years, 1868-70. The records of fatal explosions were obtained from the published reports of the inspectors, while the dates of the non-fatal accidents were obtained from the inspectors themselves, who, almost without exception, replied to the communications addressed to them, and furnished the desired information.

Mr. Dobson, in his paper, having spoken of the explosions occurring principally at the commencement of a storm, the authors showed that it was not, in some cases, until two or three days after the barometer had reached its lowest point that the accident happened. They showed also why, during a period of continued violent oscillation of the barometer, the passage of each successive barometrical minimum is not characterised by an equal number of explosions, the largest groups of accidents being reported when a serious break occurred after a period of calm weather.

The effect of a high temperature of the air in interfering with ventilation, and especially with natural ventilation, was also explained, and it was shown how the first hot days in spring were marked by explosions.

The actual dates of the explosions for the three years in question were then compared with the meteorological records, and it was shown that out of 550 explosions—

266, or 48 per cent.,		might be attributed to the state of the barometer;
123, „ 22	„	to the state of the thermometer;
161, „ 30	„	remained unaccounted for on meteorological grounds.

The next point touched upon in the paper was the action of a more or less impure ventilating current in increasing the explosive character of the air in all parts of the pit, and possibly in causing an explosion in a place which would have remained safe had the ventilating current itself remained pure. It was shown how, when an explosive mixture had been formed in places and under conditions similar to those described, some time, possibly several days, must elapse before the contents of such an accumulation of dangerous gases shall have been rendered innocuous again.

The effect of warm weather in stopping natural ventilation was explained. The natural temperature of a mine of the depth of 50 fathoms being 55°, that of one of the depth of 200 fathoms 70°, and so on (speaking generally), it was shown that if the temperature of the air rose to 55° natural ventilation must cease in shallow pits, and similarly in other cases. Accordingly, if a warm day occurs in the cold season of the year, and the furnaces are not in action, an explosion is very likely to occur.

These statements were illustrated by one instance of a fatal explosion, the cause of which had been declared by the inspector to be inexplicable, the pit having "strong natural ventilation." It appeared, however, that the explosion occurred on a warm day, while the inspector visited it twice on colder days after the explosion; so that the state of ventilation which he witnessed had no reference to that which must have prevailed when the accident happened.

The paper concluded by stating that it appeared that the evidence fairly justified the view that meteorological changes are the proximate causes of most of the accidents, it being remembered, as has before been observed, that the records contain no account of the number of times when the pits have been too dangerous for the men to go down, and so explosions have not happened.

Whatever be the meteorological changes, it is absolutely necessary to keep a most careful watch over the amount of air passing through the workings.

Thirty years ago George Stephenson said, in a letter to the South Shields Committee, referring to explosions:—"Generally speaking, there has been some fault in the ventilation of the mines when accidents have occurred;" and the same opinion is held by many of the most experienced authorities at the present day. In this matter the one cry, whether we look to security against explosion, or to the affording to miners an atmosphere which they can breathe without injury to health, is "More air!"

* "On the Connection between Colliery Explosions and Weather," by Robert H. Scott, F.R.S., and Mr. W. Galloway. Read at the meeting of the Royal Society, April 18, 1872.